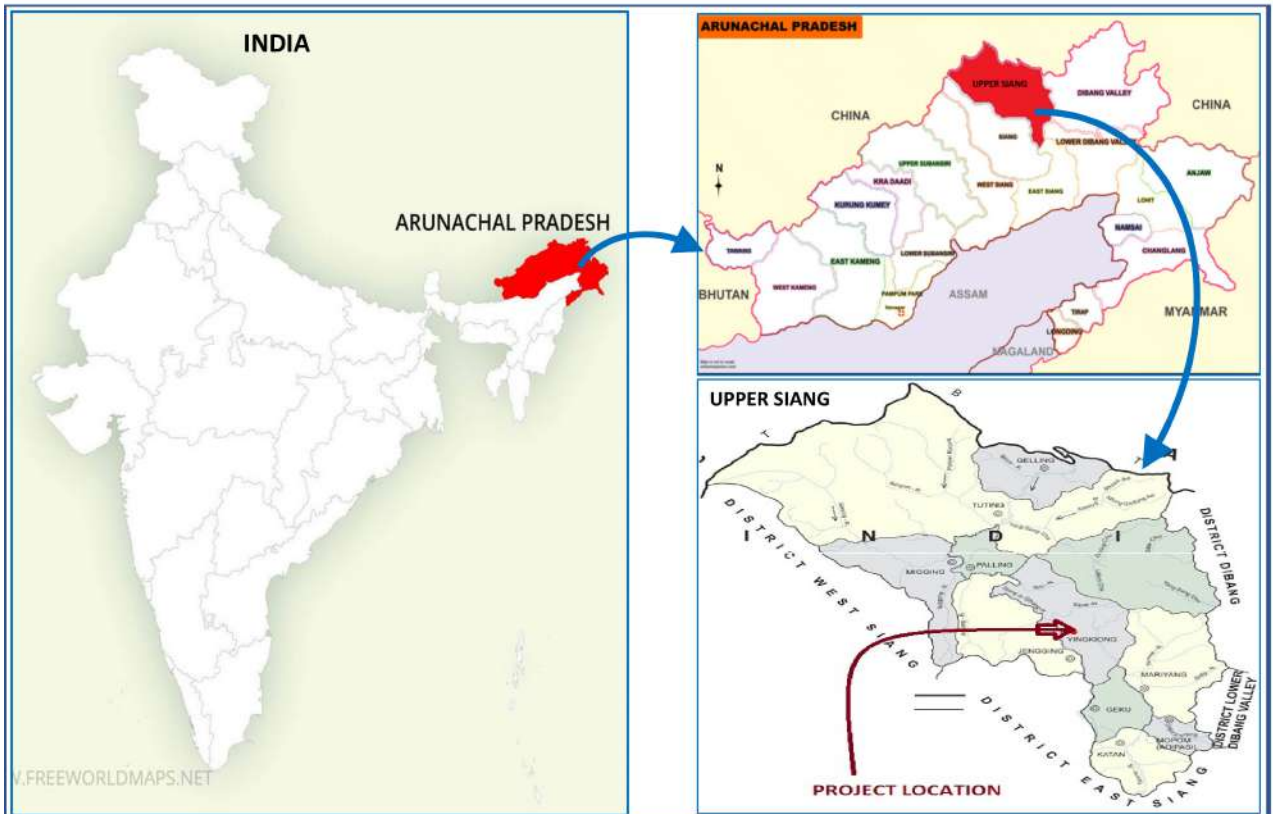




# Border Roads Organisation

Ministry of Defence  
Government of India

**Name Of Project:-** Consultancy Services for Feasibility Study, Preparation of Detailed Project Report (DPR) and Providing Preconstruction Services (including Selection of Site, Type of bridge, Sub Soil Investigation, Estimation, Preparation of Tender documents etc.) (Indicative length of Bridge-300 mtr & Approach Road -4.50 Kms) over Siang River at Km 93.50 on Ditte-Dimme-Migging Road under 761 BRTF of Project Brahmark in Arunachal Pradesh State



## DETAILED PROJECT REPORT (PKG-I:BRIDGES) SEPTEMBER 2022

**DOCUMENT NO : VKSIMPL-BRO-P134**

**TITLE : VOLUME II DESIGN REPORT (PKG-I:BRIDGES)**




**VKS Infratech Management Pvt. Ltd.**


*Consulting Engineers Planners & Managers*


**Raghunath Bhawan, B-17/882, Block-B, Opp Prachin Shiv Mandir,  
New Ashok Nagar, Delhi – 110096 (Ph: 011-45061563)**

# **Extradosed Bridge at Km 2+908**

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|   |   |  |             |   |         |   |     |  |   |       |                                  |   |       |                            |   |       |                                    |   |       |                   |   |       |                        |   |       |                  |   |       |                      |   |       |   |   |     |                          |   |   |              |   |     |             |   |     |                         |   |     |                              |   |     |                            |   |     |                                    |   |       |  |   |       |   |   |       |                     |    |       |                    |    |       |                   |    |     |       |    |       |                  |    |       |  |    |     |   |    |       |                            |    |       |                          |    |       |                              |    |       |                    |    |         |                                    |    |         |                                 |    |         |                     |    |         |                                      |    |         |   |    |     |   |    |       |   |    |       |   |    |     |  |    |       |   |    |         |  |    |         |   |    |       |   |    |       |  |    |         |                                  |    |         |                        |    |         |                         |    |         |                           |    |   |                                 |    |     |                   |    |
|---|---|--|-------------|---|---------|---|-----|--|---|-------|----------------------------------|---|-------|----------------------------|---|-------|------------------------------------|---|-------|-------------------|---|-------|------------------------|---|-------|------------------|---|-------|----------------------|---|-------|---|---|-----|--------------------------|---|---|--------------|---|-----|-------------|---|-----|-------------------------|---|-----|------------------------------|---|-----|----------------------------|---|-----|------------------------------------|---|-------|--|---|-------|---|---|-------|---------------------|----|-------|--------------------|----|-------|-------------------|----|-----|-------|----|-------|------------------|----|-------|--|----|-----|---|----|-------|----------------------------|----|-------|--------------------------|----|-------|------------------------------|----|-------|--------------------|----|---------|------------------------------------|----|---------|---------------------------------|----|---------|---------------------|----|---------|--------------------------------------|----|---------|---|----|-----|---|----|-------|---|----|-------|---|----|-----|--|----|-------|---|----|---------|--|----|---------|---|----|-------|---|----|-------|--|----|---------|----------------------------------|----|---------|------------------------|----|---------|-------------------------|----|---------|---------------------------|----|---|---------------------------------|----|-----|-------------------|----|
| Designer: VKS Infratech Management Pvt. Ltd.  |   |  |             |   |         |   |     |  |   |       |                                  |   |       |                            |   |       |                                    |   |       |                   |   |       |                        |   |       |                  |   |       |                      |   |       |   |   |     |                          |   |   |              |   |     |             |   |     |                         |   |     |                              |   |     |                            |   |     |                                    |   |       |  |   |       |   |   |       |                     |    |       |                    |    |       |                   |    |     |       |    |       |                  |    |       |  |    |     |   |    |       |                            |    |       |                          |    |       |                              |    |       |                    |    |         |                                    |    |         |                                 |    |         |                     |    |         |                                      |    |         |   |    |     |   |    |       |   |    |       |   |    |     |  |    |       |   |    |         |  |    |         |   |    |       |   |    |       |  |    |         |                                  |    |         |                        |    |         |                         |    |         |                           |    |   |                                 |    |     |                   |    |
| RM Bridge Professional Engineering Software   |   |  |             |   |         |   |     |  |   |       |                                  |   |       |                            |   |       |                                    |   |       |                   |   |       |                        |   |       |                  |   |       |                      |   |       |   |   |     |                          |   |   |              |   |     |             |   |     |                         |   |     |                              |   |     |                            |   |     |                                    |   |       |  |   |       |   |   |       |                     |    |       |                    |    |       |                   |    |     |       |    |       |                  |    |       |  |    |     |   |    |       |                            |    |       |                          |    |       |                              |    |       |                    |    |         |                                    |    |         |                                 |    |         |                     |    |         |                                      |    |         |   |    |     |   |    |       |   |    |       |   |    |     |  |    |       |   |    |         |  |    |         |   |    |       |   |    |       |  |    |         |                                  |    |         |                        |    |         |                         |    |         |                           |    |   |                                 |    |     |                   |    |
| project   | Arunachal Extradosed 63m+260m+63m                               |  | 6/03/2022   |   |         |   |     |  |   |       |                                  |   |       |                            |   |       |                                    |   |       |                   |   |       |                        |   |       |                  |   |       |                      |   |       |   |   |     |                          |   |   |              |   |     |             |   |     |                         |   |     |                              |   |     |                            |   |     |                                    |   |       |  |   |       |   |   |       |                     |    |       |                    |    |       |                   |    |     |       |    |       |                  |    |       |  |    |     |   |    |       |                            |    |       |                          |    |       |                              |    |       |                    |    |         |                                    |    |         |                                 |    |         |                     |    |         |                                      |    |         |   |    |     |   |    |       |   |    |       |   |    |     |  |    |       |   |    |         |  |    |         |   |    |       |   |    |       |  |    |         |                                  |    |         |                        |    |         |                         |    |         |                           |    |   |                                 |    |     |                   |    |
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| 1.1   | Salient Features of Proposed Extradosed Bridge                  | 1  |             |   |         |   |     |  |   |       |                                  |   |       |                            |   |       |                                    |   |       |                   |   |       |                        |   |       |                  |   |       |                      |   |       |   |   |     |                          |   |   |              |   |     |             |   |     |                         |   |     |                              |   |     |                            |   |     |                                    |   |       |  |   |       |   |   |       |                     |    |       |                    |    |       |                   |    |     |       |    |       |                  |    |       |  |    |     |   |    |       |                            |    |       |                          |    |       |                              |    |       |                    |    |         |                                    |    |         |                                 |    |         |                     |    |         |                                      |    |         |   |    |     |   |    |       |   |    |       |   |    |     |  |    |       |   |    |         |  |    |         |   |    |       |   |    |       |  |    |         |                                  |    |         |                        |    |         |                         |    |         |                           |    |   |                                 |    |     |                   |    |
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| 1.1.2   | Superstructure Arrangement                                      | 1  |             |   |         |   |     |  |   |       |                                  |   |       |                            |   |       |                                    |   |       |                   |   |       |                        |   |       |                  |   |       |                      |   |       |   |   |     |                          |   |   |              |   |     |             |   |     |                         |   |     |                              |   |     |                            |   |     |                                    |   |       |  |   |       |   |   |       |                     |    |       |                    |    |       |                   |    |     |       |    |       |                  |    |       |  |    |     |   |    |       |                            |    |       |                          |    |       |                              |    |       |                    |    |         |                                    |    |         |                                 |    |         |                     |    |         |                                      |    |         |   |    |     |   |    |       |   |    |       |   |    |     |  |    |       |   |    |         |  |    |         |   |    |       |   |    |       |  |    |         |                                  |    |         |                        |    |         |                         |    |         |                           |    |   |                                 |    |     |                   |    |
| 1.1.3   | Superstructure Bearing Arrangement                              | 2  |             |   |         |   |     |  |   |       |                                  |   |       |                            |   |       |                                    |   |       |                   |   |       |                        |   |       |                  |   |       |                      |   |       |   |   |     |                          |   |   |              |   |     |             |   |     |                         |   |     |                              |   |     |                            |   |     |                                    |   |       |  |   |       |   |   |       |                     |    |       |                    |    |       |                   |    |     |       |    |       |                  |    |       |  |    |     |   |    |       |                            |    |       |                          |    |       |                              |    |       |                    |    |         |                                    |    |         |                                 |    |         |                     |    |         |                                      |    |         |   |    |     |   |    |       |   |    |       |   |    |     |  |    |       |   |    |         |  |    |         |   |    |       |   |    |       |  |    |         |                                  |    |         |                        |    |         |                         |    |         |                           |    |   |                                 |    |     |                   |    |
| 1.1.4   | Pylon Arrangement   | 2  |             |   |         |   |     |  |   |       |                                  |   |       |                            |   |       |                                    |   |       |                   |   |       |                        |   |       |                  |   |       |                      |   |       |   |   |     |                          |   |   |              |   |     |             |   |     |                         |   |     |                              |   |     |                            |   |     |                                    |   |       |  |   |       |   |   |       |                     |    |       |                    |    |       |                   |    |     |       |    |       |                  |    |       |  |    |     |   |    |       |                            |    |       |                          |    |       |                              |    |       |                    |    |         |                                    |    |         |                                 |    |         |                     |    |         |                                      |    |         |   |    |     |   |    |       |   |    |       |   |    |     |  |    |       |   |    |         |  |    |         |   |    |       |   |    |       |  |    |         |                                  |    |         |                        |    |         |                         |    |         |                           |    |   |                                 |    |     |                   |    |
| 1.1.5   | Stay Cable Arrangement  | 2  |             |   |         |   |     |  |   |       |                                  |   |       |                            |   |       |                                    |   |       |                   |   |       |                        |   |       |                  |   |       |                      |   |       |   |   |     |                          |   |   |              |   |     |             |   |     |                         |   |     |                              |   |     |                            |   |     |                                    |   |       |  |   |       |   |   |       |                     |    |       |                    |    |       |                   |    |     |       |    |       |                  |    |       |  |    |     |   |    |       |                            |    |       |                          |    |       |                              |    |       |                    |    |         |                                    |    |         |                                 |    |         |                     |    |         |                                      |    |         |   |    |     |   |    |       |   |    |       |   |    |     |  |    |       |   |    |         |  |    |         |   |    |       |   |    |       |  |    |         |                                  |    |         |                        |    |         |                         |    |         |                           |    |   |                                 |    |     |                   |    |
| 1.1.6   | Pylon Foundation  | 2  |             |   |         |   |     |  |   |       |                                  |   |       |                            |   |       |                                    |   |       |                   |   |       |                        |   |       |                  |   |       |                      |   |       |   |   |     |                          |   |   |              |   |     |             |   |     |                         |   |     |                              |   |     |                            |   |     |                                    |   |       |  |   |       |   |   |       |                     |    |       |                    |    |       |                   |    |     |       |    |       |                  |    |       |  |    |     |   |    |       |                            |    |       |                          |    |       |                              |    |       |                    |    |         |                                    |    |         |                                 |    |         |                     |    |         |                                      |    |         |   |    |     |   |    |       |   |    |       |   |    |     |  |    |       |   |    |         |  |    |         |   |    |       |   |    |       |  |    |         |                                  |    |         |                        |    |         |                         |    |         |                           |    |   |                                 |    |     |                   |    |
| 1.1.7   | Abutment Arrangement  | 2  |             |   |         |   |     |  |   |       |                                  |   |       |                            |   |       |                                    |   |       |                   |   |       |                        |   |       |                  |   |       |                      |   |       |   |   |     |                          |   |   |              |   |     |             |   |     |                         |   |     |                              |   |     |                            |   |     |                                    |   |       |  |   |       |   |   |       |                     |    |       |                    |    |       |                   |    |     |       |    |       |                  |    |       |  |    |     |   |    |       |                            |    |       |                          |    |       |                              |    |       |                    |    |         |                                    |    |         |                                 |    |         |                     |    |         |                                      |    |         |   |    |     |   |    |       |   |    |       |   |    |     |  |    |       |   |    |         |  |    |         |   |    |       |   |    |       |  |    |         |                                  |    |         |                        |    |         |                         |    |         |                           |    |   |                                 |    |     |                   |    |
| 1.1.8   | Tie Down cable arrangement in Back span                         | 3  |             |   |         |   |     |  |   |       |                                  |   |       |                            |   |       |                                    |   |       |                   |   |       |                        |   |       |                  |   |       |                      |   |       |   |   |     |                          |   |   |              |   |     |             |   |     |                         |   |     |                              |   |     |                            |   |     |                                    |   |       |  |   |       |   |   |       |                     |    |       |                    |    |       |                   |    |     |       |    |       |                  |    |       |  |    |     |   |    |       |                            |    |       |                          |    |       |                              |    |       |                    |    |         |                                    |    |         |                                 |    |         |                     |    |         |                                      |    |         |   |    |     |   |    |       |   |    |       |   |    |     |  |    |       |   |    |         |  |    |         |   |    |       |   |    |       |  |    |         |                                  |    |         |                        |    |         |                         |    |         |                           |    |   |                                 |    |     |                   |    |
| 1.2   | Construction Methodology  | 3  |             |   |         |   |     |  |   |       |                                  |   |       |                            |   |       |                                    |   |       |                   |   |       |                        |   |       |                  |   |       |                      |   |       |   |   |     |                          |   |   |              |   |     |             |   |     |                         |   |     |                              |   |     |                            |   |     |                                    |   |       |  |   |       |   |   |       |                     |    |       |                    |    |       |                   |    |     |       |    |       |                  |    |       |  |    |     |   |    |       |                            |    |       |                          |    |       |                              |    |       |                    |    |         |                                    |    |         |                                 |    |         |                     |    |         |                                      |    |         |   |    |     |   |    |       |   |    |       |   |    |     |  |    |       |   |    |         |  |    |         |   |    |       |   |    |       |  |    |         |                                  |    |         |                        |    |         |                         |    |         |                           |    |   |                                 |    |     |                   |    |
| 2   | Design Basis  | 8  |             |   |         |   |     |  |   |       |                                  |   |       |                            |   |       |                                    |   |       |                   |   |       |                        |   |       |                  |   |       |                      |   |       |   |   |     |                          |   |   |              |   |     |             |   |     |                         |   |     |                              |   |     |                            |   |     |                                    |   |       |  |   |       |   |   |       |                     |    |       |                    |    |       |                   |    |     |       |    |       |                  |    |       |  |    |     |   |    |       |                            |    |       |                          |    |       |                              |    |       |                    |    |         |                                    |    |         |                                 |    |         |                     |    |         |                                      |    |         |   |    |     |   |    |       |   |    |       |   |    |     |  |    |       |   |    |         |  |    |         |   |    |       |   |    |       |  |    |         |                                  |    |         |                        |    |         |                         |    |         |                           |    |   |                                 |    |     |                   |    |
| 2.1   | Design Life   | 8  |             |   |         |   |     |  |   |       |                                  |   |       |                            |   |       |                                    |   |       |                   |   |       |                        |   |       |                  |   |       |                      |   |       |   |   |     |                          |   |   |              |   |     |             |   |     |                         |   |     |                              |   |     |                            |   |     |                                    |   |       |  |   |       |   |   |       |                     |    |       |                    |    |       |                   |    |     |       |    |       |                  |    |       |  |    |     |   |    |       |                            |    |       |                          |    |       |                              |    |       |                    |    |         |                                    |    |         |                                 |    |         |                     |    |         |                                      |    |         |   |    |     |   |    |       |   |    |       |   |    |     |  |    |       |   |    |         |  |    |         |   |    |       |   |    |       |  |    |         |                                  |    |         |                        |    |         |                         |    |         |                           |    |   |                                 |    |     |                   |    |
| 2.2   | Functional Requirements   | 8  |             |   |         |   |     |  |   |       |                                  |   |       |                            |   |       |                                    |   |       |                   |   |       |                        |   |       |                  |   |       |                      |   |       |   |   |     |                          |   |   |              |   |     |             |   |     |                         |   |     |                              |   |     |                            |   |     |                                    |   |       |  |   |       |   |   |       |                     |    |       |                    |    |       |                   |    |     |       |    |       |                  |    |       |  |    |     |   |    |       |                            |    |       |                          |    |       |                              |    |       |                    |    |         |                                    |    |         |                                 |    |         |                     |    |         |                                      |    |         |   |    |     |   |    |       |   |    |       |   |    |     |  |    |       |   |    |         |  |    |         |   |    |       |   |    |       |  |    |         |                                  |    |         |                        |    |         |                         |    |         |                           |    |   |                                 |    |     |                   |    |
| 2.3   | Structural Design Philosophy                                    | 8  |             |   |         |   |     |  |   |       |                                  |   |       |                            |   |       |                                    |   |       |                   |   |       |                        |   |       |                  |   |       |                      |   |       |   |   |     |                          |   |   |              |   |     |             |   |     |                         |   |     |                              |   |     |                            |   |     |                                    |   |       |  |   |       |   |   |       |                     |    |       |                    |    |       |                   |    |     |       |    |       |                  |    |       |  |    |     |   |    |       |                            |    |       |                          |    |       |                              |    |       |                    |    |         |                                    |    |         |                                 |    |         |                     |    |         |                                      |    |         |   |    |     |   |    |       |   |    |       |   |    |     |  |    |       |   |    |         |  |    |         |   |    |       |   |    |       |  |    |         |                                  |    |         |                        |    |         |                         |    |         |                           |    |   |                                 |    |     |                   |    |
| 2.4   | Design Codes and Standards                                      | 9  |             |   |         |   |     |  |   |       |                                  |   |       |                            |   |       |                                    |   |       |                   |   |       |                        |   |       |                  |   |       |                      |   |       |   |   |     |                          |   |   |              |   |     |             |   |     |                         |   |     |                              |   |     |                            |   |     |                                    |   |       |  |   |       |   |   |       |                     |    |       |                    |    |       |                   |    |     |       |    |       |                  |    |       |  |    |     |   |    |       |                            |    |       |                          |    |       |                              |    |       |                    |    |         |                                    |    |         |                                 |    |         |                     |    |         |                                      |    |         |   |    |     |   |    |       |   |    |       |   |    |     |  |    |       |   |    |         |  |    |         |   |    |       |   |    |       |  |    |         |                                  |    |         |                        |    |         |                         |    |         |                           |    |   |                                 |    |     |                   |    |
| 2.5   | Materials For Permanent Components                              | 9  |             |   |         |   |     |  |   |       |                                  |   |       |                            |   |       |                                    |   |       |                   |   |       |                        |   |       |                  |   |       |                      |   |       |   |   |     |                          |   |   |              |   |     |             |   |     |                         |   |     |                              |   |     |                            |   |     |                                    |   |       |  |   |       |   |   |       |                     |    |       |                    |    |       |                   |    |     |       |    |       |                  |    |       |  |    |     |   |    |       |                            |    |       |                          |    |       |                              |    |       |                    |    |         |                                    |    |         |                                 |    |         |                     |    |         |                                      |    |         |   |    |     |   |    |       |   |    |       |   |    |     |  |    |       |   |    |         |  |    |         |   |    |       |   |    |       |  |    |         |                                  |    |         |                        |    |         |                         |    |         |                           |    |   |                                 |    |     |                   |    |
| 2.5.1   | Concrete for Pylon Legs and Superstructure                      | 9  |             |   |         |   |     |  |   |       |                                  |   |       |                            |   |       |                                    |   |       |                   |   |       |                        |   |       |                  |   |       |                      |   |       |   |   |     |                          |   |   |              |   |     |             |   |     |                         |   |     |                              |   |     |                            |   |     |                                    |   |       |  |   |       |   |   |       |                     |    |       |                    |    |       |                   |    |     |       |    |       |                  |    |       |  |    |     |   |    |       |                            |    |       |                          |    |       |                              |    |       |                    |    |         |                                    |    |         |                                 |    |         |                     |    |         |                                      |    |         |   |    |     |   |    |       |   |    |       |   |    |     |  |    |       |   |    |         |  |    |         |   |    |       |   |    |       |  |    |         |                                  |    |         |                        |    |         |                         |    |         |                           |    |   |                                 |    |     |                   |    |
| 2.5.2   | Concrete for Pylon Foundation and Box Cell Abutment             | 9  |             |   |         |   |     |  |   |       |                                  |   |       |                            |   |       |                                    |   |       |                   |   |       |                        |   |       |                  |   |       |                      |   |       |   |   |     |                          |   |   |              |   |     |             |   |     |                         |   |     |                              |   |     |                            |   |     |                                    |   |       |  |   |       |   |   |       |                     |    |       |                    |    |       |                   |    |     |       |    |       |                  |    |       |  |    |     |   |    |       |                            |    |       |                          |    |       |                              |    |       |                    |    |         |                                    |    |         |                                 |    |         |                     |    |         |                                      |    |         |   |    |     |   |    |       |   |    |       |   |    |     |  |    |       |   |    |         |  |    |         |   |    |       |   |    |       |  |    |         |                                  |    |         |                        |    |         |                         |    |         |                           |    |   |                                 |    |     |                   |    |
| 2.5.3   | Reinforcement Steel   | 10   |             |   |         |   |     |  |   |       |                                  |   |       |                            |   |       |                                    |   |       |                   |   |       |                        |   |       |                  |   |       |                      |   |       |   |   |     |                          |   |   |              |   |     |             |   |     |                         |   |     |                              |   |     |                            |   |     |                                    |   |       |  |   |       |   |   |       |                     |    |       |                    |    |       |                   |    |     |       |    |       |                  |    |       |  |    |     |   |    |       |                            |    |       |                          |    |       |                              |    |       |                    |    |         |                                    |    |         |                                 |    |         |                     |    |         |                                      |    |         |   |    |     |   |    |       |   |    |       |   |    |     |  |    |       |   |    |         |  |    |         |   |    |       |   |    |       |  |    |         |                                  |    |         |                        |    |         |                         |    |         |                           |    |   |                                 |    |     |                   |    |
| 2.5.4   | Prestressing Steel  | 10   |             |   |         |   |     |  |   |       |                                  |   |       |                            |   |       |                                    |   |       |                   |   |       |                        |   |       |                  |   |       |                      |   |       |   |   |     |                          |   |   |              |   |     |             |   |     |                         |   |     |                              |   |     |                            |   |     |                                    |   |       |  |   |       |   |   |       |                     |    |       |                    |    |       |                   |    |     |       |    |       |                  |    |       |  |    |     |   |    |       |                            |    |       |                          |    |       |                              |    |       |                    |    |         |                                    |    |         |                                 |    |         |                     |    |         |                                      |    |         |   |    |     |   |    |       |   |    |       |   |    |     |  |    |       |   |    |         |  |    |         |   |    |       |   |    |       |  |    |         |                                  |    |         |                        |    |         |                         |    |         |                           |    |   |                                 |    |     |                   |    |
| 2.5.5   | Stay Cable System   | 10   |             |   |         |   |     |  |   |       |                                  |   |       |                            |   |       |                                    |   |       |                   |   |       |                        |   |       |                  |   |       |                      |   |       |   |   |     |                          |   |   |              |   |     |             |   |     |                         |   |     |                              |   |     |                            |   |     |                                    |   |       |  |   |       |   |   |       |                     |    |       |                    |    |       |                   |    |     |       |    |       |                  |    |       |  |    |     |   |    |       |                            |    |       |                          |    |       |                              |    |       |                    |    |         |                                    |    |         |                                 |    |         |                     |    |         |                                      |    |         |   |    |     |   |    |       |   |    |       |   |    |     |  |    |       |   |    |         |  |    |         |   |    |       |   |    |       |  |    |         |                                  |    |         |                        |    |         |                         |    |         |                           |    |   |                                 |    |     |                   |    |
| 2.6   | Loads   | 11   |             |   |         |   |     |  |   |       |                                  |   |       |                            |   |       |                                    |   |       |                   |   |       |                        |   |       |                  |   |       |                      |   |       |   |   |     |                          |   |   |              |   |     |             |   |     |                         |   |     |                              |   |     |                            |   |     |                                    |   |       |  |   |       |   |   |       |                     |    |       |                    |    |       |                   |    |     |       |    |       |                  |    |       |  |    |     |   |    |       |                            |    |       |                          |    |       |                              |    |       |                    |    |         |                                    |    |         |                                 |    |         |                     |    |         |                                      |    |         |   |    |     |   |    |       |   |    |       |   |    |     |  |    |       |   |    |         |  |    |         |   |    |       |   |    |       |  |    |         |                                  |    |         |                        |    |         |                         |    |         |                           |    |   |                                 |    |     |                   |    |
| 2.6.1   | Self weight (SW)  | 11   |             |   |         |   |     |  |   |       |                                  |   |       |                            |   |       |                                    |   |       |                   |   |       |                        |   |       |                  |   |       |                      |   |       |   |   |     |                          |   |   |              |   |     |             |   |     |                         |   |     |                              |   |     |                            |   |     |                                    |   |       |  |   |       |   |   |       |                     |    |       |                    |    |       |                   |    |     |       |    |       |                  |    |       |  |    |     |   |    |       |                            |    |       |                          |    |       |                              |    |       |                    |    |         |                                    |    |         |                                 |    |         |                     |    |         |                                      |    |         |   |    |     |   |    |       |   |    |       |   |    |     |  |    |       |   |    |         |  |    |         |   |    |       |   |    |       |  |    |         |                                  |    |         |                        |    |         |                         |    |         |                           |    |   |                                 |    |     |                   |    |
| 2.6.2   | Superimposed Dead Load of Crash Barrier and Railing (SD)        | 11   |             |   |         |   |     |  |   |       |                                  |   |       |                            |   |       |                                    |   |       |                   |   |       |                        |   |       |                  |   |       |                      |   |       |   |   |     |                          |   |   |              |   |     |             |   |     |                         |   |     |                              |   |     |                            |   |     |                                    |   |       |  |   |       |   |   |       |                     |    |       |                    |    |       |                   |    |     |       |    |       |                  |    |       |  |    |     |   |    |       |                            |    |       |                          |    |       |                              |    |       |                    |    |         |                                    |    |         |                                 |    |         |                     |    |         |                                      |    |         |   |    |     |   |    |       |   |    |       |   |    |     |  |    |       |   |    |         |  |    |         |   |    |       |   |    |       |  |    |         |                                  |    |         |                        |    |         |                         |    |         |                           |    |   |                                 |    |     |                   |    |
| 2.7   | Superimposed Dead Load of Surfacing (SDS)                       | 11   |             |   |         |   |     |  |   |       |                                  |   |       |                            |   |       |                                    |   |       |                   |   |       |                        |   |       |                  |   |       |                      |   |       |   |   |     |                          |   |   |              |   |     |             |   |     |                         |   |     |                              |   |     |                            |   |     |                                    |   |       |  |   |       |   |   |       |                     |    |       |                    |    |       |                   |    |     |       |    |       |                  |    |       |  |    |     |   |    |       |                            |    |       |                          |    |       |                              |    |       |                    |    |         |                                    |    |         |                                 |    |         |                     |    |         |                                      |    |         |   |    |     |   |    |       |   |    |       |   |    |     |  |    |       |   |    |         |  |    |         |   |    |       |   |    |       |  |    |         |                                  |    |         |                        |    |         |                         |    |         |                           |    |   |                                 |    |     |                   |    |
| 2.7.1   | Live Load Including Impact                                      | 11   |             |   |         |   |     |  |   |       |                                  |   |       |                            |   |       |                                    |   |       |                   |   |       |                        |   |       |                  |   |       |                      |   |       |   |   |     |                          |   |   |              |   |     |             |   |     |                         |   |     |                              |   |     |                            |   |     |                                    |   |       |  |   |       |   |   |       |                     |    |       |                    |    |       |                   |    |     |       |    |       |                  |    |       |  |    |     |   |    |       |                            |    |       |                          |    |       |                              |    |       |                    |    |         |                                    |    |         |                                 |    |         |                     |    |         |                                      |    |         |   |    |     |   |    |       |   |    |       |   |    |     |  |    |       |   |    |         |  |    |         |   |    |       |   |    |       |  |    |         |                                  |    |         |                        |    |         |                         |    |         |                           |    |   |                                 |    |     |                   |    |
| 2.7.2   | Overall Temperature (OT)  | 12   |             |   |         |   |     |  |   |       |                                  |   |       |                            |   |       |                                    |   |       |                   |   |       |                        |   |       |                  |   |       |                      |   |       |   |   |     |                          |   |   |              |   |     |             |   |     |                         |   |     |                              |   |     |                            |   |     |                                    |   |       |  |   |       |   |   |       |                     |    |       |                    |    |       |                   |    |     |       |    |       |                  |    |       |  |    |     |   |    |       |                            |    |       |                          |    |       |                              |    |       |                    |    |         |                                    |    |         |                                 |    |         |                     |    |         |                                      |    |         |   |    |     |   |    |       |   |    |       |   |    |     |  |    |       |   |    |         |  |    |         |   |    |       |   |    |       |  |    |         |                                  |    |         |                        |    |         |                         |    |         |                           |    |   |                                 |    |     |                   |    |
| 2.7.3   | Temperature Gradient (TGRAD)                                    | 12   |             |   |         |   |     |  |   |       |                                  |   |       |                            |   |       |                                    |   |       |                   |   |       |                        |   |       |                  |   |       |                      |   |       |   |   |     |                          |   |   |              |   |     |             |   |     |                         |   |     |                              |   |     |                            |   |     |                                    |   |       |  |   |       |   |   |       |                     |    |       |                    |    |       |                   |    |     |       |    |       |                  |    |       |  |    |     |   |    |       |                            |    |       |                          |    |       |                              |    |       |                    |    |         |                                    |    |         |                                 |    |         |                     |    |         |                                      |    |         |   |    |     |   |    |       |   |    |       |   |    |     |  |    |       |   |    |         |  |    |         |   |    |       |   |    |       |  |    |         |                                  |    |         |                        |    |         |                         |    |         |                           |    |   |                                 |    |     |                   |    |
| 2.7.4   | SEISMIC FORCE (EQ)  | 12   |             |   |         |   |     |  |   |       |                                  |   |       |                            |   |       |                                    |   |       |                   |   |       |                        |   |       |                  |   |       |                      |   |       |   |   |     |                          |   |   |              |   |     |             |   |     |                         |   |     |                              |   |     |                            |   |     |                                    |   |       |  |   |       |   |   |       |                     |    |       |                    |    |       |                   |    |     |       |    |       |                  |    |       |  |    |     |   |    |       |                            |    |       |                          |    |       |                              |    |       |                    |    |         |                                    |    |         |                                 |    |         |                     |    |         |                                      |    |         |   |    |     |   |    |       |   |    |       |   |    |     |  |    |       |   |    |         |  |    |         |   |    |       |   |    |       |  |    |         |                                  |    |         |                        |    |         |                         |    |         |                           |    |   |                                 |    |     |                   |    |
| 2.7.4.1   | Seismic Zone And Zone Factor ( Z )                              | 12   |             |   |         |   |     |  |   |       |                                  |   |       |                            |   |       |                                    |   |       |                   |   |       |                        |   |       |                  |   |       |                      |   |       |   |   |     |                          |   |   |              |   |     |             |   |     |                         |   |     |                              |   |     |                            |   |     |                                    |   |       |  |   |       |   |   |       |                     |    |       |                    |    |       |                   |    |     |       |    |       |                  |    |       |  |    |     |   |    |       |                            |    |       |                          |    |       |                              |    |       |                    |    |         |                                    |    |         |                                 |    |         |                     |    |         |                                      |    |         |   |    |     |   |    |       |   |    |       |   |    |     |  |    |       |   |    |         |  |    |         |   |    |       |   |    |       |  |    |         |                                  |    |         |                        |    |         |                         |    |         |                           |    |   |                                 |    |     |                   |    |
| 2.7.4.2   | Seismic Importance Factor ( I )                                 | 12   |             |   |         |   |     |  |   |       |                                  |   |       |                            |   |       |                                    |   |       |                   |   |       |                        |   |       |                  |   |       |                      |   |       |   |   |     |                          |   |   |              |   |     |             |   |     |                         |   |     |                              |   |     |                            |   |     |                                    |   |       |  |   |       |   |   |       |                     |    |       |                    |    |       |                   |    |     |       |    |       |                  |    |       |  |    |     |   |    |       |                            |    |       |                          |    |       |                              |    |       |                    |    |         |                                    |    |         |                                 |    |         |                     |    |         |                                      |    |         |   |    |     |   |    |       |   |    |       |   |    |     |  |    |       |   |    |         |  |    |         |   |    |       |   |    |       |  |    |         |                                  |    |         |                        |    |         |                         |    |         |                           |    |   |                                 |    |     |                   |    |
| 2.7.4.3   | Method for analysis   | 13   |             |   |         |   |     |  |   |       |                                  |   |       |                            |   |       |                                    |   |       |                   |   |       |                        |   |       |                  |   |       |                      |   |       |   |   |     |                          |   |   |              |   |     |             |   |     |                         |   |     |                              |   |     |                            |   |     |                                    |   |       |  |   |       |   |   |       |                     |    |       |                    |    |       |                   |    |     |       |    |       |                  |    |       |  |    |     |   |    |       |                            |    |       |                          |    |       |                              |    |       |                    |    |         |                                    |    |         |                                 |    |         |                     |    |         |                                      |    |         |   |    |     |   |    |       |   |    |       |   |    |     |  |    |       |   |    |         |  |    |         |   |    |       |   |    |       |  |    |         |                                  |    |         |                        |    |         |                         |    |         |                           |    |   |                                 |    |     |                   |    |
| 2.7.4.4   | Horizontal Seismic Force Coefficient                            | 13   |             |   |         |   |     |  |   |       |                                  |   |       |                            |   |       |                                    |   |       |                   |   |       |                        |   |       |                  |   |       |                      |   |       |   |   |     |                          |   |   |              |   |     |             |   |     |                         |   |     |                              |   |     |                            |   |     |                                    |   |       |  |   |       |   |   |       |                     |    |       |                    |    |       |                   |    |     |       |    |       |                  |    |       |  |    |     |   |    |       |                            |    |       |                          |    |       |                              |    |       |                    |    |         |                                    |    |         |                                 |    |         |                     |    |         |                                      |    |         |   |    |     |   |    |       |   |    |       |   |    |     |  |    |       |   |    |         |  |    |         |   |    |       |   |    |       |  |    |         |                                  |    |         |                        |    |         |                         |    |         |                           |    |   |                                 |    |     |                   |    |
| 2.7.4.5   | Components of Seismic Force and Combination                     | 13   |             |   |         |   |     |  |   |       |                                  |   |       |                            |   |       |                                    |   |       |                   |   |       |                        |   |       |                  |   |       |                      |   |       |   |   |     |                          |   |   |              |   |     |             |   |     |                         |   |     |                              |   |     |                            |   |     |                                    |   |       |  |   |       |   |   |       |                     |    |       |                    |    |       |                   |    |     |       |    |       |                  |    |       |  |    |     |   |    |       |                            |    |       |                          |    |       |                              |    |       |                    |    |         |                                    |    |         |                                 |    |         |                     |    |         |                                      |    |         |   |    |     |   |    |       |   |    |       |   |    |     |  |    |       |   |    |         |  |    |         |   |    |       |   |    |       |  |    |         |                                  |    |         |                        |    |         |                         |    |         |                           |    |   |                                 |    |     |                   |    |
| 2.8   | Load Combination For Limit State Design                         | 14   |             |   |         |   |     |  |   |       |                                  |   |       |                            |   |       |                                    |   |       |                   |   |       |                        |   |       |                  |   |       |                      |   |       |   |   |     |                          |   |   |              |   |     |             |   |     |                         |   |     |                              |   |     |                            |   |     |                                    |   |       |  |   |       |   |   |       |                     |    |       |                    |    |       |                   |    |     |       |    |       |                  |    |       |  |    |     |   |    |       |                            |    |       |                          |    |       |                              |    |       |                    |    |         |                                    |    |         |                                 |    |         |                     |    |         |                                      |    |         |   |    |     |   |    |       |   |    |       |   |    |     |  |    |       |   |    |         |  |    |         |   |    |       |   |    |       |  |    |         |                                  |    |         |                        |    |         |                         |    |         |                           |    |   |                                 |    |     |                   |    |
| 2.8.1   | Load Combination for Ultimate Limit State (Structural Strength) | 14   |             |   |         |   |     |  |   |       |                                  |   |       |                            |   |       |                                    |   |       |                   |   |       |                        |   |       |                  |   |       |                      |   |       |   |   |     |                          |   |   |              |   |     |             |   |     |                         |   |     |                              |   |     |                            |   |     |                                    |   |       |  |   |       |   |   |       |                     |    |       |                    |    |       |                   |    |     |       |    |       |                  |    |       |  |    |     |   |    |       |                            |    |       |                          |    |       |                              |    |       |                    |    |         |                                    |    |         |                                 |    |         |                     |    |         |                                      |    |         |   |    |     |   |    |       |   |    |       |   |    |     |  |    |       |   |    |         |  |    |         |   |    |       |   |    |       |  |    |         |                                  |    |         |                        |    |         |                         |    |         |                           |    |   |                                 |    |     |                   |    |
| 2.8.2   | Load Combination for Serviceability Limit State                 | 14   |             |   |         |   |     |  |   |       |                                  |   |       |                            |   |       |                                    |   |       |                   |   |       |                        |   |       |                  |   |       |                      |   |       |   |   |     |                          |   |   |              |   |     |             |   |     |                         |   |     |                              |   |     |                            |   |     |                                    |   |       |  |   |       |   |   |       |                     |    |       |                    |    |       |                   |    |     |       |    |       |                  |    |       |  |    |     |   |    |       |                            |    |       |                          |    |       |                              |    |       |                    |    |         |                                    |    |         |                                 |    |         |                     |    |         |                                      |    |         |   |    |     |   |    |       |   |    |       |   |    |     |  |    |       |   |    |         |  |    |         |   |    |       |   |    |       |  |    |         |                                  |    |         |                        |    |         |                         |    |         |                           |    |   |                                 |    |     |                   |    |
| 2.9   | Design Code Check for Verification of Limit states              | 14   |             |   |         |   |     |  |   |       |                                  |   |       |                            |   |       |                                    |   |       |                   |   |       |                        |   |       |                  |   |       |                      |   |       |   |   |     |                          |   |   |              |   |     |             |   |     |                         |   |     |                              |   |     |                            |   |     |                                    |   |       |  |   |       |   |   |       |                     |    |       |                    |    |       |                   |    |     |       |    |       |                  |    |       |  |    |     |   |    |       |                            |    |       |                          |    |       |                              |    |       |                    |    |         |                                    |    |         |                                 |    |         |                     |    |         |                                      |    |         |   |    |     |   |    |       |   |    |       |   |    |     |  |    |       |   |    |         |  |    |         |   |    |       |   |    |       |  |    |         |                                  |    |         |                        |    |         |                         |    |         |                           |    |   |                                 |    |     |                   |    |
| 2.9.1   | Verification of Ultimate Limit State of Structural Strength     | 14   |             |   |         |   |     |  |   |       |                                  |   |       |                            |   |       |                                    |   |       |                   |   |       |                        |   |       |                  |   |       |                      |   |       |   |   |     |                          |   |   |              |   |     |             |   |     |                         |   |     |                              |   |     |                            |   |     |                                    |   |       |  |   |       |   |   |       |                     |    |       |                    |    |       |                   |    |     |       |    |       |                  |    |       |  |    |     |   |    |       |                            |    |       |                          |    |       |                              |    |       |                    |    |         |                                    |    |         |                                 |    |         |                     |    |         |                                      |    |         |   |    |     |   |    |       |   |    |       |   |    |     |  |    |       |   |    |         |  |    |         |   |    |       |   |    |       |  |    |         |                                  |    |         |                        |    |         |                         |    |         |                           |    |   |                                 |    |     |                   |    |
| 2.9.1.1   | Parabolic Rectangular Concrete Stress Strain Block              | 15   |             |   |         |   |     |  |   |       |                                  |   |       |                            |   |       |                                    |   |       |                   |   |       |                        |   |       |                  |   |       |                      |   |       |   |   |     |                          |   |   |              |   |     |             |   |     |                         |   |     |                              |   |     |                            |   |     |                                    |   |       |  |   |       |   |   |       |                     |    |       |                    |    |       |                   |    |     |       |    |       |                  |    |       |  |    |     |   |    |       |                            |    |       |                          |    |       |                              |    |       |                    |    |         |                                    |    |         |                                 |    |         |                     |    |         |                                      |    |         |   |    |     |   |    |       |   |    |       |   |    |     |  |    |       |   |    |         |  |    |         |   |    |       |   |    |       |  |    |         |                                  |    |         |                        |    |         |                         |    |         |                           |    |   |                                 |    |     |                   |    |
| 2.9.1.2   | Stress Strain relation for Prestressing Steel                   | 15   |             |   |         |   |     |  |   |       |                                  |   |       |                            |   |       |                                    |   |       |                   |   |       |                        |   |       |                  |   |       |                      |   |       |   |   |     |                          |   |   |              |   |     |             |   |     |                         |   |     |                              |   |     |                            |   |     |                                    |   |       |  |   |       |   |   |       |                     |    |       |                    |    |       |                   |    |     |       |    |       |                  |    |       |  |    |     |   |    |       |                            |    |       |                          |    |       |                              |    |       |                    |    |         |                                    |    |         |                                 |    |         |                     |    |         |                                      |    |         |   |    |     |   |    |       |   |    |       |   |    |     |  |    |       |   |    |         |  |    |         |   |    |       |   |    |       |  |    |         |                                  |    |         |                        |    |         |                         |    |         |                           |    |   |                                 |    |     |                   |    |
| 2.9.2   | Verification of Ultimate Limit State Of Shear and Torsion       | 18   |             |   |         |   |     |  |   |       |                                  |   |       |                            |   |       |                                    |   |       |                   |   |       |                        |   |       |                  |   |       |                      |   |       |   |   |     |                          |   |   |              |   |     |             |   |     |                         |   |     |                              |   |     |                            |   |     |                                    |   |       |  |   |       |   |   |       |                     |    |       |                    |    |       |                   |    |     |       |    |       |                  |    |       |  |    |     |   |    |       |                            |    |       |                          |    |       |                              |    |       |                    |    |         |                                    |    |         |                                 |    |         |                     |    |         |                                      |    |         |   |    |     |   |    |       |   |    |       |   |    |     |  |    |       |   |    |         |  |    |         |   |    |       |   |    |       |  |    |         |                                  |    |         |                        |    |         |                         |    |         |                           |    |   |                                 |    |     |                   |    |
| 2.9.3   | Verification of Serviceability Limit State                      | 18   |             |   |         |   |     |  |   |       |                                  |   |       |                            |   |       |                                    |   |       |                   |   |       |                        |   |       |                  |   |       |                      |   |       |   |   |     |                          |   |   |              |   |     |             |   |     |                         |   |     |                              |   |     |                            |   |     |                                    |   |       |  |   |       |   |   |       |                     |    |       |                    |    |       |                   |    |     |       |    |       |                  |    |       |  |    |     |   |    |       |                            |    |       |                          |    |       |                              |    |       |                    |    |         |                                    |    |         |                                 |    |         |                     |    |         |                                      |    |         |   |    |     |   |    |       |   |    |       |   |    |     |  |    |       |   |    |         |  |    |         |   |    |       |   |    |       |  |    |         |                                  |    |         |                        |    |         |                         |    |         |                           |    |   |                                 |    |     |                   |    |
| 2.9.3.1   | Limit State of Internal Stresses                                | 18   |             |   |         |   |     |  |   |       |                                  |   |       |                            |   |       |                                    |   |       |                   |   |       |                        |   |       |                  |   |       |                      |   |       |   |   |     |                          |   |   |              |   |     |             |   |     |                         |   |     |                              |   |     |                            |   |     |                                    |   |       |  |   |       |   |   |       |                     |    |       |                    |    |       |                   |    |     |       |    |       |                  |    |       |  |    |     |   |    |       |                            |    |       |                          |    |       |                              |    |       |                    |    |         |                                    |    |         |                                 |    |         |                     |    |         |                                      |    |         |   |    |     |   |    |       |   |    |       |   |    |     |  |    |       |   |    |         |  |    |         |   |    |       |   |    |       |  |    |         |                                  |    |         |                        |    |         |                         |    |         |                           |    |   |                                 |    |     |                   |    |
| 2.9.3.2   | Limit State of Fatigue  | 19   |             |   |         |   |     |  |   |       |                                  |   |       |                            |   |       |                                    |   |       |                   |   |       |                        |   |       |                  |   |       |                      |   |       |   |   |     |                          |   |   |              |   |     |             |   |     |                         |   |     |                              |   |     |                            |   |     |                                    |   |       |  |   |       |   |   |       |                     |    |       |                    |    |       |                   |    |     |       |    |       |                  |    |       |  |    |     |   |    |       |                            |    |       |                          |    |       |                              |    |       |                    |    |         |                                    |    |         |                                 |    |         |                     |    |         |                                      |    |         |   |    |     |   |    |       |   |    |       |   |    |     |  |    |       |   |    |         |  |    |         |   |    |       |   |    |       |  |    |         |                                  |    |         |                        |    |         |                         |    |         |                           |    |   |                                 |    |     |                   |    |
| 2.9.3.3   | Limit State of Cracking   | 19   |             |   |         |   |     |  |   |       |                                  |   |       |                            |   |       |                                    |   |       |                   |   |       |                        |   |       |                  |   |       |                      |   |       |   |   |     |                          |   |   |              |   |     |             |   |     |                         |   |     |                              |   |     |                            |   |     |                                    |   |       |  |   |       |   |   |       |                     |    |       |                    |    |       |                   |    |     |       |    |       |                  |    |       |  |    |     |   |    |       |                            |    |       |                          |    |       |                              |    |       |                    |    |         |                                    |    |         |                                 |    |         |                     |    |         |                                      |    |         |   |    |     |   |    |       |   |    |       |   |    |     |  |    |       |   |    |         |  |    |         |   |    |       |   |    |       |  |    |         |                                  |    |         |                        |    |         |                         |    |         |                           |    |   |                                 |    |     |                   |    |
| 2.9.3.4   | Limit State of Deflection                                       | 19   |             |   |         |   |     |  |   |       |                                  |   |       |                            |   |       |                                    |   |       |                   |   |       |                        |   |       |                  |   |       |                      |   |       |   |   |     |                          |   |   |              |   |     |             |   |     |                         |   |     |                              |   |     |                            |   |     |                                    |   |       |  |   |       |   |   |       |                     |    |       |                    |    |       |                   |    |     |       |    |       |                  |    |       |  |    |     |   |    |       |                            |    |       |                          |    |       |                              |    |       |                    |    |         |                                    |    |         |                                 |    |         |                     |    |         |                                      |    |         |   |    |     |   |    |       |   |    |       |   |    |     |  |    |       |   |    |         |  |    |         |   |    |       |   |    |       |  |    |         |                                  |    |         |                        |    |         |                         |    |         |                           |    |   |                                 |    |     |                   |    |
| 3   | Description of Structural Model                                 | 19   |             |   |         |   |     |  |   |       |                                  |   |       |                            |   |       |                                    |   |       |                   |   |       |                        |   |       |                  |   |       |                      |   |       |   |   |     |                          |   |   |              |   |     |             |   |     |                         |   |     |                              |   |     |                            |   |     |                                    |   |       |  |   |       |   |   |       |                     |    |       |                    |    |       |                   |    |     |       |    |       |                  |    |       |  |    |     |   |    |       |                            |    |       |                          |    |       |                              |    |       |                    |    |         |                                    |    |         |                                 |    |         |                     |    |         |                                      |    |         |   |    |     |   |    |       |   |    |       |   |    |     |  |    |       |   |    |         |  |    |         |   |    |       |   |    |       |  |    |         |                                  |    |         |                        |    |         |                         |    |         |                           |    |   |                                 |    |     |                   |    |
| 3.1   | Nodal Coordinates   | 19   |             |   |         |   |     |  |   |       |                                  |   |       |                            |   |       |                                    |   |       |                   |   |       |                        |   |       |                  |   |       |                      |   |       |   |   |     |                          |   |   |              |   |     |             |   |     |                         |   |     |                              |   |     |                            |   |     |                                    |   |       |  |   |       |   |   |       |                     |    |       |                    |    |       |                   |    |     |       |    |       |                  |    |       |  |    |     |   |    |       |                            |    |       |                          |    |       |                              |    |       |                    |    |         |                                    |    |         |                                 |    |         |                     |    |         |                                      |    |         |   |    |     |   |    |       |   |    |       |   |    |     |  |    |       |   |    |         |  |    |         |   |    |       |   |    |       |  |    |         |                                  |    |         |                        |    |         |                         |    |         |                           |    |   |                                 |    |     |                   |    |
| Description: Contents   |   |  | Project No. |   |         |   |     |  |   |       |                                  |   |       |                            |   |       |                                    |   |       |                   |   |       |                        |   |       |                  |   |       |                      |   |       |   |   |     |                          |   |   |              |   |     |             |   |     |                         |   |     |                              |   |     |                            |   |     |                                    |   |       |  |   |       |   |   |       |                     |    |       |                    |    |       |                   |    |     |       |    |       |                  |    |       |  |    |     |   |    |       |                            |    |       |                          |    |       |                              |    |       |                    |    |         |                                    |    |         |                                 |    |         |                     |    |         |                                      |    |         |   |    |     |   |    |       |   |    |       |   |    |     |  |    |       |   |    |         |  |    |         |   |    |       |   |    |       |  |    |         |                                  |    |         |                        |    |         |                         |    |         |                           |    |   |                                 |    |     |                   |    |
|   |   | Page :   | i           |   |         |   |     |  |   |       |                                  |   |       |                            |   |       |                                    |   |       |                   |   |       |                        |   |       |                  |   |       |                      |   |       |   |   |     |                          |   |   |              |   |     |             |   |     |                         |   |     |                              |   |     |                            |   |     |                                    |   |       |  |   |       |   |   |       |                     |    |       |                    |    |       |                   |    |     |       |    |       |                  |    |       |  |    |     |   |    |       |                            |    |       |                          |    |       |                              |    |       |                    |    |         |                                    |    |         |                                 |    |         |                     |    |         |                                      |    |         |   |    |     |   |    |       |   |    |       |   |    |     |  |    |       |   |    |         |  |    |         |   |    |       |   |    |       |  |    |         |                                  |    |         |                        |    |         |                         |    |         |                           |    |   |                                 |    |     |                   |    |

|   |   |  |             |     |                    |    |     |                                  |    |     |                         |    |   |                     |    |     |                                       |    |     |                   |    |     |                                   |    |     |                              |    |   |       |    |     |              |    |     |            |    |       |             |    |       |                       |    |       |                        |    |       |                     |    |       |                                |    |       |  |    |       |  |    |       |  |    |       |                                       |    |        |      |    |        |                     |    |        |                      |    |        |                       |    |        |           |    |        |                |     |        |                              |     |        |                   |     |   |                                     |     |   |  |     |     |   |     |     |   |     |     |   |     |       |                               |     |
|---|---|--|-------------|-----|--------------------|----|-----|----------------------------------|----|-----|-------------------------|----|---|---------------------|----|-----|---------------------------------------|----|-----|-------------------|----|-----|-----------------------------------|----|-----|------------------------------|----|---|-------|----|-----|--------------|----|-----|------------|----|-------|-------------|----|-------|-----------------------|----|-------|------------------------|----|-------|---------------------|----|-------|--------------------------------|----|-------|--|----|-------|--|----|-------|--|----|-------|---------------------------------------|----|--------|------|----|--------|---------------------|----|--------|----------------------|----|--------|-----------------------|----|--------|-----------|----|--------|----------------|-----|--------|------------------------------|-----|--------|-------------------|-----|---|-------------------------------------|-----|---|--|-----|-----|---|-----|-----|---|-----|-----|---|-----|-------|-------------------------------|-----|
| Designer: VKS Infratech Management Pvt. Ltd.  |   |  |             |     |                    |    |     |                                  |    |     |                         |    |   |                     |    |     |                                       |    |     |                   |    |     |                                   |    |     |                              |    |   |       |    |     |              |    |     |            |    |       |             |    |       |                       |    |       |                        |    |       |                     |    |       |                                |    |       |  |    |       |  |    |       |  |    |       |                                       |    |        |      |    |        |                     |    |        |                      |    |        |                       |    |        |           |    |        |                |     |        |                              |     |        |                   |     |   |                                     |     |   |  |     |     |   |     |     |   |     |     |   |     |       |                               |     |
| RM Bridge Professional Engineering Software   |   |  |             |     |                    |    |     |                                  |    |     |                         |    |   |                     |    |     |                                       |    |     |                   |    |     |                                   |    |     |                              |    |   |       |    |     |              |    |     |            |    |       |             |    |       |                       |    |       |                        |    |       |                     |    |       |                                |    |       |  |    |       |  |    |       |  |    |       |                                       |    |        |      |    |        |                     |    |        |                      |    |        |                       |    |        |           |    |        |                |     |        |                              |     |        |                   |     |   |                                     |     |   |  |     |     |   |     |     |   |     |     |   |     |       |                               |     |
| project   | Arunachal Extradosed 63m+260m+63m               |  | 6/03/2022   |     |                    |    |     |                                  |    |     |                         |    |   |                     |    |     |                                       |    |     |                   |    |     |                                   |    |     |                              |    |   |       |    |     |              |    |     |            |    |       |             |    |       |                       |    |       |                        |    |       |                     |    |       |                                |    |       |  |    |       |  |    |       |  |    |       |                                       |    |        |      |    |        |                     |    |        |                      |    |        |                       |    |        |           |    |        |                |     |        |                              |     |        |                   |     |   |                                     |     |   |  |     |     |   |     |     |   |     |     |   |     |       |                               |     |
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| 4   | Material Properties                             | 39   |             |     |                    |    |     |                                  |    |     |                         |    |   |                     |    |     |                                       |    |     |                   |    |     |                                   |    |     |                              |    |   |       |    |     |              |    |     |            |    |       |             |    |       |                       |    |       |                        |    |       |                     |    |       |                                |    |       |  |    |       |  |    |       |  |    |       |                                       |    |        |      |    |        |                     |    |        |                      |    |        |                       |    |        |           |    |        |                |     |        |                              |     |        |                   |     |   |                                     |     |   |  |     |     |   |     |     |   |     |     |   |     |       |                               |     |
| 4.1   | Concrete for Superstructure and Pylon           | 39   |             |     |                    |    |     |                                  |    |     |                         |    |   |                     |    |     |                                       |    |     |                   |    |     |                                   |    |     |                              |    |   |       |    |     |              |    |     |            |    |       |             |    |       |                       |    |       |                        |    |       |                     |    |       |                                |    |       |  |    |       |  |    |       |  |    |       |                                       |    |        |      |    |        |                     |    |        |                      |    |        |                       |    |        |           |    |        |                |     |        |                              |     |        |                   |     |   |                                     |     |   |  |     |     |   |     |     |   |     |     |   |     |       |                               |     |
| 4.2   | Reinforcing Steel                               | 40   |             |     |                    |    |     |                                  |    |     |                         |    |   |                     |    |     |                                       |    |     |                   |    |     |                                   |    |     |                              |    |   |       |    |     |              |    |     |            |    |       |             |    |       |                       |    |       |                        |    |       |                     |    |       |                                |    |       |  |    |       |  |    |       |  |    |       |                                       |    |        |      |    |        |                     |    |        |                      |    |        |                       |    |        |           |    |        |                |     |        |                              |     |        |                   |     |   |                                     |     |   |  |     |     |   |     |     |   |     |     |   |     |       |                               |     |
| 4.3   | Prestressing and Stay cable Steel               | 40   |             |     |                    |    |     |                                  |    |     |                         |    |   |                     |    |     |                                       |    |     |                   |    |     |                                   |    |     |                              |    |   |       |    |     |              |    |     |            |    |       |             |    |       |                       |    |       |                        |    |       |                     |    |       |                                |    |       |  |    |       |  |    |       |  |    |       |                                       |    |        |      |    |        |                     |    |        |                      |    |        |                       |    |        |           |    |        |                |     |        |                              |     |        |                   |     |   |                                     |     |   |  |     |     |   |     |     |   |     |     |   |     |       |                               |     |
| 4.4   | Element Material Assignments                    | 40   |             |     |                    |    |     |                                  |    |     |                         |    |   |                     |    |     |                                       |    |     |                   |    |     |                                   |    |     |                              |    |   |       |    |     |              |    |     |            |    |       |             |    |       |                       |    |       |                        |    |       |                     |    |       |                                |    |       |  |    |       |  |    |       |  |    |       |                                       |    |        |      |    |        |                     |    |        |                      |    |        |                       |    |        |           |    |        |                |     |        |                              |     |        |                   |     |   |                                     |     |   |  |     |     |   |     |     |   |     |     |   |     |       |                               |     |
| 5   | Loads   | 47   |             |     |                    |    |     |                                  |    |     |                         |    |   |                     |    |     |                                       |    |     |                   |    |     |                                   |    |     |                              |    |   |       |    |     |              |    |     |            |    |       |             |    |       |                       |    |       |                        |    |       |                     |    |       |                                |    |       |  |    |       |  |    |       |  |    |       |                                       |    |        |      |    |        |                     |    |        |                      |    |        |                       |    |        |           |    |        |                |     |        |                              |     |        |                   |     |   |                                     |     |   |  |     |     |   |     |     |   |     |     |   |     |       |                               |     |
| 5.1   | Load Manager                                    | 47   |             |     |                    |    |     |                                  |    |     |                         |    |   |                     |    |     |                                       |    |     |                   |    |     |                                   |    |     |                              |    |   |       |    |     |              |    |     |            |    |       |             |    |       |                       |    |       |                        |    |       |                     |    |       |                                |    |       |  |    |       |  |    |       |  |    |       |                                       |    |        |      |    |        |                     |    |        |                      |    |        |                       |    |        |           |    |        |                |     |        |                              |     |        |                   |     |   |                                     |     |   |  |     |     |   |     |     |   |     |     |   |     |       |                               |     |
| 5.2   | Load Cases                                      | 52   |             |     |                    |    |     |                                  |    |     |                         |    |   |                     |    |     |                                       |    |     |                   |    |     |                                   |    |     |                              |    |   |       |    |     |              |    |     |            |    |       |             |    |       |                       |    |       |                        |    |       |                     |    |       |                                |    |       |  |    |       |  |    |       |  |    |       |                                       |    |        |      |    |        |                     |    |        |                      |    |        |                       |    |        |           |    |        |                |     |        |                              |     |        |                   |     |   |                                     |     |   |  |     |     |   |     |     |   |     |     |   |     |       |                               |     |
| 5.2.1   | Self Weight                                     | 52   |             |     |                    |    |     |                                  |    |     |                         |    |   |                     |    |     |                                       |    |     |                   |    |     |                                   |    |     |                              |    |   |       |    |     |              |    |     |            |    |       |             |    |       |                       |    |       |                        |    |       |                     |    |       |                                |    |       |  |    |       |  |    |       |  |    |       |                                       |    |        |      |    |        |                     |    |        |                      |    |        |                       |    |        |           |    |        |                |     |        |                              |     |        |                   |     |   |                                     |     |   |  |     |     |   |     |     |   |     |     |   |     |       |                               |     |
| 5.2.2   | Form Traveller weight                           | 58   |             |     |                    |    |     |                                  |    |     |                         |    |   |                     |    |     |                                       |    |     |                   |    |     |                                   |    |     |                              |    |   |       |    |     |              |    |     |            |    |       |             |    |       |                       |    |       |                        |    |       |                     |    |       |                                |    |       |  |    |       |  |    |       |  |    |       |                                       |    |        |      |    |        |                     |    |        |                      |    |        |                       |    |        |           |    |        |                |     |        |                              |     |        |                   |     |   |                                     |     |   |  |     |     |   |     |     |   |     |     |   |     |       |                               |     |
| 5.2.3   | Form Traveller Removal                          | 63   |             |     |                    |    |     |                                  |    |     |                         |    |   |                     |    |     |                                       |    |     |                   |    |     |                                   |    |     |                              |    |   |       |    |     |              |    |     |            |    |       |             |    |       |                       |    |       |                        |    |       |                     |    |       |                                |    |       |  |    |       |  |    |       |  |    |       |                                       |    |        |      |    |        |                     |    |        |                      |    |        |                       |    |        |           |    |        |                |     |        |                              |     |        |                   |     |   |                                     |     |   |  |     |     |   |     |     |   |     |     |   |     |       |                               |     |
| 5.2.4   | Wet Concrete weight                             | 69   |             |     |                    |    |     |                                  |    |     |                         |    |   |                     |    |     |                                       |    |     |                   |    |     |                                   |    |     |                              |    |   |       |    |     |              |    |     |            |    |       |             |    |       |                       |    |       |                        |    |       |                     |    |       |                                |    |       |  |    |       |  |    |       |  |    |       |                                       |    |        |      |    |        |                     |    |        |                      |    |        |                       |    |        |           |    |        |                |     |        |                              |     |        |                   |     |   |                                     |     |   |  |     |     |   |     |     |   |     |     |   |     |       |                               |     |
| 5.2.5   | Prestressing Force Application                  | 74   |             |     |                    |    |     |                                  |    |     |                         |    |   |                     |    |     |                                       |    |     |                   |    |     |                                   |    |     |                              |    |   |       |    |     |              |    |     |            |    |       |             |    |       |                       |    |       |                        |    |       |                     |    |       |                                |    |       |  |    |       |  |    |       |  |    |       |                                       |    |        |      |    |        |                     |    |        |                      |    |        |                       |    |        |           |    |        |                |     |        |                              |     |        |                   |     |   |                                     |     |   |  |     |     |   |     |     |   |     |     |   |     |       |                               |     |
| 5.2.6   | Empty Load Cases for Creep and Shrinkage        | 78   |             |     |                    |    |     |                                  |    |     |                         |    |   |                     |    |     |                                       |    |     |                   |    |     |                                   |    |     |                              |    |   |       |    |     |              |    |     |            |    |       |             |    |       |                       |    |       |                        |    |       |                     |    |       |                                |    |       |  |    |       |  |    |       |  |    |       |                                       |    |        |      |    |        |                     |    |        |                      |    |        |                       |    |        |           |    |        |                |     |        |                              |     |        |                   |     |   |                                     |     |   |  |     |     |   |     |     |   |     |     |   |     |       |                               |     |
| 5.2.7   | Stay Force Application During Construction      | 78   |             |     |                    |    |     |                                  |    |     |                         |    |   |                     |    |     |                                       |    |     |                   |    |     |                                   |    |     |                              |    |   |       |    |     |              |    |     |            |    |       |             |    |       |                       |    |       |                        |    |       |                     |    |       |                                |    |       |  |    |       |  |    |       |  |    |       |                                       |    |        |      |    |        |                     |    |        |                      |    |        |                       |    |        |           |    |        |                |     |        |                              |     |        |                   |     |   |                                     |     |   |  |     |     |   |     |     |   |     |     |   |     |       |                               |     |
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| 5.2.9   | Stay Force Application After Clousure           | 85   |             |     |                    |    |     |                                  |    |     |                         |    |   |                     |    |     |                                       |    |     |                   |    |     |                                   |    |     |                              |    |   |       |    |     |              |    |     |            |    |       |             |    |       |                       |    |       |                        |    |       |                     |    |       |                                |    |       |  |    |       |  |    |       |  |    |       |                                       |    |        |      |    |        |                     |    |        |                      |    |        |                       |    |        |           |    |        |                |     |        |                              |     |        |                   |     |   |                                     |     |   |  |     |     |   |     |     |   |     |     |   |     |       |                               |     |
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| 5.2.13  | Diffretial Settlement                           | 93   |             |     |                    |    |     |                                  |    |     |                         |    |   |                     |    |     |                                       |    |     |                   |    |     |                                   |    |     |                              |    |   |       |    |     |              |    |     |            |    |       |             |    |       |                       |    |       |                        |    |       |                     |    |       |                                |    |       |  |    |       |  |    |       |  |    |       |                                       |    |        |      |    |        |                     |    |        |                      |    |        |                       |    |        |           |    |        |                |     |        |                              |     |        |                   |     |   |                                     |     |   |  |     |     |   |     |     |   |     |     |   |     |       |                               |     |
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| 5.2.15  | Breaking Force                                  | 101  |             |     |                    |    |     |                                  |    |     |                         |    |   |                     |    |     |                                       |    |     |                   |    |     |                                   |    |     |                              |    |   |       |    |     |              |    |     |            |    |       |             |    |       |                       |    |       |                        |    |       |                     |    |       |                                |    |       |  |    |       |  |    |       |  |    |       |                                       |    |        |      |    |        |                     |    |        |                      |    |        |                       |    |        |           |    |        |                |     |        |                              |     |        |                   |     |   |                                     |     |   |  |     |     |   |     |     |   |     |     |   |     |       |                               |     |
| 5.2.16  | Mass For Seismic Calculation                    | 101  |             |     |                    |    |     |                                  |    |     |                         |    |   |                     |    |     |                                       |    |     |                   |    |     |                                   |    |     |                              |    |   |       |    |     |              |    |     |            |    |       |             |    |       |                       |    |       |                        |    |       |                     |    |       |                                |    |       |  |    |       |  |    |       |  |    |       |                                       |    |        |      |    |        |                     |    |        |                      |    |        |                       |    |        |           |    |        |                |     |        |                              |     |        |                   |     |   |                                     |     |   |  |     |     |   |     |     |   |     |     |   |     |       |                               |     |
| 5.2.17  | Load Combinations                               | 103  |             |     |                    |    |     |                                  |    |     |                         |    |   |                     |    |     |                                       |    |     |                   |    |     |                                   |    |     |                              |    |   |       |    |     |              |    |     |            |    |       |             |    |       |                       |    |       |                        |    |       |                     |    |       |                                |    |       |  |    |       |  |    |       |  |    |       |                                       |    |        |      |    |        |                     |    |        |                      |    |        |                       |    |        |           |    |        |                |     |        |                              |     |        |                   |     |   |                                     |     |   |  |     |     |   |     |     |   |     |     |   |     |       |                               |     |
| 6   | Stage Actions (Calculation Actions)             | 106  |             |     |                    |    |     |                                  |    |     |                         |    |   |                     |    |     |                                       |    |     |                   |    |     |                                   |    |     |                              |    |   |       |    |     |              |    |     |            |    |       |             |    |       |                       |    |       |                        |    |       |                     |    |       |                                |    |       |  |    |       |  |    |       |  |    |       |                                       |    |        |      |    |        |                     |    |        |                      |    |        |                       |    |        |           |    |        |                |     |        |                              |     |        |                   |     |   |                                     |     |   |  |     |     |   |     |     |   |     |     |   |     |       |                               |     |
| 7   | DESIGN CODE VERIFICATION OF LIMIT STATES        | 136  |             |     |                    |    |     |                                  |    |     |                         |    |   |                     |    |     |                                       |    |     |                   |    |     |                                   |    |     |                              |    |   |       |    |     |              |    |     |            |    |       |             |    |       |                       |    |       |                        |    |       |                     |    |       |                                |    |       |  |    |       |  |    |       |  |    |       |                                       |    |        |      |    |        |                     |    |        |                      |    |        |                       |    |        |           |    |        |                |     |        |                              |     |        |                   |     |   |                                     |     |   |  |     |     |   |     |     |   |     |     |   |     |       |                               |     |
| 7.1   | ULTIMATE LIMIT STATE OF STRUCTURAL STRENGTH     | 136  |             |     |                    |    |     |                                  |    |     |                         |    |   |                     |    |     |                                       |    |     |                   |    |     |                                   |    |     |                              |    |   |       |    |     |              |    |     |            |    |       |             |    |       |                       |    |       |                        |    |       |                     |    |       |                                |    |       |  |    |       |  |    |       |  |    |       |                                       |    |        |      |    |        |                     |    |        |                      |    |        |                       |    |        |           |    |        |                |     |        |                              |     |        |                   |     |   |                                     |     |   |  |     |     |   |     |     |   |     |     |   |     |       |                               |     |
| 7.2   | ULTIMATE LIMIT STATE OF SHEAR AND TORSION       | 137  |             |     |                    |    |     |                                  |    |     |                         |    |   |                     |    |     |                                       |    |     |                   |    |     |                                   |    |     |                              |    |   |       |    |     |              |    |     |            |    |       |             |    |       |                       |    |       |                        |    |       |                     |    |       |                                |    |       |  |    |       |  |    |       |  |    |       |                                       |    |        |      |    |        |                     |    |        |                      |    |        |                       |    |        |           |    |        |                |     |        |                              |     |        |                   |     |   |                                     |     |   |  |     |     |   |     |     |   |     |     |   |     |       |                               |     |
| 7.3   | SERVICEABILITY LIMIT STATE OF INTERNAL STRESSES | 138  |             |     |                    |    |     |                                  |    |     |                         |    |   |                     |    |     |                                       |    |     |                   |    |     |                                   |    |     |                              |    |   |       |    |     |              |    |     |            |    |       |             |    |       |                       |    |       |                        |    |       |                     |    |       |                                |    |       |  |    |       |  |    |       |  |    |       |                                       |    |        |      |    |        |                     |    |        |                      |    |        |                       |    |        |           |    |        |                |     |        |                              |     |        |                   |     |   |                                     |     |   |  |     |     |   |     |     |   |     |     |   |     |       |                               |     |
| 7.3.1   | Stress Limitation in Concrete                   | 138  |             |     |                    |    |     |                                  |    |     |                         |    |   |                     |    |     |                                       |    |     |                   |    |     |                                   |    |     |                              |    |   |       |    |     |              |    |     |            |    |       |             |    |       |                       |    |       |                        |    |       |                     |    |       |                                |    |       |  |    |       |  |    |       |  |    |       |                                       |    |        |      |    |        |                     |    |        |                      |    |        |                       |    |        |           |    |        |                |     |        |                              |     |        |                   |     |   |                                     |     |   |  |     |     |   |     |     |   |     |     |   |     |       |                               |     |
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| Designer: VKS Infratech Management Pvt. Ltd. |                                   |  |           |
| RM Bridge Professional Engineering Software  |                                   |  |           |
| project                                      | Arunachal Extradosed 63m+260m+63m |  | 6/03/2022 |

# 1 General

This design note pertains to detailed longitudinal analysis & design of Extradosed Bridge with span arrangement "63m + 260m + 63m" for the Project "CONSULTANCY SERVICES FOR FEASIBILITY STUDY, PREPARATION OF DETAILED PROJECT REPORT (DPR) AND PROVIDING PRECONSTRUCTION SERVICES (INCLUDING SELECTION OF SITE, TYPE OF BRIDGE, SUB SOIL INVESTIGATION, ESTIMATION, PREPARATION OF TENDER DOCUMENTS ETC.) (INDICATIVE LENGTH OF BRIDGE-300 MTR & APPROACH ROAD -4.50 KMS) OVER SIANG RIVER AT KM 93.50 ON DITTE-DIMME-MIGGING ROAD UNDER 761 BRTF OF PROJECT BRAHMANK IN ARUNACHAL PRADESH STATE".

The analysis and design have been carried out on 3D Structural Model created in RM Bridge software in accordance with latest IRC code provisions and Latest International Publications for Design of Stay Cables.

## 1.1 Salient Features of Proposed Extradosed Bridge

The silent features of the proposed Extradosed Bridge are shown on "Drawing No - VKSIMPL/P-134/BRO/GAD/MJB-01/01" Titled "GENERAL ARRANGEMENT DRAWING FOR EXTRADOSED BRIDGE OVER SIANG RIVER AT CH. 2+908Km" and are briefly described below:


### 1.1.1 Road Configuration at Deck Level


|                                      |   |                     |
|--------------------------------------|---|---------------------|
| Carriageway width                    | : | 7.5 m               |
| Crash Barrier width                  | : | 0.45 m on both side |
| Footpath Width                       | : | 1.5 m on both side  |
| Pedestrian Railing Kerb width        | : | 0.3 m on both side  |
| Extra width for stay Cable Anchorage | : | 1.5 m on both side  |

### 1.1.2 Superstructure Arrangement


|   |   |                                |
|---|---|--------------------------------|
| Span Arrangement                            | : | 63 m + 260 m + 63 m            |
| Superstructure Type                         | : | Box Girder                     |
| Material                                    | : | Prestressed Concrete Grade M55 |
| Deck width                                  | : | 15 m                           |
| Soffit width                                | : | 7.0 m                          |
| Box Depth at Abutment                       | : | 7.5 m                          |
| Box Depth at Pylon                          | : | 10.5 m                         |
| Box Depth at Mid-Span of main span          | : | 4.5 m                          |
| Deck Slab Thickness                         | : | 0.3 m                          |
| Soffit Slab Thickness at Abutment           | : | 0.95 m                         |
| Soffit Slab Thickness at Pylon              | : | 1.275 m                        |
| Soffit Slab Thickness Mid-Span of main span | : | 0.3 m                          |
| Web Thickness at Abutment                   | : | 1.0 m                          |
| Web Thickness at Pylon                      | : | 1.2 m                          |
| Web Thickness at Mid-Span of main span      | : | 0.35 m                         |

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| Description: 1 General<br>1.1 Salient Features of Proposed Extradosed Bridge |          | Project No. |
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|---|-----------------------------------|--|-------------|
| Designer: VKS Infratech Management Pvt. Ltd.  |                                   |  |             |
| RM Bridge Professional Engineering Software   |                                   |  |             |
| project   | Arunachal Extradosed 63m+260m+63m |  | 6/03/2022   |
| <div>1.1.3 Superstructure Bearing Arrangement</div> <div><div>Bearing Nos &amp; Type at Abutment</div><div>:</div><div>2 Nos. POT-PTFE BEARINGS</div></div> <div><div>Bearing 1 Fixity</div><div>:</div><div>Longitudinally Guided</div></div> <div><div>Bearing 2 Fixity</div><div>:</div><div>Free in both Long. &amp; Trans. Directions</div></div> <div><div>Bearing Arrangement at Pylon</div><div>:</div><div>Box Girder Monolithic with Pylon</div></div> <div>1.1.4 Pylon Arrangement</div> <div><div>Material</div><div>:</div><div>Reinforced Concrete Grade M55</div></div> <div><div>No of Legs of Pylon</div><div>:</div><div>2 Legs arranged transversely</div></div> <div><div>Leg Spacing in Transverse Direction</div><div>:</div><div>13.5 m</div></div> <div><div>Height Below Soffit</div><div>:</div><div>42.1 m (up to Foundation Top)</div></div> <div><div>Height above Deck Level</div><div>:</div><div>26 m</div></div> <div><div>Dimension of Legs at Foundation Top</div><div>:</div><div>6 m (Longitudinal) x 4.5 m (Transverse)</div></div> <div><div>Dimension of Legs at Soffit</div><div>:</div><div>3 m (Longitudinal) x 1.5 m (Transverse)</div></div> <div><div>Dimension of Legs above Deck</div><div>:</div><div>3 m (Longitudinal) x 1.5 m (Transverse)</div></div> <div>1.1.5 Stay Cable Arrangement</div> <div><div>Material</div><div>:</div><div>High strength Steel with UTS 1860 Mpa</div></div> <div><div>No of Stays at each Pylon leg</div><div>:</div><div>9 Nos. passing over Saddle at Pylon</div></div> <div><div>Stressing End</div><div>:</div><div>Both Ends at Deck Level</div></div> <div><div>Stay Arrangement main Span</div><div>:</div><div>FAN pattern</div></div> <div><div>Stay Arrangement Back Span</div><div>:</div><div>HARP pattern</div></div> <div><div>CS Area of each strand</div><div>:</div><div>150 sq.mm</div></div> <div><div>No Of Strands in Stay No. 1 to 3</div><div>:</div><div>45 nos.</div></div> <div><div>No Of Strands in Stay No. 4 to 7</div><div>:</div><div>65 nos.</div></div> <div><div>No Of Strands in Stay No. 8 to 9</div><div>:</div><div>90 nos.</div></div> <div>1.1.6 Pylon Foundation</div> <div><div>Material</div><div>:</div><div>Reinforced Concrete Grade M45</div></div> <div><div>Type</div><div>:</div><div>Open Foundation</div></div> <div><div>Dimension</div><div>:</div><div>19 m (Longitudinal) x 31 m (Transverse)</div></div> <div><div>Thickness at Pylon Legs</div><div>:</div><div>4 m</div></div> <div><div>Thickness at Toe</div><div>:</div><div>1 m</div></div> <div>1.1.7 Abutment Arrangement</div> <div><div>Material</div><div>:</div><div>Reinforced Concrete Grade M45</div></div> <div><div>Type</div><div>:</div><div>Box Cell Abutment</div></div> <div><div>Total no of Cells</div><div>:</div><div>13 nos.</div></div> <div><div>Dimensions at Bottom Raft slab</div><div>:</div><div>18.625 m (Longitudinal) x 30.6 m (Transverse)</div></div> <div><div>Cell Fill Material</div><div>:</div><div>Granular Fill (Sand/Gravel)</div></div> |                                   |  |             |
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| Designer: VKS Infratech Management Pvt. Ltd.   |                                   |  |             |
| RM Bridge Professional Engineering Software  |                                   |  |             |
| project  | Arunachal Extradosed 63m+260m+63m |  | 6/03/2022   |
| <div>1.1.8 Tie Down cable arrangement in Back span</div> <div><div><div>Function</div><div>Material</div><div>No of U-Shaped Ties at each Abutment</div><div>Anchorage To Abutment</div><div>Stressing End</div><div>CS Area of each strand</div><div>No Of Strands in Each Tie Down cable</div></div><div><div>:</div><div>:</div><div>:</div><div>:</div><div>:</div><div>:</div><div>:</div></div><div><div>To Prevent Uplift at Back span Bearings</div><div>High strength Steel with UTS 1860 Mpa</div><div>4 Nos.</div><div>U-shaped in Tie Down Anchor Wall 1m Thick</div><div>Both Ends at Deck Level</div><div>150 sq.mm</div><div>100 nos.</div></div></div>   |                                   |  |             |
| <div>1.2 Construction Methodology</div> <div><div>Construction Stage-&gt; Foundation and Substructure</div><div><div>&gt; Cast Box cell Abutment</div><div>&gt; Cast Pylon Open Foundation</div><div>&gt; Cast Pylon Legs with Slip/Jump Formwork</div></div></div> <div><div>Construction Stage-&gt; Superstructure Launching (Stage-00)</div><div><div>&gt; Cast Box Girder in Both Back Spans Plus 3m Cantilever on Ground Supported Formwork</div><div>&gt; Allow Concrete to mature for 10 Days or when concrete attains strength of 45 Mpa whichever is later</div><div>&gt; Activate Bearings at abutment</div><div>&gt; Stress Prestressing Tendon Required at bottom for Back span</div><div>&gt; Remove Ground supported Formwork</div></div></div> <div><div>Construction Stage-&gt; Superstructure Launching (Stage-01)</div><div><div>&gt; Install Form Traveller at tip of cantilever coming out of both back spans for main span Launching</div><div>&gt; Cast Segment - 01 of 5m length on formwork Hanging Form Traveller</div><div>&gt; Allow Concrete to mature for 10 Days or when concrete attains strength of 45 Mpa whichever is later</div><div>&gt; Stress pair of Prestressing Tendon Required at Top</div><div>&gt; Release Formwork</div></div></div> <div><div>Construction Stage-&gt; Superstructure Launching (Stage-02)</div><div><div>&gt; Move Forward Form Traveller To tip of cantilever for next Segment Launching</div><div>&gt; Cast Segment -02 of 5m length on formwork Hanging Form Traveller</div><div>&gt; Allow Concrete to mature for 10 Days or when concrete attains strength of 45 Mpa whichever is later</div><div>&gt; Stress pair of Prestressing Tendon Required at Top</div><div>&gt; Release Formwork</div></div></div> <div><div>Construction Stage-&gt; Superstructure Launching (Stage-03)</div><div><div>&gt; Move Forward Form Traveller To tip of cantilever for next Segment Launching</div><div>&gt; Cast Segment - 03 of 5m length on formwork Hanging Form Traveller</div><div>&gt; Allow Concrete to mature for 10 Days or when concrete attains strength of 45 Mpa whichever is later</div><div>&gt; Stress pair of Prestressing Tendon Required at Top</div><div>&gt; Release Formwork</div></div></div> <div><div>Construction Stage-&gt; Superstructure Launching (Stage-04)</div><div><div>&gt; Move Forward Form Traveller To tip of cantilever for next Segment Launching</div><div>&gt; Cast Segment - 04 of 5m length on formwork Hanging Form Traveller</div><div>&gt; Allow Concrete to mature for 10 Days or when concrete attains strength of 45 Mpa whichever is later</div><div>&gt; Stress pair of Prestressing Tendon Required at Top</div><div>&gt; Release Formwork</div></div></div> |                                   |  |             |
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| Designer: VKS Infratech Management Pvt. Ltd.  |                                   |  |             |
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| project   | Arunachal Extradosed 63m+260m+63m |  | 6/03/2022   |
| <p><b>Construction Stage-&gt; Superstructure Launching (Stage-05)</b></p> <ul style="list-style-type: none"><li>&gt; Move Forward Form Traveller To tip of cantilever for next Segment Launching</li><li>&gt; Cast Segment - 05 of 5m length on formwork Hanging Form Traveller</li><li>&gt; Allow Concrete to mature for 10 Days or when concrete attains strength of 45 Mpa whichever is later</li></ul> <p>&gt; Stress pair of Prestressing Tendon Required at Top</p> <p>&gt; Release Formwork</p> <p><b>Construction Stage-&gt; Superstructure Launching (Stage-06)</b></p> <ul style="list-style-type: none"><li>&gt; Move Forward Form Traveller To tip of cantilever for next Segment Launching</li><li>&gt; Cast Segment - 06 of 5m length on formwork Hanging Form Traveller</li><li>&gt; Allow Concrete to mature for 10 Days or when concrete attains strength of 45 Mpa whichever is later</li></ul> <p>&gt; Stress pair of Prestressing Tendon Required at Top</p> <p>&gt; Release Formwork</p> <p><b>Construction Stage-&gt; Superstructure Launching (Stage-07)</b></p> <ul style="list-style-type: none"><li>&gt; Move Forward Form Traveller To tip of cantilever for next Segment Launching</li><li>&gt; Cast Segment - 07 of 5m length on formwork Hanging Form Traveller</li><li>&gt; Allow Concrete to mature for 10 Days or when concrete attains strength of 45 Mpa whichever is later</li></ul> <p>&gt; Stress pair of Prestressing Tendon Required at Top</p> <p>&gt; Release Formwork</p> <p><b>Construction Stage-&gt; Superstructure Launching (Stage-08)</b></p> <ul style="list-style-type: none"><li>&gt; Move Forward Form Traveller To tip of cantilever for next Segment Launching</li><li>&gt; Cast Segment - 08 of 5m length on formwork Hanging Form Traveller</li><li>&gt; Allow Concrete to mature for 10 Days or when concrete attains strength of 45 Mpa whichever is later</li></ul> <p>&gt; Stress pair of Prestressing Tendon Required at Top</p> <p>&gt; Release Formwork</p> <p><b>Construction Stage-&gt; Superstructure Launching (Stage-09)</b></p> <ul style="list-style-type: none"><li>&gt; Move Forward Form Traveller To tip of cantilever for next Segment Launching</li><li>&gt; Cast Segment - 09 of 5m length on formwork Hanging Form Traveller</li><li>&gt; Allow Concrete to mature for 10 Days or when concrete attains strength of 45 Mpa whichever is later</li></ul> <p>&gt; Install First pair of stay cable on each Pylon leg</p> <p>&gt; Stress First Stay Cable to specified Force from anchorage at deck level</p> <p>&gt; Release Formwork</p> <p><b>Construction Stage-&gt; Superstructure Launching (Stage-10)</b></p> <ul style="list-style-type: none"><li>&gt; Move Forward Form Traveller To tip of cantilever for next Segment Launching</li><li>&gt; Cast Segment - 10 of 5m length on formwork Hanging Form Traveller</li><li>&gt; Allow Concrete to mature for 10 Days or when concrete attains strength of 45 Mpa whichever is later</li></ul> <p>&gt; Stress pair of Prestressing Tendon Required at Top</p> <p>&gt; Release Formwork</p> <p><b>Construction Stage-&gt; Superstructure Launching (Stage-11)</b></p> <ul style="list-style-type: none"><li>&gt; Move Forward Form Traveller To tip of cantilever for next Segment Launching</li><li>&gt; Cast Segment - 11 of 5m length on formwork Hanging Form Traveller</li><li>&gt; Allow Concrete to mature for 10 Days or when concrete attains strength of 45 Mpa whichever is later</li></ul> <p>&gt; Install Second pair of stay cable on each Pylon leg</p> <p>&gt; Stress Second Pair of Stay Cable to specified Force from anchorage at deck level</p> |                                   |  |             |
| Description: 1 General<br>1.2 Construction Methodology  |                                   |  | Project No. |
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| RM Bridge Professional Engineering Software  |                                   |  |             |
| project  | Arunachal Extradosed 63m+260m+63m |  | 6/03/2022   |
| <div>&gt; Release Formwork</div> <div><b>Construction Stage-&gt; Superstructure Launching (Stage-12)</b><div>&gt; Install First U Shaped Tie Down cable at Each Abutment</div><div>&gt; Stress First U-Shaped Tie Down to specified Force from anchorage at deck level</div><div>&gt;Move Forward Form Traveller To tip of cantilever for next Segment Launching</div><div>&gt; Cast Segment - 12 of 5m length on formwork Hanging Form Traveller</div><div>&gt; Allow Concrete to mature for 10 Days or when concrete attains strength of 45 Mpa whichever is later</div><div>&gt; Stress pair of Prestressing Tendon Required at Top</div><div>&gt; Release Formwork</div></div> <div><b>Construction Stage-&gt; Superstructure Launching (Stage-13)</b><div>&gt; Move Forward Form Traveller To tip of cantilever for next Segment Launching</div><div>&gt; Cast Segment - 13 of 5m length on formwork Hanging Form Traveller</div><div>&gt; Allow Concrete to mature for 10 Days or when concrete attains strength of 45 Mpa whichever is later</div><div>&gt; Install Third pair of stay cable on each Pylon leg</div><div>&gt; Stress Third Pair of Stay Cable to specified Force from anchorage at deck level</div><div>&gt; Release Formwork</div></div> <div><b>Construction Stage-&gt; Superstructure Launching (Stage-14)</b><div>&gt; Move Forward Form Traveller To tip of cantilever for next Segment Launching</div><div>&gt; Cast Segment - 14 of 5m length on formwork Hanging Form Traveller</div><div>&gt; Allow Concrete to mature for 10 Days or when concrete attains strength of 45 Mpa whichever is later</div><div>&gt; Stress pair of Prestressing Tendon Required at Top</div><div>&gt; Release Formwork</div></div> <div><b>Construction Stage-&gt; Superstructure Launching (Stage-15)</b><div>&gt; Move Forward Form Traveller To tip of cantilever for next Segment Launching</div><div>&gt; Cast Segment - 15 of 5m length on formwork Hanging Form Traveller</div><div>&gt; Allow Concrete to mature for 10 Days or when concrete attains strength of 45 Mpa whichever is later</div><div>&gt; Install Fourth pair of stay cable on each Pylon leg</div><div>&gt; Stress Fourth Pair of Stay Cable to specified Force from anchorage at deck level</div><div>&gt; Release Formwork</div></div> <div><b>Construction Stage-&gt; Superstructure Launching (Stage-16)</b><div>&gt; Install Second U Shaped Tie Down cable at Each Abutment</div><div>&gt; Stress Second U Shaped Tie Down to specified Force from anchorage at deck level</div><div>&gt; Move Forward Form Traveller To tip of cantilever for next Segment Launching</div><div>&gt; Cast Segment - 16 of 5m length on formwork Hanging Form Traveller</div><div>&gt; Allow Concrete to mature for 10 Days or when concrete attains strength of 45 Mpa whichever is later</div><div>&gt; Stress pair of Prestressing Tendon Required at Top</div><div>&gt; Release Formwork</div></div> |                                   |  |             |
| Description: 1 General<br>1.2 Construction Methodology   |                                   |  | Project No. |
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| Designer: VKS Infratech Management Pvt. Ltd.   |                                   |  |             |
| RM Bridge Professional Engineering Software  |                                   |  |             |
| project  | Arunachal Extradosed 63m+260m+63m |  | 6/03/2022   |
| <p><b>Construction Stage-&gt; Superstructure Launching (Stage-17)</b></p> <ul style="list-style-type: none"><li>&gt; Move Forward Form Traveller To tip of cantilever for next Segment Launching</li><li>&gt; Cast Segment - 17 of 5m length on formwork Hanging Form Traveller</li><li>&gt; Allow Concrete to mature for 10 Days or when concrete attains strength of 45 Mpa whichever is later</li></ul> <p>&gt; Install Fifth pair of stay cable on each Pylon leg</p> <p>&gt; Stress Fifth Pair of Stay Cable to specified Force from anchorage at deck level</p> <p>&gt; Release Formwork</p> <p><b>Construction Stage-&gt; Superstructure Launching (Stage-18)</b></p> <ul style="list-style-type: none"><li>&gt; Move Forward Form Traveller To tip of cantilever for next Segment Launching</li><li>&gt; Cast Segment - 18 of 5m length on formwork Hanging Form Traveller</li><li>&gt; Allow Concrete to mature for 10 Days or when concrete attains strength of 45 Mpa whichever is later</li></ul> <p>&gt; Stress pair of Prestressing Tendon Required at Top</p> <p>&gt; Release Formwork</p> <p><b>Construction Stage-&gt; Superstructure Launching (Stage-19)</b></p> <ul style="list-style-type: none"><li>&gt; Move Forward Form Traveller To tip of cantilever for next Segment Launching</li><li>&gt; Cast Segment - 19 of 5m length on formwork Hanging Form Traveller</li><li>&gt; Allow Concrete to mature for 10 Days or when concrete attains strength of 45 Mpa whichever is later</li></ul> <p>&gt; Install Sixth pair of stay cable on each Pylon leg</p> <p>&gt; Stress Sixth Pair of Stay Cable to specified Force from anchorage at deck level</p> <p>&gt; Release Formwork</p> <p><b>Construction Stage-&gt; Superstructure Launching (Stage-20)</b></p> <ul style="list-style-type: none"><li>&gt; Install Third U Shaped Tie Down cable at Each Abutment</li><li>&gt; Stress Third U Shaped Tie Down to specified Force from anchorage at deck level</li><li>&gt; Move Forward Form Traveller To tip of cantilever for next Segment Launching</li><li>&gt; Cast Segment - 20 of 5m length on formwork Hanging Form Traveller</li><li>&gt; Allow Concrete to mature for 10 Days or when concrete attains strength of 45 Mpa whichever is later</li></ul> <p>&gt; Stress pair of Prestressing Tendon Required at Top</p> <p>&gt; Release Formwork</p> <p><b>Construction Stage-&gt; Superstructure Launching (Stage-21)</b></p> <ul style="list-style-type: none"><li>&gt; Move Forward Form Traveller To tip of cantilever for next Segment Launching</li><li>&gt; Cast Segment - 21 of 5m length on formwork Hanging Form Traveller</li><li>&gt; Allow Concrete to mature for 10 Days or when concrete attains strength of 45 Mpa whichever is later</li></ul> <p>&gt; Install Seventh pair of stay cable on each Pylon leg</p> <p>&gt; Stress Seventh Pair of Stay Cable to specified Force from anchorage at deck level</p> <p>&gt; Release Formwork</p> <p><b>Construction Stage-&gt; Superstructure Launching (Stage-22)</b></p> <ul style="list-style-type: none"><li>&gt; Move Forward Form Traveller To tip of cantilever for next Segment Launching</li><li>&gt; Cast Segment - 22 of 5m length on formwork Hanging Form Traveller</li><li>&gt; Allow Concrete to mature for 10 Days or when concrete attains strength of 45 Mpa whichever is later</li></ul> <p>&gt; Stress pair of Prestressing Tendon Required at Top</p> <p>&gt; Release Formwork</p> <p><b>Construction Stage-&gt; Superstructure Launching (Stage-23)</b></p> <ul style="list-style-type: none"><li>&gt; Move Forward Form Traveller To tip of cantilever for next Segment Launching</li><li>&gt; Cast Segment - 23 of 5m length on formwork Hanging Form Traveller</li><li>&gt; Allow Concrete to mature for 10 Days or when concrete attains strength of 45 Mpa whichever is later</li></ul> |                                   |  |             |
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| Designer: VKS Infratech Management Pvt. Ltd.  |                                   |  |             |
| RM Bridge Professional Engineering Software   |                                   |  |             |
| project   | Arunachal Extradosed 63m+260m+63m |  | 6/03/2022   |
| <div>&gt; Install Eighth pair of stay cable on each Pylon leg</div> <div>&gt; Stress Eighth Pair of Stay Cable to specified Force from anchorage at deck level</div> <div>&gt; Release Formwork</div> <div>Construction Stage-&gt; Superstructure Launching (Stage-24)</div> <div>&gt; Install Fourth U Shaped Tie Down cable at Each Abutment</div> <div>&gt; Stress Fourth U Shaped Tie Down to specified Force from anchorage at deck level</div> <div>&gt; Move Forward Form Traveller To tip of cantilever for next Segment Launching</div> <div>&gt; Cast Segment - 24 of 5m length on formwork Hanging Form Traveller</div> <div>&gt; Allow Concrete to mature for 10 Days or when concrete attains strength of 45 Mpa whichever is later</div> <div>&gt; Stress pair of Prestressing Tendon Required at Top</div> <div>&gt; Release Formwork</div> <div>Construction Stage-&gt; Superstructure Launching (Stage-25)</div> <div>&gt; Move Forward Form Traveller To tip of cantilever for next Segment Launching</div> <div>&gt; Cast Segment - 25 of 5m length on formwork Hanging Form Traveller</div> <div>&gt; Allow Concrete to mature for 10 Days or when concrete attains strength of 45 Mpa whichever is later</div> <div>&gt; Install Ninth pair of stay cable on each Pylon leg</div> <div>&gt; Stress Ninth Pair of Stay Cable to specified Force from anchorage at deck level</div> <div>&gt; Release Formwork</div> <div>Construction Stage-&gt; Superstructure Launching (Stage-26)</div> <div>&gt; Remove Form Traveller</div> <div>&gt; Cast Closure Pour of 4m length on formwork Hanging Form Tips of both cantilevers</div> <div>&gt; Allow Concrete to mature for 10 Days or when concrete attains strength of 45 Mpa whichever is later</div> <div>&gt; Stress continuity prestressing tendons required at Bottom Of main span</div> <div>&gt; Remove Formwork</div> <div>Construction Stage-&gt; Superstructure Launching (Stage-26c)</div> <div>&gt; Stress All Nine Pair of Stay Cable to achieve Final specified Force from anchorage at deck level</div> <div>Construction Stage-&gt; Superstructure Launching (Stage-27)</div> <div>&gt; Cast Crash Barriers and Pedestrian Railing</div> <div>&gt; Lay Down Concrete Wearing Course</div> <div>&gt; The Bridge is now ready to Receive Traffic</div> |                                   |  |             |
| Description: 1 General<br>1.2 Construction Methodology  |                                   |  | Project No. |
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| Designer: VKS Infratech Management Pvt. Ltd.   |                                   |  |             |
| RM Bridge Professional Engineering Software  |                                   |  |             |
| project  | Arunachal Extradosed 63m+260m+63m |  | 6/03/2022   |
| <div><div>2</div><div>Design Basis</div></div> <p>This section of the report pertains to criteria for the design of Extradosed Bridge for the Project. The comprehensive design criteria developed in this section are a general guidance for the structural design of all permanent components of extradosed bridge.</p> <div><div>2.1</div><div>Design Life</div></div> <p>The Design life of the bridge shall be 100 years. However replaceable components shall have a design life of 25 years.</p> <p>In order to maintain above stated criteria, the bridge shall a optimum level of periodic inspection and maintenance.</p> <div><div>2.2</div><div>Functional Requirements</div></div> <p>The Bridge shall cater to Two Lane for Motorised and non-motorised traffic with Pedestrian facility on both sides. Thus, bridge shall have a carriageway of 7.5m flanked by separated footpath of 1.5m on both side</p> <p>Minimum Vertical Clearance for Roadway Traffic is as Per IRC:54 - 1974 and is 5.5 m from the Finished Top Level of wearing surface.</p> <p>Lateral Clearance for Roadway traffic is as Per IRC:54 - 1974 and is 0.5 m from the Carriageway Edge.</p> <p>The Transverse Camber for Carriageway is 2.5% as per IRC codes.</p> <div><div>2.3</div><div>Structural Design Philosophy</div></div> <p>The design of the bridge is based on limit state design approach in accordance with IRC:6-2017, IRC:112-2011, expect for Base Pressure check Open foundation wherein working stress method shall be used in accordance with IRC:78-2014.</p> <p>Load combinations are categorized into three load combination for Verification of Ultimate Limit State (Basic Combination, Accidental Combination and Seismic Combination) and Three Combination according for Verification of Serviceability Limit State (Rare Combination, Frequent Combination and Quasi-Permanent Combination) as specified in IRC:6 2017.</p> <p>Global load factors as given therein, depending on the load case, are used to calculate factored loads effects.</p> <p>For open Foundation Base Pressure Check by Working Stress Method the combination is to be taken as per IRC: 78-2014.</p> <p>Other, internationally accepted codes/Publications are to be used for stay cables and other aspects which not covered by the IRC standards.</p> |                                   |  |             |
| Description: 2 Design Basis<br>2.1 Design Life   |                                   |  | Project No. |
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| Designer: VKS Infratech Management Pvt. Ltd. |  |           |
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## 2.4 Design Codes and Standards

The design is based on latest relevant Codes of the Indian Road Congress (IRC) and Indian Standard (IS) as specified below:

- > IRC:5-2015 Standard Specifications and Code of Practice for Road Bridges, Section:I General Features of Design
- > IRC:6-2017 Standard Specifications and Code of Practice for Road Bridges, Section: II Load and Stresses
- > IRC:112-2011 Code Of Practice for Concrete Road Bridges
- > IRC:78-2014 Standard Specifications and Code of Practice for Road Bridges, Section:VII Foundation and Substructure.
- > IRC:83-2002 Part-III Standard Specifications and Code of Practice for Road Bridges, Section IX – Bearings, Part III: POT, POT-CUM-PTFE, PIN and Metallic Guide Bearings
- > IRC: SP:69-2005 Guidelines to Design and Construction of Expansion Joints
- > IS:1786-2008 Specification for High strength Deformed steel bars and wires for Concrete Reinforcement
- > MORTH – Standard Specification for Road and Bridge Works (Fifth Revision)

In addition to above following internationally accepted Documents shall be used for Design of Stay Cable systems and cantilever erection of Extra dosed bridges

- > Post-Tensioning Institute: Recommendation for Stay Cable Design, Testing and Installation
- > SETRA: Cable Stays Recommendation of French Interministerial Commission on Prestressing. June 2002
- > CEB-FIP: Acceptance of stay cable systems using prestressing steels, Recommendation Prepared by Task Group 9.2, January 2005
- > SETRA: Design Guide for Prestressed Concrete Bridges Built Using Cantilever Method

## 2.5 Materials For Permanent Components


### 2.5.1 Concrete for Pylon Legs and Superstructure


|   |   |  |
|---|---|--|
| Grade of Concrete                           | : | M55  |
| Compressive strength (cube) f <sub>ck</sub> | : | 55 MPa                                       |
| Density                                     | : | 2.5 t/m <sup>3</sup> or 25 KN/m <sup>3</sup> |
| Modulus of elasticity                       | : | 36 GPa                                       |
| Poissons Ratio                              | : | 0.2  |
| Coeff. of Thermal Expansion                 | : | 12.0 x 10 <sup>-06</sup> per deg.            |

### 2.5.2 Concrete for Pylon Foundation and Box Cell Abutment

|   |   |  |
|---|---|--|
| Grade of Concrete                           | : | M45  |
| Compressive strength (cube) f <sub>ck</sub> | : | 45 MPa                                       |
| Density                                     | : | 2.5 t/m <sup>3</sup> or 25 KN/m <sup>3</sup> |
| Modulus of elasticity                       | : | 33 GPa                                       |
| Poissons Ratio                              | : | 0.2  |
| Coeff. of Thermal Expansion                 | : | 12.0 x 10 <sup>-06</sup> per deg.            |

|   |             |
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| Description: 2 Design Basis<br>2.4 Design Codes and Standards | Project No. |
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|   |                                   |  |             |               |   |           |   |   |                       |                                 |   |                       |                   |   |                          |                     |   |         |                                  |   |         |                |   |            |  |   |                        |                               |   |                          |                       |   |              |                |   |     |                           |   |      |                                |   |       |        |   |                   |                  |   |         |                                |   |                     |                                 |   |          |  |   |               |                                    |   |      |                       |   |              |  |   |     |
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| Designer: VKS Infratech Management Pvt. Ltd.  |                                   |  |             |               |   |           |   |   |                       |                                 |   |                       |                   |   |                          |                     |   |         |                                  |   |         |                |   |            |  |   |                        |                               |   |                          |                       |   |              |                |   |     |                           |   |      |                                |   |       |        |   |                   |                  |   |         |                                |   |                     |                                 |   |          |  |   |               |                                    |   |      |                       |   |              |  |   |     |
| RM Bridge Professional Engineering Software   |                                   |  |             |               |   |           |   |   |                       |                                 |   |                       |                   |   |                          |                     |   |         |                                  |   |         |                |   |            |  |   |                        |                               |   |                          |                       |   |              |                |   |     |                           |   |      |                                |   |       |        |   |                   |                  |   |         |                                |   |                     |                                 |   |          |  |   |               |                                    |   |      |                       |   |              |  |   |     |
| project   | Arunachal Extradosed 63m+260m+63m |  | 6/03/2022   |               |   |           |   |   |                       |                                 |   |                       |                   |   |                          |                     |   |         |                                  |   |         |                |   |            |  |   |                        |                               |   |                          |                       |   |              |                |   |     |                           |   |      |                                |   |       |        |   |                   |                  |   |         |                                |   |                     |                                 |   |          |  |   |               |                                    |   |      |                       |   |              |  |   |     |
| <div>2.5.3 Reinforcement Steel</div> <p>All reinforcement shall be high yield strength deformed (HYSD steel) TMT bar, Grade Fe500 conforming to IS 1786-2008 and Table 18.1 of IRC: 112-2011.</p> <table><tr><td>Nominal sizes</td><td>:</td><td>All sizes</td></tr><tr><td>Characteristic Yeild Strength, <math>f_{yk}</math></td><td>:</td><td>500 N/mm<sup>2</sup></td></tr><tr><td>Design Yeild Strength, <math>f_{yd}</math></td><td>:</td><td>434 N/mm<sup>2</sup></td></tr><tr><td>Young's modulus E</td><td>:</td><td>200000 N/mm<sup>2</sup></td></tr></table> <div>2.5.4 Prestressing Steel</div> <p>Pre-stressing steel shall be stress relieved Class II 7 ply strands of low relaxation type conforming to IS:14268 and Table 18.4 of IRC:112. The characteristics of stress relieved strands are as follows,</p> <table><tr><td>Young's Modulus (E)</td><td>:</td><td>195 GPa</td></tr><tr><td>Pre-stressing strand nominal dia</td><td>:</td><td>15.2 mm</td></tr><tr><td>Area of strand</td><td>:</td><td>140 sq. mm</td></tr><tr><td>Characteristic Tensile Strength <math>f_{pk}</math></td><td>:</td><td>1860 N/mm<sup>2</sup></td></tr><tr><td>0.1% Proof stress <math>f_{p0.1k}</math></td><td>:</td><td>1618.2 N/mm<sup>2</sup></td></tr><tr><td>Maximum Jacking force</td><td>:</td><td>78.3% of UTS</td></tr><tr><td>Anchorage Slip</td><td>:</td><td>6mm</td></tr></table> <p>Strand relaxation Loss shall not be more than 2.5% of 0.7 UTS tested at 1000 hours.<br/>Sheeting Duct Shall be Corrugated HDPE and friction and wobble effect shall be as per Table 7.1 IRC: 112-2011</p> <table><tr><td>Coefficient of Friction ?</td><td>:</td><td>0.17</td></tr><tr><td>Coefficient of Wobble Effect k</td><td>:</td><td>0.002</td></tr></table> <div>2.5.5 Stay Cable System</div> <p>Stay Cable system shall consist of Parallel Strand stay system Conforming to following specification</p> <table><tr><td>Strand</td><td>:</td><td>7-wire galvanized</td></tr><tr><td>Nominal diameter</td><td>:</td><td>15.7 mm</td></tr><tr><td>Specified cross-sectional area</td><td>:</td><td>150 mm<sup>2</sup></td></tr><tr><td>Nominal tensile strength (GUTS)</td><td>:</td><td>1860 MPa</td></tr><tr><td>Specified characteristic breaking load</td><td>:</td><td>260 or 279 kN</td></tr><tr><td>Minimum elongation at maximum load</td><td>:</td><td>3.5%</td></tr><tr><td>Modulus of elasticity</td><td>:</td><td>195 ± 5% GPa</td></tr><tr><td>Max. D-value in deflected tensile test</td><td>:</td><td>20%</td></tr></table> |                                   |  |             | Nominal sizes | : | All sizes | Characteristic Yeild Strength, $f_{yk}$ | : | 500 N/mm <sup>2</sup> | Design Yeild Strength, $f_{yd}$ | : | 434 N/mm <sup>2</sup> | Young's modulus E | : | 200000 N/mm <sup>2</sup> | Young's Modulus (E) | : | 195 GPa | Pre-stressing strand nominal dia | : | 15.2 mm | Area of strand | : | 140 sq. mm | Characteristic Tensile Strength $f_{pk}$ | : | 1860 N/mm <sup>2</sup> | 0.1% Proof stress $f_{p0.1k}$ | : | 1618.2 N/mm <sup>2</sup> | Maximum Jacking force | : | 78.3% of UTS | Anchorage Slip | : | 6mm | Coefficient of Friction ? | : | 0.17 | Coefficient of Wobble Effect k | : | 0.002 | Strand | : | 7-wire galvanized | Nominal diameter | : | 15.7 mm | Specified cross-sectional area | : | 150 mm <sup>2</sup> | Nominal tensile strength (GUTS) | : | 1860 MPa | Specified characteristic breaking load | : | 260 or 279 kN | Minimum elongation at maximum load | : | 3.5% | Modulus of elasticity | : | 195 ± 5% GPa | Max. D-value in deflected tensile test | : | 20% |
| Nominal sizes   | :                                 | All sizes  |             |               |   |           |   |   |                       |                                 |   |                       |                   |   |                          |                     |   |         |                                  |   |         |                |   |            |  |   |                        |                               |   |                          |                       |   |              |                |   |     |                           |   |      |                                |   |       |        |   |                   |                  |   |         |                                |   |                     |                                 |   |          |  |   |               |                                    |   |      |                       |   |              |  |   |     |
| Characteristic Yeild Strength, $f_{yk}$   | :                                 | 500 N/mm <sup>2</sup>  |             |               |   |           |   |   |                       |                                 |   |                       |                   |   |                          |                     |   |         |                                  |   |         |                |   |            |  |   |                        |                               |   |                          |                       |   |              |                |   |     |                           |   |      |                                |   |       |        |   |                   |                  |   |         |                                |   |                     |                                 |   |          |  |   |               |                                    |   |      |                       |   |              |  |   |     |
| Design Yeild Strength, $f_{yd}$   | :                                 | 434 N/mm <sup>2</sup>  |             |               |   |           |   |   |                       |                                 |   |                       |                   |   |                          |                     |   |         |                                  |   |         |                |   |            |  |   |                        |                               |   |                          |                       |   |              |                |   |     |                           |   |      |                                |   |       |        |   |                   |                  |   |         |                                |   |                     |                                 |   |          |  |   |               |                                    |   |      |                       |   |              |  |   |     |
| Young's modulus E   | :                                 | 200000 N/mm <sup>2</sup>   |             |               |   |           |   |   |                       |                                 |   |                       |                   |   |                          |                     |   |         |                                  |   |         |                |   |            |  |   |                        |                               |   |                          |                       |   |              |                |   |     |                           |   |      |                                |   |       |        |   |                   |                  |   |         |                                |   |                     |                                 |   |          |  |   |               |                                    |   |      |                       |   |              |  |   |     |
| Young's Modulus (E)   | :                                 | 195 GPa  |             |               |   |           |   |   |                       |                                 |   |                       |                   |   |                          |                     |   |         |                                  |   |         |                |   |            |  |   |                        |                               |   |                          |                       |   |              |                |   |     |                           |   |      |                                |   |       |        |   |                   |                  |   |         |                                |   |                     |                                 |   |          |  |   |               |                                    |   |      |                       |   |              |  |   |     |
| Pre-stressing strand nominal dia  | :                                 | 15.2 mm  |             |               |   |           |   |   |                       |                                 |   |                       |                   |   |                          |                     |   |         |                                  |   |         |                |   |            |  |   |                        |                               |   |                          |                       |   |              |                |   |     |                           |   |      |                                |   |       |        |   |                   |                  |   |         |                                |   |                     |                                 |   |          |  |   |               |                                    |   |      |                       |   |              |  |   |     |
| Area of strand  | :                                 | 140 sq. mm   |             |               |   |           |   |   |                       |                                 |   |                       |                   |   |                          |                     |   |         |                                  |   |         |                |   |            |  |   |                        |                               |   |                          |                       |   |              |                |   |     |                           |   |      |                                |   |       |        |   |                   |                  |   |         |                                |   |                     |                                 |   |          |  |   |               |                                    |   |      |                       |   |              |  |   |     |
| Characteristic Tensile Strength $f_{pk}$  | :                                 | 1860 N/mm <sup>2</sup>   |             |               |   |           |   |   |                       |                                 |   |                       |                   |   |                          |                     |   |         |                                  |   |         |                |   |            |  |   |                        |                               |   |                          |                       |   |              |                |   |     |                           |   |      |                                |   |       |        |   |                   |                  |   |         |                                |   |                     |                                 |   |          |  |   |               |                                    |   |      |                       |   |              |  |   |     |
| 0.1% Proof stress $f_{p0.1k}$   | :                                 | 1618.2 N/mm <sup>2</sup>   |             |               |   |           |   |   |                       |                                 |   |                       |                   |   |                          |                     |   |         |                                  |   |         |                |   |            |  |   |                        |                               |   |                          |                       |   |              |                |   |     |                           |   |      |                                |   |       |        |   |                   |                  |   |         |                                |   |                     |                                 |   |          |  |   |               |                                    |   |      |                       |   |              |  |   |     |
| Maximum Jacking force   | :                                 | 78.3% of UTS   |             |               |   |           |   |   |                       |                                 |   |                       |                   |   |                          |                     |   |         |                                  |   |         |                |   |            |  |   |                        |                               |   |                          |                       |   |              |                |   |     |                           |   |      |                                |   |       |        |   |                   |                  |   |         |                                |   |                     |                                 |   |          |  |   |               |                                    |   |      |                       |   |              |  |   |     |
| Anchorage Slip  | :                                 | 6mm  |             |               |   |           |   |   |                       |                                 |   |                       |                   |   |                          |                     |   |         |                                  |   |         |                |   |            |  |   |                        |                               |   |                          |                       |   |              |                |   |     |                           |   |      |                                |   |       |        |   |                   |                  |   |         |                                |   |                     |                                 |   |          |  |   |               |                                    |   |      |                       |   |              |  |   |     |
| Coefficient of Friction ?   | :                                 | 0.17   |             |               |   |           |   |   |                       |                                 |   |                       |                   |   |                          |                     |   |         |                                  |   |         |                |   |            |  |   |                        |                               |   |                          |                       |   |              |                |   |     |                           |   |      |                                |   |       |        |   |                   |                  |   |         |                                |   |                     |                                 |   |          |  |   |               |                                    |   |      |                       |   |              |  |   |     |
| Coefficient of Wobble Effect k  | :                                 | 0.002  |             |               |   |           |   |   |                       |                                 |   |                       |                   |   |                          |                     |   |         |                                  |   |         |                |   |            |  |   |                        |                               |   |                          |                       |   |              |                |   |     |                           |   |      |                                |   |       |        |   |                   |                  |   |         |                                |   |                     |                                 |   |          |  |   |               |                                    |   |      |                       |   |              |  |   |     |
| Strand  | :                                 | 7-wire galvanized  |             |               |   |           |   |   |                       |                                 |   |                       |                   |   |                          |                     |   |         |                                  |   |         |                |   |            |  |   |                        |                               |   |                          |                       |   |              |                |   |     |                           |   |      |                                |   |       |        |   |                   |                  |   |         |                                |   |                     |                                 |   |          |  |   |               |                                    |   |      |                       |   |              |  |   |     |
| Nominal diameter  | :                                 | 15.7 mm  |             |               |   |           |   |   |                       |                                 |   |                       |                   |   |                          |                     |   |         |                                  |   |         |                |   |            |  |   |                        |                               |   |                          |                       |   |              |                |   |     |                           |   |      |                                |   |       |        |   |                   |                  |   |         |                                |   |                     |                                 |   |          |  |   |               |                                    |   |      |                       |   |              |  |   |     |
| Specified cross-sectional area  | :                                 | 150 mm <sup>2</sup>  |             |               |   |           |   |   |                       |                                 |   |                       |                   |   |                          |                     |   |         |                                  |   |         |                |   |            |  |   |                        |                               |   |                          |                       |   |              |                |   |     |                           |   |      |                                |   |       |        |   |                   |                  |   |         |                                |   |                     |                                 |   |          |  |   |               |                                    |   |      |                       |   |              |  |   |     |
| Nominal tensile strength (GUTS)   | :                                 | 1860 MPa   |             |               |   |           |   |   |                       |                                 |   |                       |                   |   |                          |                     |   |         |                                  |   |         |                |   |            |  |   |                        |                               |   |                          |                       |   |              |                |   |     |                           |   |      |                                |   |       |        |   |                   |                  |   |         |                                |   |                     |                                 |   |          |  |   |               |                                    |   |      |                       |   |              |  |   |     |
| Specified characteristic breaking load  | :                                 | 260 or 279 kN  |             |               |   |           |   |   |                       |                                 |   |                       |                   |   |                          |                     |   |         |                                  |   |         |                |   |            |  |   |                        |                               |   |                          |                       |   |              |                |   |     |                           |   |      |                                |   |       |        |   |                   |                  |   |         |                                |   |                     |                                 |   |          |  |   |               |                                    |   |      |                       |   |              |  |   |     |
| Minimum elongation at maximum load  | :                                 | 3.5%   |             |               |   |           |   |   |                       |                                 |   |                       |                   |   |                          |                     |   |         |                                  |   |         |                |   |            |  |   |                        |                               |   |                          |                       |   |              |                |   |     |                           |   |      |                                |   |       |        |   |                   |                  |   |         |                                |   |                     |                                 |   |          |  |   |               |                                    |   |      |                       |   |              |  |   |     |
| Modulus of elasticity   | :                                 | 195 ± 5% GPa   |             |               |   |           |   |   |                       |                                 |   |                       |                   |   |                          |                     |   |         |                                  |   |         |                |   |            |  |   |                        |                               |   |                          |                       |   |              |                |   |     |                           |   |      |                                |   |       |        |   |                   |                  |   |         |                                |   |                     |                                 |   |          |  |   |               |                                    |   |      |                       |   |              |  |   |     |
| Max. D-value in deflected tensile test  | :                                 | 20%  |             |               |   |           |   |   |                       |                                 |   |                       |                   |   |                          |                     |   |         |                                  |   |         |                |   |            |  |   |                        |                               |   |                          |                       |   |              |                |   |     |                           |   |      |                                |   |       |        |   |                   |                  |   |         |                                |   |                     |                                 |   |          |  |   |               |                                    |   |      |                       |   |              |  |   |     |
| Description: 2 Design Basis<br>2.4 Design Codes and Standards   |                                   |  | Project No. |               |   |           |   |   |                       |                                 |   |                       |                   |   |                          |                     |   |         |                                  |   |         |                |   |            |  |   |                        |                               |   |                          |                       |   |              |                |   |     |                           |   |      |                                |   |       |        |   |                   |                  |   |         |                                |   |                     |                                 |   |          |  |   |               |                                    |   |      |                       |   |              |  |   |     |
| Page : 10   |                                   |  |             |               |   |           |   |   |                       |                                 |   |                       |                   |   |                          |                     |   |         |                                  |   |         |                |   |            |  |   |                        |                               |   |                          |                       |   |              |                |   |     |                           |   |      |                                |   |       |        |   |                   |                  |   |         |                                |   |                     |                                 |   |          |  |   |               |                                    |   |      |                       |   |              |  |   |     |

|  |                                   |  |  |
|--|-----------------------------------|--|--|
| Designer: VKS Infratech Management Pvt. Ltd. |                                   |  |  |
| RM Bridge Professional Engineering Software  |                                   |  |  |
| project                                      | Arunachal Extradosed 63m+260m+63m | 6/03/2022  |  |

## 2.6 Loads

### 2.6.1 Self weight (SW)

Self Weight of structure is automatically calculated by software from the density of concrete specified ie. 25 t/m<sup>3</sup> (Clause 203 of IRC:6-2017) or 25 kN/m<sup>3</sup>.

### 2.6.2 Superimposed Dead Load of Crash Barrier and Railing (SD)

Super imposed Dead load consist of Load of Crash Barrier and is take as follows

|                                     |              |                        |
|-------------------------------------|--------------|------------------------|
| Cross Section area of Crash Barrier | =            | 0.5 m <sup>2</sup>     |
| Density of Concrete                 | =            | 25 kN/m <sup>3</sup>   |
| Load per unit length                | = 0.5*25     | = 12.5 kN/m            |
| Width of Crash Barrier              | =            | 0.5 m                  |
| Plan Area                           | = 1 * 0.5    | = 0.5 m <sup>2</sup>   |
| Load per unit plan area             | = 12.5 / 0.5 | = 25 kN/m <sup>2</sup> |

## 2.7 Superimposed Dead Load of Surfacing (SDS)

Surfacing consist of 75mm thick concrete wearing course. The load calculation is as follows

|                             |              |                           |
|-----------------------------|--------------|---------------------------|
| Thickness of Wearing course | =            | 0.075 m                   |
| Density of Concrete         | =            | 25 kN/m <sup>3</sup>      |
| Load per unit plan area     | = 0.075 * 25 | = 1.875 kN/m <sup>2</sup> |

### 2.7.1 Live Load Including Impact

The bridge is to be designed as per Clause 204.3 of IRC:6-2010. Since the Cairrageway width is 8.7m

| Cairrageway width                | 11 m   |                          |
|----------------------------------|--|--------------------------|
| No of lanes for design purposed  | 3  | Table 2 of IRC:6 2017    |
| Design Live Load Combination     | 3 Lane of Class-A or 1 lane 70R + 1Lane Class- | Table 2 of IRC:6 2017    |
| Reduction in Longitudinal Effect | NIL  | Clause 205 of IRC:6 2017 |


Analysis is carried out for both the above loadings and worst effect is taken for design

Dynamic Impact to be taken as per Clause 208 of IRC:6-2017. The impact factor for Longitudinal direction is as given below

| Effective Span   | Impact % = 8.8% ie. Impact Factor on LL = 1.088 |                                 |
|------------------|---|---------------------------------|
| Class A Train    | Impact % = 8.8% ie. Impact Factor on LL = 1.088 | Cl. 208.2 (i) of IRC:6 2017     |
| Class 70 R Train | Impact % = 8.8% ie. Impact Factor on LL = 1.088 | Cl. 208.3 (b) (i) of IRC:6 2017 |

|  |             |
|--|-------------|
| Description: 2 Design Basis<br>2.6 Loads | Project No. |
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|  |  |           |
|--|--|-----------|
| Designer: VKS Infratech Management Pvt. Ltd. |  |           |
| RM Bridge Professional Engineering Software  |  |           |
| project Arunachal Extradosed 63m+260m+63m    |  | 6/03/2022 |

## 2.7.2 Overall Temperature (OT)

Overall temperature rises and fall 28 deg C is considered in design as per Clause 215.2 of IRC:6-2017 as calculated below

|  |             |                        |
|--|-------------|------------------------|
| Maximum air shade Temperature                                  | 37.50 deg C | Fig. 15 of IRC:6 2017  |
| Minimum air shade Temperature                                  | 2.500 deg C | Fig. 16 of IRC:6 2017  |
| Mean of maximum and minimum airshade temp.                     | 20.00 deg C |                        |
| Increment temp.  | 10.00 deg C | Table 15 of IRC:6 2017 |
| Assumed Bridge Temp. when it is effectively restrained For Tem | 10.00 deg C | Table 15 of IRC:6 2017 |
| Assumed Bridge Temp. when it is effectively restrained For Tem | 30.00 deg C | Table 15 of IRC:6 2017 |
| Temperature Rise   | 27.50 deg C | say 28 deg C           |
| Temperature fall   | -27.5 deg C | say -28 deg C          |

## 2.7.3 Temperature Gradient (TGRAD)

Temperature Gradient for both rise and fall considered as per Figure 10a of Clause 215.3 of IRC:6-2017 as shown below

Girder Height (h) = 2.6 m

### For Temp Rise Case

$h_1 = \min(0.3h, 0.15m)$  = 0.15 m

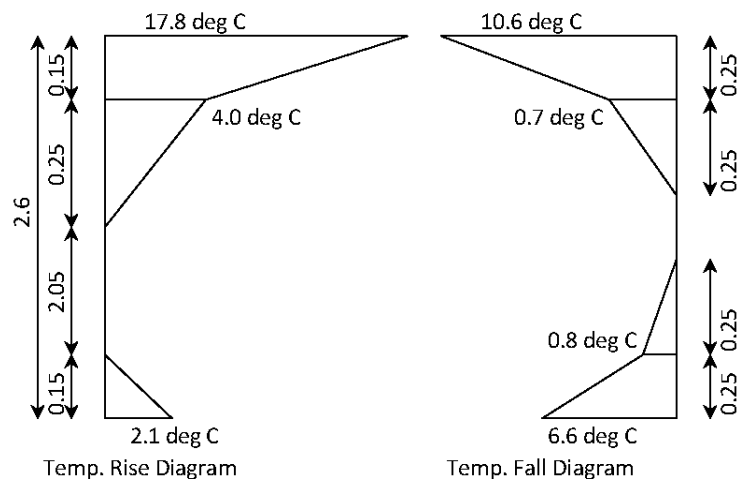
$h_1 = \min(\max(0.3h, 0.15m), 0.25m)$  = 0.25 m

$h_1 = \min(0.3h, 0.15m)$  = 0.15 m

### For Temp Fall Case

$h_1 = h_4 = \min(0.2h, 0.25m)$  = 0.25 m

$h_2 = h_3 = \min(0.25h, 0.25m)$  = 0.25 m



## 2.7.4 SEISMIC FORCE (EQ)

### 2.7.4.1 Seismic Zone And Zone Factor ( Z )

As Per Fig 18 of IRC:6-2017 Agra is in Seismic Zone - V. Hence as per Table 16 Clause 219.2 of IRC:6-2017 the zone factor is taken as below


Zone Factor (Z) = 0.36

### 2.7.4.2 Seismic Importance Factor ( I )

As Per Table 19 Clause 219.5.1.1 of IRC:6-2017 importance factor for Bridge on national and state highways is taken as below

Seismic importance Factor ( I ) = 1.2

|  |             |
|--|-------------|
| Description: 2 Design Basis<br>2.6 Loads | Project No. |
|  | Page : 12   |

|   |                                   |  |           |
|---|-----------------------------------|--|-----------|
| Designer: VKS Infratech Management Pvt. Ltd.  |                                   |  |           |
| RM Bridge Professional Engineering Software   |                                   |  |           |
| project   | Arunachal Extradosed 63m+260m+63m |  | 6/03/2022 |
| <div>2.7.4.3      Method for analysis</div> <p>Elastic Response Spectrum Method Is used for Calculation of seismic force as per Clause 219.5 (2) of IRC:6 - 2017</p> <div>2.7.4.4      Horizontal Seismic Force Coefficient</div> <p>As per Clause 219.5.1 of IRC:6 - 2017 the seismic force acting at centre of mass is given as<br/>Feq = Ah (Dead Load + Appropriate Live Load)<br/>where Ah is Horizontal seismic coefficient and is given by<br/>Ah = ( Z/2 ) x ( I ) x ( Sa/g )<br/>where Sa/g is average responses acceleration coeff for 5 % damping and depend on period of vibration and for the Rockt or Hard soil (Type-I soil with N&gt;30) assumed at site is calculated as below<br/>Sa/g = 1+1.5T    for 0.00 &lt;= T &lt;= 0.10<br/>Sa/g = 2.5    </p> |                                   |  |           |



## 2.8 Load Combination For Limit State Design

The superstructure is designed as per Limit state Design approach (IRC: 112-2011) and Combination of load for limit state design as per Clause 202.3/Annexure-B of IRC: 6-2017 are taken for design verification. The load factors for various loads under Ultimate Limit State and Serviceability Limit state

### 2.8.1 Load Combination for Ultimate Limit State (Structural Strength)

| LC     | Description                | Basic Combination |              | Seismic Combination |              |
|--------|----------------------------|-------------------|--------------|---------------------|--------------|
|        |                            | Fav. Fact.        | Un-Fav. Fact | Fav. Fact.          | Un-Fav. Fact |
| SW     | Self Weight                | 1.00              | 1.35         | 1.00                | 1.35         |
| SD     | SIDL for Crash Barrier     | 1.00              | 1.35         | 1.00                | 1.35         |
| SDS    | SIDL for Surfacing         | 1.00              | 1.75         | 1.00                | 1.75         |
| PS     | Prestressing Force         | 1.00              | 1.00         | 1.00                | 1.00         |
| CS     | Creep Shrinkage            | 1.00              | 1.00         | 1.00                | 1.00         |
| LL_Dyn | Live Load Including Impact | 1.50              | 1.50         | 0.20                | 0.2          |
| OT     | Overall Temperature        | 0.90              | 0.90         | 0.50                | 0.50         |
| TGRAD  | Temperature Gradient       | 0.90              | 0.90         | 0.50                | 0.50         |
| EQ     | Seismic Force              |                   |              | 1.50                | 1.50         |

### 2.8.2 Load Combination for Serviceability Limit State


| LC     | Description                | Rare Comb. |              | Freq. Comb. |              | Quasi-perm. Comb. |              |
|--------|----------------------------|------------|--------------|-------------|--------------|-------------------|--------------|
|        |                            | Fav. Fact. | Un-Fav. Fact | Fav. Fact.  | Un-Fav. Fact | Fav. Fact.        | Un-Fav. Fact |
| SW     | Self Weight                | 1.00       | 1.00         | 1.00        | 1.00         | 1.00              | 1.00         |
| SD     | SIDL for Crash Barrier     | 1.00       | 1.00         | 1.00        | 1.00         | 1.00              | 1.00         |
| SDS    | SIDL for Surfacing         | 1.00       | 1.20         | 1.00        | 1.20         | 1.00              | 1.20         |
| PS     | Prestressing Force         | 0.90       | 1.10         | 0.90        | 1.10         | 0.90              | 1.10         |
| CS     | Creep Shrinkage            | 1.00       | 1.00         | 1.00        | 1.00         | 1.00              | 1.00         |
| LL_Dyn | Live Load Including Impact | 1.00       | 1.00         | 0.75        | 0.75         |                   |              |
| OT     | Overall Temperature        | 0.60       | 0.60         | 0.50        | 0.50         | 0.50              | 0.50         |
| TGRAD  | Temperature Gradient       | 0.60       | 0.60         | 0.50        | 0.50         | 0.50              | 0.50         |

## 2.9 Design Code Check for Verification of Limit states

Verification of Limit states shall be carried out in accordance with provision of IRC:112-2011.

### 2.9.1 Verification of Ultimate Limit State of Structural Strength

Verification of Ultimate Limit State of Structural Strength shall be carried out by checking that Ultimate Moment of Resistance of Prestressed section does not exceed Ultimate Section Moment Capacity. The Ultimate moment capacity is calculated by considering following stress-strain relationship for concrete material and prestressing materials. Conservatively reinforcing steel is ignored in calculation.

|  |                                   |  |           |
|--|-----------------------------------|--|-----------|
| Designer: VKS Infratech Management Pvt. Ltd. |                                   |  |           |
| RM Bridge Professional Engineering Software  |                                   |  |           |
| project                                      | Arunachal Extradosed 63m+260m+63m |  | 6/03/2022 |

2.9.1.1

Parabolic Rectangular Concrete Stress Strain Block

The stress strain relation for concrete is taken as parabolic rectangular stress strain block as per clause 6.4.2.8 (1)(a) of IRC:112-2011. Specifically for grade M55 of concrete used the stress strain block is as defined below and RM V8i implementation is shown in Fig. 1

|                  |                               |                                   |                           |
|------------------|-------------------------------|-----------------------------------|---------------------------|
| Concrete Grade   | M40                           |                                   |                           |
| $f_{ck}$         | 40                            | $N/mm^2$                          |                           |
| $\epsilon_{cu2}$ | 0.0035                        | IRC:112-2011 Table 6.5            |                           |
| $\epsilon_{c2}$  | 0.002                         | IRC:112-2011 Table 6.5            |                           |
| $\alpha$         | 0.67                          |                                   |                           |
| $\gamma_m$       | 1.5                           | For Basic and seismic combination |                           |
| $f_{cd}$         | $=\alpha f_{ck} / \gamma_m =$ | 17.8667                           | $N/mm^2$ 17866.7 $kN/m^2$ |

then eq. for concrete stress for any given strain is

|            |   |   |  |
|------------|---|---|--|
| $\sigma_c$ | $=f_{cd}( 1 - ( 1-\epsilon_c/\epsilon_{c2} )^n )$ | For $0 \leq \epsilon_c \leq \epsilon_{c2}$              |  |
|            | $=f_{cd}$   | For $\epsilon_{c2} \leq \epsilon_c \leq \epsilon_{cu2}$ |  |

where  $n=$  2 IRC:112-2011 Table 6.5

2.9.1.2

Stress Strain relation for Prestressing Steel

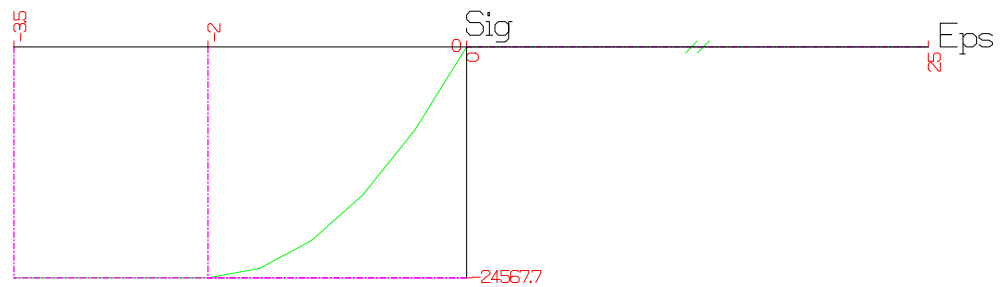
The stress strain relation for Prestressing steel is taken as bilinear diagram as per clause 6.3.5 of IRC:112-2011. Specifically for grade 1860 used the stress strain relation is as defined below RM V8i implementation is shown in Fig. 2

|                 |                      |                                   |  |
|-----------------|----------------------|-----------------------------------|--|
| $f_{pk}$        | 1861.196             | $N/mm^2$                          |  |
| $f_{p0.1k}$     | $=0.87f_{pk}=$       | 1619.240                          | $N/mm^2$ IRC:112-2011 Cl. 6.3.5            |
| $\gamma_s$      | 1.15                 | For Basic and seismic combination |  |
| $f_{pd}$        | 1408.035             | $N/mm^2$                          | 1408035 $kN/m^2$ IRC:112-2011 Cl. 6.3.5    |
| $E_p$           | 195                  | GPa                               | 195000 $N/mm^2$ IRC:112-2011 Cl. 6.3.5     |
| $\epsilon$      | $=f_{pd}/E_p=$       | 0.00722                           | IRC:112-2011 Cl. 6.3.5                     |
| $\epsilon_{ud}$ | 0.020                | IRC:105-2015 Cl. 4.3.1            |  |
| $\epsilon_{uk}$ | $=\epsilon_{ud}/0.9$ | 0.0222                            | IRC:112-2011 Cl. 6.3.5                     |
| $f_{ud}$        | 1587.954             | $N/mm^2$                          | 1587954 $kN/m^2$ Obtained by Interpolation |

|  |  |             |
|--|--|-------------|
| Description: 2 Design Basis<br>2.8 Load Combination For Limit State Design |  | Project No. |
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## Material Ultimate diagram IRCIndia-2011:M55

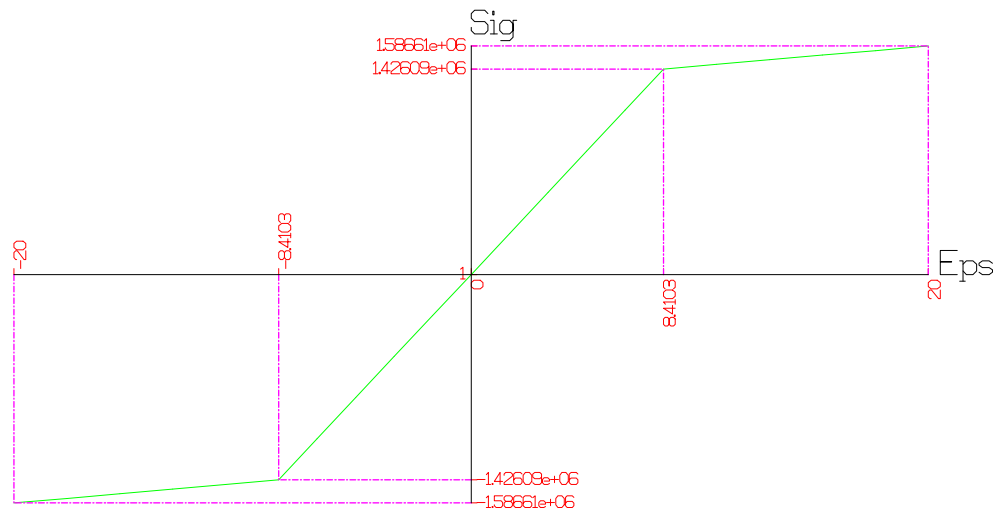


| EPS  | SIG (kN/m <sup>2</sup> ) | Delt-L     | Delt-R | Delt-inp |
|------|--------------------------|------------|--------|----------|
| -3.5 | -24567.7                 |            |        | No       |
| -2   | -24566.7                 |            | 0      | Right    |
| 0    | 0                        | 2.4567e+07 |        | Left     |
| 25   | 1                        |            |        | No       |

"Figure 1. RM V8i implementation of parabolic stress block for Concrete Grade M55"




# Material Ultimate diagram EN Eurocode: Strand-1640/1860



| EPS     | SIG (kN/m <sup>2</sup> ) | Delt-L | Delt-R | Delt-inp |
|---------|--------------------------|--------|--------|----------|
| -20     | -1.58661e+06             |        |        | No       |
| -8.4103 | -1.42609e+06             |        |        | No       |
| 0       | 1                        |        |        | No       |
| 8.4103  | 1.42609e+06              |        |        | No       |
| 20      | 1.58661e+06              |        |        | No       |

"Figure 2. RM V8i implementation of stress strain relation for prestressing steel grade 1860"

|  |                                   |  |           |
|--|-----------------------------------|--|-----------|
| Designer: VKS Infratech Management Pvt. Ltd. |                                   |  |           |
| RM Bridge Professional Engineering Software  |                                   |  |           |
| project                                      | Arunachal Extradosed 63m+260m+63m |  | 6/03/2022 |

### 2.9.2 Verification of Ultimate Limit State Of Shear and Torsion

Verification For Shear is carried out on basis of clause 10.3.3.2 and for torsion based on clause 10.5.2.1 of IRC:112-2011

RM V8i calculates at all points in structure

1.

Shear Capacity Factor CFQ

2.

Torsion Capacity Factor CFT

3.

Combined Shear and Torsion Capacity Factor CFQT

= VEd / VRd.max

=TEd / TRd.max

=TEd / TRd.max + VEd / VRd.max

Where

VEd is design shear force,

VRd,max is Shear Resistance of section calculated in accordance with equation 10.8 of IRC:112-2011.

TEd is design torsional moment

TRd.max is torsional moment of resistance calculated in accordance with Equation 10.48 of IRC:112-2011.

For Safety of structural Dimension it shall be ensured that CFQ and CFT are less than equal to 1.0 and also the combined factor CFQT is also less than equal to 1.0 as per equation 10.47 of IRC:112-2011 If this condition is not satisfied the dimension of section need to be revised.

The software then calculates the Shear Reinforcement requirement for shear due to flexure (Avq) and shear reinforcement requirement for shear due to torsion (Avt) as per equation 10.7 of IRC:112-2011 The minimum shear reinforcement is calculated as per equation 16.4 and 16.5 of IRC:112-2011.

### 2.9.3 Verification of Serviceability Limit State

Verification of Serviceability Limit State consist of Following checks

#### 2.9.3.1 Limit State of Internal Stresses

As per Annexure-B clause 7.1 of IRC:6-2017 the internal stress in the structure shall be checked under Rare Combination.

**Stress Limitation in Concrete**

1. As per clause 12. (2) of IRC:112-2011 the section shall be assumed as uncracked if tensile stress is less than fctm or fctm/tl else stresses shall be calculated by cracked section analysis.

For M50 Grade of concrete used

fctm = 3.5 Mpa or 3500 kN/m^2

Table 6.5 of IRC:112-2011

2. As per Clause 12.2.1. allowable compressive strength for concrete shall be 0.48 fck.

For M50 grade concrete used

Allowable comp stresss = 24 Mpa or 24000 kN/m^2

For Construction stage at 7 days

S = 2.5 for OPC

t =7 days

t1 =1 days

Bcc(t) = exp(S(1-(28/(t/t1))^(1/2))) = 0.7788

fcm(t) = Bcc(t) x fcm = 38.9 MPa

Allowable comp stresss = 18.691 Mpa or 18691 kN/m^2

**Stress Limitation in Prestressing Steel**

As per clause 7.9.2 of IRC:112-2011 Maximum prestressing force applied immediately after transfer shall not exceed minimum of 0.75fpk or 0.85\*fp0.1k


For 1860 grade cable used

fpk = 1861.196 Mpa

fp0.1k = 1619.240 Mpa

|  |  |             |
|--|--|-------------|
| Description: 2 Design Basis<br>2.8 Load Combination For Limit State Design |  | Project No. |
|  |  | Page : 18   |



|  |  |             |        |
|--|--|-------------|--------|
| Designer: VKS Infratech Management Pvt. Ltd.<br>RM Bridge Professional Engineering Software  |  |             |        |
| project Arunachal Extradosed 63m+260m+63m  | 6/03/2022  |             |        |
| $0.75f_{pk} = 1395.897 \text{ Mpa}$ $0.85f_{p0.1k} = 1376.354 \text{ Mpa}$ <p>Allowable stress in prestressing steel at transfer is limited to 1376 Mpa</p>  |  |             |        |
| <h3>2.9.3.2 Limit State of Fatigue</h3> <p>As per Clause 204.6 of IRC:6-2017 the bridge shall be checked for fatigue under frequent combination with load factor for fatigue load taken as 1.0.<br/>         However as per clause 5.3.2.5 (b) of IRC:112-2017 fatigue varification is nort nessessary for prestressed concrete structures if under frequent combination of action only compressive stress occur in extreme fibre.</p> <p>Hence for design purpose we ensure no tensile stress design under frequent combination. Hence no fatigue verification is required.</p> |  |             |        |
| <h3>2.9.3.3 Limit State of Cracking</h3> <p>As per Annexure-B clause 7.1 of IRC:6-2017 the crack width in the Prestressed structure shall be checked under Frequent Combination.<br/>         How ever since we a ensuring as stated above no tensile stress design, the cracking do not occur. hence no crack width check is carried out.</p>   |  |             |        |
| <h3>2.9.3.4 Limit State of Deflection</h3> <p>As per Clause 12.4.1 (2) of IRC:112-2011 the deflection under live load shall be limited to Span /1000</p> <div style="display: flex; justify-content: center; align-items: center; gap: 20px;"> <div>Span</div> <div>=</div> <div>260000mm</div> </div> <div style="display: flex; justify-content: center; align-items: center; gap: 20px;"> <div>Span/800</div> <div>=</div> <div>260 mm</div> </div>   |  |             |        |
| <h2>3 Description of Structural Model</h2>   |  |             |        |
| <h3>3.1 Nodal Coordinates</h3>   |  |             |        |
| <b>Nodes - Coordinates</b>   |  |             |        |
| node   | x<br>m   | y<br>m      | z<br>m |
| 101  | 0.0000   | 0.0000      | 0.0000 |
| 102  | 1.1500   | 0.0000      | 0.0000 |
| 103  | 1.5000   | 0.0000      | 0.0000 |
| 104  | 3.0000   | 0.0000      | 0.0000 |
| 105  | 5.3438   | 0.0000      | 0.0000 |
| 106  | 7.6875   | 0.0000      | 0.0000 |
| 107  | 10.0313  | 0.0000      | 0.0000 |
| 108  | 12.3750  | 0.0000      | 0.0000 |
| 109  | 15.0000  | 0.0000      | 0.0000 |
| 110  | 17.0625  | 0.0000      | 0.0000 |
| 111  | 19.4063  | 0.0000      | 0.0000 |
| 112  | 21.7500  | 0.0000      | 0.0000 |
| 113  | 24.0938  | 0.0000      | 0.0000 |
| 114  | 26.4375  | 0.0000      | 0.0000 |
| 115  | 28.7813  | 0.0000      | 0.0000 |
| 116  | 31.1250  | 0.0000      | 0.0000 |
| 117  | 33.4688  | 0.0000      | 0.0000 |
| 118  | 35.8125  | 0.0000      | 0.0000 |
| 119  | 38.1563  | 0.0000      | 0.0000 |
| Description: 3 Description of Structural Model<br>3.1 Nodal Coordinates  |  | Project No. |        |
|  |  | Page : 19   |        |



| Nodes - Coordinates |          |        |        |  |
|---------------------|----------|--------|--------|--|
| node                | x        | y      | z      |  |
|                     | m        | m      | m      |  |
| 120                 | 40.5000  | 0.0000 | 0.0000 |  |
| 121                 | 42.8438  | 0.0000 | 0.0000 |  |
| 122                 | 45.1875  | 0.0000 | 0.0000 |  |
| 123                 | 47.5313  | 0.0000 | 0.0000 |  |
| 124                 | 49.8750  | 0.0000 | 0.0000 |  |
| 125                 | 51.9000  | 0.0000 | 0.0000 |  |
| 126                 | 53.9250  | 0.0000 | 0.0000 |  |
| 127                 | 55.9500  | 0.0000 | 0.0000 |  |
| 128                 | 57.9750  | 0.0000 | 0.0000 |  |
| 129                 | 60.0000  | 0.0000 | 0.0000 |  |
| 130                 | 61.5000  | 0.0000 | 0.0000 |  |
| 131                 | 63.0000  | 0.0000 | 0.0000 |  |
| 132                 | 64.5000  | 0.0000 | 0.0000 |  |
| 133                 | 66.0000  | 0.0000 | 0.0000 |  |
| 134                 | 71.0000  | 0.0000 | 0.0000 |  |
| 135                 | 76.0000  | 0.0000 | 0.0000 |  |
| 136                 | 81.0000  | 0.0000 | 0.0000 |  |
| 137                 | 86.0000  | 0.0000 | 0.0000 |  |
| 138                 | 91.0000  | 0.0000 | 0.0000 |  |
| 139                 | 96.0000  | 0.0000 | 0.0000 |  |
| 140                 | 101.0000 | 0.0000 | 0.0000 |  |
| 141                 | 106.0000 | 0.0000 | 0.0000 |  |
| 142                 | 111.0000 | 0.0000 | 0.0000 |  |
| 143                 | 116.0000 | 0.0000 | 0.0000 |  |
| 144                 | 121.0000 | 0.0000 | 0.0000 |  |
| 145                 | 126.0000 | 0.0000 | 0.0000 |  |
| 146                 | 131.0000 | 0.0000 | 0.0000 |  |
| 147                 | 136.0000 | 0.0000 | 0.0000 |  |
| 148                 | 141.0000 | 0.0000 | 0.0000 |  |
| 149                 | 146.0000 | 0.0000 | 0.0000 |  |
| 150                 | 151.0000 | 0.0000 | 0.0000 |  |
| 151                 | 156.0000 | 0.0000 | 0.0000 |  |
| 152                 | 161.0000 | 0.0000 | 0.0000 |  |
| 153                 | 166.0000 | 0.0000 | 0.0000 |  |
| 154                 | 171.0000 | 0.0000 | 0.0000 |  |
| 155                 | 176.0000 | 0.0000 | 0.0000 |  |
| 156                 | 181.0000 | 0.0000 | 0.0000 |  |
| 157                 | 186.0000 | 0.0000 | 0.0000 |  |
| 158                 | 191.0000 | 0.0000 | 0.0000 |  |
| 159                 | 193.0000 | 0.0000 | 0.0000 |  |
| 160                 | 195.0000 | 0.0000 | 0.0000 |  |
| 161                 | 200.0000 | 0.0000 | 0.0000 |  |
| 162                 | 205.0000 | 0.0000 | 0.0000 |  |
| 163                 | 210.0000 | 0.0000 | 0.0000 |  |
| 164                 | 215.0000 | 0.0000 | 0.0000 |  |
| 165                 | 220.0000 | 0.0000 | 0.0000 |  |
| 166                 | 225.0000 | 0.0000 | 0.0000 |  |
| 167                 | 230.0000 | 0.0000 | 0.0000 |  |
| 168                 | 235.0000 | 0.0000 | 0.0000 |  |
| 169                 | 240.0000 | 0.0000 | 0.0000 |  |
| 170                 | 245.0000 | 0.0000 | 0.0000 |  |
| 171                 | 250.0000 | 0.0000 | 0.0000 |  |
| 172                 | 255.0000 | 0.0000 | 0.0000 |  |
| 173                 | 260.0000 | 0.0000 | 0.0000 |  |
| 174                 | 265.0000 | 0.0000 | 0.0000 |  |
| 175                 | 270.0000 | 0.0000 | 0.0000 |  |
| 176                 | 275.0000 | 0.0000 | 0.0000 |  |
| 177                 | 280.0000 | 0.0000 | 0.0000 |  |
| 178                 | 285.0000 | 0.0000 | 0.0000 |  |
| 179                 | 290.0000 | 0.0000 | 0.0000 |  |
| 180                 | 295.0000 | 0.0000 | 0.0000 |  |



| Nodes - Coordinates |          |          |         |  |
|---------------------|----------|----------|---------|--|
| node                | x<br>m   | y<br>m   | z<br>m  |  |
| 181                 | 300.0000 | 0.0000   | 0.0000  |  |
| 182                 | 305.0000 | 0.0000   | 0.0000  |  |
| 183                 | 310.0000 | 0.0000   | 0.0000  |  |
| 184                 | 315.0000 | 0.0000   | 0.0000  |  |
| 185                 | 320.0000 | 0.0000   | 0.0000  |  |
| 186                 | 321.5000 | 0.0000   | 0.0000  |  |
| 187                 | 323.0000 | 0.0000   | 0.0000  |  |
| 188                 | 324.5000 | 0.0000   | 0.0000  |  |
| 189                 | 326.0000 | 0.0000   | 0.0000  |  |
| 190                 | 328.0250 | 0.0000   | 0.0000  |  |
| 191                 | 330.0500 | 0.0000   | 0.0000  |  |
| 192                 | 332.0750 | 0.0000   | 0.0000  |  |
| 193                 | 334.1000 | 0.0000   | 0.0000  |  |
| 194                 | 336.1250 | 0.0000   | 0.0000  |  |
| 195                 | 338.4688 | 0.0000   | 0.0000  |  |
| 196                 | 340.8125 | 0.0000   | 0.0000  |  |
| 197                 | 343.1563 | 0.0000   | 0.0000  |  |
| 198                 | 345.5000 | 0.0000   | 0.0000  |  |
| 199                 | 347.8438 | 0.0000   | 0.0000  |  |
| 200                 | 350.1875 | 0.0000   | 0.0000  |  |
| 201                 | 352.5313 | 0.0000   | 0.0000  |  |
| 202                 | 354.8750 | 0.0000   | 0.0000  |  |
| 203                 | 357.2188 | 0.0000   | 0.0000  |  |
| 204                 | 359.5625 | 0.0000   | 0.0000  |  |
| 205                 | 361.9063 | 0.0000   | 0.0000  |  |
| 206                 | 364.2500 | 0.0000   | 0.0000  |  |
| 207                 | 366.5938 | 0.0000   | 0.0000  |  |
| 208                 | 368.9375 | 0.0000   | 0.0000  |  |
| 209                 | 371.0000 | 0.0000   | 0.0000  |  |
| 210                 | 373.6250 | 0.0000   | 0.0000  |  |
| 211                 | 375.9688 | 0.0000   | 0.0000  |  |
| 212                 | 378.3125 | 0.0000   | 0.0000  |  |
| 213                 | 380.6563 | 0.0000   | 0.0000  |  |
| 214                 | 383.0000 | 0.0000   | 0.0000  |  |
| 215                 | 384.5000 | 0.0000   | 0.0000  |  |
| 216                 | 384.8500 | 0.0000   | 0.0000  |  |
| 217                 | 386.0000 | 0.0000   | 0.0000  |  |
| 1000                | 1.5000   | -7.5000  | 0.0000  |  |
| 2000                | 63.0000  | -52.6000 | 0.0000  |  |
| 2101                | 63.0000  | -52.6000 | -6.7500 |  |
| 2102                | 63.0000  | -50.0000 | -6.7500 |  |
| 2103                | 63.0000  | -47.4000 | -6.7500 |  |
| 2104                | 63.0000  | -44.8000 | -6.7500 |  |
| 2105                | 63.0000  | -42.2000 | -6.7500 |  |
| 2106                | 63.0000  | -39.6000 | -6.7500 |  |
| 2107                | 63.0000  | -37.0000 | -6.7500 |  |
| 2108                | 63.0000  | -34.4000 | -6.7500 |  |
| 2109                | 63.0000  | -31.8000 | -6.7500 |  |
| 2110                | 63.0000  | -29.2000 | -6.7500 |  |
| 2111                | 63.0000  | -26.6000 | -6.7500 |  |
| 2112                | 63.0000  | -24.0000 | -6.7500 |  |
| 2113                | 63.0000  | -21.4000 | -6.7500 |  |
| 2114                | 63.0000  | -18.8000 | -6.7500 |  |
| 2115                | 63.0000  | -16.2000 | -6.7500 |  |
| 2116                | 63.0000  | -13.6000 | -6.7500 |  |
| 2117                | 63.0000  | -11.0000 | -6.7500 |  |
| 2118                | 63.0000  | -10.5000 | -6.7500 |  |
| 2119                | 63.0000  | -7.9172  | -6.7500 |  |
| 2120                | 63.0000  | -5.3344  | -6.7500 |  |
| 2121                | 63.0000  | -2.7516  | -6.7500 |  |
| 2122                | 63.0000  | -0.1688  | -6.7500 |  |



| Nodes - Coordinates |         |          |         |  |
|---------------------|---------|----------|---------|--|
| node                | x       | y        | z       |  |
|                     | m       | m        | m       |  |
| 2123                | 63.0000 | 2.5839   | -6.7500 |  |
| 2124                | 63.0000 | 5.3366   | -6.7500 |  |
| 2125                | 63.0000 | 8.0893   | -6.7500 |  |
| 2126                | 63.0000 | 10.8420  | -6.7500 |  |
| 2127                | 63.0000 | 13.5947  | -6.7500 |  |
| 2128                | 63.0000 | 16.3474  | -6.7500 |  |
| 2129                | 63.0000 | 16.4428  | -6.7500 |  |
| 2130                | 63.0000 | 17.4067  | -6.7500 |  |
| 2131                | 63.0000 | 17.5751  | -6.7500 |  |
| 2132                | 63.0000 | 18.4661  | -6.7500 |  |
| 2133                | 63.0000 | 18.6860  | -6.7500 |  |
| 2134                | 63.0000 | 19.5254  | -6.7500 |  |
| 2135                | 63.0000 | 19.7837  | -6.7500 |  |
| 2136                | 63.0000 | 20.5847  | -6.7500 |  |
| 2137                | 63.0000 | 20.8727  | -6.7500 |  |
| 2138                | 63.0000 | 21.6441  | -6.7500 |  |
| 2139                | 63.0000 | 21.9556  | -6.7500 |  |
| 2140                | 63.0000 | 22.7034  | -6.7500 |  |
| 2141                | 63.0000 | 23.0341  | -6.7500 |  |
| 2142                | 63.0000 | 23.7627  | -6.7500 |  |
| 2143                | 63.0000 | 24.1094  | -6.7500 |  |
| 2144                | 63.0000 | 24.8220  | -6.7500 |  |
| 2145                | 63.0000 | 25.1822  | -6.7500 |  |
| 2146                | 63.0000 | 26.0000  | -6.7500 |  |
| 2201                | 63.0000 | -52.6000 | 6.7500  |  |
| 2202                | 63.0000 | -50.0000 | 6.7500  |  |
| 2203                | 63.0000 | -47.4000 | 6.7500  |  |
| 2204                | 63.0000 | -44.8000 | 6.7500  |  |
| 2205                | 63.0000 | -42.2000 | 6.7500  |  |
| 2206                | 63.0000 | -39.6000 | 6.7500  |  |
| 2207                | 63.0000 | -37.0000 | 6.7500  |  |
| 2208                | 63.0000 | -34.4000 | 6.7500  |  |
| 2209                | 63.0000 | -31.8000 | 6.7500  |  |
| 2210                | 63.0000 | -29.2000 | 6.7500  |  |
| 2211                | 63.0000 | -26.6000 | 6.7500  |  |
| 2212                | 63.0000 | -24.0000 | 6.7500  |  |
| 2213                | 63.0000 | -21.4000 | 6.7500  |  |
| 2214                | 63.0000 | -18.8000 | 6.7500  |  |
| 2215                | 63.0000 | -16.2000 | 6.7500  |  |
| 2216                | 63.0000 | -13.6000 | 6.7500  |  |
| 2217                | 63.0000 | -11.0000 | 6.7500  |  |
| 2218                | 63.0000 | -10.5000 | 6.7500  |  |
| 2219                | 63.0000 | -7.9172  | 6.7500  |  |
| 2220                | 63.0000 | -5.3344  | 6.7500  |  |
| 2221                | 63.0000 | -2.7516  | 6.7500  |  |
| 2222                | 63.0000 | -0.1688  | 6.7500  |  |
| 2223                | 63.0000 | 2.5839   | 6.7500  |  |
| 2224                | 63.0000 | 5.3366   | 6.7500  |  |
| 2225                | 63.0000 | 8.0893   | 6.7500  |  |
| 2226                | 63.0000 | 10.8420  | 6.7500  |  |
| 2227                | 63.0000 | 13.5947  | 6.7500  |  |
| 2228                | 63.0000 | 16.3474  | 6.7500  |  |
| 2229                | 63.0000 | 16.4428  | 6.7500  |  |
| 2230                | 63.0000 | 17.4067  | 6.7500  |  |
| 2231                | 63.0000 | 17.5751  | 6.7500  |  |
| 2232                | 63.0000 | 18.4661  | 6.7500  |  |
| 2233                | 63.0000 | 18.6860  | 6.7500  |  |
| 2234                | 63.0000 | 19.5254  | 6.7500  |  |
| 2235                | 63.0000 | 19.7837  | 6.7500  |  |
| 2236                | 63.0000 | 20.5847  | 6.7500  |  |
| 2237                | 63.0000 | 20.8727  | 6.7500  |  |



| Nodes - Coordinates |          |          |         |  |
|---------------------|----------|----------|---------|--|
| node                | x        | y        | z       |  |
|                     | m        | m        | m       |  |
| 2238                | 63.0000  | 21.6441  | 6.7500  |  |
| 2239                | 63.0000  | 21.9556  | 6.7500  |  |
| 2240                | 63.0000  | 22.7034  | 6.7500  |  |
| 2241                | 63.0000  | 23.0341  | 6.7500  |  |
| 2242                | 63.0000  | 23.7627  | 6.7500  |  |
| 2243                | 63.0000  | 24.1094  | 6.7500  |  |
| 2244                | 63.0000  | 24.8220  | 6.7500  |  |
| 2245                | 63.0000  | 25.1822  | 6.7500  |  |
| 2246                | 63.0000  | 26.0000  | 6.7500  |  |
| 3000                | 323.0000 | -52.6000 | 0.0000  |  |
| 3101                | 323.0000 | -52.6000 | -6.7500 |  |
| 3102                | 323.0000 | -50.0000 | -6.7500 |  |
| 3103                | 323.0000 | -47.4000 | -6.7500 |  |
| 3104                | 323.0000 | -44.8000 | -6.7500 |  |
| 3105                | 323.0000 | -42.2000 | -6.7500 |  |
| 3106                | 323.0000 | -39.6000 | -6.7500 |  |
| 3107                | 323.0000 | -37.0000 | -6.7500 |  |
| 3108                | 323.0000 | -34.4000 | -6.7500 |  |
| 3109                | 323.0000 | -31.8000 | -6.7500 |  |
| 3110                | 323.0000 | -29.2000 | -6.7500 |  |
| 3111                | 323.0000 | -26.6000 | -6.7500 |  |
| 3112                | 323.0000 | -24.0000 | -6.7500 |  |
| 3113                | 323.0000 | -21.4000 | -6.7500 |  |
| 3114                | 323.0000 | -18.8000 | -6.7500 |  |
| 3115                | 323.0000 | -16.2000 | -6.7500 |  |
| 3116                | 323.0000 | -13.6000 | -6.7500 |  |
| 3117                | 323.0000 | -11.0000 | -6.7500 |  |
| 3118                | 323.0000 | -10.5000 | -6.7500 |  |
| 3119                | 323.0000 | -7.9172  | -6.7500 |  |
| 3120                | 323.0000 | -5.3344  | -6.7500 |  |
| 3121                | 323.0000 | -2.7516  | -6.7500 |  |
| 3122                | 323.0000 | -0.1688  | -6.7500 |  |
| 3123                | 323.0000 | 2.5839   | -6.7500 |  |
| 3124                | 323.0000 | 5.3366   | -6.7500 |  |
| 3125                | 323.0000 | 8.0893   | -6.7500 |  |
| 3126                | 323.0000 | 10.8420  | -6.7500 |  |
| 3127                | 323.0000 | 13.5947  | -6.7500 |  |
| 3128                | 323.0000 | 16.3474  | -6.7500 |  |
| 3129                | 323.0000 | 16.4428  | -6.7500 |  |
| 3130                | 323.0000 | 17.4067  | -6.7500 |  |
| 3131                | 323.0000 | 17.5751  | -6.7500 |  |
| 3132                | 323.0000 | 18.4661  | -6.7500 |  |
| 3133                | 323.0000 | 18.6860  | -6.7500 |  |
| 3134                | 323.0000 | 19.5254  | -6.7500 |  |
| 3135                | 323.0000 | 19.7837  | -6.7500 |  |
| 3136                | 323.0000 | 20.5847  | -6.7500 |  |
| 3137                | 323.0000 | 20.8727  | -6.7500 |  |
| 3138                | 323.0000 | 21.6441  | -6.7500 |  |
| 3139                | 323.0000 | 21.9556  | -6.7500 |  |
| 3140                | 323.0000 | 22.7034  | -6.7500 |  |
| 3141                | 323.0000 | 23.0341  | -6.7500 |  |
| 3142                | 323.0000 | 23.7627  | -6.7500 |  |
| 3143                | 323.0000 | 24.1094  | -6.7500 |  |
| 3144                | 323.0000 | 24.8220  | -6.7500 |  |
| 3145                | 323.0000 | 25.1822  | -6.7500 |  |
| 3146                | 323.0000 | 26.0000  | -6.7500 |  |
| 3201                | 323.0000 | -52.6000 | 6.7500  |  |
| 3202                | 323.0000 | -50.0000 | 6.7500  |  |
| 3203                | 323.0000 | -47.4000 | 6.7500  |  |
| 3204                | 323.0000 | -44.8000 | 6.7500  |  |
| 3205                | 323.0000 | -42.2000 | 6.7500  |  |



| Nodes - Coordinates |          |          |        |
|---------------------|----------|----------|--------|
| node                | x<br>m   | y<br>m   | z<br>m |
| 3206                | 323.0000 | -39.6000 | 6.7500 |
| 3207                | 323.0000 | -37.0000 | 6.7500 |
| 3208                | 323.0000 | -34.4000 | 6.7500 |
| 3209                | 323.0000 | -31.8000 | 6.7500 |
| 3210                | 323.0000 | -29.2000 | 6.7500 |
| 3211                | 323.0000 | -26.6000 | 6.7500 |
| 3212                | 323.0000 | -24.0000 | 6.7500 |
| 3213                | 323.0000 | -21.4000 | 6.7500 |
| 3214                | 323.0000 | -18.8000 | 6.7500 |
| 3215                | 323.0000 | -16.2000 | 6.7500 |
| 3216                | 323.0000 | -13.6000 | 6.7500 |
| 3217                | 323.0000 | -11.0000 | 6.7500 |
| 3218                | 323.0000 | -10.5000 | 6.7500 |
| 3219                | 323.0000 | -7.9172  | 6.7500 |
| 3220                | 323.0000 | -5.3344  | 6.7500 |
| 3221                | 323.0000 | -2.7516  | 6.7500 |
| 3222                | 323.0000 | -0.1688  | 6.7500 |
| 3223                | 323.0000 | 2.5839   | 6.7500 |
| 3224                | 323.0000 | 5.3366   | 6.7500 |
| 3225                | 323.0000 | 8.0893   | 6.7500 |
| 3226                | 323.0000 | 10.8420  | 6.7500 |
| 3227                | 323.0000 | 13.5947  | 6.7500 |
| 3228                | 323.0000 | 16.3474  | 6.7500 |
| 3229                | 323.0000 | 16.4428  | 6.7500 |
| 3230                | 323.0000 | 17.4067  | 6.7500 |
| 3231                | 323.0000 | 17.5751  | 6.7500 |
| 3232                | 323.0000 | 18.4661  | 6.7500 |
| 3233                | 323.0000 | 18.6860  | 6.7500 |
| 3234                | 323.0000 | 19.5254  | 6.7500 |
| 3235                | 323.0000 | 19.7837  | 6.7500 |
| 3236                | 323.0000 | 20.5847  | 6.7500 |
| 3237                | 323.0000 | 20.8727  | 6.7500 |
| 3238                | 323.0000 | 21.6441  | 6.7500 |
| 3239                | 323.0000 | 21.9556  | 6.7500 |
| 3240                | 323.0000 | 22.7034  | 6.7500 |
| 3241                | 323.0000 | 23.0341  | 6.7500 |
| 3242                | 323.0000 | 23.7627  | 6.7500 |
| 3243                | 323.0000 | 24.1094  | 6.7500 |
| 3244                | 323.0000 | 24.8220  | 6.7500 |
| 3245                | 323.0000 | 25.1822  | 6.7500 |
| 3246                | 323.0000 | 26.0000  | 6.7500 |
| 4000                | 384.5000 | -7.5000  | 0.0000 |
| 5101                | 3.0000   | -14.5000 | 0.0000 |
| 5102                | 5.3438   | -14.5000 | 0.0000 |
| 5103                | 6.5156   | -14.5000 | 0.0000 |
| 5104                | 7.6875   | -14.5000 | 0.0000 |
| 5105                | 10.0312  | -14.5000 | 0.0000 |
| 6101                | 383.0000 | -14.5000 | 0.0000 |
| 6102                | 380.6563 | -14.5000 | 0.0000 |
| 6103                | 379.4844 | -14.5000 | 0.0000 |
| 6104                | 378.3125 | -14.5000 | 0.0000 |
| 6105                | 375.9688 | -14.5000 | 0.0000 |



## 3.2 Element Incidences

| Elements - Parameters |        |        |      |        |         |         |        |      |        |
|-----------------------|--------|--------|------|--------|---------|---------|--------|------|--------|
| Elem                  | Node 1 | Node 2 | Typ  | Length | Alpha 1 | Alpha 2 | Beta   | NDiv | Active |
|                       |        |        |      | m      | [Deg]   | [Deg]   | [Deg]  |      |        |
| 101                   | 101    | 102    | BEAM | 1.1500 | 0.0000  | 0.0000  | 0.0000 | 1    | Yes    |
| 102                   | 102    | 103    | BEAM | 0.3500 | 0.0000  | 0.0000  | 0.0000 | 1    | Yes    |
| 103                   | 103    | 104    | BEAM | 1.5000 | 0.0000  | 0.0000  | 0.0000 | 1    | Yes    |
| 104                   | 104    | 105    | BEAM | 2.3438 | 0.0000  | 0.0000  | 0.0000 | 1    | Yes    |
| 105                   | 105    | 106    | BEAM | 2.3438 | 0.0000  | 0.0000  | 0.0000 | 1    | Yes    |
| 106                   | 106    | 107    | BEAM | 2.3438 | 0.0000  | 0.0000  | 0.0000 | 1    | Yes    |
| 107                   | 107    | 108    | BEAM | 2.3438 | 0.0000  | 0.0000  | 0.0000 | 1    | Yes    |
| 108                   | 108    | 109    | BEAM | 2.6250 | 0.0000  | 0.0000  | 0.0000 | 1    | Yes    |
| 109                   | 109    | 110    | BEAM | 2.0625 | -0.3084 | 0.0000  | 0.0000 | 1    | Yes    |
| 110                   | 110    | 111    | BEAM | 2.3438 | -0.4756 | 0.0000  | 0.0000 | 1    | Yes    |
| 111                   | 111    | 112    | BEAM | 2.3439 | -0.6547 | 0.0000  | 0.0000 | 1    | Yes    |
| 112                   | 112    | 113    | BEAM | 2.3440 | -0.8354 | 0.0000  | 0.0000 | 1    | Yes    |
| 113                   | 113    | 114    | BEAM | 2.3441 | -1.0179 | 0.0000  | 0.0000 | 1    | Yes    |
| 114                   | 114    | 115    | BEAM | 2.3443 | -1.2020 | 0.0000  | 0.0000 | 1    | Yes    |
| 115                   | 115    | 116    | BEAM | 2.3444 | -1.3876 | 0.0000  | 0.0000 | 1    | Yes    |
| 116                   | 116    | 117    | BEAM | 2.3446 | -1.5747 | 0.0000  | 0.0000 | 1    | Yes    |
| 117                   | 117    | 118    | BEAM | 2.3449 | -1.7633 | 0.0000  | 0.0000 | 1    | Yes    |
| 118                   | 118    | 119    | BEAM | 2.3449 | -1.7633 | 0.0000  | 0.0000 | 1    | Yes    |
| 119                   | 119    | 120    | BEAM | 2.3451 | -1.9535 | 0.0000  | 0.0000 | 1    | Yes    |
| 120                   | 120    | 121    | BEAM | 2.3458 | -2.3916 | 0.0000  | 0.0000 | 1    | Yes    |
| 121                   | 121    | 122    | BEAM | 2.3461 | -2.5845 | 0.0000  | 0.0000 | 1    | Yes    |
| 122                   | 122    | 123    | BEAM | 2.3465 | -2.7784 | 0.0000  | 0.0000 | 1    | Yes    |
| 123                   | 123    | 124    | BEAM | 2.3469 | -2.9733 | 0.0000  | 0.0000 | 1    | Yes    |
| 124                   | 124    | 125    | BEAM | 2.0281 | -3.1562 | 0.0000  | 0.0000 | 1    | Yes    |
| 125                   | 125    | 126    | BEAM | 2.0284 | -3.3261 | 0.0000  | 0.0000 | 1    | Yes    |
| 126                   | 126    | 127    | BEAM | 2.0288 | -3.4967 | 0.0000  | 0.0000 | 1    | Yes    |
| 127                   | 127    | 128    | BEAM | 2.0292 | -3.6680 | 0.0000  | 0.0000 | 1    | Yes    |
| 128                   | 128    | 129    | BEAM | 2.0296 | -3.8394 | 0.0000  | 0.0000 | 1    | Yes    |
| 129                   | 129    | 130    | BEAM | 1.5000 | 0.0000  | 0.0000  | 0.0000 | 1    | Yes    |
| 130                   | 130    | 131    | BEAM | 1.5000 | 0.0000  | 0.0000  | 0.0000 | 1    | Yes    |
| 131                   | 131    | 132    | BEAM | 1.5000 | 0.0000  | 0.0000  | 0.0000 | 1    | Yes    |
| 132                   | 132    | 133    | BEAM | 1.5000 | 0.0000  | 0.0000  | 0.0000 | 1    | Yes    |
| 133                   | 133    | 134    | BEAM | 5.0124 | 4.0309  | 0.0000  | 0.0000 | 1    | Yes    |
| 134                   | 134    | 135    | BEAM | 5.0108 | 3.7606  | 0.0000  | 0.0000 | 1    | Yes    |
| 135                   | 135    | 136    | BEAM | 5.0093 | 3.4909  | 0.0000  | 0.0000 | 1    | Yes    |
| 136                   | 136    | 137    | BEAM | 5.0079 | 3.2222  | 0.0000  | 0.0000 | 1    | Yes    |
| 137                   | 137    | 138    | BEAM | 5.0067 | 2.9545  | 0.0000  | 0.0000 | 1    | Yes    |
| 138                   | 138    | 139    | BEAM | 5.0055 | 2.6882  | 0.0000  | 0.0000 | 1    | Yes    |
| 139                   | 139    | 140    | BEAM | 5.0045 | 2.4234  | 0.0000  | 0.0000 | 1    | Yes    |
| 140                   | 140    | 141    | BEAM | 5.0039 | 2.2749  | 0.0000  | 0.0000 | 1    | Yes    |
| 141                   | 141    | 142    | BEAM | 5.0031 | 2.0064  | 0.0000  | 0.0000 | 1    | Yes    |
| 142                   | 142    | 143    | BEAM | 5.0023 | 1.7417  | 0.0000  | 0.0000 | 1    | Yes    |
| 143                   | 143    | 144    | BEAM | 5.0017 | 1.4817  | 0.0000  | 0.0000 | 1    | Yes    |
| 144                   | 144    | 145    | BEAM | 5.0009 | 1.0978  | 0.0000  | 0.0000 | 1    | Yes    |
| 145                   | 145    | 146    | BEAM | 5.0010 | 1.1523  | 0.0000  | 0.0000 | 1    | Yes    |
| 146                   | 146    | 147    | BEAM | 5.0007 | 0.9660  | 0.0000  | 0.0000 | 1    | Yes    |
| 147                   | 147    | 148    | BEAM | 5.0005 | 0.8097  | 0.0000  | 0.0000 | 1    | Yes    |
| 148                   | 148    | 149    | BEAM | 5.0004 | 0.6938  | 0.0000  | 0.0000 | 1    | Yes    |
| 149                   | 149    | 150    | BEAM | 5.0004 | 0.7338  | 0.0000  | 0.0000 | 1    | Yes    |
| 150                   | 150    | 151    | BEAM | 5.0007 | 0.9243  | 0.0000  | 0.0000 | 1    | Yes    |
| 151                   | 151    | 152    | BEAM | 5.0010 | 1.1680  | 0.0000  | 0.0000 | 1    | Yes    |
| 152                   | 152    | 153    | BEAM | 5.0017 | 1.4858  | 0.0000  | 0.0000 | 1    | Yes    |
| 153                   | 153    | 154    | BEAM | 5.0000 | 0.0000  | 0.0000  | 0.0000 | 1    | Yes    |
| 154                   | 154    | 155    | BEAM | 5.0000 | 0.0000  | 0.0000  | 0.0000 | 1    | Yes    |
| 155                   | 155    | 156    | BEAM | 5.0000 | 0.0000  | 0.0000  | 0.0000 | 1    | Yes    |
| 156                   | 156    | 157    | BEAM | 5.0000 | 0.0000  | 0.0000  | 0.0000 | 1    | Yes    |
| 157                   | 157    | 158    | BEAM | 5.0000 | 0.0000  | 0.0000  | 0.0000 | 1    | Yes    |

Description: 3 Description of Structural Model  
3.2 Element Incidences

Project No.





| Elements - Parameters |        |        |        |        |         |         |        |      |        |
|-----------------------|--------|--------|--------|--------|---------|---------|--------|------|--------|
| Elem                  | Node 1 | Node 2 | Typ    | Length | Alpha 1 | Alpha 2 | Beta   | NDiv | Active |
|                       |        |        |        | m      | [Deg]   | [Deg]   | [Deg]  |      |        |
| 158                   | 158    | 159    | BEAM   | 2.0000 | 0.0000  | 0.0000  | 0.0000 | 1    | Yes    |
| 159                   | 159    | 160    | BEAM   | 2.0000 | 0.0000  | 0.0000  | 0.0000 | 1    | Yes    |
| 160                   | 160    | 161    | BEAM   | 5.0000 | 0.0000  | 0.0000  | 0.0000 | 1    | Yes    |
| 161                   | 161    | 162    | BEAM   | 5.0000 | 0.0000  | 0.0000  | 0.0000 | 1    | Yes    |
| 162                   | 162    | 163    | BEAM   | 5.0000 | 0.0000  | 0.0000  | 0.0000 | 1    | Yes    |
| 163                   | 163    | 164    | BEAM   | 5.0000 | 0.0000  | 0.0000  | 0.0000 | 1    | Yes    |
| 164                   | 164    | 165    | BEAM   | 5.0000 | 0.0000  | 0.0000  | 0.0000 | 1    | Yes    |
| 165                   | 165    | 166    | BEAM   | 5.0017 | -1.4858 | 0.0000  | 0.0000 | 1    | Yes    |
| 166                   | 166    | 167    | BEAM   | 5.0010 | -1.1680 | 0.0000  | 0.0000 | 1    | Yes    |
| 167                   | 167    | 168    | BEAM   | 5.0007 | -0.9243 | 0.0000  | 0.0000 | 1    | Yes    |
| 168                   | 168    | 169    | BEAM   | 5.0004 | -0.7338 | 0.0000  | 0.0000 | 1    | Yes    |
| 169                   | 169    | 170    | BEAM   | 5.0004 | -0.6938 | 0.0000  | 0.0000 | 1    | Yes    |
| 170                   | 170    | 171    | BEAM   | 5.0005 | -0.8097 | 0.0000  | 0.0000 | 1    | Yes    |
| 171                   | 171    | 172    | BEAM   | 5.0007 | -0.9660 | 0.0000  | 0.0000 | 1    | Yes    |
| 172                   | 172    | 173    | BEAM   | 5.0010 | -1.1523 | 0.0000  | 0.0000 | 1    | Yes    |
| 173                   | 173    | 174    | BEAM   | 5.0009 | -1.0978 | 0.0000  | 0.0000 | 1    | Yes    |
| 174                   | 174    | 175    | BEAM   | 5.0017 | -1.4817 | 0.0000  | 0.0000 | 1    | Yes    |
| 175                   | 175    | 176    | BEAM   | 5.0023 | -1.7417 | 0.0000  | 0.0000 | 1    | Yes    |
| 176                   | 176    | 177    | BEAM   | 5.0031 | -2.0064 | 0.0000  | 0.0000 | 1    | Yes    |
| 177                   | 177    | 178    | BEAM   | 5.0039 | -2.2749 | 0.0000  | 0.0000 | 1    | Yes    |
| 178                   | 178    | 179    | BEAM   | 5.0045 | -2.4234 | 0.0000  | 0.0000 | 1    | Yes    |
| 179                   | 179    | 180    | BEAM   | 5.0055 | -2.6882 | 0.0000  | 0.0000 | 1    | Yes    |
| 180                   | 180    | 181    | BEAM   | 5.0067 | -2.9545 | 0.0000  | 0.0000 | 1    | Yes    |
| 181                   | 181    | 182    | BEAM   | 5.0079 | -3.2222 | 0.0000  | 0.0000 | 1    | Yes    |
| 182                   | 182    | 183    | BEAM   | 5.0093 | -3.4909 | 0.0000  | 0.0000 | 1    | Yes    |
| 183                   | 183    | 184    | BEAM   | 5.0108 | -3.7606 | 0.0000  | 0.0000 | 1    | Yes    |
| 184                   | 184    | 185    | BEAM   | 5.0124 | -4.0309 | 0.0000  | 0.0000 | 1    | Yes    |
| 185                   | 185    | 186    | BEAM   | 1.5000 | 0.0000  | 0.0000  | 0.0000 | 1    | Yes    |
| 186                   | 186    | 187    | BEAM   | 1.5000 | 0.0000  | 0.0000  | 0.0000 | 1    | Yes    |
| 187                   | 187    | 188    | BEAM   | 1.5000 | 0.0000  | 0.0000  | 0.0000 | 1    | Yes    |
| 188                   | 188    | 189    | BEAM   | 1.5000 | 0.0000  | 0.0000  | 0.0000 | 1    | Yes    |
| 189                   | 189    | 190    | BEAM   | 2.0295 | 3.8247  | 0.0000  | 0.0000 | 1    | Yes    |
| 190                   | 190    | 191    | BEAM   | 2.0291 | 3.6553  | 0.0000  | 0.0000 | 1    | Yes    |
| 191                   | 191    | 192    | BEAM   | 2.0288 | 3.4860  | 0.0000  | 0.0000 | 1    | Yes    |
| 192                   | 192    | 193    | BEAM   | 2.0284 | 3.3173  | 0.0000  | 0.0000 | 1    | Yes    |
| 193                   | 193    | 194    | BEAM   | 2.0281 | 3.1492  | 0.0000  | 0.0000 | 1    | Yes    |
| 194                   | 194    | 195    | BEAM   | 2.3469 | 2.9683  | 0.0000  | 0.0000 | 1    | Yes    |
| 195                   | 195    | 196    | BEAM   | 2.3465 | 2.7756  | 0.0000  | 0.0000 | 1    | Yes    |
| 196                   | 196    | 197    | BEAM   | 2.3461 | 2.5839  | 0.0000  | 0.0000 | 1    | Yes    |
| 197                   | 197    | 198    | BEAM   | 2.3458 | 2.3932  | 0.0000  | 0.0000 | 1    | Yes    |
| 198                   | 198    | 199    | BEAM   | 2.3451 | 1.9519  | 0.0000  | 0.0000 | 1    | Yes    |
| 199                   | 199    | 200    | BEAM   | 2.3449 | 1.7618  | 0.0000  | 0.0000 | 1    | Yes    |
| 200                   | 200    | 201    | BEAM   | 2.3449 | 1.7759  | 0.0000  | 0.0000 | 1    | Yes    |
| 201                   | 201    | 202    | BEAM   | 2.3446 | 1.5858  | 0.0000  | 0.0000 | 1    | Yes    |
| 202                   | 202    | 203    | BEAM   | 2.3444 | 1.3972  | 0.0000  | 0.0000 | 1    | Yes    |
| 203                   | 203    | 204    | BEAM   | 2.3443 | 1.2100  | 0.0000  | 0.0000 | 1    | Yes    |
| 204                   | 204    | 205    | BEAM   | 2.3441 | 1.0244  | 0.0000  | 0.0000 | 1    | Yes    |
| 205                   | 205    | 206    | BEAM   | 2.3440 | 0.8403  | 0.0000  | 0.0000 | 1    | Yes    |
| 206                   | 206    | 207    | BEAM   | 2.3439 | 0.6578  | 0.0000  | 0.0000 | 1    | Yes    |
| 207                   | 207    | 208    | BEAM   | 2.3438 | 0.4768  | 0.0000  | 0.0000 | 1    | Yes    |
| 208                   | 208    | 209    | BEAM   | 2.0625 | 0.3078  | 0.0000  | 0.0000 | 1    | Yes    |
| 209                   | 209    | 210    | BEAM   | 2.6250 | 0.0000  | 0.0000  | 0.0000 | 1    | Yes    |
| 210                   | 210    | 211    | BEAM   | 2.3438 | 0.0000  | 0.0000  | 0.0000 | 1    | Yes    |
| 211                   | 211    | 212    | BEAM   | 2.3438 | 0.0000  | 0.0000  | 0.0000 | 1    | Yes    |
| 212                   | 212    | 213    | BEAM   | 2.3438 | 0.0000  | 0.0000  | 0.0000 | 1    | Yes    |
| 213                   | 213    | 214    | BEAM   | 2.3438 | 0.0000  | 0.0000  | 0.0000 | 1    | Yes    |
| 214                   | 214    | 215    | BEAM   | 1.5000 | 0.0000  | 0.0000  | 0.0000 | 1    | Yes    |
| 215                   | 215    | 216    | BEAM   | 0.3500 | 0.0000  | 0.0000  | 0.0000 | 1    | Yes    |
| 216                   | 216    | 217    | BEAM   | 1.1500 | 0.0000  | 0.0000  | 0.0000 | 1    | Yes    |
| 1000                  | 0      | 1000   | SPRING | 1.0000 | 90.0000 | 0.0000  | 0.0000 | 1    | Yes    |
| 1001                  | 1000   | 103    | SPRING | 0.0000 | 90.0000 | 0.0000  | 0.0000 | 1    | Yes    |

Description: 3 Description of Structural Model  
3.2 Element Incidences

Project No.



| Elements - Parameters |        |        |        |          |         |           |        |      |        |
|-----------------------|--------|--------|--------|----------|---------|-----------|--------|------|--------|
| Elem                  | Node 1 | Node 2 | Typ    | Length   | Alpha 1 | Alpha 2   | Beta   | NDiv | Active |
|                       |        |        |        | m        | [Deg]   | [Deg]     | [Deg]  |      |        |
| 1002                  | 1000   | 103    | SPRING | 0.0000   | 90.0000 | 0.0000    | 0.0000 | 1    | Yes    |
| 1101                  | 114    | 2124   | CABLE  | 35.7457  | 11.2202 | 0.0000    | 0.0000 | 1    | No     |
| 1102                  | 113    | 2126   | CABLE  | 39.4271  | 18.4240 | 0.0000    | 0.0000 | 1    | No     |
| 1103                  | 112    | 2128   | CABLE  | 43.6216  | 24.3220 | 0.0000    | 0.0000 | 1    | Yes    |
| 1104                  | 111    | 2130   | CABLE  | 46.1936  | 24.3220 | 0.0000    | 0.0000 | 1    | Yes    |
| 1105                  | 110    | 2132   | CABLE  | 48.7657  | 24.3220 | 0.0000    | 0.0000 | 1    | Yes    |
| 1106                  | 109    | 2134   | CABLE  | 51.0816  | 24.4519 | 0.0000    | 0.0000 | 1    | Yes    |
| 1107                  | 108    | 2136   | CABLE  | 53.9097  | 24.3220 | 0.0000    | 0.0000 | 1    | Yes    |
| 1108                  | 107    | 2138   | CABLE  | 56.4818  | 24.3220 | 0.0000    | 0.0000 | 1    | Yes    |
| 1109                  | 106    | 2140   | CABLE  | 59.0538  | 24.3220 | 0.0000    | 0.0000 | 1    | Yes    |
| 1110                  | 105    | 2142   | CABLE  | 61.6258  | 24.3220 | 0.0000    | 0.0000 | 1    | Yes    |
| 1111                  | 104    | 2144   | CABLE  | 64.1979  | 24.3220 | 0.0000    | 0.0000 | 1    | Yes    |
| 1201                  | 114    | 2224   | CABLE  | 35.7457  | 11.2202 | 0.0000    | 0.0000 | 1    | No     |
| 1202                  | 113    | 2226   | CABLE  | 39.4271  | 18.4240 | 0.0000    | 0.0000 | 1    | No     |
| 1203                  | 112    | 2228   | CABLE  | 43.6216  | 24.3220 | 0.0000    | 0.0000 | 1    | Yes    |
| 1204                  | 111    | 2230   | CABLE  | 46.1936  | 24.3220 | 0.0000    | 0.0000 | 1    | Yes    |
| 1205                  | 110    | 2232   | CABLE  | 48.7657  | 24.3220 | 0.0000    | 0.0000 | 1    | Yes    |
| 1206                  | 109    | 2234   | CABLE  | 51.0816  | 24.4519 | 0.0000    | 0.0000 | 1    | Yes    |
| 1207                  | 108    | 2236   | CABLE  | 53.9097  | 24.3220 | 0.0000    | 0.0000 | 1    | Yes    |
| 1208                  | 107    | 2238   | CABLE  | 56.4818  | 24.3220 | 0.0000    | 0.0000 | 1    | Yes    |
| 1209                  | 106    | 2240   | CABLE  | 59.0538  | 24.3220 | 0.0000    | 0.0000 | 1    | Yes    |
| 1210                  | 105    | 2242   | CABLE  | 61.6258  | 24.3220 | 0.0000    | 0.0000 | 1    | Yes    |
| 1211                  | 104    | 2244   | CABLE  | 64.1979  | 24.3220 | 0.0000    | 0.0000 | 1    | Yes    |
| 1301                  | 138    | 2125   | CABLE  | 28.2223  | 20.1199 | -180.0000 | 0.0000 | 1    | No     |
| 1302                  | 140    | 2127   | CABLE  | 39.5436  | 22.6267 | -180.0000 | 0.0000 | 1    | No     |
| 1303                  | 142    | 2129   | CABLE  | 49.8845  | 21.2271 | -180.0000 | 0.0000 | 1    | Yes    |
| 1304                  | 144    | 2131   | CABLE  | 59.6712  | 18.7634 | -180.0000 | 0.0000 | 1    | Yes    |
| 1305                  | 146    | 2133   | CABLE  | 69.5308  | 16.9793 | -180.0000 | 0.0000 | 1    | Yes    |
| 1306                  | 148    | 2135   | CABLE  | 79.4375  | 15.6301 | -180.0000 | 0.0000 | 1    | Yes    |
| 1307                  | 150    | 2137   | CABLE  | 89.3762  | 14.5751 | -180.0000 | 0.0000 | 1    | Yes    |
| 1308                  | 152    | 2139   | CABLE  | 99.3378  | 13.7281 | -180.0000 | 0.0000 | 1    | Yes    |
| 1309                  | 154    | 2141   | CABLE  | 109.3161 | 13.0334 | -180.0000 | 0.0000 | 1    | Yes    |
| 1310                  | 156    | 2143   | CABLE  | 119.3071 | 12.4535 | -180.0000 | 0.0000 | 1    | Yes    |
| 1311                  | 158    | 2145   | CABLE  | 129.3079 | 11.9621 | -180.0000 | 0.0000 | 1    | Yes    |
| 1401                  | 138    | 2225   | CABLE  | 28.2223  | 20.1199 | -180.0000 | 0.0000 | 1    | No     |
| 1402                  | 140    | 2227   | CABLE  | 39.5436  | 22.6267 | -180.0000 | 0.0000 | 1    | No     |
| 1403                  | 142    | 2229   | CABLE  | 49.8845  | 21.2271 | -180.0000 | 0.0000 | 1    | Yes    |
| 1404                  | 144    | 2231   | CABLE  | 59.6712  | 18.7634 | -180.0000 | 0.0000 | 1    | Yes    |
| 1405                  | 146    | 2233   | CABLE  | 69.5308  | 16.9793 | -180.0000 | 0.0000 | 1    | Yes    |
| 1406                  | 148    | 2235   | CABLE  | 79.4375  | 15.6301 | -180.0000 | 0.0000 | 1    | Yes    |
| 1407                  | 150    | 2237   | CABLE  | 89.3762  | 14.5751 | -180.0000 | 0.0000 | 1    | Yes    |
| 1408                  | 152    | 2239   | CABLE  | 99.3378  | 13.7281 | -180.0000 | 0.0000 | 1    | Yes    |
| 1409                  | 154    | 2241   | CABLE  | 109.3161 | 13.0334 | -180.0000 | 0.0000 | 1    | Yes    |
| 1410                  | 156    | 2243   | CABLE  | 119.3071 | 12.4535 | -180.0000 | 0.0000 | 1    | Yes    |
| 1411                  | 158    | 2245   | CABLE  | 129.3079 | 11.9621 | -180.0000 | 0.0000 | 1    | Yes    |
| 1501                  | 180    | 3125   | CABLE  | 28.2223  | 20.1199 | 0.0000    | 0.0000 | 1    | No     |
| 1502                  | 178    | 3127   | CABLE  | 39.5436  | 22.6267 | 0.0000    | 0.0000 | 1    | No     |
| 1503                  | 176    | 3129   | CABLE  | 49.8845  | 21.2271 | 0.0000    | 0.0000 | 1    | Yes    |
| 1504                  | 174    | 3131   | CABLE  | 59.6712  | 18.7634 | 0.0000    | 0.0000 | 1    | Yes    |
| 1505                  | 172    | 3133   | CABLE  | 69.5308  | 16.9793 | 0.0000    | 0.0000 | 1    | Yes    |
| 1506                  | 170    | 3135   | CABLE  | 79.4375  | 15.6301 | 0.0000    | 0.0000 | 1    | Yes    |
| 1507                  | 168    | 3137   | CABLE  | 89.3762  | 14.5751 | 0.0000    | 0.0000 | 1    | Yes    |
| 1508                  | 166    | 3139   | CABLE  | 99.3378  | 13.7281 | 0.0000    | 0.0000 | 1    | Yes    |
| 1509                  | 164    | 3141   | CABLE  | 109.3161 | 13.0334 | 0.0000    | 0.0000 | 1    | Yes    |
| 1510                  | 162    | 3143   | CABLE  | 119.3071 | 12.4535 | 0.0000    | 0.0000 | 1    | Yes    |
| 1511                  | 160    | 3145   | CABLE  | 129.3079 | 11.9621 | 0.0000    | 0.0000 | 1    | Yes    |
| 1601                  | 180    | 3225   | CABLE  | 28.2223  | 20.1199 | 0.0000    | 0.0000 | 1    | No     |
| 1602                  | 178    | 3227   | CABLE  | 39.5436  | 22.6267 | 0.0000    | 0.0000 | 1    | No     |
| 1603                  | 176    | 3229   | CABLE  | 49.8845  | 21.2271 | 0.0000    | 0.0000 | 1    | Yes    |
| 1604                  | 174    | 3231   | CABLE  | 59.6712  | 18.7634 | 0.0000    | 0.0000 | 1    | Yes    |
| 1605                  | 172    | 3233   | CABLE  | 69.5308  | 16.9793 | 0.0000    | 0.0000 | 1    | Yes    |

Description: 3 Description of Structural Model  
3.2 Element Incidences

Project No.



| Elements - Parameters |        |        |        |          |         |           |        |      |        |
|-----------------------|--------|--------|--------|----------|---------|-----------|--------|------|--------|
| Elem                  | Node 1 | Node 2 | Typ    | Length   | Alpha 1 | Alpha 2   | Beta   | NDiv | Active |
|                       |        |        |        | m        | [Deg]   | [Deg]     | [Deg]  |      |        |
| 1606                  | 170    | 3235   | CABLE  | 79.4375  | 15.6301 | 0.0000    | 0.0000 | 1    | Yes    |
| 1607                  | 168    | 3237   | CABLE  | 89.3762  | 14.5751 | 0.0000    | 0.0000 | 1    | Yes    |
| 1608                  | 166    | 3239   | CABLE  | 99.3378  | 13.7281 | 0.0000    | 0.0000 | 1    | Yes    |
| 1609                  | 164    | 3241   | CABLE  | 109.3161 | 13.0334 | 0.0000    | 0.0000 | 1    | Yes    |
| 1610                  | 162    | 3243   | CABLE  | 119.3071 | 12.4535 | 0.0000    | 0.0000 | 1    | Yes    |
| 1611                  | 160    | 3245   | CABLE  | 129.3079 | 11.9621 | 0.0000    | 0.0000 | 1    | Yes    |
| 1701                  | 204    | 3124   | CABLE  | 35.7457  | 11.2202 | -180.0000 | 0.0000 | 1    | No     |
| 1702                  | 205    | 3126   | CABLE  | 39.4271  | 18.4240 | -180.0000 | 0.0000 | 1    | No     |
| 1703                  | 206    | 3128   | CABLE  | 43.6216  | 24.3220 | -180.0000 | 0.0000 | 1    | Yes    |
| 1704                  | 207    | 3130   | CABLE  | 46.1936  | 24.3220 | -180.0000 | 0.0000 | 1    | Yes    |
| 1705                  | 208    | 3132   | CABLE  | 48.7657  | 24.3220 | -180.0000 | 0.0000 | 1    | Yes    |
| 1706                  | 209    | 3134   | CABLE  | 51.0816  | 24.4519 | -180.0000 | 0.0000 | 1    | Yes    |
| 1707                  | 210    | 3136   | CABLE  | 53.9097  | 24.3220 | -180.0000 | 0.0000 | 1    | Yes    |
| 1708                  | 211    | 3138   | CABLE  | 56.4818  | 24.3220 | -180.0000 | 0.0000 | 1    | Yes    |
| 1709                  | 212    | 3140   | CABLE  | 59.0538  | 24.3220 | -180.0000 | 0.0000 | 1    | Yes    |
| 1710                  | 213    | 3142   | CABLE  | 61.6258  | 24.3220 | -180.0000 | 0.0000 | 1    | Yes    |
| 1711                  | 214    | 3144   | CABLE  | 64.1979  | 24.3220 | -180.0000 | 0.0000 | 1    | Yes    |
| 1801                  | 204    | 3224   | CABLE  | 35.7457  | 11.2202 | -180.0000 | 0.0000 | 1    | No     |
| 1802                  | 205    | 3226   | CABLE  | 39.4271  | 18.4240 | -180.0000 | 0.0000 | 1    | No     |
| 1803                  | 206    | 3228   | CABLE  | 43.6216  | 24.3220 | -180.0000 | 0.0000 | 1    | Yes    |
| 1804                  | 207    | 3230   | CABLE  | 46.1936  | 24.3220 | -180.0000 | 0.0000 | 1    | Yes    |
| 1805                  | 208    | 3232   | CABLE  | 48.7657  | 24.3220 | -180.0000 | 0.0000 | 1    | Yes    |
| 1806                  | 209    | 3234   | CABLE  | 51.0816  | 24.4519 | -180.0000 | 0.0000 | 1    | Yes    |
| 1807                  | 210    | 3236   | CABLE  | 53.9097  | 24.3220 | -180.0000 | 0.0000 | 1    | Yes    |
| 1808                  | 211    | 3238   | CABLE  | 56.4818  | 24.3220 | -180.0000 | 0.0000 | 1    | Yes    |
| 1809                  | 212    | 3240   | CABLE  | 59.0538  | 24.3220 | -180.0000 | 0.0000 | 1    | Yes    |
| 1810                  | 213    | 3242   | CABLE  | 61.6258  | 24.3220 | -180.0000 | 0.0000 | 1    | Yes    |
| 1811                  | 214    | 3244   | CABLE  | 64.1979  | 24.3220 | -180.0000 | 0.0000 | 1    | Yes    |
| 2000                  | 0      | 2000   | SPRING | 1.0000   | 90.0000 | 0.0000    | 0.0000 | 1    | Yes    |
| 2001                  | 2000   | 2101   | SPRING | 0.0000   | 90.0000 | 0.0000    | 0.0000 | 1    | Yes    |
| 2002                  | 2000   | 2201   | SPRING | 0.0000   | 90.0000 | 0.0000    | 0.0000 | 1    | Yes    |
| 2101                  | 2101   | 2102   | BEAM   | 2.6000   | 90.0000 | 0.0000    | 0.0000 | 1    | Yes    |
| 2102                  | 2102   | 2103   | BEAM   | 2.6000   | 90.0000 | 0.0000    | 0.0000 | 1    | Yes    |
| 2103                  | 2103   | 2104   | BEAM   | 2.6000   | 90.0000 | 0.0000    | 0.0000 | 1    | Yes    |
| 2104                  | 2104   | 2105   | BEAM   | 2.6000   | 90.0000 | 0.0000    | 0.0000 | 1    | Yes    |
| 2105                  | 2105   | 2106   | BEAM   | 2.6000   | 90.0000 | 0.0000    | 0.0000 | 1    | Yes    |
| 2106                  | 2106   | 2107   | BEAM   | 2.6000   | 90.0000 | 0.0000    | 0.0000 | 1    | Yes    |
| 2107                  | 2107   | 2108   | BEAM   | 2.6000   | 90.0000 | 0.0000    | 0.0000 | 1    | Yes    |
| 2108                  | 2108   | 2109   | BEAM   | 2.6000   | 90.0000 | 0.0000    | 0.0000 | 1    | Yes    |
| 2109                  | 2109   | 2110   | BEAM   | 2.6000   | 90.0000 | 0.0000    | 0.0000 | 1    | Yes    |
| 2110                  | 2110   | 2111   | BEAM   | 2.6000   | 90.0000 | 0.0000    | 0.0000 | 1    | Yes    |
| 2111                  | 2111   | 2112   | BEAM   | 2.6000   | 90.0000 | 0.0000    | 0.0000 | 1    | Yes    |
| 2112                  | 2112   | 2113   | BEAM   | 2.6000   | 90.0000 | 0.0000    | 0.0000 | 1    | Yes    |
| 2113                  | 2113   | 2114   | BEAM   | 2.6000   | 90.0000 | 0.0000    | 0.0000 | 1    | Yes    |
| 2114                  | 2114   | 2115   | BEAM   | 2.6000   | 90.0000 | 0.0000    | 0.0000 | 1    | Yes    |
| 2115                  | 2115   | 2116   | BEAM   | 2.6000   | 90.0000 | 0.0000    | 0.0000 | 1    | Yes    |
| 2116                  | 2116   | 2117   | BEAM   | 2.6000   | 90.0000 | 0.0000    | 0.0000 | 1    | Yes    |
| 2117                  | 2117   | 2118   | BEAM   | 0.5000   | 90.0000 | 0.0000    | 0.0000 | 1    | Yes    |
| 2118                  | 2118   | 2119   | BEAM   | 2.5828   | 90.0000 | 0.0000    | 0.0000 | 1    | Yes    |
| 2119                  | 2119   | 2120   | BEAM   | 2.5828   | 90.0000 | 0.0000    | 0.0000 | 1    | Yes    |
| 2120                  | 2120   | 2121   | BEAM   | 2.5828   | 90.0000 | 0.0000    | 0.0000 | 1    | Yes    |
| 2121                  | 2121   | 2122   | BEAM   | 2.5828   | 90.0000 | 0.0000    | 0.0000 | 1    | Yes    |
| 2122                  | 2122   | 2123   | BEAM   | 2.7527   | 90.0000 | 0.0000    | 0.0000 | 1    | Yes    |
| 2123                  | 2123   | 2124   | BEAM   | 2.7527   | 90.0000 | 0.0000    | 0.0000 | 1    | Yes    |
| 2124                  | 2124   | 2125   | BEAM   | 2.7527   | 90.0000 | 0.0000    | 0.0000 | 1    | Yes    |
| 2125                  | 2125   | 2126   | BEAM   | 2.7527   | 90.0000 | 0.0000    | 0.0000 | 1    | Yes    |
| 2126                  | 2126   | 2127   | BEAM   | 2.7527   | 90.0000 | 0.0000    | 0.0000 | 1    | Yes    |
| 2127                  | 2127   | 2128   | BEAM   | 2.7527   | 90.0000 | 0.0000    | 0.0000 | 1    | Yes    |
| 2128                  | 2128   | 2129   | BEAM   | 0.0953   | 90.0000 | 0.0000    | 0.0000 | 1    | Yes    |
| 2129                  | 2129   | 2130   | BEAM   | 0.9640   | 90.0000 | 0.0000    | 0.0000 | 1    | Yes    |
| 2130                  | 2130   | 2131   | BEAM   | 0.1684   | 90.0000 | 0.0000    | 0.0000 | 1    | Yes    |

Description: 3 Description of Structural Model  
3.2 Element Incidences

Project No.



| Elements - Parameters |        |        |        |             |                  |                  |               |      |        |
|-----------------------|--------|--------|--------|-------------|------------------|------------------|---------------|------|--------|
| Elem                  | Node 1 | Node 2 | Typ    | Length<br>m | Alpha 1<br>[Deg] | Alpha 2<br>[Deg] | Beta<br>[Deg] | NDiv | Active |
| 2131                  | 2131   | 2132   | BEAM   | 0.8909      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 2132                  | 2132   | 2133   | BEAM   | 0.2200      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 2133                  | 2133   | 2134   | BEAM   | 0.8394      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 2134                  | 2134   | 2135   | BEAM   | 0.2583      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 2135                  | 2135   | 2136   | BEAM   | 0.8010      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 2136                  | 2136   | 2137   | BEAM   | 0.2879      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 2137                  | 2137   | 2138   | BEAM   | 0.7714      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 2138                  | 2138   | 2139   | BEAM   | 0.3115      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 2139                  | 2139   | 2140   | BEAM   | 0.7478      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 2140                  | 2140   | 2141   | BEAM   | 0.3307      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 2141                  | 2141   | 2142   | BEAM   | 0.7286      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 2142                  | 2142   | 2143   | BEAM   | 0.3467      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 2143                  | 2143   | 2144   | BEAM   | 0.7126      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 2144                  | 2144   | 2145   | BEAM   | 0.3602      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 2145                  | 2145   | 2146   | BEAM   | 0.8178      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 2201                  | 2201   | 2202   | BEAM   | 2.6000      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 2202                  | 2202   | 2203   | BEAM   | 2.6000      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 2203                  | 2203   | 2204   | BEAM   | 2.6000      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 2204                  | 2204   | 2205   | BEAM   | 2.6000      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 2205                  | 2205   | 2206   | BEAM   | 2.6000      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 2206                  | 2206   | 2207   | BEAM   | 2.6000      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 2207                  | 2207   | 2208   | BEAM   | 2.6000      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 2208                  | 2208   | 2209   | BEAM   | 2.6000      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 2209                  | 2209   | 2210   | BEAM   | 2.6000      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 2210                  | 2210   | 2211   | BEAM   | 2.6000      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 2211                  | 2211   | 2212   | BEAM   | 2.6000      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 2212                  | 2212   | 2213   | BEAM   | 2.6000      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 2213                  | 2213   | 2214   | BEAM   | 2.6000      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 2214                  | 2214   | 2215   | BEAM   | 2.6000      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 2215                  | 2215   | 2216   | BEAM   | 2.6000      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 2216                  | 2216   | 2217   | BEAM   | 2.6000      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 2217                  | 2217   | 2218   | BEAM   | 0.5000      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 2218                  | 2218   | 2219   | BEAM   | 2.5828      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 2219                  | 2219   | 2220   | BEAM   | 2.5828      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 2220                  | 2220   | 2221   | BEAM   | 2.5828      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 2221                  | 2221   | 2222   | BEAM   | 2.5828      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 2222                  | 2222   | 2223   | BEAM   | 2.7527      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 2223                  | 2223   | 2224   | BEAM   | 2.7527      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 2224                  | 2224   | 2225   | BEAM   | 2.7527      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 2225                  | 2225   | 2226   | BEAM   | 2.7527      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 2226                  | 2226   | 2227   | BEAM   | 2.7527      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 2227                  | 2227   | 2228   | BEAM   | 2.7527      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 2228                  | 2228   | 2229   | BEAM   | 0.0953      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 2229                  | 2229   | 2230   | BEAM   | 0.9640      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 2230                  | 2230   | 2231   | BEAM   | 0.1684      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 2231                  | 2231   | 2232   | BEAM   | 0.8909      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 2232                  | 2232   | 2233   | BEAM   | 0.2200      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 2233                  | 2233   | 2234   | BEAM   | 0.8394      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 2234                  | 2234   | 2235   | BEAM   | 0.2583      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 2235                  | 2235   | 2236   | BEAM   | 0.8010      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 2236                  | 2236   | 2237   | BEAM   | 0.2879      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 2237                  | 2237   | 2238   | BEAM   | 0.7714      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 2238                  | 2238   | 2239   | BEAM   | 0.3115      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 2239                  | 2239   | 2240   | BEAM   | 0.7478      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 2240                  | 2240   | 2241   | BEAM   | 0.3307      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 2241                  | 2241   | 2242   | BEAM   | 0.7286      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 2242                  | 2242   | 2243   | BEAM   | 0.3467      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 2243                  | 2243   | 2244   | BEAM   | 0.7126      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 2244                  | 2244   | 2245   | BEAM   | 0.3602      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 2245                  | 2245   | 2246   | BEAM   | 0.8178      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 2500                  | 130    | 2118   | SPRING | 0.0000      | 90.0000          | 0.0000           | 0.0000        | 1    | No     |

Description: 3 Description of Structural Model  
3.2 Element Incidences

Project No.



| Elements - Parameters |        |        |        |             |                  |                  |               |      |        |
|-----------------------|--------|--------|--------|-------------|------------------|------------------|---------------|------|--------|
| Elem                  | Node 1 | Node 2 | Typ    | Length<br>m | Alpha 1<br>[Deg] | Alpha 2<br>[Deg] | Beta<br>[Deg] | NDiv | Active |
| 2501                  | 130    | 2119   | SPRING | 0.0000      | 90.0000          | 0.0000           | 0.0000        | 1    | No     |
| 2502                  | 130    | 2120   | SPRING | 0.0000      | 90.0000          | 0.0000           | 0.0000        | 1    | No     |
| 2503                  | 130    | 2121   | SPRING | 0.0000      | 90.0000          | 0.0000           | 0.0000        | 1    | No     |
| 2504                  | 130    | 2122   | SPRING | 0.0000      | 90.0000          | 0.0000           | 0.0000        | 1    | No     |
| 2510                  | 131    | 2118   | SPRING | 0.0000      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 2511                  | 131    | 2119   | SPRING | 0.0000      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 2512                  | 131    | 2120   | SPRING | 0.0000      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 2513                  | 131    | 2121   | SPRING | 0.0000      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 2514                  | 131    | 2122   | SPRING | 0.0000      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 2520                  | 132    | 2118   | SPRING | 0.0000      | 90.0000          | 0.0000           | 0.0000        | 1    | No     |
| 2521                  | 132    | 2119   | SPRING | 0.0000      | 90.0000          | 0.0000           | 0.0000        | 1    | No     |
| 2522                  | 132    | 2120   | SPRING | 0.0000      | 90.0000          | 0.0000           | 0.0000        | 1    | No     |
| 2523                  | 132    | 2121   | SPRING | 0.0000      | 90.0000          | 0.0000           | 0.0000        | 1    | No     |
| 2524                  | 132    | 2122   | SPRING | 0.0000      | 90.0000          | 0.0000           | 0.0000        | 1    | No     |
| 2530                  | 130    | 2218   | SPRING | 0.0000      | 90.0000          | 0.0000           | 0.0000        | 1    | No     |
| 2531                  | 130    | 2219   | SPRING | 0.0000      | 90.0000          | 0.0000           | 0.0000        | 1    | No     |
| 2532                  | 130    | 2220   | SPRING | 0.0000      | 90.0000          | 0.0000           | 0.0000        | 1    | No     |
| 2533                  | 130    | 2221   | SPRING | 0.0000      | 90.0000          | 0.0000           | 0.0000        | 1    | No     |
| 2534                  | 130    | 2222   | SPRING | 0.0000      | 90.0000          | 0.0000           | 0.0000        | 1    | No     |
| 2540                  | 131    | 2218   | SPRING | 0.0000      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 2541                  | 131    | 2219   | SPRING | 0.0000      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 2542                  | 131    | 2220   | SPRING | 0.0000      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 2543                  | 131    | 2221   | SPRING | 0.0000      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 2544                  | 131    | 2222   | SPRING | 0.0000      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 2550                  | 132    | 2218   | SPRING | 0.0000      | 90.0000          | 0.0000           | 0.0000        | 1    | No     |
| 2551                  | 132    | 2219   | SPRING | 0.0000      | 90.0000          | 0.0000           | 0.0000        | 1    | No     |
| 2552                  | 132    | 2220   | SPRING | 0.0000      | 90.0000          | 0.0000           | 0.0000        | 1    | No     |
| 2553                  | 132    | 2221   | SPRING | 0.0000      | 90.0000          | 0.0000           | 0.0000        | 1    | No     |
| 2554                  | 132    | 2222   | SPRING | 0.0000      | 90.0000          | 0.0000           | 0.0000        | 1    | No     |
| 3000                  | 0      | 3000   | SPRING | 1.0000      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 3001                  | 3000   | 3101   | SPRING | 0.0000      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 3002                  | 3000   | 3201   | SPRING | 0.0000      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 3101                  | 3101   | 3102   | BEAM   | 2.6000      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 3102                  | 3102   | 3103   | BEAM   | 2.6000      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 3103                  | 3103   | 3104   | BEAM   | 2.6000      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 3104                  | 3104   | 3105   | BEAM   | 2.6000      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 3105                  | 3105   | 3106   | BEAM   | 2.6000      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 3106                  | 3106   | 3107   | BEAM   | 2.6000      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 3107                  | 3107   | 3108   | BEAM   | 2.6000      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 3108                  | 3108   | 3109   | BEAM   | 2.6000      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 3109                  | 3109   | 3110   | BEAM   | 2.6000      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 3110                  | 3110   | 3111   | BEAM   | 2.6000      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 3111                  | 3111   | 3112   | BEAM   | 2.6000      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 3112                  | 3112   | 3113   | BEAM   | 2.6000      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 3113                  | 3113   | 3114   | BEAM   | 2.6000      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 3114                  | 3114   | 3115   | BEAM   | 2.6000      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 3115                  | 3115   | 3116   | BEAM   | 2.6000      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 3116                  | 3116   | 3117   | BEAM   | 2.6000      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 3117                  | 3117   | 3118   | BEAM   | 0.5000      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 3118                  | 3118   | 3119   | BEAM   | 2.5828      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 3119                  | 3119   | 3120   | BEAM   | 2.5828      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 3120                  | 3120   | 3121   | BEAM   | 2.5828      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 3121                  | 3121   | 3122   | BEAM   | 2.5828      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 3122                  | 3122   | 3123   | BEAM   | 2.7527      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 3123                  | 3123   | 3124   | BEAM   | 2.7527      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 3124                  | 3124   | 3125   | BEAM   | 2.7527      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 3125                  | 3125   | 3126   | BEAM   | 2.7527      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 3126                  | 3126   | 3127   | BEAM   | 2.7527      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 3127                  | 3127   | 3128   | BEAM   | 2.7527      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 3128                  | 3128   | 3129   | BEAM   | 0.0953      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 3129                  | 3129   | 3130   | BEAM   | 0.9640      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |

Description: 3 Description of Structural Model  
3.2 Element Incidences

Project No.



| Elements - Parameters |        |        |      |             |                  |                  |               |      |        |
|-----------------------|--------|--------|------|-------------|------------------|------------------|---------------|------|--------|
| Elem                  | Node 1 | Node 2 | Typ  | Length<br>m | Alpha 1<br>[Deg] | Alpha 2<br>[Deg] | Beta<br>[Deg] | NDiv | Active |
| 3130                  | 3130   | 3131   | BEAM | 0.1684      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 3131                  | 3131   | 3132   | BEAM | 0.8909      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 3132                  | 3132   | 3133   | BEAM | 0.2200      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 3133                  | 3133   | 3134   | BEAM | 0.8394      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 3134                  | 3134   | 3135   | BEAM | 0.2583      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 3135                  | 3135   | 3136   | BEAM | 0.8010      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 3136                  | 3136   | 3137   | BEAM | 0.2879      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 3137                  | 3137   | 3138   | BEAM | 0.7714      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 3138                  | 3138   | 3139   | BEAM | 0.3115      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 3139                  | 3139   | 3140   | BEAM | 0.7478      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 3140                  | 3140   | 3141   | BEAM | 0.3307      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 3141                  | 3141   | 3142   | BEAM | 0.7286      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 3142                  | 3142   | 3143   | BEAM | 0.3467      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 3143                  | 3143   | 3144   | BEAM | 0.7126      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 3144                  | 3144   | 3145   | BEAM | 0.3602      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 3145                  | 3145   | 3146   | BEAM | 0.8178      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 3201                  | 3201   | 3202   | BEAM | 2.6000      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 3202                  | 3202   | 3203   | BEAM | 2.6000      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 3203                  | 3203   | 3204   | BEAM | 2.6000      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 3204                  | 3204   | 3205   | BEAM | 2.6000      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 3205                  | 3205   | 3206   | BEAM | 2.6000      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 3206                  | 3206   | 3207   | BEAM | 2.6000      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 3207                  | 3207   | 3208   | BEAM | 2.6000      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 3208                  | 3208   | 3209   | BEAM | 2.6000      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 3209                  | 3209   | 3210   | BEAM | 2.6000      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 3210                  | 3210   | 3211   | BEAM | 2.6000      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 3211                  | 3211   | 3212   | BEAM | 2.6000      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 3212                  | 3212   | 3213   | BEAM | 2.6000      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 3213                  | 3213   | 3214   | BEAM | 2.6000      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 3214                  | 3214   | 3215   | BEAM | 2.6000      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 3215                  | 3215   | 3216   | BEAM | 2.6000      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 3216                  | 3216   | 3217   | BEAM | 2.6000      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 3217                  | 3217   | 3218   | BEAM | 0.5000      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 3218                  | 3218   | 3219   | BEAM | 2.5828      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 3219                  | 3219   | 3220   | BEAM | 2.5828      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 3220                  | 3220   | 3221   | BEAM | 2.5828      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 3221                  | 3221   | 3222   | BEAM | 2.5828      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 3222                  | 3222   | 3223   | BEAM | 2.7527      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 3223                  | 3223   | 3224   | BEAM | 2.7527      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 3224                  | 3224   | 3225   | BEAM | 2.7527      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 3225                  | 3225   | 3226   | BEAM | 2.7527      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 3226                  | 3226   | 3227   | BEAM | 2.7527      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 3227                  | 3227   | 3228   | BEAM | 2.7527      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 3228                  | 3228   | 3229   | BEAM | 0.0953      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 3229                  | 3229   | 3230   | BEAM | 0.9640      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 3230                  | 3230   | 3231   | BEAM | 0.1684      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 3231                  | 3231   | 3232   | BEAM | 0.8909      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 3232                  | 3232   | 3233   | BEAM | 0.2200      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 3233                  | 3233   | 3234   | BEAM | 0.8394      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 3234                  | 3234   | 3235   | BEAM | 0.2583      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 3235                  | 3235   | 3236   | BEAM | 0.8010      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 3236                  | 3236   | 3237   | BEAM | 0.2879      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 3237                  | 3237   | 3238   | BEAM | 0.7714      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 3238                  | 3238   | 3239   | BEAM | 0.3115      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 3239                  | 3239   | 3240   | BEAM | 0.7478      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 3240                  | 3240   | 3241   | BEAM | 0.3307      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 3241                  | 3241   | 3242   | BEAM | 0.7286      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 3242                  | 3242   | 3243   | BEAM | 0.3467      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 3243                  | 3243   | 3244   | BEAM | 0.7126      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 3244                  | 3244   | 3245   | BEAM | 0.3602      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 3245                  | 3245   | 3246   | BEAM | 0.8178      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |

Description: 3 Description of Structural Model  
3.2 Element Incidences

Project No.





| Elements - Parameters |        |        |        |             |                  |                  |               |      |        |
|-----------------------|--------|--------|--------|-------------|------------------|------------------|---------------|------|--------|
| Elem                  | Node 1 | Node 2 | Typ    | Length<br>m | Alpha 1<br>[Deg] | Alpha 2<br>[Deg] | Beta<br>[Deg] | NDiv | Active |
| 3500                  | 186    | 3118   | SPRING | 0.0000      | 90.0000          | 0.0000           | 0.0000        | 1    | No     |
| 3501                  | 186    | 3119   | SPRING | 0.0000      | 90.0000          | 0.0000           | 0.0000        | 1    | No     |
| 3502                  | 186    | 3120   | SPRING | 0.0000      | 90.0000          | 0.0000           | 0.0000        | 1    | No     |
| 3503                  | 186    | 3121   | SPRING | 0.0000      | 90.0000          | 0.0000           | 0.0000        | 1    | No     |
| 3504                  | 186    | 3122   | SPRING | 0.0000      | 90.0000          | 0.0000           | 0.0000        | 1    | No     |
| 3510                  | 187    | 3118   | SPRING | 0.0000      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 3511                  | 187    | 3119   | SPRING | 0.0000      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 3512                  | 187    | 3120   | SPRING | 0.0000      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 3513                  | 187    | 3121   | SPRING | 0.0000      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 3514                  | 187    | 3122   | SPRING | 0.0000      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 3520                  | 188    | 3118   | SPRING | 0.0000      | 90.0000          | 0.0000           | 0.0000        | 1    | No     |
| 3521                  | 188    | 3119   | SPRING | 0.0000      | 90.0000          | 0.0000           | 0.0000        | 1    | No     |
| 3522                  | 188    | 3120   | SPRING | 0.0000      | 90.0000          | 0.0000           | 0.0000        | 1    | No     |
| 3523                  | 188    | 3121   | SPRING | 0.0000      | 90.0000          | 0.0000           | 0.0000        | 1    | No     |
| 3524                  | 188    | 3122   | SPRING | 0.0000      | 90.0000          | 0.0000           | 0.0000        | 1    | No     |
| 3530                  | 186    | 3218   | SPRING | 0.0000      | 90.0000          | 0.0000           | 0.0000        | 1    | No     |
| 3531                  | 186    | 3219   | SPRING | 0.0000      | 90.0000          | 0.0000           | 0.0000        | 1    | No     |
| 3532                  | 186    | 3220   | SPRING | 0.0000      | 90.0000          | 0.0000           | 0.0000        | 1    | No     |
| 3533                  | 186    | 3221   | SPRING | 0.0000      | 90.0000          | 0.0000           | 0.0000        | 1    | No     |
| 3534                  | 186    | 3222   | SPRING | 0.0000      | 90.0000          | 0.0000           | 0.0000        | 1    | No     |
| 3540                  | 187    | 3218   | SPRING | 0.0000      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 3541                  | 187    | 3219   | SPRING | 0.0000      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 3542                  | 187    | 3220   | SPRING | 0.0000      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 3543                  | 187    | 3221   | SPRING | 0.0000      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 3544                  | 187    | 3222   | SPRING | 0.0000      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 3550                  | 188    | 3218   | SPRING | 0.0000      | 90.0000          | 0.0000           | 0.0000        | 1    | No     |
| 3551                  | 188    | 3219   | SPRING | 0.0000      | 90.0000          | 0.0000           | 0.0000        | 1    | No     |
| 3552                  | 188    | 3220   | SPRING | 0.0000      | 90.0000          | 0.0000           | 0.0000        | 1    | No     |
| 3553                  | 188    | 3221   | SPRING | 0.0000      | 90.0000          | 0.0000           | 0.0000        | 1    | No     |
| 3554                  | 188    | 3222   | SPRING | 0.0000      | 90.0000          | 0.0000           | 0.0000        | 1    | No     |
| 4000                  | 0      | 4000   | SPRING | 1.0000      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 4001                  | 4000   | 215    | SPRING | 0.0000      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 4002                  | 4000   | 215    | SPRING | 0.0000      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 5000                  | 0      | 5103   | SPRING | 1.0000      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 5001                  | 5101   | 5103   | SPRING | 0.0000      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 5002                  | 5102   | 5103   | SPRING | 0.0000      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 5004                  | 5104   | 5103   | SPRING | 0.0000      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 5005                  | 5105   | 5103   | SPRING | 0.0000      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 5201                  | 107    | 5105   | CABLE  | 14.4409     | -86.0292         | 90.0000          | -90.0000      | 1    | Yes    |
| 5202                  | 106    | 5104   | CABLE  | 14.4409     | -86.0292         | 90.0000          | -90.0000      | 1    | Yes    |
| 5203                  | 105    | 5102   | CABLE  | 14.4409     | -86.0292         | 90.0000          | -90.0000      | 1    | Yes    |
| 5204                  | 104    | 5101   | CABLE  | 14.4409     | -86.0292         | 90.0000          | -90.0000      | 1    | Yes    |
| 5301                  | 107    | 5105   | CABLE  | 14.4409     | -86.0292         | -90.0000         | 90.0000       | 1    | Yes    |
| 5302                  | 106    | 5104   | CABLE  | 14.4409     | -86.0292         | -90.0000         | 90.0000       | 1    | Yes    |
| 5303                  | 105    | 5102   | CABLE  | 14.4409     | -86.0292         | -90.0000         | 90.0000       | 1    | Yes    |
| 5304                  | 104    | 5101   | CABLE  | 14.4409     | -86.0292         | -90.0000         | 90.0000       | 1    | Yes    |
| 6000                  | 0      | 6103   | SPRING | 1.0000      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 6001                  | 6101   | 6103   | SPRING | 0.0000      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 6002                  | 6102   | 6103   | SPRING | 0.0000      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 6004                  | 6104   | 6103   | SPRING | 0.0000      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 6005                  | 6105   | 6103   | SPRING | 0.0000      | 90.0000          | 0.0000           | 0.0000        | 1    | Yes    |
| 6201                  | 211    | 6105   | CABLE  | 14.4409     | -86.0292         | 90.0000          | -90.0000      | 1    | Yes    |
| 6202                  | 212    | 6104   | CABLE  | 14.4409     | -86.0292         | 90.0000          | -90.0000      | 1    | Yes    |
| 6203                  | 213    | 6102   | CABLE  | 14.4409     | -86.0292         | 90.0000          | -90.0000      | 1    | Yes    |
| 6204                  | 214    | 6101   | CABLE  | 14.4409     | -86.0292         | 90.0029          | -90.0029      | 1    | Yes    |
| 6301                  | 211    | 6105   | CABLE  | 14.4409     | -86.0292         | -90.0000         | 90.0000       | 1    | Yes    |
| 6302                  | 212    | 6104   | CABLE  | 14.4409     | -86.0292         | -90.0000         | 90.0000       | 1    | Yes    |
| 6303                  | 213    | 6102   | CABLE  | 14.4409     | -86.0292         | -90.0000         | 90.0000       | 1    | Yes    |
| 6304                  | 214    | 6101   | CABLE  | 14.4409     | -86.0292         | -90.0029         | 90.0029       | 1    | Yes    |



### 3.3 Element Cross-Section Properties

| Crossection - Beams |      |                   |                   |                   |                   |                   |                   |         |         |
|---------------------|------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|---------|---------|
| Elem                | Type | Ax                | Ay                | Az                | Ix                | Iy                | Iz                | U       | UIN     |
|                     |      | [m <sup>2</sup> ] | [m <sup>2</sup> ] | [m <sup>2</sup> ] | [m <sup>4</sup> ] | [m <sup>4</sup> ] | [m <sup>4</sup> ] | m       | m       |
| 101                 | BEAM | 27.9471           | 12.7030           | 10.1887           | 225.4024          | 369.0664          | 193.7661          | 41.2242 | 38.8787 |
| 102                 | BEAM | 27.9471           | 12.7030           | 10.1887           | 225.4024          | 369.0664          | 193.7661          | 41.2242 | 38.8787 |
| 103                 | BEAM | 27.9471           | 12.7030           | 10.1887           | 225.4024          | 369.0664          | 193.7661          | 41.2242 | 38.8787 |
| 104                 | BEAM | 27.9471           | 12.7030           | 10.1887           | 225.4024          | 369.0664          | 193.7661          | 41.2242 | 38.8787 |
| 105                 | BEAM | 27.9471           | 12.7030           | 10.1887           | 225.4024          | 369.0664          | 193.7661          | 41.2242 | 38.8787 |
| 106                 | BEAM | 27.9471           | 12.7030           | 10.1887           | 225.4024          | 369.0664          | 193.7661          | 41.2242 | 38.8787 |
| 107                 | BEAM | 27.9471           | 12.7030           | 10.1887           | 225.4024          | 369.0664          | 193.7661          | 41.2242 | 38.8787 |
| 108                 | BEAM | 27.9471           | 12.7030           | 10.1887           | 225.4024          | 369.0664          | 193.7661          | 41.2242 | 38.8787 |
| 109                 | BEAM | 28.0496           | 12.7619           | 10.2222           | 225.8406          | 369.5683          | 194.5020          | 41.2305 | 38.8536 |
| 110                 | BEAM | 28.2842           | 12.9032           | 10.2902           | 227.1365          | 370.7779          | 196.5885          | 41.2593 | 38.8151 |
| 111                 | BEAM | 28.5652           | 13.0850           | 10.3549           | 229.2407          | 372.3410          | 199.8545          | 41.3205 | 38.8050 |
| 112                 | BEAM | 28.8806           | 13.3011           | 10.4113           | 232.1314          | 374.2031          | 204.2754          | 41.4142 | 38.8279 |
| 113                 | BEAM | 29.2315           | 13.5527           | 10.4594           | 235.8269          | 376.3718          | 209.9084          | 41.5405 | 38.8836 |
| 114                 | BEAM | 29.6191           | 13.8410           | 10.4990           | 240.3477          | 378.8536          | 216.8230          | 41.6994 | 38.9722 |
| 115                 | BEAM | 30.0444           | 14.1670           | 10.5302           | 245.7160          | 381.6547          | 225.1013          | 41.8908 | 39.0938 |
| 116                 | BEAM | 30.5086           | 14.5318           | 10.5530           | 251.9563          | 384.7814          | 234.8392          | 42.1147 | 39.2483 |
| 117                 | BEAM | 31.0128           | 14.9365           | 10.5674           | 259.0949          | 388.2399          | 246.1479          | 42.3713 | 39.4360 |
| 118                 | BEAM | 31.4429           | 15.3141           | 10.5367           | 266.8324          | 391.5312          | 258.4487          | 42.6603 | 39.6907 |
| 119                 | BEAM | 31.7967           | 15.6620           | 10.4620           | 275.1721          | 394.6455          | 271.8055          | 42.9819 | 40.0123 |
| 120                 | BEAM | 32.3205           | 16.1223           | 10.4253           | 284.8538          | 398.6519          | 287.9301          | 43.3361 | 40.3272 |
| 121                 | BEAM | 33.0187           | 16.6997           | 10.4257           | 295.9359          | 403.5704          | 307.0859          | 43.7228 | 40.6357 |
| 122                 | BEAM | 33.7621           | 17.3226           | 10.4183           | 308.0721          | 408.8475          | 328.6349          | 44.1421 | 40.9776 |
| 123                 | BEAM | 34.5518           | 17.9920           | 10.4034           | 321.2990          | 414.4886          | 352.8045          | 44.5939 | 41.3530 |
| 124                 | BEAM | 35.3289           | 18.6571           | 10.3832           | 334.6052          | 420.0673          | 377.8144          | 45.0433 | 41.7320 |
| 125                 | BEAM | 36.0883           | 19.3128           | 10.3587           | 347.8763          | 425.5405          | 403.5081          | 45.4861 | 42.1105 |
| 126                 | BEAM | 36.8849           | 20.0058           | 10.3292           | 362.0431          | 431.2985          | 431.7372          | 45.9532 | 42.5142 |
| 127                 | BEAM | 37.7193           | 20.7366           | 10.2948           | 377.1295          | 437.3436          | 462.7114          | 46.4446 | 42.9432 |
| 128                 | BEAM | 38.5920           | 21.5058           | 10.2556           | 393.1614          | 443.6787          | 496.6615          | 46.9603 | 43.3977 |
| 129                 | BEAM | 39.0381           | 21.9001           | 10.2348           | 401.4167          | 446.9192          | 514.4096          | 47.2242 | 43.6313 |
| 130                 | BEAM | 39.0381           | 21.9001           | 10.2348           | 401.4167          | 446.9192          | 514.4096          | 47.2242 | 43.6313 |
| 131                 | BEAM | 39.0381           | 21.9001           | 10.2348           | 401.4167          | 446.9192          | 514.4096          | 47.2242 | 43.6313 |
| 132                 | BEAM | 39.0381           | 21.9001           | 10.2348           | 401.4167          | 446.9192          | 514.4096          | 47.2242 | 43.6313 |
| 133                 | BEAM | 38.1662           | 21.0421           | 10.3872           | 380.1045          | 439.4821          | 470.4885          | 46.4976 | 42.9047 |
| 134                 | BEAM | 36.4787           | 19.3811           | 10.6939           | 339.4503          | 425.0877          | 389.9357          | 45.0914 | 41.4985 |
| 135                 | BEAM | 34.9037           | 17.8304           | 11.0038           | 302.6764          | 411.6530          | 322.9006          | 43.7789 | 40.1860 |
| 136                 | BEAM | 33.4412           | 16.3914           | 11.3162           | 269.6535          | 399.1779          | 267.3930          | 42.5601 | 38.9672 |
| 137                 | BEAM | 32.0912           | 15.0655           | 11.6302           | 240.2342          | 387.6624          | 221.6732          | 41.4351 | 37.8422 |
| 138                 | BEAM | 30.8537           | 13.8539           | 11.9443           | 214.2540          | 377.1065          | 184.2283          | 40.4039 | 36.8110 |
| 139                 | BEAM | 29.7287           | 12.7578           | 12.2564           | 191.5324          | 367.5102          | 153.7499          | 39.4664 | 35.8735 |
| 140                 | BEAM | 28.4572           | 11.6345           | 12.4409           | 171.5506          | 357.8447          | 128.5146          | 38.6226 | 35.1200 |
| 141                 | BEAM | 27.0625           | 10.5069           | 12.4844           | 154.2030          | 348.2100          | 107.7799          | 37.8726 | 34.5566 |
| 142                 | BEAM | 25.8217           | 9.5353            | 12.4959           | 139.6740          | 339.7116          | 91.4733           | 37.2164 | 34.0974 |
| 143                 | BEAM | 24.7243           | 8.7075            | 12.4706           | 127.7037          | 332.3005          | 78.7831           | 36.6539 | 33.7391 |
| 144                 | BEAM | 23.9886           | 8.1172            | 12.5388           | 118.2696          | 326.8800          | 69.3960           | 36.1851 | 33.3739 |
| 145                 | BEAM | 23.0758           | 7.5084            | 12.3879           | 110.6643          | 321.1663          | 61.9996           | 35.8101 | 33.2455 |
| 146                 | BEAM | 21.7466           | 6.7759            | 11.8781           | 104.4506          | 314.0489          | 55.8353           | 35.5289 | 33.4628 |
| 147                 | BEAM | 20.5126           | 6.1585            | 11.3159           | 99.8620           | 307.5459          | 51.3133           | 35.3414 | 33.7819 |
| 148                 | BEAM | 19.3491           | 5.6312            | 10.7043           | 96.6006           | 301.4803          | 48.0701           | 35.2476 | 34.1990 |
| 149                 | BEAM | 18.2170           | 5.1544            | 10.0548           | 93.9503           | 295.5053          | 45.4932           | 35.2242 | 34.6889 |
| 150                 | BEAM | 17.0714           | 4.6826            | 9.3856            | 90.8210           | 289.1732          | 42.7645           | 35.2242 | 35.2038 |
| 151                 | BEAM | 15.8937           | 4.1958            | 8.7020            | 86.4754           | 282.2726          | 39.4375           | 35.2242 | 35.7198 |
| 152                 | BEAM | 14.6839           | 3.6913            | 7.9960            | 80.3861           | 274.7706          | 35.3418           | 35.2242 | 36.2365 |
| 153                 | BEAM | 14.0710           | 3.4343            | 7.6359            | 76.8246           | 270.8650          | 33.0771           | 35.2242 | 36.4950 |
| 154                 | BEAM | 14.0710           | 3.4343            | 7.6359            | 76.8246           | 270.8650          | 33.0771           | 35.2242 | 36.4950 |
| 155                 | BEAM | 14.0710           | 3.4343            | 7.6359            | 76.8246           | 270.8650          | 33.0771           | 35.2242 | 36.4950 |
| 156                 | BEAM | 14.0710           | 3.4343            | 7.6359            | 76.8246           | 270.8650          | 33.0771           | 35.2242 | 36.4950 |
| 157                 | BEAM | 14.0710           | 3.4343            | 7.6359            | 76.8246           | 270.8650          | 33.0771           | 35.2242 | 36.4950 |





| Crossection - Beams |      |            |            |            |            |            |            |         |          |
|---------------------|------|------------|------------|------------|------------|------------|------------|---------|----------|
| Elem                | Type | Ax<br>[m2] | Ay<br>[m2] | Az<br>[m2] | Ix<br>[m4] | Iy<br>[m4] | Iz<br>[m4] | U<br>m  | UIN<br>m |
| 158                 | BEAM | 14.0710    | 3.4343     | 7.6359     | 76.8246    | 270.8650   | 33.0771    | 35.2242 | 36.4950  |
| 159                 | BEAM | 14.0710    | 3.4343     | 7.6359     | 76.8246    | 270.8650   | 33.0771    | 35.2242 | 36.4950  |
| 160                 | BEAM | 14.0710    | 3.4343     | 7.6359     | 76.8246    | 270.8650   | 33.0771    | 35.2242 | 36.4950  |
| 161                 | BEAM | 14.0710    | 3.4343     | 7.6359     | 76.8246    | 270.8650   | 33.0771    | 35.2242 | 36.4950  |
| 162                 | BEAM | 14.0710    | 3.4343     | 7.6359     | 76.8246    | 270.8650   | 33.0771    | 35.2242 | 36.4950  |
| 163                 | BEAM | 14.0710    | 3.4343     | 7.6359     | 76.8246    | 270.8650   | 33.0771    | 35.2242 | 36.4950  |
| 164                 | BEAM | 14.0710    | 3.4343     | 7.6359     | 76.8246    | 270.8650   | 33.0771    | 35.2242 | 36.4950  |
| 165                 | BEAM | 14.6839    | 3.6913     | 7.9960     | 80.3861    | 274.7706   | 35.3418    | 35.2242 | 36.2365  |
| 166                 | BEAM | 15.8937    | 4.1958     | 8.7020     | 86.4754    | 282.2726   | 39.4375    | 35.2242 | 35.7198  |
| 167                 | BEAM | 17.0714    | 4.6826     | 9.3856     | 90.8210    | 289.1732   | 42.7645    | 35.2242 | 35.2038  |
| 168                 | BEAM | 18.2170    | 5.1544     | 10.0548    | 93.9503    | 295.5053   | 45.4932    | 35.2242 | 34.6889  |
| 169                 | BEAM | 19.3491    | 5.6312     | 10.7043    | 96.6006    | 301.4803   | 48.0701    | 35.2476 | 34.1990  |
| 170                 | BEAM | 20.5126    | 6.1585     | 11.3159    | 99.8620    | 307.5459   | 51.3133    | 35.3414 | 33.7819  |
| 171                 | BEAM | 21.7466    | 6.7759     | 11.8781    | 104.4506   | 314.0489   | 55.8353    | 35.5289 | 33.4628  |
| 172                 | BEAM | 23.0758    | 7.5084     | 12.3879    | 110.6643   | 321.1663   | 61.9996    | 35.8101 | 33.2455  |
| 173                 | BEAM | 23.9886    | 8.1172     | 12.5388    | 118.2696   | 326.8800   | 69.3960    | 36.1851 | 33.3739  |
| 174                 | BEAM | 24.7243    | 8.7075     | 12.4706    | 127.7037   | 332.3005   | 78.7831    | 36.6539 | 33.7391  |
| 175                 | BEAM | 25.8217    | 9.5353     | 12.4959    | 139.6740   | 339.7116   | 91.4733    | 37.2164 | 34.0974  |
| 176                 | BEAM | 27.0625    | 10.5069    | 12.4844    | 154.2030   | 348.2100   | 107.7799   | 37.8726 | 34.5566  |
| 177                 | BEAM | 28.4572    | 11.6345    | 12.4409    | 171.5506   | 357.8447   | 128.5146   | 38.6226 | 35.1200  |
| 178                 | BEAM | 29.7287    | 12.7578    | 12.2564    | 191.5324   | 367.5102   | 153.7499   | 39.4664 | 35.8735  |
| 179                 | BEAM | 30.8537    | 13.8539    | 11.9443    | 214.2540   | 377.1065   | 184.2283   | 40.4039 | 36.8110  |
| 180                 | BEAM | 32.0912    | 15.0655    | 11.6302    | 240.2342   | 387.6624   | 221.6732   | 41.4351 | 37.8422  |
| 181                 | BEAM | 33.4412    | 16.3914    | 11.3162    | 269.6535   | 399.1779   | 267.3930   | 42.5601 | 38.9672  |
| 182                 | BEAM | 34.9037    | 17.8304    | 11.0038    | 302.6764   | 411.6530   | 322.9006   | 43.7789 | 40.1860  |
| 183                 | BEAM | 36.4787    | 19.3811    | 10.6939    | 339.4503   | 425.0877   | 389.9357   | 45.0914 | 41.4985  |
| 184                 | BEAM | 38.1662    | 21.0421    | 10.3872    | 380.1045   | 439.4821   | 470.4885   | 46.4976 | 42.9047  |
| 185                 | BEAM | 39.0381    | 21.9001    | 10.2348    | 401.4167   | 446.9192   | 514.4096   | 47.2242 | 43.6313  |
| 186                 | BEAM | 39.0381    | 21.9001    | 10.2348    | 401.4167   | 446.9192   | 514.4096   | 47.2242 | 43.6313  |
| 187                 | BEAM | 39.0381    | 21.9001    | 10.2348    | 401.4167   | 446.9192   | 514.4096   | 47.2242 | 43.6313  |
| 188                 | BEAM | 39.0381    | 21.9001    | 10.2348    | 401.4167   | 446.9192   | 514.4096   | 47.2242 | 43.6313  |
| 189                 | BEAM | 38.5481    | 21.4652    | 10.2531    | 393.0017   | 443.4440   | 496.3991   | 46.9603 | 43.4040  |
| 190                 | BEAM | 37.5901    | 20.6174    | 10.2871    | 376.6662   | 436.6477   | 461.9672   | 46.4446 | 42.9628  |
| 191                 | BEAM | 36.6754    | 19.8128    | 10.3163    | 361.3067   | 430.1576   | 430.5917   | 45.9532 | 42.5483  |
| 192                 | BEAM | 35.8029    | 19.0505    | 10.3405    | 346.8939   | 423.9695   | 402.0291   | 45.4861 | 42.1601  |
| 193                 | BEAM | 34.9713    | 18.3293    | 10.3595    | 333.3997   | 418.0780   | 376.0569   | 45.0433 | 41.7980  |
| 194                 | BEAM | 34.1204    | 17.5976    | 10.3738    | 319.8755   | 412.0601   | 350.7990   | 44.5939 | 41.4375  |
| 195                 | BEAM | 33.2556    | 16.8609    | 10.3822    | 306.4363   | 405.9601   | 326.4100   | 44.1421 | 41.0827  |
| 196                 | BEAM | 32.4407    | 16.1745    | 10.3830    | 294.1063   | 400.2344   | 304.6804   | 43.7228 | 40.7618  |
| 197                 | BEAM | 31.6741    | 15.5367    | 10.3761    | 282.8447   | 394.8746   | 285.3731   | 43.3361 | 40.4748  |
| 198                 | BEAM | 31.1253    | 15.0553    | 10.4091    | 273.1348   | 390.6992   | 269.2742   | 42.9819 | 40.1707  |
| 199                 | BEAM | 30.7876    | 14.7232    | 10.4832    | 264.9045   | 387.6794   | 256.0941   | 42.6603 | 39.8491  |
| 200                 | BEAM | 30.4068    | 14.3914    | 10.5167    | 257.3549   | 384.6670   | 244.0591   | 42.3713 | 39.5861  |
| 201                 | BEAM | 29.9844    | 14.0616    | 10.5084    | 250.4777   | 381.6689   | 233.0963   | 42.1147 | 39.3818  |
| 202                 | BEAM | 29.5982    | 13.7679    | 10.4918    | 244.4765   | 378.9869   | 223.6638   | 41.8908 | 39.2101  |
| 203                 | BEAM | 29.2476    | 13.5097    | 10.4668    | 239.3286   | 376.6178   | 215.6581   | 41.6994 | 39.0711  |
| 204                 | BEAM | 28.9322    | 13.2865    | 10.4333    | 235.0133   | 374.5584   | 208.9900   | 41.5405 | 38.9646  |
| 205                 | BEAM | 28.6514    | 13.0977    | 10.3914    | 231.5119   | 372.8053   | 203.5836   | 41.4142 | 38.8908  |
| 206                 | BEAM | 28.4047    | 12.9428    | 10.3409    | 228.8077   | 371.3552   | 199.3751   | 41.3205 | 38.8496  |
| 207                 | BEAM | 28.1914    | 12.8212    | 10.2822    | 226.8860   | 370.2047   | 196.3131   | 41.2593 | 38.8411  |
| 208                 | BEAM | 28.0201    | 12.7358    | 10.2197    | 225.7609   | 369.3854   | 194.4147   | 41.2305 | 38.8618  |
| 209                 | BEAM | 27.9471    | 12.7030    | 10.1887    | 225.4024   | 369.0664   | 193.7661   | 41.2242 | 38.8787  |
| 210                 | BEAM | 27.9471    | 12.7030    | 10.1887    | 225.4024   | 369.0664   | 193.7661   | 41.2242 | 38.8787  |
| 211                 | BEAM | 27.9471    | 12.7030    | 10.1887    | 225.4024   | 369.0664   | 193.7661   | 41.2242 | 38.8787  |
| 212                 | BEAM | 27.9471    | 12.7030    | 10.1887    | 225.4024   | 369.0664   | 193.7661   | 41.2242 | 38.8787  |
| 213                 | BEAM | 27.9471    | 12.7030    | 10.1887    | 225.4024   | 369.0664   | 193.7661   | 41.2242 | 38.8787  |
| 214                 | BEAM | 27.9471    | 12.7030    | 10.1887    | 225.4024   | 369.0664   | 193.7661   | 41.2242 | 38.8787  |
| 215                 | BEAM | 27.9471    | 12.7030    | 10.1887    | 225.4024   | 369.0664   | 193.7661   | 41.2242 | 38.8787  |
| 216                 | BEAM | 27.9471    | 12.7030    | 10.1887    | 225.4024   | 369.0664   | 193.7661   | 41.2242 | 38.8787  |
| 2101                | BEAM | 26.0332    | 21.9227    | 21.9227    | 93.1509    | 42.2053    | 75.7864    | 20.6250 | 0.0000   |
| 2102                | BEAM | 24.1348    | 20.3240    | 20.3240    | 79.8342    | 35.8747    | 65.8764    | 19.8750 | 0.0000   |

Description: 3 Description of Structural Model  
3.3 Element Cross-Section Properties

Project No.



| Crossection - Beams |      |            |            |            |            |            |            |         |          |
|---------------------|------|------------|------------|------------|------------|------------|------------|---------|----------|
| Elem                | Type | Ax<br>[m2] | Ay<br>[m2] | Az<br>[m2] | Ix<br>[m4] | Iy<br>[m4] | Iz<br>[m4] | U<br>m  | UIN<br>m |
| 2103                | BEAM | 22.3066    | 18.7845    | 18.7845    | 67.9822    | 30.2815    | 56.9659    | 19.1250 | 0.0000   |
| 2104                | BEAM | 20.5488    | 17.3043    | 17.3043    | 57.4850    | 25.3665    | 48.9858    | 18.3750 | 0.0000   |
| 2105                | BEAM | 18.8613    | 15.8832    | 15.8832    | 48.2368    | 21.0728    | 41.8691    | 17.6250 | 0.0000   |
| 2106                | BEAM | 17.2441    | 14.5214    | 14.5214    | 40.1361    | 17.3460    | 35.5517    | 16.8750 | 0.0000   |
| 2107                | BEAM | 15.6973    | 13.2188    | 13.2188    | 33.0856    | 14.1341    | 29.9717    | 16.1250 | 0.0000   |
| 2108                | BEAM | 14.2207    | 11.9753    | 11.9753    | 26.9920    | 11.3878    | 25.0699    | 15.3750 | 0.0000   |
| 2109                | BEAM | 12.8145    | 10.7911    | 10.7911    | 21.7666    | 9.0601     | 20.7893    | 14.6250 | 0.0000   |
| 2110                | BEAM | 11.4785    | 9.6661     | 9.6661     | 17.3248    | 7.1064     | 17.0757    | 13.8750 | 0.0000   |
| 2111                | BEAM | 10.2129    | 8.6003     | 8.6003     | 13.5860    | 5.4848     | 13.8770    | 13.1250 | 0.0000   |
| 2112                | BEAM | 9.0176     | 7.5938     | 7.5938     | 10.4741    | 4.1558     | 11.1439    | 12.3750 | 0.0000   |
| 2113                | BEAM | 7.8926     | 6.6464     | 6.6464     | 7.9171     | 3.0821     | 8.8294     | 11.6250 | 0.0000   |
| 2114                | BEAM | 6.8379     | 5.7582     | 5.7582     | 5.8472     | 2.2293     | 6.8889     | 10.8750 | 0.0000   |
| 2115                | BEAM | 5.8535     | 4.9293     | 4.9293     | 4.2008     | 1.5652     | 5.2805     | 10.1250 | 0.0000   |
| 2116                | BEAM | 4.9395     | 4.1595     | 4.1595     | 2.9186     | 1.0601     | 3.9646     | 9.3750  | 0.0000   |
| 2117                | BEAM | 4.5000     | 3.7895     | 3.7895     | 2.3613     | 0.8438     | 3.3750     | 9.0000  | 0.0000   |
| 2118                | BEAM | 4.5000     | 3.7895     | 3.7895     | 2.3613     | 0.8438     | 3.3750     | 9.0000  | 0.0000   |
| 2119                | BEAM | 4.5000     | 3.7895     | 3.7895     | 2.3613     | 0.8438     | 3.3750     | 9.0000  | 0.0000   |
| 2120                | BEAM | 4.5000     | 3.7895     | 3.7895     | 2.3613     | 0.8438     | 3.3750     | 9.0000  | 0.0000   |
| 2121                | BEAM | 4.5000     | 3.7895     | 3.7895     | 2.3613     | 0.8438     | 3.3750     | 9.0000  | 0.0000   |
| 2122                | BEAM | 4.5000     | 3.7895     | 3.7895     | 2.3613     | 0.8438     | 3.3750     | 9.0000  | 0.0000   |
| 2123                | BEAM | 4.5000     | 3.7895     | 3.7895     | 2.3613     | 0.8438     | 3.3750     | 9.0000  | 0.0000   |
| 2124                | BEAM | 4.5000     | 3.7895     | 3.7895     | 2.3613     | 0.8438     | 3.3750     | 9.0000  | 0.0000   |
| 2125                | BEAM | 4.5000     | 3.7895     | 3.7895     | 2.3613     | 0.8438     | 3.3750     | 9.0000  | 0.0000   |
| 2126                | BEAM | 4.5000     | 3.7895     | 3.7895     | 2.3613     | 0.8438     | 3.3750     | 9.0000  | 0.0000   |
| 2127                | BEAM | 4.5000     | 3.7895     | 3.7895     | 2.3613     | 0.8438     | 3.3750     | 9.0000  | 0.0000   |
| 2128                | BEAM | 4.5000     | 3.7895     | 3.7895     | 2.3613     | 0.8438     | 3.3750     | 9.0000  | 0.0000   |
| 2129                | BEAM | 4.5000     | 3.7895     | 3.7895     | 2.3613     | 0.8438     | 3.3750     | 9.0000  | 0.0000   |
| 2130                | BEAM | 4.5000     | 3.7895     | 3.7895     | 2.3613     | 0.8438     | 3.3750     | 9.0000  | 0.0000   |
| 2131                | BEAM | 4.5000     | 3.7895     | 3.7895     | 2.3613     | 0.8438     | 3.3750     | 9.0000  | 0.0000   |
| 2132                | BEAM | 4.5000     | 3.7895     | 3.7895     | 2.3613     | 0.8438     | 3.3750     | 9.0000  | 0.0000   |
| 2133                | BEAM | 4.5000     | 3.7895     | 3.7895     | 2.3613     | 0.8438     | 3.3750     | 9.0000  | 0.0000   |
| 2134                | BEAM | 4.5000     | 3.7895     | 3.7895     | 2.3613     | 0.8438     | 3.3750     | 9.0000  | 0.0000   |
| 2135                | BEAM | 4.5000     | 3.7895     | 3.7895     | 2.3613     | 0.8438     | 3.3750     | 9.0000  | 0.0000   |
| 2136                | BEAM | 4.5000     | 3.7895     | 3.7895     | 2.3613     | 0.8438     | 3.3750     | 9.0000  | 0.0000   |
| 2137                | BEAM | 4.5000     | 3.7895     | 3.7895     | 2.3613     | 0.8438     | 3.3750     | 9.0000  | 0.0000   |
| 2138                | BEAM | 4.5000     | 3.7895     | 3.7895     | 2.3613     | 0.8438     | 3.3750     | 9.0000  | 0.0000   |
| 2139                | BEAM | 4.5000     | 3.7895     | 3.7895     | 2.3613     | 0.8438     | 3.3750     | 9.0000  | 0.0000   |
| 2140                | BEAM | 4.5000     | 3.7895     | 3.7895     | 2.3613     | 0.8438     | 3.3750     | 9.0000  | 0.0000   |
| 2141                | BEAM | 4.5000     | 3.7895     | 3.7895     | 2.3613     | 0.8438     | 3.3750     | 9.0000  | 0.0000   |
| 2142                | BEAM | 4.5000     | 3.7895     | 3.7895     | 2.3613     | 0.8438     | 3.3750     | 9.0000  | 0.0000   |
| 2143                | BEAM | 4.5000     | 3.7895     | 3.7895     | 2.3613     | 0.8438     | 3.3750     | 9.0000  | 0.0000   |
| 2144                | BEAM | 4.5000     | 3.7895     | 3.7895     | 2.3613     | 0.8438     | 3.3750     | 9.0000  | 0.0000   |
| 2145                | BEAM | 4.5000     | 3.7895     | 3.7895     | 2.3613     | 0.8438     | 3.3750     | 9.0000  | 0.0000   |
| 2201                | BEAM | 26.0332    | 21.9227    | 21.9227    | 93.1509    | 42.2053    | 75.7864    | 20.6250 | 0.0000   |
| 2202                | BEAM | 24.1348    | 20.3240    | 20.3240    | 79.8342    | 35.8747    | 65.8764    | 19.8750 | 0.0000   |
| 2203                | BEAM | 22.3066    | 18.7845    | 18.7845    | 67.9822    | 30.2815    | 56.9659    | 19.1250 | 0.0000   |
| 2204                | BEAM | 20.5488    | 17.3043    | 17.3043    | 57.4850    | 25.3665    | 48.9858    | 18.3750 | 0.0000   |
| 2205                | BEAM | 18.8613    | 15.8832    | 15.8832    | 48.2368    | 21.0728    | 41.8691    | 17.6250 | 0.0000   |
| 2206                | BEAM | 17.2441    | 14.5214    | 14.5214    | 40.1361    | 17.3460    | 35.5517    | 16.8750 | 0.0000   |
| 2207                | BEAM | 15.6973    | 13.2188    | 13.2188    | 33.0856    | 14.1341    | 29.9717    | 16.1250 | 0.0000   |
| 2208                | BEAM | 14.2207    | 11.9753    | 11.9753    | 26.9920    | 11.3878    | 25.0699    | 15.3750 | 0.0000   |
| 2209                | BEAM | 12.8145    | 10.7911    | 10.7911    | 21.7666    | 9.0601     | 20.7893    | 14.6250 | 0.0000   |
| 2210                | BEAM | 11.4785    | 9.6661     | 9.6661     | 17.3248    | 7.1064     | 17.0757    | 13.8750 | 0.0000   |
| 2211                | BEAM | 10.2129    | 8.6003     | 8.6003     | 13.5860    | 5.4848     | 13.8770    | 13.1250 | 0.0000   |
| 2212                | BEAM | 9.0176     | 7.5938     | 7.5938     | 10.4741    | 4.1558     | 11.1439    | 12.3750 | 0.0000   |
| 2213                | BEAM | 7.8926     | 6.6464     | 6.6464     | 7.9171     | 3.0821     | 8.8294     | 11.6250 | 0.0000   |
| 2214                | BEAM | 6.8379     | 5.7582     | 5.7582     | 5.8472     | 2.2293     | 6.8889     | 10.8750 | 0.0000   |
| 2215                | BEAM | 5.8535     | 4.9293     | 4.9293     | 4.2008     | 1.5652     | 5.2805     | 10.1250 | 0.0000   |
| 2216                | BEAM | 4.9395     | 4.1595     | 4.1595     | 2.9186     | 1.0601     | 3.9646     | 9.3750  | 0.0000   |
| 2217                | BEAM | 4.5000     | 3.7895     | 3.7895     | 2.3613     | 0.8438     | 3.3750     | 9.0000  | 0.0000   |
| 2218                | BEAM | 4.5000     | 3.7895     | 3.7895     | 2.3613     | 0.8438     | 3.3750     | 9.0000  | 0.0000   |

Description: 3 Description of Structural Model  
3.3 Element Cross-Section Properties

Project No.



| Crossection - Beams |      |            |            |            |            |            |            |         |          |
|---------------------|------|------------|------------|------------|------------|------------|------------|---------|----------|
| Elem                | Type | Ax<br>[m2] | Ay<br>[m2] | Az<br>[m2] | Ix<br>[m4] | Iy<br>[m4] | Iz<br>[m4] | U<br>m  | UIN<br>m |
| 2219                | BEAM | 4.5000     | 3.7895     | 3.7895     | 2.3613     | 0.8438     | 3.3750     | 9.0000  | 0.0000   |
| 2220                | BEAM | 4.5000     | 3.7895     | 3.7895     | 2.3613     | 0.8438     | 3.3750     | 9.0000  | 0.0000   |
| 2221                | BEAM | 4.5000     | 3.7895     | 3.7895     | 2.3613     | 0.8438     | 3.3750     | 9.0000  | 0.0000   |
| 2222                | BEAM | 4.5000     | 3.7895     | 3.7895     | 2.3613     | 0.8438     | 3.3750     | 9.0000  | 0.0000   |
| 2223                | BEAM | 4.5000     | 3.7895     | 3.7895     | 2.3613     | 0.8438     | 3.3750     | 9.0000  | 0.0000   |
| 2224                | BEAM | 4.5000     | 3.7895     | 3.7895     | 2.3613     | 0.8438     | 3.3750     | 9.0000  | 0.0000   |
| 2225                | BEAM | 4.5000     | 3.7895     | 3.7895     | 2.3613     | 0.8438     | 3.3750     | 9.0000  | 0.0000   |
| 2226                | BEAM | 4.5000     | 3.7895     | 3.7895     | 2.3613     | 0.8438     | 3.3750     | 9.0000  | 0.0000   |
| 2227                | BEAM | 4.5000     | 3.7895     | 3.7895     | 2.3613     | 0.8438     | 3.3750     | 9.0000  | 0.0000   |
| 2228                | BEAM | 4.5000     | 3.7895     | 3.7895     | 2.3613     | 0.8438     | 3.3750     | 9.0000  | 0.0000   |
| 2229                | BEAM | 4.5000     | 3.7895     | 3.7895     | 2.3613     | 0.8438     | 3.3750     | 9.0000  | 0.0000   |
| 2230                | BEAM | 4.5000     | 3.7895     | 3.7895     | 2.3613     | 0.8438     | 3.3750     | 9.0000  | 0.0000   |
| 2231                | BEAM | 4.5000     | 3.7895     | 3.7895     | 2.3613     | 0.8438     | 3.3750     | 9.0000  | 0.0000   |
| 2232                | BEAM | 4.5000     | 3.7895     | 3.7895     | 2.3613     | 0.8438     | 3.3750     | 9.0000  | 0.0000   |
| 2233                | BEAM | 4.5000     | 3.7895     | 3.7895     | 2.3613     | 0.8438     | 3.3750     | 9.0000  | 0.0000   |
| 2234                | BEAM | 4.5000     | 3.7895     | 3.7895     | 2.3613     | 0.8438     | 3.3750     | 9.0000  | 0.0000   |
| 2235                | BEAM | 4.5000     | 3.7895     | 3.7895     | 2.3613     | 0.8438     | 3.3750     | 9.0000  | 0.0000   |
| 2236                | BEAM | 4.5000     | 3.7895     | 3.7895     | 2.3613     | 0.8438     | 3.3750     | 9.0000  | 0.0000   |
| 2237                | BEAM | 4.5000     | 3.7895     | 3.7895     | 2.3613     | 0.8438     | 3.3750     | 9.0000  | 0.0000   |
| 2238                | BEAM | 4.5000     | 3.7895     | 3.7895     | 2.3613     | 0.8438     | 3.3750     | 9.0000  | 0.0000   |
| 2239                | BEAM | 4.5000     | 3.7895     | 3.7895     | 2.3613     | 0.8438     | 3.3750     | 9.0000  | 0.0000   |
| 2240                | BEAM | 4.5000     | 3.7895     | 3.7895     | 2.3613     | 0.8438     | 3.3750     | 9.0000  | 0.0000   |
| 2241                | BEAM | 4.5000     | 3.7895     | 3.7895     | 2.3613     | 0.8438     | 3.3750     | 9.0000  | 0.0000   |
| 2242                | BEAM | 4.5000     | 3.7895     | 3.7895     | 2.3613     | 0.8438     | 3.3750     | 9.0000  | 0.0000   |
| 2243                | BEAM | 4.5000     | 3.7895     | 3.7895     | 2.3613     | 0.8438     | 3.3750     | 9.0000  | 0.0000   |
| 2244                | BEAM | 4.5000     | 3.7895     | 3.7895     | 2.3613     | 0.8438     | 3.3750     | 9.0000  | 0.0000   |
| 2245                | BEAM | 4.5000     | 3.7895     | 3.7895     | 2.3613     | 0.8438     | 3.3750     | 9.0000  | 0.0000   |
| 3101                | BEAM | 26.0332    | 21.9227    | 21.9227    | 93.1509    | 42.2053    | 75.7864    | 20.6250 | 0.0000   |
| 3102                | BEAM | 24.1348    | 20.3240    | 20.3240    | 79.8342    | 35.8747    | 65.8764    | 19.8750 | 0.0000   |
| 3103                | BEAM | 22.3066    | 18.7845    | 18.7845    | 67.9822    | 30.2815    | 56.9659    | 19.1250 | 0.0000   |
| 3104                | BEAM | 20.5488    | 17.3043    | 17.3043    | 57.4850    | 25.3665    | 48.9858    | 18.3750 | 0.0000   |
| 3105                | BEAM | 18.8613    | 15.8832    | 15.8832    | 48.2368    | 21.0728    | 41.8691    | 17.6250 | 0.0000   |
| 3106                | BEAM | 17.2441    | 14.5214    | 14.5214    | 40.1361    | 17.3460    | 35.5517    | 16.8750 | 0.0000   |
| 3107                | BEAM | 15.6973    | 13.2188    | 13.2188    | 33.0856    | 14.1341    | 29.9717    | 16.1250 | 0.0000   |
| 3108                | BEAM | 14.2207    | 11.9753    | 11.9753    | 26.9920    | 11.3878    | 25.0699    | 15.3750 | 0.0000   |
| 3109                | BEAM | 12.8145    | 10.7911    | 10.7911    | 21.7666    | 9.0601     | 20.7893    | 14.6250 | 0.0000   |
| 3110                | BEAM | 11.4785    | 9.6661     | 9.6661     | 17.3248    | 7.1064     | 17.0757    | 13.8750 | 0.0000   |
| 3111                | BEAM | 10.2129    | 8.6003     | 8.6003     | 13.5860    | 5.4848     | 13.8770    | 13.1250 | 0.0000   |
| 3112                | BEAM | 9.0176     | 7.5938     | 7.5938     | 10.4741    | 4.1558     | 11.1439    | 12.3750 | 0.0000   |
| 3113                | BEAM | 7.8926     | 6.6464     | 6.6464     | 7.9171     | 3.0821     | 8.8294     | 11.6250 | 0.0000   |
| 3114                | BEAM | 6.8379     | 5.7582     | 5.7582     | 5.8472     | 2.2293     | 6.8889     | 10.8750 | 0.0000   |
| 3115                | BEAM | 5.8535     | 4.9293     | 4.9293     | 4.2008     | 1.5652     | 5.2805     | 10.1250 | 0.0000   |
| 3116                | BEAM | 4.9395     | 4.1595     | 4.1595     | 2.9186     | 1.0601     | 3.9646     | 9.3750  | 0.0000   |
| 3117                | BEAM | 4.5000     | 3.7895     | 3.7895     | 2.3613     | 0.8438     | 3.3750     | 9.0000  | 0.0000   |
| 3118                | BEAM | 4.5000     | 3.7895     | 3.7895     | 2.3613     | 0.8438     | 3.3750     | 9.0000  | 0.0000   |
| 3119                | BEAM | 4.5000     | 3.7895     | 3.7895     | 2.3613     | 0.8438     | 3.3750     | 9.0000  | 0.0000   |
| 3120                | BEAM | 4.5000     | 3.7895     | 3.7895     | 2.3613     | 0.8438     | 3.3750     | 9.0000  | 0.0000   |
| 3121                | BEAM | 4.5000     | 3.7895     | 3.7895     | 2.3613     | 0.8438     | 3.3750     | 9.0000  | 0.0000   |
| 3122                | BEAM | 4.5000     | 3.7895     | 3.7895     | 2.3613     | 0.8438     | 3.3750     | 9.0000  | 0.0000   |
| 3123                | BEAM | 4.5000     | 3.7895     | 3.7895     | 2.3613     | 0.8438     | 3.3750     | 9.0000  | 0.0000   |
| 3124                | BEAM | 4.5000     | 3.7895     | 3.7895     | 2.3613     | 0.8438     | 3.3750     | 9.0000  | 0.0000   |
| 3125                | BEAM | 4.5000     | 3.7895     | 3.7895     | 2.3613     | 0.8438     | 3.3750     | 9.0000  | 0.0000   |
| 3126                | BEAM | 4.5000     | 3.7895     | 3.7895     | 2.3613     | 0.8438     | 3.3750     | 9.0000  | 0.0000   |
| 3127                | BEAM | 4.5000     | 3.7895     | 3.7895     | 2.3613     | 0.8438     | 3.3750     | 9.0000  | 0.0000   |
| 3128                | BEAM | 4.5000     | 3.7895     | 3.7895     | 2.3613     | 0.8438     | 3.3750     | 9.0000  | 0.0000   |
| 3129                | BEAM | 4.5000     | 3.7895     | 3.7895     | 2.3613     | 0.8438     | 3.3750     | 9.0000  | 0.0000   |
| 3130                | BEAM | 4.5000     | 3.7895     | 3.7895     | 2.3613     | 0.8438     | 3.3750     | 9.0000  | 0.0000   |
| 3131                | BEAM | 4.5000     | 3.7895     | 3.7895     | 2.3613     | 0.8438     | 3.3750     | 9.0000  | 0.0000   |
| 3132                | BEAM | 4.5000     | 3.7895     | 3.7895     | 2.3613     | 0.8438     | 3.3750     | 9.0000  | 0.0000   |
| 3133                | BEAM | 4.5000     | 3.7895     | 3.7895     | 2.3613     | 0.8438     | 3.3750     | 9.0000  | 0.0000   |
| 3134                | BEAM | 4.5000     | 3.7895     | 3.7895     | 2.3613     | 0.8438     | 3.3750     | 9.0000  | 0.0000   |

Description: 3 Description of Structural Model  
3.3 Element Cross-Section Properties

Project No.



| Crossection - Beams |      |         |         |         |         |         |         |         |        |
|---------------------|------|---------|---------|---------|---------|---------|---------|---------|--------|
| Elem                | Type | Ax      | Ay      | Az      | Ix      | Iy      | Iz      | U       | UIN    |
|                     |      | [m2]    | [m2]    | [m2]    | [m4]    | [m4]    | [m4]    | m       | m      |
| 3135                | BEAM | 4.5000  | 3.7895  | 3.7895  | 2.3613  | 0.8438  | 3.3750  | 9.0000  | 0.0000 |
| 3136                | BEAM | 4.5000  | 3.7895  | 3.7895  | 2.3613  | 0.8438  | 3.3750  | 9.0000  | 0.0000 |
| 3137                | BEAM | 4.5000  | 3.7895  | 3.7895  | 2.3613  | 0.8438  | 3.3750  | 9.0000  | 0.0000 |
| 3138                | BEAM | 4.5000  | 3.7895  | 3.7895  | 2.3613  | 0.8438  | 3.3750  | 9.0000  | 0.0000 |
| 3139                | BEAM | 4.5000  | 3.7895  | 3.7895  | 2.3613  | 0.8438  | 3.3750  | 9.0000  | 0.0000 |
| 3140                | BEAM | 4.5000  | 3.7895  | 3.7895  | 2.3613  | 0.8438  | 3.3750  | 9.0000  | 0.0000 |
| 3141                | BEAM | 4.5000  | 3.7895  | 3.7895  | 2.3613  | 0.8438  | 3.3750  | 9.0000  | 0.0000 |
| 3142                | BEAM | 4.5000  | 3.7895  | 3.7895  | 2.3613  | 0.8438  | 3.3750  | 9.0000  | 0.0000 |
| 3143                | BEAM | 4.5000  | 3.7895  | 3.7895  | 2.3613  | 0.8438  | 3.3750  | 9.0000  | 0.0000 |
| 3144                | BEAM | 4.5000  | 3.7895  | 3.7895  | 2.3613  | 0.8438  | 3.3750  | 9.0000  | 0.0000 |
| 3145                | BEAM | 4.5000  | 3.7895  | 3.7895  | 2.3613  | 0.8438  | 3.3750  | 9.0000  | 0.0000 |
| 3201                | BEAM | 26.0332 | 21.9227 | 21.9227 | 93.1509 | 42.2053 | 75.7864 | 20.6250 | 0.0000 |
| 3202                | BEAM | 24.1348 | 20.3240 | 20.3240 | 79.8342 | 35.8747 | 65.8764 | 19.8750 | 0.0000 |
| 3203                | BEAM | 22.3066 | 18.7845 | 18.7845 | 67.9822 | 30.2815 | 56.9659 | 19.1250 | 0.0000 |
| 3204                | BEAM | 20.5488 | 17.3043 | 17.3043 | 57.4850 | 25.3665 | 48.9858 | 18.3750 | 0.0000 |
| 3205                | BEAM | 18.8613 | 15.8832 | 15.8832 | 48.2368 | 21.0728 | 41.8691 | 17.6250 | 0.0000 |
| 3206                | BEAM | 17.2441 | 14.5214 | 14.5214 | 40.1361 | 17.3460 | 35.5517 | 16.8750 | 0.0000 |
| 3207                | BEAM | 15.6973 | 13.2188 | 13.2188 | 33.0856 | 14.1341 | 29.9717 | 16.1250 | 0.0000 |
| 3208                | BEAM | 14.2207 | 11.9753 | 11.9753 | 26.9920 | 11.3878 | 25.0699 | 15.3750 | 0.0000 |
| 3209                | BEAM | 12.8145 | 10.7911 | 10.7911 | 21.7666 | 9.0601  | 20.7893 | 14.6250 | 0.0000 |
| 3210                | BEAM | 11.4785 | 9.6661  | 9.6661  | 17.3248 | 7.1064  | 17.0757 | 13.8750 | 0.0000 |
| 3211                | BEAM | 10.2129 | 8.6003  | 8.6003  | 13.5860 | 5.4848  | 13.8770 | 13.1250 | 0.0000 |
| 3212                | BEAM | 9.0176  | 7.5938  | 7.5938  | 10.4741 | 4.1558  | 11.1439 | 12.3750 | 0.0000 |
| 3213                | BEAM | 7.8926  | 6.6464  | 6.6464  | 7.9171  | 3.0821  | 8.8294  | 11.6250 | 0.0000 |
| 3214                | BEAM | 6.8379  | 5.7582  | 5.7582  | 5.8472  | 2.2293  | 6.8889  | 10.8750 | 0.0000 |
| 3215                | BEAM | 5.8535  | 4.9293  | 4.9293  | 4.2008  | 1.5652  | 5.2805  | 10.1250 | 0.0000 |
| 3216                | BEAM | 4.9395  | 4.1595  | 4.1595  | 2.9186  | 1.0601  | 3.9646  | 9.3750  | 0.0000 |
| 3217                | BEAM | 4.5000  | 3.7895  | 3.7895  | 2.3613  | 0.8438  | 3.3750  | 9.0000  | 0.0000 |
| 3218                | BEAM | 4.5000  | 3.7895  | 3.7895  | 2.3613  | 0.8438  | 3.3750  | 9.0000  | 0.0000 |
| 3219                | BEAM | 4.5000  | 3.7895  | 3.7895  | 2.3613  | 0.8438  | 3.3750  | 9.0000  | 0.0000 |
| 3220                | BEAM | 4.5000  | 3.7895  | 3.7895  | 2.3613  | 0.8438  | 3.3750  | 9.0000  | 0.0000 |
| 3221                | BEAM | 4.5000  | 3.7895  | 3.7895  | 2.3613  | 0.8438  | 3.3750  | 9.0000  | 0.0000 |
| 3222                | BEAM | 4.5000  | 3.7895  | 3.7895  | 2.3613  | 0.8438  | 3.3750  | 9.0000  | 0.0000 |
| 3223                | BEAM | 4.5000  | 3.7895  | 3.7895  | 2.3613  | 0.8438  | 3.3750  | 9.0000  | 0.0000 |
| 3224                | BEAM | 4.5000  | 3.7895  | 3.7895  | 2.3613  | 0.8438  | 3.3750  | 9.0000  | 0.0000 |
| 3225                | BEAM | 4.5000  | 3.7895  | 3.7895  | 2.3613  | 0.8438  | 3.3750  | 9.0000  | 0.0000 |
| 3226                | BEAM | 4.5000  | 3.7895  | 3.7895  | 2.3613  | 0.8438  | 3.3750  | 9.0000  | 0.0000 |
| 3227                | BEAM | 4.5000  | 3.7895  | 3.7895  | 2.3613  | 0.8438  | 3.3750  | 9.0000  | 0.0000 |
| 3228                | BEAM | 4.5000  | 3.7895  | 3.7895  | 2.3613  | 0.8438  | 3.3750  | 9.0000  | 0.0000 |
| 3229                | BEAM | 4.5000  | 3.7895  | 3.7895  | 2.3613  | 0.8438  | 3.3750  | 9.0000  | 0.0000 |
| 3230                | BEAM | 4.5000  | 3.7895  | 3.7895  | 2.3613  | 0.8438  | 3.3750  | 9.0000  | 0.0000 |
| 3231                | BEAM | 4.5000  | 3.7895  | 3.7895  | 2.3613  | 0.8438  | 3.3750  | 9.0000  | 0.0000 |
| 3232                | BEAM | 4.5000  | 3.7895  | 3.7895  | 2.3613  | 0.8438  | 3.3750  | 9.0000  | 0.0000 |
| 3233                | BEAM | 4.5000  | 3.7895  | 3.7895  | 2.3613  | 0.8438  | 3.3750  | 9.0000  | 0.0000 |
| 3234                | BEAM | 4.5000  | 3.7895  | 3.7895  | 2.3613  | 0.8438  | 3.3750  | 9.0000  | 0.0000 |
| 3235                | BEAM | 4.5000  | 3.7895  | 3.7895  | 2.3613  | 0.8438  | 3.3750  | 9.0000  | 0.0000 |
| 3236                | BEAM | 4.5000  | 3.7895  | 3.7895  | 2.3613  | 0.8438  | 3.3750  | 9.0000  | 0.0000 |
| 3237                | BEAM | 4.5000  | 3.7895  | 3.7895  | 2.3613  | 0.8438  | 3.3750  | 9.0000  | 0.0000 |
| 3238                | BEAM | 4.5000  | 3.7895  | 3.7895  | 2.3613  | 0.8438  | 3.3750  | 9.0000  | 0.0000 |
| 3239                | BEAM | 4.5000  | 3.7895  | 3.7895  | 2.3613  | 0.8438  | 3.3750  | 9.0000  | 0.0000 |
| 3240                | BEAM | 4.5000  | 3.7895  | 3.7895  | 2.3613  | 0.8438  | 3.3750  | 9.0000  | 0.0000 |
| 3241                | BEAM | 4.5000  | 3.7895  | 3.7895  | 2.3613  | 0.8438  | 3.3750  | 9.0000  | 0.0000 |
| 3242                | BEAM | 4.5000  | 3.7895  | 3.7895  | 2.3613  | 0.8438  | 3.3750  | 9.0000  | 0.0000 |
| 3243                | BEAM | 4.5000  | 3.7895  | 3.7895  | 2.3613  | 0.8438  | 3.3750  | 9.0000  | 0.0000 |
| 3244                | BEAM | 4.5000  | 3.7895  | 3.7895  | 2.3613  | 0.8438  | 3.3750  | 9.0000  | 0.0000 |
| 3245                | BEAM | 4.5000  | 3.7895  | 3.7895  | 2.3613  | 0.8438  | 3.3750  | 9.0000  | 0.0000 |



### 3.4 Support Spring Elements

| Spring Constants |            |            |            |            |            |            |
|------------------|------------|------------|------------|------------|------------|------------|
| Spring           | CX<br>kN/m | CY<br>kN/m | CZ<br>kN/m | CMX<br>kNm | CMY<br>kNm | CMZ<br>kNm |
| 1000             | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        |
| 1001             | 1e8        | 0          | 0          | 0          | 0          | 0          |
| 1002             | 1e8        | 0          | 1e8        | 0          | 0          | 0          |
| 2000             | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        |
| 2001             | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        |
| 2002             | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        |
| 2500             | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        |
| 2501             | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        |
| 2502             | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        |
| 2503             | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        |
| 2504             | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        |
| 2510             | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        |
| 2511             | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        |
| 2512             | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        |
| 2513             | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        |
| 2514             | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        |
| 2520             | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        |
| 2521             | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        |
| 2522             | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        |
| 2523             | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        |
| 2524             | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        |
| 2530             | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        |
| 2531             | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        |
| 2532             | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        |
| 2533             | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        |
| 2534             | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        |
| 2540             | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        |
| 2541             | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        |
| 2542             | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        |
| 2543             | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        |
| 2544             | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        |
| 2550             | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        |
| 2551             | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        |
| 2552             | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        |
| 2553             | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        |
| 2554             | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        |
| 3000             | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        |
| 3001             | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        |
| 3002             | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        |
| 3500             | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        |
| 3501             | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        |
| 3502             | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        |
| 3503             | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        |
| 3504             | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        |
| 3510             | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        |
| 3511             | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        |
| 3512             | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        |
| 3513             | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        |
| 3514             | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        |
| 3520             | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        |
| 3521             | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        |
| 3522             | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        |
| 3523             | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        |
| 3524             | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        |
| 3530             | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        |
| 3531             | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        |
| 3532             | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        |



| Spring Constants |            |            |            |            |            |            |
|------------------|------------|------------|------------|------------|------------|------------|
| Spring           | CX<br>kN/m | CY<br>kN/m | CZ<br>kN/m | CMX<br>kNm | CMY<br>kNm | CMZ<br>kNm |
| 3533             | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        |
| 3534             | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        |
| 3540             | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        |
| 3541             | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        |
| 3542             | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        |
| 3543             | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        |
| 3544             | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        |
| 3550             | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        |
| 3551             | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        |
| 3552             | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        |
| 3553             | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        |
| 3554             | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        |
| 4000             | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        |
| 4001             | 1e8        | 0          | 0          | 0          | 0          | 0          |
| 4002             | 1e8        | 0          | 1e8        | 0          | 0          | 0          |
| 5000             | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        |
| 5001             | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        |
| 5002             | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        |
| 5004             | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        |
| 5005             | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        |
| 6000             | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        |
| 6001             | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        |
| 6002             | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        |
| 6004             | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        |
| 6005             | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        | 1e8        |

## 4 Material Properties

### 4.1 Concrete for Superstructure and Pylon

| Material Properties   |                     | M_55 (used) |            |
|---|---------------------|-------------|------------|
| Group   | IRC_India-2011      |             |            |
| Description   | M_55 (IRC:112-2011) |             |            |
| Type  | CONCRETE            |             |            |
| Modulus of elasticity                                       | Emod                | 36000000    | KN/M2      |
| Poisson's ratio   | ny                  | 0.20        | -          |
| Shear-Modulus   | Gmod                | 15000000    | KN/M2      |
| Specific weight   | Gamma               | 25.00       | KN/M3      |
| Coeff. of thermal expansion                                 | AlphaT              | 12e-6       | 1/CELSIUS  |
|   |                     |             |            |
| Coefficient of concrete consistency (1-3)                   | (CF)                | 0           | -          |
| Degree of cement hardening (1-3)                            | (HCF)               | 2           | -          |
| Water cement ratio  | (WCR)               | 0           | -          |
| Cement content in concrete                                  | (CECO)              | 0           | -          |
|   |                     |             |            |
| Characteristic compressive cylinder strength of concrete at | (fck,cy)            | 0           | KN/M2      |
| Characteristic cube compressive strength of concrete at 28  | fck                 | 55e3        | KN/M2      |
| Mean value of concrete compressive strength                 | fcm                 | 65e3        | KN/M2      |
| Mean value of axial tensile strength of concrete            | fctm                | 3746        | KN/M2      |
| Tension split strenght                                      | fctk,0.05           | 2622        | KN/M2      |
| Tension bending strenght                                    | (TSB)               | 0           | KN/M2      |
|   |                     |             |            |
| Stress limits   |                     | min         | max        |
|   | 1                   | -26400.00   | 0.00 KN/M2 |
|   | 2                   | -19800.00   | 0.00 KN/M2 |



Designer: VKS Infratech Management Pvt. Ltd.

RM Bridge Professional Engineering Software



project Arunachal Extradosed 63m+260m+63m

6/03/2022

## 4.2 Reinforcing Steel

| Material Properties                      |                     | Fe_500 (unused) |           |  |
|--|---------------------|-----------------|-----------|--|
| Group                                    | IRC_India-2011      |                 |           |  |
| Description                              | Fe_500 (IRC:112-201 |                 |           |  |
| Type                                     | REINFORCEMENT       |                 |           |  |
| Modulus of elasticity                    | Emod                | 200000000       | KN/M2     |  |
| Poisson's ratio                          | ny                  | 0.30            | -         |  |
| Shear-Modulus                            | Gmod                | 76923080        | KN/M2     |  |
| Specific weight                          | Gamma               | 78.50           | KN/M3     |  |
| Coeff. of thermal expansion              | AlphaT              | 12e-6           | 1/CELSIUS |  |
| Yield strength (of reinforcement)        | fpk                 | 5e5             | KN/M2     |  |
| Design yield strength (of reinforcement) | fpd                 | 434782.6        | KN/M2     |  |

## 4.3 Prestressing and Stay cable Steel

| Material Properties                           |                     | Strand-1640/1860 (u |           |  |
|---|---------------------|---------------------|-----------|--|
| Group   | EN_Eurocode         |                     |           |  |
| Description                                   | Strand-1640/1860 (p |                     |           |  |
| Type  | PRESTRESSING        |                     |           |  |
| Modulus of elasticity                         | Emod                | 195000000           | KN/M2     |  |
| Poisson's ratio                               | ny                  | 0.30                | -         |  |
| Shear-Modulus                                 | Gmod                | 75000000            | KN/M2     |  |
| Specific weight                               | Gamma               | 78.50               | KN/M3     |  |
| Coeff. of thermal expansion                   | AlphaT              | 1e-5                | 1/CELSIUS |  |
| Tensile strength of prestressing steel        | fpk                 | 186e4               | KN/M2     |  |
| Design tensile strength of prestressing steel | fpd                 | 1617391             | KN/M2     |  |
| Modulus of elasticity of prestressing steel   | Ep                  | 195e6               | KN/M2     |  |
| Stressing limit                               | SIGP                | 1394e3              | KN/M2     |  |
| Coeff. for prestr. type (smooth or profiled)  | XI                  | 0.5                 | -         |  |
| Relaxation class                              | RELCL               | 2                   | -         |  |

## 4.4 Element Material Assignments

| Elements - Material |      |          |                |                |           |       |
|---------------------|------|----------|----------------|----------------|-----------|-------|
| Element             | Typ  | Mat-Name | E-Mod<br>KN/M2 | G-Mod<br>KN/M2 | Alpha-T   | Gamma |
| 101                 | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 102                 | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 103                 | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 104                 | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 105                 | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 106                 | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 107                 | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 108                 | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 109                 | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 110                 | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 111                 | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 112                 | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 113                 | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 114                 | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |

Description: 4 Material Properties  
4.2 Reinforcing Steel

Project No.



| Elements - Material |      |          |                |                |           |       |
|---------------------|------|----------|----------------|----------------|-----------|-------|
| Element             | Type | Mat-Name | E-Mod<br>KN/M2 | G-Mod<br>KN/M2 | Alpha-T   | Gamma |
| 115                 | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 116                 | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 117                 | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 118                 | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 119                 | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 120                 | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 121                 | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 122                 | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 123                 | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 124                 | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 125                 | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 126                 | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 127                 | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 128                 | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 129                 | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 130                 | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 131                 | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 132                 | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 133                 | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 134                 | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 135                 | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 136                 | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 137                 | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 138                 | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 139                 | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 140                 | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 141                 | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 142                 | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 143                 | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 144                 | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 145                 | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 146                 | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 147                 | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 148                 | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 149                 | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 150                 | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 151                 | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 152                 | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 153                 | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 154                 | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 155                 | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 156                 | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 157                 | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 158                 | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 159                 | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 160                 | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 161                 | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 162                 | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 163                 | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 164                 | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 165                 | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 166                 | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 167                 | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 168                 | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 169                 | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 170                 | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 171                 | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 172                 | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 173                 | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 174                 | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 175                 | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |

Description: 4 Material Properties  
4.2 Reinforcing Steel

Project No.





| Elements - Material |       |          |                |                |           |       |
|---------------------|-------|----------|----------------|----------------|-----------|-------|
| Element             | Type  | Mat-Name | E-Mod<br>KN/M2 | G-Mod<br>KN/M2 | Alpha-T   | Gamma |
| 176                 | BEAM  | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 177                 | BEAM  | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 178                 | BEAM  | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 179                 | BEAM  | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 180                 | BEAM  | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 181                 | BEAM  | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 182                 | BEAM  | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 183                 | BEAM  | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 184                 | BEAM  | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 185                 | BEAM  | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 186                 | BEAM  | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 187                 | BEAM  | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 188                 | BEAM  | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 189                 | BEAM  | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 190                 | BEAM  | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 191                 | BEAM  | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 192                 | BEAM  | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 193                 | BEAM  | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 194                 | BEAM  | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 195                 | BEAM  | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 196                 | BEAM  | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 197                 | BEAM  | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 198                 | BEAM  | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 199                 | BEAM  | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 200                 | BEAM  | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 201                 | BEAM  | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 202                 | BEAM  | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 203                 | BEAM  | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 204                 | BEAM  | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 205                 | BEAM  | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 206                 | BEAM  | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 207                 | BEAM  | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 208                 | BEAM  | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 209                 | BEAM  | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 210                 | BEAM  | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 211                 | BEAM  | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 212                 | BEAM  | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 213                 | BEAM  | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 214                 | BEAM  | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 215                 | BEAM  | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 216                 | BEAM  | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 1101                | CABLE | Strand-  | 195000000      | 75000000       | 1.0000e-5 | 78.50 |
| 1102                | CABLE | Strand-  | 195000000      | 75000000       | 1.0000e-5 | 78.50 |
| 1103                | CABLE | Strand-  | 195000000      | 75000000       | 1.0000e-5 | 78.50 |
| 1104                | CABLE | Strand-  | 195000000      | 75000000       | 1.0000e-5 | 78.50 |
| 1105                | CABLE | Strand-  | 195000000      | 75000000       | 1.0000e-5 | 78.50 |
| 1106                | CABLE | Strand-  | 195000000      | 75000000       | 1.0000e-5 | 78.50 |
| 1107                | CABLE | Strand-  | 195000000      | 75000000       | 1.0000e-5 | 78.50 |
| 1108                | CABLE | Strand-  | 195000000      | 75000000       | 1.0000e-5 | 78.50 |
| 1109                | CABLE | Strand-  | 195000000      | 75000000       | 1.0000e-5 | 78.50 |
| 1110                | CABLE | Strand-  | 195000000      | 75000000       | 1.0000e-5 | 78.50 |
| 1111                | CABLE | Strand-  | 195000000      | 75000000       | 1.0000e-5 | 78.50 |
| 1201                | CABLE | Strand-  | 195000000      | 75000000       | 1.0000e-5 | 78.50 |
| 1202                | CABLE | Strand-  | 195000000      | 75000000       | 1.0000e-5 | 78.50 |
| 1203                | CABLE | Strand-  | 195000000      | 75000000       | 1.0000e-5 | 78.50 |
| 1204                | CABLE | Strand-  | 195000000      | 75000000       | 1.0000e-5 | 78.50 |
| 1205                | CABLE | Strand-  | 195000000      | 75000000       | 1.0000e-5 | 78.50 |
| 1206                | CABLE | Strand-  | 195000000      | 75000000       | 1.0000e-5 | 78.50 |
| 1207                | CABLE | Strand-  | 195000000      | 75000000       | 1.0000e-5 | 78.50 |
| 1208                | CABLE | Strand-  | 195000000      | 75000000       | 1.0000e-5 | 78.50 |
| 1209                | CABLE | Strand-  | 195000000      | 75000000       | 1.0000e-5 | 78.50 |

Description: 4 Material Properties  
4.2 Reinforcing Steel

Project No.



| Elements - Material |       |          |                |                |           |       |
|---------------------|-------|----------|----------------|----------------|-----------|-------|
| Element             | Type  | Mat-Name | E-Mod<br>KN/M2 | G-Mod<br>KN/M2 | Alpha-T   | Gamma |
| 1210                | CABLE | Strand-  | 195000000      | 75000000       | 1.0000e-5 | 78.50 |
| 1211                | CABLE | Strand-  | 195000000      | 75000000       | 1.0000e-5 | 78.50 |
| 1301                | CABLE | Strand-  | 195000000      | 75000000       | 1.0000e-5 | 78.50 |
| 1302                | CABLE | Strand-  | 195000000      | 75000000       | 1.0000e-5 | 78.50 |
| 1303                | CABLE | Strand-  | 195000000      | 75000000       | 1.0000e-5 | 78.50 |
| 1304                | CABLE | Strand-  | 195000000      | 75000000       | 1.0000e-5 | 78.50 |
| 1305                | CABLE | Strand-  | 195000000      | 75000000       | 1.0000e-5 | 78.50 |
| 1306                | CABLE | Strand-  | 195000000      | 75000000       | 1.0000e-5 | 78.50 |
| 1307                | CABLE | Strand-  | 195000000      | 75000000       | 1.0000e-5 | 78.50 |
| 1308                | CABLE | Strand-  | 195000000      | 75000000       | 1.0000e-5 | 78.50 |
| 1309                | CABLE | Strand-  | 195000000      | 75000000       | 1.0000e-5 | 78.50 |
| 1310                | CABLE | Strand-  | 195000000      | 75000000       | 1.0000e-5 | 78.50 |
| 1311                | CABLE | Strand-  | 195000000      | 75000000       | 1.0000e-5 | 78.50 |
| 1401                | CABLE | Strand-  | 195000000      | 75000000       | 1.0000e-5 | 78.50 |
| 1402                | CABLE | Strand-  | 195000000      | 75000000       | 1.0000e-5 | 78.50 |
| 1403                | CABLE | Strand-  | 195000000      | 75000000       | 1.0000e-5 | 78.50 |
| 1404                | CABLE | Strand-  | 195000000      | 75000000       | 1.0000e-5 | 78.50 |
| 1405                | CABLE | Strand-  | 195000000      | 75000000       | 1.0000e-5 | 78.50 |
| 1406                | CABLE | Strand-  | 195000000      | 75000000       | 1.0000e-5 | 78.50 |
| 1407                | CABLE | Strand-  | 195000000      | 75000000       | 1.0000e-5 | 78.50 |
| 1408                | CABLE | Strand-  | 195000000      | 75000000       | 1.0000e-5 | 78.50 |
| 1409                | CABLE | Strand-  | 195000000      | 75000000       | 1.0000e-5 | 78.50 |
| 1410                | CABLE | Strand-  | 195000000      | 75000000       | 1.0000e-5 | 78.50 |
| 1411                | CABLE | Strand-  | 195000000      | 75000000       | 1.0000e-5 | 78.50 |
| 1501                | CABLE | Strand-  | 195000000      | 75000000       | 1.0000e-5 | 78.50 |
| 1502                | CABLE | Strand-  | 195000000      | 75000000       | 1.0000e-5 | 78.50 |
| 1503                | CABLE | Strand-  | 195000000      | 75000000       | 1.0000e-5 | 78.50 |
| 1504                | CABLE | Strand-  | 195000000      | 75000000       | 1.0000e-5 | 78.50 |
| 1505                | CABLE | Strand-  | 195000000      | 75000000       | 1.0000e-5 | 78.50 |
| 1506                | CABLE | Strand-  | 195000000      | 75000000       | 1.0000e-5 | 78.50 |
| 1507                | CABLE | Strand-  | 195000000      | 75000000       | 1.0000e-5 | 78.50 |
| 1508                | CABLE | Strand-  | 195000000      | 75000000       | 1.0000e-5 | 78.50 |
| 1509                | CABLE | Strand-  | 195000000      | 75000000       | 1.0000e-5 | 78.50 |
| 1510                | CABLE | Strand-  | 195000000      | 75000000       | 1.0000e-5 | 78.50 |
| 1511                | CABLE | Strand-  | 195000000      | 75000000       | 1.0000e-5 | 78.50 |
| 1601                | CABLE | Strand-  | 195000000      | 75000000       | 1.0000e-5 | 78.50 |
| 1602                | CABLE | Strand-  | 195000000      | 75000000       | 1.0000e-5 | 78.50 |
| 1603                | CABLE | Strand-  | 195000000      | 75000000       | 1.0000e-5 | 78.50 |
| 1604                | CABLE | Strand-  | 195000000      | 75000000       | 1.0000e-5 | 78.50 |
| 1605                | CABLE | Strand-  | 195000000      | 75000000       | 1.0000e-5 | 78.50 |
| 1606                | CABLE | Strand-  | 195000000      | 75000000       | 1.0000e-5 | 78.50 |
| 1607                | CABLE | Strand-  | 195000000      | 75000000       | 1.0000e-5 | 78.50 |
| 1608                | CABLE | Strand-  | 195000000      | 75000000       | 1.0000e-5 | 78.50 |
| 1609                | CABLE | Strand-  | 195000000      | 75000000       | 1.0000e-5 | 78.50 |
| 1610                | CABLE | Strand-  | 195000000      | 75000000       | 1.0000e-5 | 78.50 |
| 1611                | CABLE | Strand-  | 195000000      | 75000000       | 1.0000e-5 | 78.50 |
| 1701                | CABLE | Strand-  | 195000000      | 75000000       | 1.0000e-5 | 78.50 |
| 1702                | CABLE | Strand-  | 195000000      | 75000000       | 1.0000e-5 | 78.50 |
| 1703                | CABLE | Strand-  | 195000000      | 75000000       | 1.0000e-5 | 78.50 |
| 1704                | CABLE | Strand-  | 195000000      | 75000000       | 1.0000e-5 | 78.50 |
| 1705                | CABLE | Strand-  | 195000000      | 75000000       | 1.0000e-5 | 78.50 |
| 1706                | CABLE | Strand-  | 195000000      | 75000000       | 1.0000e-5 | 78.50 |
| 1707                | CABLE | Strand-  | 195000000      | 75000000       | 1.0000e-5 | 78.50 |
| 1708                | CABLE | Strand-  | 195000000      | 75000000       | 1.0000e-5 | 78.50 |
| 1709                | CABLE | Strand-  | 195000000      | 75000000       | 1.0000e-5 | 78.50 |
| 1710                | CABLE | Strand-  | 195000000      | 75000000       | 1.0000e-5 | 78.50 |
| 1711                | CABLE | Strand-  | 195000000      | 75000000       | 1.0000e-5 | 78.50 |
| 1801                | CABLE | Strand-  | 195000000      | 75000000       | 1.0000e-5 | 78.50 |
| 1802                | CABLE | Strand-  | 195000000      | 75000000       | 1.0000e-5 | 78.50 |
| 1803                | CABLE | Strand-  | 195000000      | 75000000       | 1.0000e-5 | 78.50 |
| 1804                | CABLE | Strand-  | 195000000      | 75000000       | 1.0000e-5 | 78.50 |

Description: 4 Material Properties  
4.2 Reinforcing Steel

Project No.



| Elements - Material |       |          |                |                |           |       |
|---------------------|-------|----------|----------------|----------------|-----------|-------|
| Element             | Type  | Mat-Name | E-Mod<br>KN/M2 | G-Mod<br>KN/M2 | Alpha-T   | Gamma |
| 1805                | CABLE | Strand-  | 195000000      | 75000000       | 1.0000e-5 | 78.50 |
| 1806                | CABLE | Strand-  | 195000000      | 75000000       | 1.0000e-5 | 78.50 |
| 1807                | CABLE | Strand-  | 195000000      | 75000000       | 1.0000e-5 | 78.50 |
| 1808                | CABLE | Strand-  | 195000000      | 75000000       | 1.0000e-5 | 78.50 |
| 1809                | CABLE | Strand-  | 195000000      | 75000000       | 1.0000e-5 | 78.50 |
| 1810                | CABLE | Strand-  | 195000000      | 75000000       | 1.0000e-5 | 78.50 |
| 1811                | CABLE | Strand-  | 195000000      | 75000000       | 1.0000e-5 | 78.50 |
| 2101                | BEAM  | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 2102                | BEAM  | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 2103                | BEAM  | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 2104                | BEAM  | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 2105                | BEAM  | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 2106                | BEAM  | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 2107                | BEAM  | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 2108                | BEAM  | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 2109                | BEAM  | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 2110                | BEAM  | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 2111                | BEAM  | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 2112                | BEAM  | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 2113                | BEAM  | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 2114                | BEAM  | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 2115                | BEAM  | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 2116                | BEAM  | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 2117                | BEAM  | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 2118                | BEAM  | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 2119                | BEAM  | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 2120                | BEAM  | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 2121                | BEAM  | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 2122                | BEAM  | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 2123                | BEAM  | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 2124                | BEAM  | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 2125                | BEAM  | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 2126                | BEAM  | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 2127                | BEAM  | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 2128                | BEAM  | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 2129                | BEAM  | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 2130                | BEAM  | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 2131                | BEAM  | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 2132                | BEAM  | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 2133                | BEAM  | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 2134                | BEAM  | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 2135                | BEAM  | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 2136                | BEAM  | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 2137                | BEAM  | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 2138                | BEAM  | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 2139                | BEAM  | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 2140                | BEAM  | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 2141                | BEAM  | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 2142                | BEAM  | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 2143                | BEAM  | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 2144                | BEAM  | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 2145                | BEAM  | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 2201                | BEAM  | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 2202                | BEAM  | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 2203                | BEAM  | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 2204                | BEAM  | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 2205                | BEAM  | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 2206                | BEAM  | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 2207                | BEAM  | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 2208                | BEAM  | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 2209                | BEAM  | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |

Description: 4 Material Properties  
4.2 Reinforcing Steel

Project No.



| Elements - Material |      |          |                |                |           |       |
|---------------------|------|----------|----------------|----------------|-----------|-------|
| Element             | Type | Mat-Name | E-Mod<br>KN/M2 | G-Mod<br>KN/M2 | Alpha-T   | Gamma |
| 2210                | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 2211                | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 2212                | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 2213                | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 2214                | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 2215                | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 2216                | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 2217                | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 2218                | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 2219                | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 2220                | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 2221                | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 2222                | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 2223                | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 2224                | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 2225                | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 2226                | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 2227                | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 2228                | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 2229                | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 2230                | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 2231                | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 2232                | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 2233                | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 2234                | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 2235                | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 2236                | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 2237                | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 2238                | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 2239                | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 2240                | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 2241                | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 2242                | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 2243                | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 2244                | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 2245                | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 3101                | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 3102                | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 3103                | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 3104                | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 3105                | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 3106                | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 3107                | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 3108                | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 3109                | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 3110                | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 3111                | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 3112                | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 3113                | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 3114                | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 3115                | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 3116                | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 3117                | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 3118                | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 3119                | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 3120                | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 3121                | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 3122                | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 3123                | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 3124                | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 3125                | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |

Description: 4 Material Properties  
4.2 Reinforcing Steel

Project No.



| Elements - Material |      |          |                |                |           |       |
|---------------------|------|----------|----------------|----------------|-----------|-------|
| Element             | Type | Mat-Name | E-Mod<br>KN/M2 | G-Mod<br>KN/M2 | Alpha-T   | Gamma |
| 3126                | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 3127                | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 3128                | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 3129                | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 3130                | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 3131                | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 3132                | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 3133                | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 3134                | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 3135                | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 3136                | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 3137                | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 3138                | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 3139                | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 3140                | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 3141                | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 3142                | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 3143                | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 3144                | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 3145                | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 3201                | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 3202                | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 3203                | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 3204                | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 3205                | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 3206                | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 3207                | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 3208                | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 3209                | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 3210                | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 3211                | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 3212                | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 3213                | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 3214                | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 3215                | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 3216                | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 3217                | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 3218                | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 3219                | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 3220                | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 3221                | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 3222                | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 3223                | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 3224                | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 3225                | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 3226                | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 3227                | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 3228                | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 3229                | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 3230                | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 3231                | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 3232                | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 3233                | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 3234                | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 3235                | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 3236                | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 3237                | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 3238                | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 3239                | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 3240                | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 3241                | BEAM | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |

Description: 4 Material Properties  
4.2 Reinforcing Steel

Project No.

Designer: VKS Infratech Management Pvt. Ltd.

RM Bridge Professional Engineering Software



project Arunachal Extradosed 63m+260m+63m

6/03/2022

| Elements - Material |       |          |                |                |           |       |
|---------------------|-------|----------|----------------|----------------|-----------|-------|
| Element             | Typ   | Mat-Name | E-Mod<br>KN/M2 | G-Mod<br>KN/M2 | Alpha-T   | Gamma |
| 3242                | BEAM  | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 3243                | BEAM  | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 3244                | BEAM  | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 3245                | BEAM  | M 55     | 36000000       | 15000000       | 1.2000e-5 | 25.00 |
| 5201                | CABLE | Strand-  | 195000000      | 75000000       | 1.0000e-5 | 78.50 |
| 5202                | CABLE | Strand-  | 195000000      | 75000000       | 1.0000e-5 | 78.50 |
| 5203                | CABLE | Strand-  | 195000000      | 75000000       | 1.0000e-5 | 78.50 |
| 5204                | CABLE | Strand-  | 195000000      | 75000000       | 1.0000e-5 | 78.50 |
| 5301                | CABLE | Strand-  | 195000000      | 75000000       | 1.0000e-5 | 78.50 |
| 5302                | CABLE | Strand-  | 195000000      | 75000000       | 1.0000e-5 | 78.50 |
| 5303                | CABLE | Strand-  | 195000000      | 75000000       | 1.0000e-5 | 78.50 |
| 5304                | CABLE | Strand-  | 195000000      | 75000000       | 1.0000e-5 | 78.50 |
| 6201                | CABLE | Strand-  | 195000000      | 75000000       | 1.0000e-5 | 78.50 |
| 6202                | CABLE | Strand-  | 195000000      | 75000000       | 1.0000e-5 | 78.50 |
| 6203                | CABLE | Strand-  | 195000000      | 75000000       | 1.0000e-5 | 78.50 |
| 6204                | CABLE | Strand-  | 195000000      | 75000000       | 1.0000e-5 | 78.50 |
| 6301                | CABLE | Strand-  | 195000000      | 75000000       | 1.0000e-5 | 78.50 |
| 6302                | CABLE | Strand-  | 195000000      | 75000000       | 1.0000e-5 | 78.50 |
| 6303                | CABLE | Strand-  | 195000000      | 75000000       | 1.0000e-5 | 78.50 |
| 6304                | CABLE | Strand-  | 195000000      | 75000000       | 1.0000e-5 | 78.50 |

## 5 Loads

### 5.1 Load Manager

| Load Info<br>Name | Load Case Rules |       | Envelope Rules |      |       |
|-------------------|-----------------|-------|----------------|------|-------|
|                   | SumLC           | Part  | Envelope       | Rule | LCase |
| <b>SW</b>         | SW_SUM          | Total |                |      |       |
|                   | STG_SUM         | Total |                |      |       |
| <b>PS</b>         | PS_SUM          | Total |                |      |       |
|                   | STG_SUM         | Total |                |      |       |
| <b>TR</b>         | TR_SUM          | Total |                |      |       |
|                   | STG_SUM         | Total |                |      |       |
| <b>WC</b>         | WC_SUM          | Total |                |      |       |
|                   | STG_SUM         | Total |                |      |       |
| <b>CS</b>         | CS_SUM          | Total |                |      |       |
|                   | STG_SUM         | Total |                |      |       |
| <b>CAB</b>        | CAB_SUM         | Total |                |      |       |
|                   | STG_SUM         | Total |                |      |       |
| <b>SD</b>         | SD_SUM          | Total |                |      |       |
|                   | STG_SUM         | Total |                |      |       |
| <b>SDS</b>        | SDS_SUM         | Total |                |      |       |
|                   | STG_SUM         | Total |                |      |       |

Description: 5 Loads  
5.1 Load Manager

Project No.





| Name | Sum LC  | Stg      | Skipped | LC      | Desc                                 |
|------|---------|----------|---------|---------|--------------------------------------|
| SW   | SW_SUM  | STG_PIER |         | SW_PIER | Self Weight Of Pylon                 |
|      | STG_SUM | STG_00   |         | SW_00   | Self Weight Of Box Girder - Stage-00 |
|      |         | STG_01   |         | SW_01   | Self Weight Of Box Girder - Stage-01 |
|      |         | STG_02   |         | SW_02   | Self Weight Of Box Girder - Stage-02 |
|      |         | STG_03   |         | SW_03   | Self Weight Of Box Girder - Stage-03 |
|      |         | STG_04   |         | SW_04   | Self Weight Of Box Girder - Stage-04 |
|      |         | STG_05   |         | SW_05   | Self Weight Of Box Girder - Stage-05 |
|      |         | STG_06   |         | SW_06   | Self Weight Of Box Girder - Stage-06 |
|      |         | STG_07   |         | SW_07   | Self Weight Of Box Girder - Stage-07 |
|      |         | STG_08   |         | SW_08   | Self Weight Of Box Girder - Stage-08 |
|      |         | STG_09   |         | SW_09   | Self Weight Of Box Girder - Stage-09 |
|      |         | STG_10   |         | SW_10   | Self Weight Of Box Girder - Stage-10 |
|      |         | STG_11   |         | SW_11   | Self Weight Of Box Girder - Stage-11 |
|      |         | STG_12   |         | SW_12   | Self Weight Of Box Girder - Stage-12 |
|      |         | STG_13   |         | SW_13   | Self Weight Of Box Girder - Stage-13 |
|      |         | STG_14   |         | SW_14   | Self Weight Of Box Girder - Stage-14 |
|      |         | STG_15   |         | SW_15   | Self Weight Of Box Girder - Stage-15 |
|      |         | STG_16   |         | SW_16   | Self Weight Of Box Girder - Stage-16 |
|      |         | STG_17   |         | SW_17   | Self Weight Of Box Girder - Stage-17 |
|      |         | STG_18   |         | SW_18   | Self Weight Of Box Girder - Stage-18 |
|      |         | STG_19   |         | SW_19   | Self Weight Of Box Girder - Stage-19 |
|      |         | STG_20   |         | SW_20   | Self Weight Of Box Girder - Stage-20 |
|      |         | STG_21   |         | SW_21   | Self Weight Of Box Girder - Stage-21 |
|      |         | STG_22   |         | SW_22   | Self Weight Of Box Girder - Stage-22 |
|      |         | STG_23   |         | SW_23   | Self Weight Of Box Girder - Stage-23 |
|      |         | STG_24   |         | SW_24   | Self Weight Of Box Girder - Stage-24 |
|      |         | STG_25   |         | SW_25   | Self Weight Of Box Girder - Stage-25 |
|      |         | STG_26   |         | SW_26   | Self Weight Of Box Girder - Stage-26 |

|    |         |        |  |       |   |
|----|---------|--------|--|-------|---|
| PS | PS_SUM  | STG_00 |  | PS_00 | Prestressing Force Application - Stage- |
|    | STG_SUM | STG_01 |  | PS_01 | Prestressing Force Application - Stage- |
|    |         | STG_02 |  | PS_02 | Prestressing Force Application - Stage- |
|    |         | STG_03 |  | PS_03 | Prestressing Force Application - Stage- |
|    |         | STG_04 |  | PS_04 | Prestressing Force Application - Stage- |
|    |         | STG_05 |  | PS_05 | Prestressing Force Application - Stage- |
|    |         | STG_06 |  | PS_06 | Prestressing Force Application - Stage- |
|    |         | STG_07 |  | PS_07 | Prestressing Force Application - Stage- |
|    |         | STG_08 |  | PS_08 | Prestressing Force Application - Stage- |
|    |         | STG_10 |  | PS_10 | Prestressing Force Application - Stage- |
|    |         | STG_12 |  | PS_12 | Prestressing Force Application - Stage- |
|    |         | STG_14 |  | PS_14 | Prestressing Force Application - Stage- |
|    |         | STG_16 |  | PS_16 | Prestressing Force Application - Stage- |
|    |         | STG_18 |  | PS_18 | Prestressing Force Application - Stage- |
|    |         | STG_20 |  | PS_20 | Prestressing Force Application - Stage- |
|    |         | STG_22 |  | PS_22 | Prestressing Force Application - Stage- |
|    |         | STG_24 |  | PS_24 | Prestressing Force Application - Stage- |
|    |         | STG_26 |  | PS_26 | Prestressing Force Application - Stage- |

|    |         |        |  |         |  |
|----|---------|--------|--|---------|--|
| TR | TR_SUM  | STG_00 |  | TR_00   | Form Traveller Weight - Stage-00       |
|    | STG_SUM | STG_00 |  | TR_00_R | Form Traveller Removal load - Stage-00 |
|    |         | STG_01 |  | TR_01   | Form Traveller Weight - Stage-01       |
|    |         | STG_01 |  | TR_01_R | Form Traveller Removal load - Stage-01 |
|    |         | STG_02 |  | TR_02   | Form Traveller Weight - Stage-02       |
|    |         | STG_02 |  | TR_02_R | Form Traveller Removal load - Stage-02 |
|    |         | STG_03 |  | TR_03   | Form Traveller Weight - Stage-03       |
|    |         | STG_03 |  | TR_03_R | Form Traveller Removal load - Stage-03 |
|    |         | STG_04 |  | TR_04   | Form Traveller Weight - Stage-04       |
|    |         | STG_04 |  | TR_04_R | Form Traveller Removal load - Stage-04 |
|    |         | STG_05 |  | TR_05   | Form Traveller Weight - Stage-05       |
|    |         | STG_05 |  | TR_05_R | Form Traveller Removal load - Stage-05 |
|    |         | STG_06 |  | TR_06   | Form Traveller Weight - Stage-06       |
|    |         | STG_06 |  | TR_06_R | Form Traveller Removal load - Stage-06 |

Description: 5 Loads  
5.1 Load Manager

Project No.



| Name | Sum LC | Stg    | Skipped | LC      | Desc                                   |
|------|--------|--------|---------|---------|--|
|      |        | STG_07 |         | TR_07   | Form Traveller Weight - Stage-07       |
|      |        | STG_07 |         | TR_07_R | Form Traveller Removal load - Stage-07 |
|      |        | STG_08 |         | TR_08   | Form Traveller Weight - Stage-08       |
|      |        | STG_08 |         | TR_08_R | Form Traveller Removal load - Stage-08 |
|      |        | STG_09 |         | TR_09   | Form Traveller Weight - Stage-09       |
|      |        | STG_09 |         | TR_09_R | Form Traveller Removal load - Stage-09 |
|      |        | STG_10 |         | TR_10   | Form Traveller Weight - Stage-10       |
|      |        | STG_10 |         | TR_10_R | Form Traveller Removal load - Stage-10 |
|      |        | STG_11 |         | TR_11   | Form Traveller Weight - Stage-11       |
|      |        | STG_11 |         | TR_11_R | Form Traveller Removal load - Stage-11 |
|      |        | STG_12 |         | TR_12   | Form Traveller Weight - Stage-12       |
|      |        | STG_12 |         | TR_12_R | Form Traveller Removal load - Stage-12 |
|      |        | STG_13 |         | TR_13   | Form Traveller Weight - Stage-13       |
|      |        | STG_13 |         | TR_13_R | Form Traveller Removal load - Stage-13 |
|      |        | STG_14 |         | TR_14   | Form Traveller Weight - Stage-14       |
|      |        | STG_14 |         | TR_14_R | Form Traveller Removal load - Stage-14 |
|      |        | STG_15 |         | TR_15   | Form Traveller Weight - Stage-15       |
|      |        | STG_15 |         | TR_15_R | Form Traveller Removal load - Stage-15 |
|      |        | STG_16 |         | TR_16   | Form Traveller Weight - Stage-16       |
|      |        | STG_16 |         | TR_16_R | Form Traveller Removal load - Stage-16 |
|      |        | STG_17 |         | TR_17   | Form Traveller Weight - Stage-17       |
|      |        | STG_17 |         | TR_17_R | Form Traveller Removal load - Stage-17 |
|      |        | STG_18 |         | TR_18   | Form Traveller Weight - Stage-18       |
|      |        | STG_18 |         | TR_18_R | Form Traveller Removal load - Stage-18 |
|      |        | STG_19 |         | TR_19   | Form Traveller Weight - Stage-19       |
|      |        | STG_19 |         | TR_19_R | Form Traveller Removal load - Stage-19 |
|      |        | STG_20 |         | TR_20   | Form Traveller Weight - Stage-20       |
|      |        | STG_20 |         | TR_20_R | Form Traveller Removal load - Stage-20 |
|      |        | STG_21 |         | TR_21   | Form Traveller Weight - Stage-21       |
|      |        | STG_21 |         | TR_21_R | Form Traveller Removal load - Stage-21 |
|      |        | STG_22 |         | TR_22   | Form Traveller Weight - Stage-22       |
|      |        | STG_22 |         | TR_22_R | Form Traveller Removal load - Stage-22 |
|      |        | STG_23 |         | TR_23   | Form Traveller Weight - Stage-23       |
|      |        | STG_23 |         | TR_23_R | Form Traveller Removal load - Stage-23 |
|      |        | STG_24 |         | TR_24   | Form Traveller Weight - Stage-24       |
|      |        | STG_24 |         | TR_24_R | Form Traveller Removal load - Stage-24 |
|      |        | STG_25 |         | TR_25   | Form Traveller Weight - Stage-25       |
|      |        | STG_25 |         | TR_25_R | Form Traveller Removal load - Stage-25 |

|    |         |        |         |  |
|----|---------|--------|---------|--|
| WC | WC_SUM  | STG_00 | WC_00   | Wet Concrete Weight - Stage-00         |
|    | STG_SUM | STG_00 | WC_00_R | Wet Concrete Weight Removal - Stage-00 |
|    |         | STG_01 | WC_01   | Wet Concrete Weight - Stage-01         |
|    |         | STG_01 | WC_01_R | Wet Concrete Weight Removal - Stage-01 |
|    |         | STG_02 | WC_02   | Wet Concrete Weight - Stage-02         |
|    |         | STG_02 | WC_02_R | Wet Concrete Weight Removal - Stage-02 |
|    |         | STG_03 | WC_03   | Wet Concrete Weight - Stage-03         |
|    |         | STG_03 | WC_03_R | Wet Concrete Weight Removal - Stage-03 |
|    |         | STG_04 | WC_04   | Wet Concrete Weight - Stage-04         |
|    |         | STG_04 | WC_04_R | Wet Concrete Weight Removal - Stage-04 |
|    |         | STG_05 | WC_05   | Wet Concrete Weight - Stage-05         |
|    |         | STG_05 | WC_05_R | Wet Concrete Weight Removal - Stage-05 |
|    |         | STG_06 | WC_06   | Wet Concrete Weight - Stage-06         |
|    |         | STG_06 | WC_06_R | Wet Concrete Weight Removal - Stage-06 |
|    |         | STG_07 | WC_07   | Wet Concrete Weight - Stage-07         |
|    |         | STG_07 | WC_07_R | Wet Concrete Weight Removal - Stage-07 |
|    |         | STG_08 | WC_08   | Wet Concrete Weight - Stage-08         |
|    |         | STG_08 | WC_08_R | Wet Concrete Weight Removal - Stage-08 |
|    |         | STG_09 | WC_09   | Wet Concrete Weight - Stage-09         |
|    |         | STG_09 | WC_09_R | Wet Concrete Weight Removal - Stage-09 |
|    |         | STG_10 | WC_10   | Wet Concrete Weight - Stage-10         |
|    |         | STG_10 | WC_10_R | Wet Concrete Weight Removal - Stage-10 |
|    |         | STG_11 | WC_11   | Wet Concrete Weight - Stage-11         |

Description: 5 Loads  
5.1 Load Manager

Project No.





| Name | Sum LC | Stg    | Skipped | LC      | Desc                                   |
|------|--------|--------|---------|---------|--|
|      |        | STG_11 |         | WC_11_R | Wet Concrete Weight Removal - Stage-11 |
|      |        | STG_12 |         | WC_12   | Wet Concrete Weight - Stage-12         |
|      |        | STG_12 |         | WC_12_R | Wet Concrete Weight Removal - Stage-12 |
|      |        | STG_13 |         | WC_13   | Wet Concrete Weight - Stage-13         |
|      |        | STG_13 |         | WC_13_R | Wet Concrete Weight Removal - Stage-13 |
|      |        | STG_14 |         | WC_14   | Wet Concrete Weight - Stage-14         |
|      |        | STG_14 |         | WC_14_R | Wet Concrete Weight Removal - Stage-14 |
|      |        | STG_15 |         | WC_15   | Wet Concrete Weight - Stage-15         |
|      |        | STG_15 |         | WC_15_R | Wet Concrete Weight Removal - Stage-15 |
|      |        | STG_16 |         | WC_16   | Wet Concrete Weight - Stage-16         |
|      |        | STG_16 |         | WC_16_R | Wet Concrete Weight Removal - Stage-16 |
|      |        | STG_17 |         | WC_17   | Wet Concrete Weight - Stage-17         |
|      |        | STG_17 |         | WC_17_R | Wet Concrete Weight Removal - Stage-17 |
|      |        | STG_18 |         | WC_18   | Wet Concrete Weight - Stage-18         |
|      |        | STG_18 |         | WC_18_R | Wet Concrete Weight Removal - Stage-18 |
|      |        | STG_19 |         | WC_19   | Wet Concrete Weight - Stage-19         |
|      |        | STG_19 |         | WC_19_R | Wet Concrete Weight Removal - Stage-19 |
|      |        | STG_20 |         | WC_20   | Wet Concrete Weight - Stage-20         |
|      |        | STG_20 |         | WC_20_R | Wet Concrete Weight Removal - Stage-20 |
|      |        | STG_21 |         | WC_21   | Wet Concrete Weight - Stage-21         |
|      |        | STG_21 |         | WC_21_R | Wet Concrete Weight Removal - Stage-21 |
|      |        | STG_22 |         | WC_22   | Wet Concrete Weight - Stage-22         |
|      |        | STG_22 |         | WC_22_R | Wet Concrete Weight Removal - Stage-22 |
|      |        | STG_23 |         | WC_23   | Wet Concrete Weight - Stage-23         |
|      |        | STG_23 |         | WC_23_R | Wet Concrete Weight Removal - Stage-23 |
|      |        | STG_24 |         | WC_24   | Wet Concrete Weight - Stage-24         |
|      |        | STG_24 | Skip    | WC_24_R | Wet Concrete Weight Removal - Stage-24 |
|      |        | STG_25 |         | WC_25   | Wet Concrete Weight - Stage-25         |
|      |        | STG_25 |         | WC_25_R | Wet Concrete Weight Removal - Stage-25 |

|    |         |          |         |   |
|----|---------|----------|---------|---|
| CS | CS_SUM  | STG_PIER | CS_Pier | Creep & Shrinkage - Stage-PIER          |
|    | STG_SUM | STG_00   | CS_00   | Creep & Shrinkage - Stage-00            |
|    |         | STG_01   | CS_01   | Creep & Shrinkage - Stage-01            |
|    |         | STG_02   | CS_02   | Creep & Shrinkage - Stage-02            |
|    |         | STG_03   | CS_03   | Creep & Shrinkage - Stage-03            |
|    |         | STG_04   | CS_04   | Creep & Shrinkage - Stage-04            |
|    |         | STG_05   | CS_05   | Creep & Shrinkage - Stage-05            |
|    |         | STG_06   | CS_06   | Creep & Shrinkage - Stage-06            |
|    |         | STG_07   | CS_07   | Creep & Shrinkage - Stage-07            |
|    |         | STG_08   | CS_08   | Creep & Shrinkage - Stage-08            |
|    |         | STG_09   | CS_09   | Creep & Shrinkage - Stage-09            |
|    |         | STG_10   | CS_10   | Creep & Shrinkage - Stage-10            |
|    |         | STG_11   | CS_11   | Creep & Shrinkage - Stage-11            |
|    |         | STG_12   | CS_12   | Creep & Shrinkage - Stage-12            |
|    |         | STG_13   | CS_13   | Creep & Shrinkage - Stage-13            |
|    |         | STG_14   | CS_14   | Creep & Shrinkage - Stage-14            |
|    |         | STG_15   | CS_15   | Creep & Shrinkage - Stage-15            |
|    |         | STG_16   | CS_16   | Creep & Shrinkage - Stage-16            |
|    |         | STG_17   | CS_17   | Creep & Shrinkage - Stage-17            |
|    |         | STG_18   | CS_18   | Creep & Shrinkage - Stage-18            |
|    |         | STG_19   | CS_19   | Creep & Shrinkage - Stage-19            |
|    |         | STG_20   | CS_20   | Creep & Shrinkage - Stage-20            |
|    |         | STG_21   | CS_21   | Creep & Shrinkage - Stage-21            |
|    |         | STG_22   | CS_22   | Creep & Shrinkage - Stage-22            |
|    |         | STG_23   | CS_23   | Creep & Shrinkage - Stage-23            |
|    |         | STG_24   | CS_24   | Creep & Shrinkage - Stage-24            |
|    |         | STG_25   | CS_25   | Creep & Shrinkage - Stage-25            |
|    |         | STG_26   | CS_26   | Creep & Shrinkage - Stage-26            |
|    |         | STG_27   | CS_27   | Creep & Shrinkage - Stage-27            |
|    |         | STG_100  | CS_100  | Creep & Shrinkage - Stage-100 for 100 Y |

|     |         |        |      |           |
|-----|---------|--------|------|-----------|
| CAB | CAB_SUM | STG_05 | Skip | CST_BS_05 |
|-----|---------|--------|------|-----------|

Description: 5 Loads  
5.1 Load Manager

Project No.



| Name | Sum LC         | Stg     | Skipped | LC         | Desc                                    |
|------|----------------|---------|---------|------------|---|
|      | <b>STG_SUM</b> | STG_05  | Skip    | CST_MS_05  |   |
|      |                | STG_07  | Skip    | CST_BS_07  |   |
|      |                | STG_07  | Skip    | CST_MS_07  |   |
|      |                | STG_09  |         | CST_BS_09  | Stay force Application Back Span - Stag |
|      |                | STG_09  |         | CST_MS_09  | Stay force Application Main Span - Stag |
|      |                | STG_11  |         | CST_BS_11  | Stay force Application Back Span - Stag |
|      |                | STG_11  |         | CST_MS_11  | Stay force Application Main Span - Stag |
|      |                | STG_12  |         | TDS_01     | Tie Down Force Application - Stage-12   |
|      |                | STG_13  |         | CST_BS_13  | Stay force Application Back Span - Stag |
|      |                | STG_13  |         | CST_MS_13  | Stay force Application Main Span - Stag |
|      |                | STG_15  |         | CST_BS_15  | Stay force Application Back Span - Stag |
|      |                | STG_15  |         | CST_MS_15  | Stay force Application Main Span - Stag |
|      |                | STG_16  |         | TDS_02     | Tie Down Force Application - Stage-16   |
|      |                | STG_17  |         | CST_BS_17  | Stay force Application Back Span - Stag |
|      |                | STG_17  |         | CST_MS_17  | Stay force Application Main Span - Stag |
|      |                | STG_19  |         | CST_BS_19  | Stay force Application Back Span - Stag |
|      |                | STG_19  |         | CST_MS_19  | Stay force Application Main Span - Stag |
|      |                | STG_20  |         | TDS_03     | Tie Down Force Application - Stage-20   |
|      |                | STG_21  |         | CST_BS_21  | Stay force Application Back Span - Stag |
|      |                | STG_21  |         | CST_MS_21  | Stay force Application Main Span - Stag |
|      |                | STG_23  |         | CST_BS_23  | Stay force Application Back Span - Stag |
|      |                | STG_23  |         | CST_MS_23  | Stay force Application Main Span - Stag |
|      |                | STG_24  |         | TDS_04     | Tie Down Force Application - Stage-24   |
|      |                | STG_25  |         | CST_BS_25  | Stay force Application Back Span - Stag |
|      |                | STG_25  |         | CST_MS_25  | Stay force Application Main Span - Stag |
|      |                | STG_26c |         | CSTF_BS_03 | Final Stay Cable Force Application - St |
|      |                | STG_26c |         | CSTF_MS_03 | Final Stay Cable Force Application - St |
|      |                | STG_26c |         | CSTF_BS_04 | Final Stay Cable Force Application - St |
|      |                | STG_26c |         | CSTF_MS_04 | Final Stay Cable Force Application - St |
|      |                | STG_26c |         | CSTF_BS_05 | Final Stay Cable Force Application - St |
|      |                | STG_26c |         | CSTF_MS_05 | Final Stay Cable Force Application - St |
|      |                | STG_26c |         | CSTF_BS_06 | Final Stay Cable Force Application - St |
|      |                | STG_26c |         | CSTF_MS_06 | Final Stay Cable Force Application - St |
|      |                | STG_26c |         | CSTF_BS_07 | Final Stay Cable Force Application - St |
|      |                | STG_26c |         | CSTF_MS_07 | Final Stay Cable Force Application - St |
|      |                | STG_26c |         | CSTF_BS_08 | Final Stay Cable Force Application - St |
|      |                | STG_26c |         | CSTF_MS_08 | Final Stay Cable Force Application - St |
|      |                | STG_26c |         | CSTF_BS_09 | Final Stay Cable Force Application - St |
|      |                | STG_26c |         | CSTF_MS_09 | Final Stay Cable Force Application - St |
|      |                | STG_26c |         | CSTF_BS_10 | Final Stay Cable Force Application - St |
|      |                | STG_26c |         | CSTF_MS_10 | Final Stay Cable Force Application - St |
|      |                | STG_26c |         | CSTF_BS_11 | Final Stay Cable Force Application - St |
|      |                | STG_26c |         | CSTF_MS_11 | Final Stay Cable Force Application - St |

|           |               |        |    |                                     |
|-----------|---------------|--------|----|-------------------------------------|
| <b>SD</b> | <b>SD_SUM</b> | STG_27 | SD | Weight of Crash Barrier And Railing |
|           | STG SUM       | STG_27 | SD | Weight of Crash Barrier And Railing |

|            |                |        |     |                          |
|------------|----------------|--------|-----|--------------------------|
| <b>SDS</b> | <b>SDS_SUM</b> | STG_27 | SDS | Weight of Wearing Course |
|            | STG SUM        | STG_27 | SDS | Weight of Wearing Course |



## 5.2 Load Cases

### 5.2.1 Self Weight

|  |         |      |      |      |      |      |      |       |      |      |      |      |
|--|---------|------|------|------|------|------|------|-------|------|------|------|------|
| <b>load case:</b> SW_PIER<br>Self Weight Of Pylon        |         |      |      |      |      |      |      |       |      |      |      |      |
| Duration: PERMANENT                                      |         |      |      |      |      |      |      |       |      |      |      |      |
| LoadInfo: SW   |         |      |      |      |      |      |      |       |      |      |      |      |
| <b>Loads:</b>  |         |      |      |      |      |      |      |       |      |      |      |      |
|  | LSet    | Fact | From | To   | Step | proj | inp1 | inp2  | inp3 | inp4 | inp5 | inp6 |
| self-weight mass with load - direction vector r normaliz |         |      |      |      |      | p    | Rx   | Ry    | Rz   | Gam  |      |      |
| G  | SW_Pier | 1    | 2101 | 2145 | 1    | 0.00 | 0.00 | -1.00 | 0.00 | 0.00 |      |      |
| G  | SW_Pier | 1    | 2201 | 2245 | 1    | 0.00 | 0.00 | -1.00 | 0.00 | 0.00 |      |      |
| G  | SW_Pier | 1    | 3101 | 3145 | 1    | 0.00 | 0.00 | -1.00 | 0.00 | 0.00 |      |      |
| G  | SW_Pier | 1    | 3201 | 3245 | 1    | 0.00 | 0.00 | -1.00 | 0.00 | 0.00 |      |      |

|   |       |      |      |     |      |      |      |       |      |      |      |      |
|---|-------|------|------|-----|------|------|------|-------|------|------|------|------|
| <b>load case:</b> SW_00<br>Self Weight Of Box Girder - Stage-00 |       |      |      |     |      |      |      |       |      |      |      |      |
| Duration: PERMANENT   |       |      |      |     |      |      |      |       |      |      |      |      |
| LoadInfo: SW  |       |      |      |     |      |      |      |       |      |      |      |      |
| <b>Loads:</b>   |       |      |      |     |      |      |      |       |      |      |      |      |
|   | LSet  | Fact | From | To  | Step | proj | inp1 | inp2  | inp3 | inp4 | inp5 | inp6 |
| self-weight mass with load - direction vector r normaliz        |       |      |      |     |      | p    | Rx   | Ry    | Rz   | Gam  |      |      |
| G   | SW_00 | 1    | 101  | 132 | 1    | 0.00 | 0.00 | -1.00 | 0.00 | 0.00 |      |      |
| G   | SW_00 | 1    | 185  | 216 | 1    | 0.00 | 0.00 | -1.00 | 0.00 | 0.00 |      |      |

|   |       |      |      |     |      |      |      |       |      |      |      |      |
|---|-------|------|------|-----|------|------|------|-------|------|------|------|------|
| <b>load case:</b> SW_01<br>Self Weight Of Box Girder - Stage-01 |       |      |      |     |      |      |      |       |      |      |      |      |
| Duration: PERMANENT   |       |      |      |     |      |      |      |       |      |      |      |      |
| LoadInfo: SW  |       |      |      |     |      |      |      |       |      |      |      |      |
| <b>Loads:</b>   |       |      |      |     |      |      |      |       |      |      |      |      |
|   | LSet  | Fact | From | To  | Step | proj | inp1 | inp2  | inp3 | inp4 | inp5 | inp6 |
| self-weight mass with load - direction vector r normaliz        |       |      |      |     |      | p    | Rx   | Ry    | Rz   | Gam  |      |      |
| G   | SW_01 | 1    | 133  | 133 | 1    | 0.00 | 0.00 | -1.00 | 0.00 | 0.00 |      |      |
| G   | SW_01 | 1    | 184  | 184 | 1    | 0.00 | 0.00 | -1.00 | 0.00 | 0.00 |      |      |

|   |       |      |      |     |      |      |      |       |      |      |      |      |
|---|-------|------|------|-----|------|------|------|-------|------|------|------|------|
| <b>load case:</b> SW_02<br>Self Weight Of Box Girder - Stage-02 |       |      |      |     |      |      |      |       |      |      |      |      |
| Duration: PERMANENT   |       |      |      |     |      |      |      |       |      |      |      |      |
| LoadInfo: SW  |       |      |      |     |      |      |      |       |      |      |      |      |
| <b>Loads:</b>   |       |      |      |     |      |      |      |       |      |      |      |      |
|   | LSet  | Fact | From | To  | Step | proj | inp1 | inp2  | inp3 | inp4 | inp5 | inp6 |
| self-weight mass with load - direction vector r normaliz        |       |      |      |     |      | p    | Rx   | Ry    | Rz   | Gam  |      |      |
| G   | SW_02 | 1    | 134  | 134 | 1    | 0.00 | 0.00 | -1.00 | 0.00 | 0.00 |      |      |
| G   | SW_02 | 1    | 183  | 183 | 1    | 0.00 | 0.00 | -1.00 | 0.00 | 0.00 |      |      |



|   |       |      |      |     |      |      |      |       |      |      |      |      |
|---|-------|------|------|-----|------|------|------|-------|------|------|------|------|
| <b>load case:</b> SW_03<br>Self Weight Of Box Girder - Stage-03 |       |      |      |     |      |      |      |       |      |      |      |      |
| Duration: PERMANENT   |       |      |      |     |      |      |      |       |      |      |      |      |
| LoadInfo: SW  |       |      |      |     |      |      |      |       |      |      |      |      |
| <b>Loads:</b>   |       |      |      |     |      |      |      |       |      |      |      |      |
|   | LSet  | Fact | From | To  | Step | proj | inp1 | inp2  | inp3 | inp4 | inp5 | inp6 |
| self-weight mass with load - direction vector r normaliz        |       |      |      |     |      | p    | Rx   | Ry    | Rz   | Gam  |      |      |
| G   | SW_03 | 1    | 135  | 135 | 1    | 0.00 | 0.00 | -1.00 | 0.00 | 0.00 |      |      |
| G   | SW_03 | 1    | 182  | 182 | 1    | 0.00 | 0.00 | -1.00 | 0.00 | 0.00 |      |      |

|   |       |      |      |     |      |      |      |       |      |      |      |      |
|---|-------|------|------|-----|------|------|------|-------|------|------|------|------|
| <b>load case:</b> SW_04<br>Self Weight Of Box Girder - Stage-04 |       |      |      |     |      |      |      |       |      |      |      |      |
| Duration: PERMANENT   |       |      |      |     |      |      |      |       |      |      |      |      |
| LoadInfo: SW  |       |      |      |     |      |      |      |       |      |      |      |      |
| <b>Loads:</b>   |       |      |      |     |      |      |      |       |      |      |      |      |
|   | LSet  | Fact | From | To  | Step | proj | inp1 | inp2  | inp3 | inp4 | inp5 | inp6 |
| self-weight mass with load - direction vector r normaliz        |       |      |      |     |      | p    | Rx   | Ry    | Rz   | Gam  |      |      |
| G   | SW_04 | 1    | 136  | 136 | 1    | 0.00 | 0.00 | -1.00 | 0.00 | 0.00 |      |      |
| G   | SW_04 | 1    | 181  | 181 | 1    | 0.00 | 0.00 | -1.00 | 0.00 | 0.00 |      |      |

|   |       |      |      |      |      |      |      |       |      |      |      |      |
|---|-------|------|------|------|------|------|------|-------|------|------|------|------|
| <b>load case:</b> SW_05<br>Self Weight Of Box Girder - Stage-05 |       |      |      |      |      |      |      |       |      |      |      |      |
| Duration: PERMANENT   |       |      |      |      |      |      |      |       |      |      |      |      |
| LoadInfo: SW  |       |      |      |      |      |      |      |       |      |      |      |      |
| <b>Loads:</b>   |       |      |      |      |      |      |      |       |      |      |      |      |
|   | LSet  | Fact | From | To   | Step | proj | inp1 | inp2  | inp3 | inp4 | inp5 | inp6 |
| self-weight mass with load - direction vector r normaliz        |       |      |      |      |      | p    | Rx   | Ry    | Rz   | Gam  |      |      |
| G   | SW_05 | 1    | 137  | 137  | 1    | 0.00 | 0.00 | -1.00 | 0.00 | 0.00 |      |      |
| G   | SW_05 | 1    | 180  | 180  | 1    | 0.00 | 0.00 | -1.00 | 0.00 | 0.00 |      |      |
| G   | SW_05 | 1    | 1101 | 1801 | 100  | 0.00 | 0.00 | -1.00 | 0.00 | 0.00 |      |      |

|   |       |      |      |     |      |      |      |       |      |      |      |      |
|---|-------|------|------|-----|------|------|------|-------|------|------|------|------|
| <b>load case:</b> SW_06<br>Self Weight Of Box Girder - Stage-06 |       |      |      |     |      |      |      |       |      |      |      |      |
| Duration: PERMANENT   |       |      |      |     |      |      |      |       |      |      |      |      |
| LoadInfo: SW  |       |      |      |     |      |      |      |       |      |      |      |      |
| <b>Loads:</b>   |       |      |      |     |      |      |      |       |      |      |      |      |
|   | LSet  | Fact | From | To  | Step | proj | inp1 | inp2  | inp3 | inp4 | inp5 | inp6 |
| self-weight mass with load - direction vector r normaliz        |       |      |      |     |      | p    | Rx   | Ry    | Rz   | Gam  |      |      |
| G   | SW_06 | 1    | 138  | 138 | 1    | 0.00 | 0.00 | -1.00 | 0.00 | 0.00 |      |      |
| G   | SW_06 | 1    | 179  | 179 | 1    | 0.00 | 0.00 | -1.00 | 0.00 | 0.00 |      |      |

|   |       |      |      |      |      |      |      |       |      |      |      |      |
|---|-------|------|------|------|------|------|------|-------|------|------|------|------|
| <b>load case:</b> SW_07<br>Self Weight Of Box Girder - Stage-07 |       |      |      |      |      |      |      |       |      |      |      |      |
| Duration: PERMANENT   |       |      |      |      |      |      |      |       |      |      |      |      |
| LoadInfo: SW  |       |      |      |      |      |      |      |       |      |      |      |      |
| <b>Loads:</b>   |       |      |      |      |      |      |      |       |      |      |      |      |
|   | LSet  | Fact | From | To   | Step | proj | inp1 | inp2  | inp3 | inp4 | inp5 | inp6 |
| self-weight mass with load - direction vector r normaliz        |       |      |      |      |      | p    | Rx   | Ry    | Rz   | Gam  |      |      |
| G   | SW_07 | 1    | 139  | 139  | 1    | 0.00 | 0.00 | -1.00 | 0.00 | 0.00 |      |      |
| G   | SW_07 | 1    | 178  | 178  | 1    | 0.00 | 0.00 | -1.00 | 0.00 | 0.00 |      |      |
| G   | SW_07 | 1    | 1102 | 1802 | 100  | 0.00 | 0.00 | -1.00 | 0.00 | 0.00 |      |      |

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|   |       |      |      |     |      |      |      |       |      |      |      |      |
|---|-------|------|------|-----|------|------|------|-------|------|------|------|------|
| <b>load case:</b> SW_08<br>Self Weight Of Box Girder - Stage-08 |       |      |      |     |      |      |      |       |      |      |      |      |
| Duration: PERMANENT   |       |      |      |     |      |      |      |       |      |      |      |      |
| LoadInfo: SW  |       |      |      |     |      |      |      |       |      |      |      |      |
| <b>Loads:</b>   |       |      |      |     |      |      |      |       |      |      |      |      |
|   | LSet  | Fact | From | To  | Step | proj | inp1 | inp2  | inp3 | inp4 | inp5 | inp6 |
| self-weight mass with load - direction vector r normaliz        |       |      |      |     |      | p    | Rx   | Ry    | Rz   | Gam  |      |      |
| G   | SW_08 | 1    | 140  | 140 | 1    | 0.00 | 0.00 | -1.00 | 0.00 | 0.00 |      |      |
| G   | SW_08 | 1    | 177  | 177 | 1    | 0.00 | 0.00 | -1.00 | 0.00 | 0.00 |      |      |

|   |       |      |      |      |      |      |      |       |      |      |      |      |
|---|-------|------|------|------|------|------|------|-------|------|------|------|------|
| <b>load case:</b> SW_09<br>Self Weight Of Box Girder - Stage-09 |       |      |      |      |      |      |      |       |      |      |      |      |
| Duration: PERMANENT   |       |      |      |      |      |      |      |       |      |      |      |      |
| LoadInfo: SW  |       |      |      |      |      |      |      |       |      |      |      |      |
| <b>Loads:</b>   |       |      |      |      |      |      |      |       |      |      |      |      |
|   | LSet  | Fact | From | To   | Step | proj | inp1 | inp2  | inp3 | inp4 | inp5 | inp6 |
| self-weight mass with load - direction vector r normaliz        |       |      |      |      |      | p    | Rx   | Ry    | Rz   | Gam  |      |      |
| G   | SW_09 | 1    | 141  | 141  | 1    | 0.00 | 0.00 | -1.00 | 0.00 | 0.00 |      |      |
| G   | SW_09 | 1    | 176  | 176  | 1    | 0.00 | 0.00 | -1.00 | 0.00 | 0.00 |      |      |
| G   | SW_09 | 1    | 1103 | 1803 | 100  | 0.00 | 0.00 | -1.00 | 0.00 | 0.00 |      |      |

|   |       |      |      |     |      |      |      |       |      |      |      |      |
|---|-------|------|------|-----|------|------|------|-------|------|------|------|------|
| <b>load case:</b> SW_10<br>Self Weight Of Box Girder - Stage-10 |       |      |      |     |      |      |      |       |      |      |      |      |
| Duration: PERMANENT   |       |      |      |     |      |      |      |       |      |      |      |      |
| LoadInfo: SW  |       |      |      |     |      |      |      |       |      |      |      |      |
| <b>Loads:</b>   |       |      |      |     |      |      |      |       |      |      |      |      |
|   | LSet  | Fact | From | To  | Step | proj | inp1 | inp2  | inp3 | inp4 | inp5 | inp6 |
| self-weight mass with load - direction vector r normaliz        |       |      |      |     |      | p    | Rx   | Ry    | Rz   | Gam  |      |      |
| G   | SW_10 | 1    | 142  | 142 | 1    | 0.00 | 0.00 | -1.00 | 0.00 | 0.00 |      |      |
| G   | SW_10 | 1    | 175  | 175 | 1    | 0.00 | 0.00 | -1.00 | 0.00 | 0.00 |      |      |

|   |       |      |      |      |      |      |      |       |      |      |      |      |
|---|-------|------|------|------|------|------|------|-------|------|------|------|------|
| <b>load case:</b> SW_11<br>Self Weight Of Box Girder - Stage-11 |       |      |      |      |      |      |      |       |      |      |      |      |
| Duration: PERMANENT   |       |      |      |      |      |      |      |       |      |      |      |      |
| LoadInfo: SW  |       |      |      |      |      |      |      |       |      |      |      |      |
| <b>Loads:</b>   |       |      |      |      |      |      |      |       |      |      |      |      |
|   | LSet  | Fact | From | To   | Step | proj | inp1 | inp2  | inp3 | inp4 | inp5 | inp6 |
| self-weight mass with load - direction vector r normaliz        |       |      |      |      |      | p    | Rx   | Ry    | Rz   | Gam  |      |      |
| G   | SW_11 | 1    | 143  | 143  | 1    | 0.00 | 0.00 | -1.00 | 0.00 | 0.00 |      |      |
| G   | SW_11 | 1    | 174  | 174  | 1    | 0.00 | 0.00 | -1.00 | 0.00 | 0.00 |      |      |
| G   | SW_11 | 1    | 1104 | 1804 | 100  | 0.00 | 0.00 | -1.00 | 0.00 | 0.00 |      |      |

Description: 5 Loads  
5.2 Load Cases

Project No.

Designer: VKS Infratech Management Pvt. Ltd.



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|   |       |      |      |     |      |      |      |       |      |      |      |      |
|---|-------|------|------|-----|------|------|------|-------|------|------|------|------|
| <b>load case:</b> SW_12<br>Self Weight Of Box Girder - Stage-12 |       |      |      |     |      |      |      |       |      |      |      |      |
| Duration: PERMANENT   |       |      |      |     |      |      |      |       |      |      |      |      |
| LoadInfo: SW  |       |      |      |     |      |      |      |       |      |      |      |      |
| <b>Loads:</b>   |       |      |      |     |      |      |      |       |      |      |      |      |
|   | LSet  | Fact | From | To  | Step | proj | inp1 | inp2  | inp3 | inp4 | inp5 | inp6 |
| self-weight mass with load - direction vector r normaliz        |       |      |      |     |      | p    | Rx   | Ry    | Rz   | Gam  |      |      |
| G   | SW_12 | 1    | 144  | 144 | 1    | 0.00 | 0.00 | -1.00 | 0.00 | 0.00 |      |      |
| G   | SW_12 | 1    | 173  | 173 | 1    | 0.00 | 0.00 | -1.00 | 0.00 | 0.00 |      |      |

|   |       |      |      |      |      |      |      |       |      |      |      |      |
|---|-------|------|------|------|------|------|------|-------|------|------|------|------|
| <b>load case:</b> SW_13<br>Self Weight Of Box Girder - Stage-13 |       |      |      |      |      |      |      |       |      |      |      |      |
| Duration: PERMANENT   |       |      |      |      |      |      |      |       |      |      |      |      |
| LoadInfo: SW  |       |      |      |      |      |      |      |       |      |      |      |      |
| <b>Loads:</b>   |       |      |      |      |      |      |      |       |      |      |      |      |
|   | LSet  | Fact | From | To   | Step | proj | inp1 | inp2  | inp3 | inp4 | inp5 | inp6 |
| self-weight mass with load - direction vector r normaliz        |       |      |      |      |      | p    | Rx   | Ry    | Rz   | Gam  |      |      |
| G   | SW_13 | 1    | 145  | 145  | 1    | 0.00 | 0.00 | -1.00 | 0.00 | 0.00 |      |      |
| G   | SW_13 | 1    | 172  | 172  | 1    | 0.00 | 0.00 | -1.00 | 0.00 | 0.00 |      |      |
| G   | SW_13 | 1    | 1105 | 1805 | 100  | 0.00 | 0.00 | -1.00 | 0.00 | 0.00 |      |      |

|   |       |      |      |     |      |      |      |       |      |      |      |      |
|---|-------|------|------|-----|------|------|------|-------|------|------|------|------|
| <b>load case:</b> SW_14<br>Self Weight Of Box Girder - Stage-14 |       |      |      |     |      |      |      |       |      |      |      |      |
| Duration: PERMANENT   |       |      |      |     |      |      |      |       |      |      |      |      |
| LoadInfo: SW  |       |      |      |     |      |      |      |       |      |      |      |      |
| <b>Loads:</b>   |       |      |      |     |      |      |      |       |      |      |      |      |
|   | LSet  | Fact | From | To  | Step | proj | inp1 | inp2  | inp3 | inp4 | inp5 | inp6 |
| self-weight mass with load - direction vector r normaliz        |       |      |      |     |      | p    | Rx   | Ry    | Rz   | Gam  |      |      |
| G   | SW_14 | 1    | 146  | 146 | 1    | 0.00 | 0.00 | -1.00 | 0.00 | 0.00 |      |      |
| G   | SW_14 | 1    | 171  | 171 | 1    | 0.00 | 0.00 | -1.00 | 0.00 | 0.00 |      |      |

|   |       |      |      |      |      |      |      |       |      |      |      |      |
|---|-------|------|------|------|------|------|------|-------|------|------|------|------|
| <b>load case:</b> SW_15<br>Self Weight Of Box Girder - Stage-15 |       |      |      |      |      |      |      |       |      |      |      |      |
| Duration: PERMANENT   |       |      |      |      |      |      |      |       |      |      |      |      |
| LoadInfo: SW  |       |      |      |      |      |      |      |       |      |      |      |      |
| <b>Loads:</b>   |       |      |      |      |      |      |      |       |      |      |      |      |
|   | LSet  | Fact | From | To   | Step | proj | inp1 | inp2  | inp3 | inp4 | inp5 | inp6 |
| self-weight mass with load - direction vector r normaliz        |       |      |      |      |      | p    | Rx   | Ry    | Rz   | Gam  |      |      |
| G   | SW_15 | 1    | 147  | 147  | 1    | 0.00 | 0.00 | -1.00 | 0.00 | 0.00 |      |      |
| G   | SW_15 | 1    | 170  | 170  | 1    | 0.00 | 0.00 | -1.00 | 0.00 | 0.00 |      |      |
| G   | SW_15 | 1    | 1106 | 1806 | 100  | 0.00 | 0.00 | -1.00 | 0.00 | 0.00 |      |      |

Description: 5 Loads  
5.2 Load Cases

Project No.

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|   |       |      |      |     |      |      |      |       |      |      |      |      |
|---|-------|------|------|-----|------|------|------|-------|------|------|------|------|
| <b>load case:</b> SW_16<br>Self Weight Of Box Girder - Stage-16 |       |      |      |     |      |      |      |       |      |      |      |      |
| Duration: PERMANENT   |       |      |      |     |      |      |      |       |      |      |      |      |
| LoadInfo: SW  |       |      |      |     |      |      |      |       |      |      |      |      |
| <b>Loads:</b>   |       |      |      |     |      |      |      |       |      |      |      |      |
|   | LSet  | Fact | From | To  | Step | proj | inp1 | inp2  | inp3 | inp4 | inp5 | inp6 |
| self-weight mass with load - direction vector r normaliz        |       |      |      |     |      | p    | Rx   | Ry    | Rz   | Gam  |      |      |
| G   | SW_16 | 1    | 148  | 148 | 1    | 0.00 | 0.00 | -1.00 | 0.00 | 0.00 |      |      |
| G   | SW_16 | 1    | 169  | 169 | 1    | 0.00 | 0.00 | -1.00 | 0.00 | 0.00 |      |      |

|   |       |      |      |      |      |      |      |       |      |      |      |      |
|---|-------|------|------|------|------|------|------|-------|------|------|------|------|
| <b>load case:</b> SW_17<br>Self Weight Of Box Girder - Stage-17 |       |      |      |      |      |      |      |       |      |      |      |      |
| Duration: PERMANENT   |       |      |      |      |      |      |      |       |      |      |      |      |
| LoadInfo: SW  |       |      |      |      |      |      |      |       |      |      |      |      |
| <b>Loads:</b>   |       |      |      |      |      |      |      |       |      |      |      |      |
|   | LSet  | Fact | From | To   | Step | proj | inp1 | inp2  | inp3 | inp4 | inp5 | inp6 |
| self-weight mass with load - direction vector r normaliz        |       |      |      |      |      | p    | Rx   | Ry    | Rz   | Gam  |      |      |
| G   | SW_17 | 1    | 149  | 149  | 1    | 0.00 | 0.00 | -1.00 | 0.00 | 0.00 |      |      |
| G   | SW_17 | 1    | 168  | 168  | 1    | 0.00 | 0.00 | -1.00 | 0.00 | 0.00 |      |      |
| G   | SW_17 | 1    | 1107 | 1807 | 100  | 0.00 | 0.00 | -1.00 | 0.00 | 0.00 |      |      |

|   |       |      |      |     |      |      |      |       |      |      |      |      |
|---|-------|------|------|-----|------|------|------|-------|------|------|------|------|
| <b>load case:</b> SW_18<br>Self Weight Of Box Girder - Stage-18 |       |      |      |     |      |      |      |       |      |      |      |      |
| Duration: PERMANENT   |       |      |      |     |      |      |      |       |      |      |      |      |
| LoadInfo: SW  |       |      |      |     |      |      |      |       |      |      |      |      |
| <b>Loads:</b>   |       |      |      |     |      |      |      |       |      |      |      |      |
|   | LSet  | Fact | From | To  | Step | proj | inp1 | inp2  | inp3 | inp4 | inp5 | inp6 |
| self-weight mass with load - direction vector r normaliz        |       |      |      |     |      | p    | Rx   | Ry    | Rz   | Gam  |      |      |
| G   | SW_18 | 1    | 150  | 150 | 1    | 0.00 | 0.00 | -1.00 | 0.00 | 0.00 |      |      |
| G   | SW_18 | 1    | 167  | 167 | 1    | 0.00 | 0.00 | -1.00 | 0.00 | 0.00 |      |      |

|   |       |      |      |      |      |      |      |       |      |      |      |      |
|---|-------|------|------|------|------|------|------|-------|------|------|------|------|
| <b>load case:</b> SW_19<br>Self Weight Of Box Girder - Stage-19 |       |      |      |      |      |      |      |       |      |      |      |      |
| Duration: PERMANENT   |       |      |      |      |      |      |      |       |      |      |      |      |
| LoadInfo: SW  |       |      |      |      |      |      |      |       |      |      |      |      |
| <b>Loads:</b>   |       |      |      |      |      |      |      |       |      |      |      |      |
|   | LSet  | Fact | From | To   | Step | proj | inp1 | inp2  | inp3 | inp4 | inp5 | inp6 |
| self-weight mass with load - direction vector r normaliz        |       |      |      |      |      | p    | Rx   | Ry    | Rz   | Gam  |      |      |
| G   | SW_19 | 1    | 151  | 151  | 1    | 0.00 | 0.00 | -1.00 | 0.00 | 0.00 |      |      |
| G   | SW_19 | 1    | 166  | 166  | 1    | 0.00 | 0.00 | -1.00 | 0.00 | 0.00 |      |      |
| G   | SW_19 | 1    | 1108 | 1808 | 100  | 0.00 | 0.00 | -1.00 | 0.00 | 0.00 |      |      |

Description: 5 Loads  
5.2 Load Cases

Project No.

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|   |       |      |      |     |      |      |      |       |      |      |      |      |
|---|-------|------|------|-----|------|------|------|-------|------|------|------|------|
| <b>load case:</b> SW_20<br>Self Weight Of Box Girder - Stage-20 |       |      |      |     |      |      |      |       |      |      |      |      |
| Duration: PERMANENT   |       |      |      |     |      |      |      |       |      |      |      |      |
| LoadInfo: SW  |       |      |      |     |      |      |      |       |      |      |      |      |
| <b>Loads:</b>   |       |      |      |     |      |      |      |       |      |      |      |      |
|   | LSet  | Fact | From | To  | Step | proj | inp1 | inp2  | inp3 | inp4 | inp5 | inp6 |
| self-weight mass with load - direction vector r normaliz        |       |      |      |     |      | p    | Rx   | Ry    | Rz   | Gam  |      |      |
| G   | SW_20 | 1    | 152  | 152 | 1    | 0.00 | 0.00 | -1.00 | 0.00 | 0.00 |      |      |
| G   | SW_20 | 1    | 165  | 165 | 1    | 0.00 | 0.00 | -1.00 | 0.00 | 0.00 |      |      |

|   |       |      |      |      |      |      |      |       |      |      |      |      |
|---|-------|------|------|------|------|------|------|-------|------|------|------|------|
| <b>load case:</b> SW_21<br>Self Weight Of Box Girder - Stage-21 |       |      |      |      |      |      |      |       |      |      |      |      |
| Duration: PERMANENT   |       |      |      |      |      |      |      |       |      |      |      |      |
| LoadInfo: SW  |       |      |      |      |      |      |      |       |      |      |      |      |
| <b>Loads:</b>   |       |      |      |      |      |      |      |       |      |      |      |      |
|   | LSet  | Fact | From | To   | Step | proj | inp1 | inp2  | inp3 | inp4 | inp5 | inp6 |
| self-weight mass with load - direction vector r normaliz        |       |      |      |      |      | p    | Rx   | Ry    | Rz   | Gam  |      |      |
| G   | SW_21 | 1    | 153  | 153  | 1    | 0.00 | 0.00 | -1.00 | 0.00 | 0.00 |      |      |
| G   | SW_21 | 1    | 164  | 164  | 1    | 0.00 | 0.00 | -1.00 | 0.00 | 0.00 |      |      |
| G   | SW_21 | 1    | 1109 | 1809 | 100  | 0.00 | 0.00 | -1.00 | 0.00 | 0.00 |      |      |

|   |       |      |      |     |      |      |      |       |      |      |      |      |
|---|-------|------|------|-----|------|------|------|-------|------|------|------|------|
| <b>load case:</b> SW_22<br>Self Weight Of Box Girder - Stage-22 |       |      |      |     |      |      |      |       |      |      |      |      |
| Duration: PERMANENT   |       |      |      |     |      |      |      |       |      |      |      |      |
| LoadInfo: SW  |       |      |      |     |      |      |      |       |      |      |      |      |
| <b>Loads:</b>   |       |      |      |     |      |      |      |       |      |      |      |      |
|   | LSet  | Fact | From | To  | Step | proj | inp1 | inp2  | inp3 | inp4 | inp5 | inp6 |
| self-weight mass with load - direction vector r normaliz        |       |      |      |     |      | p    | Rx   | Ry    | Rz   | Gam  |      |      |
| G   | SW_22 | 1    | 154  | 154 | 1    | 0.00 | 0.00 | -1.00 | 0.00 | 0.00 |      |      |
| G   | SW_22 | 1    | 163  | 163 | 1    | 0.00 | 0.00 | -1.00 | 0.00 | 0.00 |      |      |

|   |       |      |      |      |      |      |      |       |      |      |      |      |
|---|-------|------|------|------|------|------|------|-------|------|------|------|------|
| <b>load case:</b> SW_23<br>Self Weight Of Box Girder - Stage-23 |       |      |      |      |      |      |      |       |      |      |      |      |
| Duration: PERMANENT   |       |      |      |      |      |      |      |       |      |      |      |      |
| LoadInfo: SW  |       |      |      |      |      |      |      |       |      |      |      |      |
| <b>Loads:</b>   |       |      |      |      |      |      |      |       |      |      |      |      |
|   | LSet  | Fact | From | To   | Step | proj | inp1 | inp2  | inp3 | inp4 | inp5 | inp6 |
| self-weight mass with load - direction vector r normaliz        |       |      |      |      |      | p    | Rx   | Ry    | Rz   | Gam  |      |      |
| G   | SW_23 | 1    | 155  | 155  | 1    | 0.00 | 0.00 | -1.00 | 0.00 | 0.00 |      |      |
| G   | SW_23 | 1    | 162  | 162  | 1    | 0.00 | 0.00 | -1.00 | 0.00 | 0.00 |      |      |
| G   | SW_23 | 1    | 1110 | 1810 | 100  | 0.00 | 0.00 | -1.00 | 0.00 | 0.00 |      |      |

Description: 5 Loads  
5.2 Load Cases

Project No.



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|   |       |      |      |     |      |      |      |       |      |      |      |      |
|---|-------|------|------|-----|------|------|------|-------|------|------|------|------|
| <b>load case:</b> SW_24<br>Self Weight Of Box Girder - Stage-24 |       |      |      |     |      |      |      |       |      |      |      |      |
| Duration: PERMANENT   |       |      |      |     |      |      |      |       |      |      |      |      |
| LoadInfo: SW  |       |      |      |     |      |      |      |       |      |      |      |      |
| <b>Loads:</b>   |       |      |      |     |      |      |      |       |      |      |      |      |
|   | LSet  | Fact | From | To  | Step | proj | inp1 | inp2  | inp3 | inp4 | inp5 | inp6 |
| self-weight mass with load - direction vector r normaliz        |       |      |      |     |      | p    | Rx   | Ry    | Rz   | Gam  |      |      |
| G   | SW_24 | 1    | 156  | 156 | 1    | 0.00 | 0.00 | -1.00 | 0.00 | 0.00 |      |      |
| G   | SW_24 | 1    | 161  | 161 | 1    | 0.00 | 0.00 | -1.00 | 0.00 | 0.00 |      |      |

|   |       |      |      |      |      |      |      |       |      |      |      |      |
|---|-------|------|------|------|------|------|------|-------|------|------|------|------|
| <b>load case:</b> SW_25<br>Self Weight Of Box Girder - Stage-25 |       |      |      |      |      |      |      |       |      |      |      |      |
| Duration: PERMANENT   |       |      |      |      |      |      |      |       |      |      |      |      |
| LoadInfo: SW  |       |      |      |      |      |      |      |       |      |      |      |      |
| <b>Loads:</b>   |       |      |      |      |      |      |      |       |      |      |      |      |
|   | LSet  | Fact | From | To   | Step | proj | inp1 | inp2  | inp3 | inp4 | inp5 | inp6 |
| self-weight mass with load - direction vector r normaliz        |       |      |      |      |      | p    | Rx   | Ry    | Rz   | Gam  |      |      |
| G   | SW_25 | 1    | 157  | 157  | 1    | 0.00 | 0.00 | -1.00 | 0.00 | 0.00 |      |      |
| G   | SW_25 | 1    | 160  | 160  | 1    | 0.00 | 0.00 | -1.00 | 0.00 | 0.00 |      |      |
| G   | SW_25 | 1    | 1111 | 1811 | 100  | 0.00 | 0.00 | -1.00 | 0.00 | 0.00 |      |      |

|   |       |      |      |     |      |      |      |       |      |      |      |      |
|---|-------|------|------|-----|------|------|------|-------|------|------|------|------|
| <b>load case:</b> SW_26<br>Self Weight Of Box Girder - Stage-26 |       |      |      |     |      |      |      |       |      |      |      |      |
| Duration: PERMANENT   |       |      |      |     |      |      |      |       |      |      |      |      |
| LoadInfo: SW  |       |      |      |     |      |      |      |       |      |      |      |      |
| <b>Loads:</b>   |       |      |      |     |      |      |      |       |      |      |      |      |
|   | LSet  | Fact | From | To  | Step | proj | inp1 | inp2  | inp3 | inp4 | inp5 | inp6 |
| self-weight mass with load - direction vector r normaliz        |       |      |      |     |      | p    | Rx   | Ry    | Rz   | Gam  |      |      |
| G   | SW_26 | 1    | 158  | 159 | 1    | 0.00 | 0.00 | -1.00 | 0.00 | 0.00 |      |      |

## 5.2.2 Form Traveller weight

|   |       |      |      |     |      |      |      |         |      |      |      |      |
|---|-------|------|------|-----|------|------|------|---------|------|------|------|------|
| <b>load case:</b> TR_00<br>Form Traveller Weight - Stage-00 |       |      |      |     |      |      |      |         |      |      |      |      |
| Duration: PERMANENT   |       |      |      |     |      |      |      |         |      |      |      |      |
| LoadInfo: TR  |       |      |      |     |      |      |      |         |      |      |      |      |
| <b>Loads:</b>   |       |      |      |     |      |      |      |         |      |      |      |      |
|   | LSet  | Fact | From | To  | Step | proj | inp1 | inp2    | inp3 | inp4 | inp5 | inp6 |
| nodal point load  |       |      |      |     |      |      | Fx   | Fy      | Fz   | Mx   | My   | Mz   |
| F   | TR_00 | 1    | 133  | 133 | 1    |      | 0.00 | -800.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F   | TR_00 | 1    | 185  | 185 | 1    |      | 0.00 | -800.00 | 0.00 | 0.00 | 0.00 | 0.00 |

Description: 5 Loads  
5.2 Load Cases

Project No.



|   |       |      |      |     |      |      |      |         |      |      |      |      |
|---|-------|------|------|-----|------|------|------|---------|------|------|------|------|
| <b>load case:</b> TR_01<br>Form Traveller Weight - Stage-01 |       |      |      |     |      |      |      |         |      |      |      |      |
| Duration: PERMANENT   |       |      |      |     |      |      |      |         |      |      |      |      |
| LoadInfo: TR  |       |      |      |     |      |      |      |         |      |      |      |      |
| <b>Loads:</b>   |       |      |      |     |      |      |      |         |      |      |      |      |
|   | LSet  | Fact | From | To  | Step | proj | inp1 | inp2    | inp3 | inp4 | inp5 | inp6 |
| nodal point load  |       |      |      |     |      |      | Fx   | Fy      | Fz   | Mx   | My   | Mz   |
| F   | TR_01 | 1    | 134  | 134 | 1    |      | 0.00 | -800.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F   | TR_01 | 1    | 184  | 184 | 1    |      | 0.00 | -800.00 | 0.00 | 0.00 | 0.00 | 0.00 |

|   |       |      |      |     |      |      |      |         |      |      |      |      |
|---|-------|------|------|-----|------|------|------|---------|------|------|------|------|
| <b>load case:</b> TR_02<br>Form Traveller Weight - Stage-02 |       |      |      |     |      |      |      |         |      |      |      |      |
| Duration: PERMANENT   |       |      |      |     |      |      |      |         |      |      |      |      |
| LoadInfo: TR  |       |      |      |     |      |      |      |         |      |      |      |      |
| <b>Loads:</b>   |       |      |      |     |      |      |      |         |      |      |      |      |
|   | LSet  | Fact | From | To  | Step | proj | inp1 | inp2    | inp3 | inp4 | inp5 | inp6 |
| nodal point load  |       |      |      |     |      |      | Fx   | Fy      | Fz   | Mx   | My   | Mz   |
| F   | TR_02 | 1    | 135  | 135 | 1    |      | 0.00 | -800.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F   | TR_02 | 1    | 183  | 183 | 1    |      | 0.00 | -800.00 | 0.00 | 0.00 | 0.00 | 0.00 |

|   |       |      |      |     |      |      |      |         |      |      |      |      |
|---|-------|------|------|-----|------|------|------|---------|------|------|------|------|
| <b>load case:</b> TR_03<br>Form Traveller Weight - Stage-03 |       |      |      |     |      |      |      |         |      |      |      |      |
| Duration: PERMANENT   |       |      |      |     |      |      |      |         |      |      |      |      |
| LoadInfo: TR  |       |      |      |     |      |      |      |         |      |      |      |      |
| <b>Loads:</b>   |       |      |      |     |      |      |      |         |      |      |      |      |
|   | LSet  | Fact | From | To  | Step | proj | inp1 | inp2    | inp3 | inp4 | inp5 | inp6 |
| nodal point load  |       |      |      |     |      |      | Fx   | Fy      | Fz   | Mx   | My   | Mz   |
| F   | TR_03 | 1    | 136  | 136 | 1    |      | 0.00 | -800.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F   | TR_03 | 1    | 182  | 182 | 1    |      | 0.00 | -800.00 | 0.00 | 0.00 | 0.00 | 0.00 |

|   |       |      |      |     |      |      |      |         |      |      |      |      |
|---|-------|------|------|-----|------|------|------|---------|------|------|------|------|
| <b>load case:</b> TR_04<br>Form Traveller Weight - Stage-04 |       |      |      |     |      |      |      |         |      |      |      |      |
| Duration: PERMANENT   |       |      |      |     |      |      |      |         |      |      |      |      |
| LoadInfo: TR  |       |      |      |     |      |      |      |         |      |      |      |      |
| <b>Loads:</b>   |       |      |      |     |      |      |      |         |      |      |      |      |
|   | LSet  | Fact | From | To  | Step | proj | inp1 | inp2    | inp3 | inp4 | inp5 | inp6 |
| nodal point load  |       |      |      |     |      |      | Fx   | Fy      | Fz   | Mx   | My   | Mz   |
| F   | TR_04 | 1    | 137  | 137 | 1    |      | 0.00 | -800.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F   | TR_04 | 1    | 181  | 181 | 1    |      | 0.00 | -800.00 | 0.00 | 0.00 | 0.00 | 0.00 |

|   |       |      |      |     |      |      |      |         |      |      |      |      |
|---|-------|------|------|-----|------|------|------|---------|------|------|------|------|
| <b>load case:</b> TR_05<br>Form Traveller Weight - Stage-05 |       |      |      |     |      |      |      |         |      |      |      |      |
| Duration: PERMANENT   |       |      |      |     |      |      |      |         |      |      |      |      |
| LoadInfo: TR  |       |      |      |     |      |      |      |         |      |      |      |      |
| <b>Loads:</b>   |       |      |      |     |      |      |      |         |      |      |      |      |
|   | LSet  | Fact | From | To  | Step | proj | inp1 | inp2    | inp3 | inp4 | inp5 | inp6 |
| nodal point load  |       |      |      |     |      |      | Fx   | Fy      | Fz   | Mx   | My   | Mz   |
| F   | TR_05 | 1    | 138  | 138 | 1    |      | 0.00 | -800.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F   | TR_05 | 1    | 180  | 180 | 1    |      | 0.00 | -800.00 | 0.00 | 0.00 | 0.00 | 0.00 |

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|---|-------|------|------|-----|------|------|------|---------|------|------|------|------|
| <b>load case:</b> TR_06<br>Form Traveller Weight - Stage-06 |       |      |      |     |      |      |      |         |      |      |      |      |
| Duration: PERMANENT   |       |      |      |     |      |      |      |         |      |      |      |      |
| LoadInfo: TR  |       |      |      |     |      |      |      |         |      |      |      |      |
| <b>Loads:</b>   |       |      |      |     |      |      |      |         |      |      |      |      |
|   | LSet  | Fact | From | To  | Step | proj | inp1 | inp2    | inp3 | inp4 | inp5 | inp6 |
| nodal point load  |       |      |      |     |      |      | Fx   | Fy      | Fz   | Mx   | My   | Mz   |
| F   | TR_06 | 1    | 139  | 139 | 1    |      | 0.00 | -800.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F   | TR_06 | 1    | 179  | 179 | 1    |      | 0.00 | -800.00 | 0.00 | 0.00 | 0.00 | 0.00 |

|   |       |      |      |     |      |      |      |         |      |      |      |      |
|---|-------|------|------|-----|------|------|------|---------|------|------|------|------|
| <b>load case:</b> TR_07<br>Form Traveller Weight - Stage-07 |       |      |      |     |      |      |      |         |      |      |      |      |
| Duration: PERMANENT   |       |      |      |     |      |      |      |         |      |      |      |      |
| LoadInfo: TR  |       |      |      |     |      |      |      |         |      |      |      |      |
| <b>Loads:</b>   |       |      |      |     |      |      |      |         |      |      |      |      |
|   | LSet  | Fact | From | To  | Step | proj | inp1 | inp2    | inp3 | inp4 | inp5 | inp6 |
| nodal point load  |       |      |      |     |      |      | Fx   | Fy      | Fz   | Mx   | My   | Mz   |
| F   | TR_07 | 1    | 140  | 140 | 1    |      | 0.00 | -800.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F   | TR_07 | 1    | 178  | 178 | 1    |      | 0.00 | -800.00 | 0.00 | 0.00 | 0.00 | 0.00 |

|   |       |      |      |     |      |      |      |         |      |      |      |      |
|---|-------|------|------|-----|------|------|------|---------|------|------|------|------|
| <b>load case:</b> TR_08<br>Form Traveller Weight - Stage-08 |       |      |      |     |      |      |      |         |      |      |      |      |
| Duration: PERMANENT   |       |      |      |     |      |      |      |         |      |      |      |      |
| LoadInfo: TR  |       |      |      |     |      |      |      |         |      |      |      |      |
| <b>Loads:</b>   |       |      |      |     |      |      |      |         |      |      |      |      |
|   | LSet  | Fact | From | To  | Step | proj | inp1 | inp2    | inp3 | inp4 | inp5 | inp6 |
| nodal point load  |       |      |      |     |      |      | Fx   | Fy      | Fz   | Mx   | My   | Mz   |
| F   | TR_08 | 1    | 141  | 141 | 1    |      | 0.00 | -800.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F   | TR_08 | 1    | 177  | 177 | 1    |      | 0.00 | -800.00 | 0.00 | 0.00 | 0.00 | 0.00 |

|   |       |      |      |     |      |      |      |         |      |      |      |      |
|---|-------|------|------|-----|------|------|------|---------|------|------|------|------|
| <b>load case:</b> TR_09<br>Form Traveller Weight - Stage-09 |       |      |      |     |      |      |      |         |      |      |      |      |
| Duration: PERMANENT   |       |      |      |     |      |      |      |         |      |      |      |      |
| LoadInfo: TR  |       |      |      |     |      |      |      |         |      |      |      |      |
| <b>Loads:</b>   |       |      |      |     |      |      |      |         |      |      |      |      |
|   | LSet  | Fact | From | To  | Step | proj | inp1 | inp2    | inp3 | inp4 | inp5 | inp6 |
| nodal point load  |       |      |      |     |      |      | Fx   | Fy      | Fz   | Mx   | My   | Mz   |
| F   | TR_09 | 1    | 142  | 142 | 1    |      | 0.00 | -800.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F   | TR_09 | 1    | 176  | 176 | 1    |      | 0.00 | -800.00 | 0.00 | 0.00 | 0.00 | 0.00 |

|   |       |      |      |     |      |      |      |         |      |      |      |      |
|---|-------|------|------|-----|------|------|------|---------|------|------|------|------|
| <b>load case:</b> TR_10<br>Form Traveller Weight - Stage-10 |       |      |      |     |      |      |      |         |      |      |      |      |
| Duration: PERMANENT   |       |      |      |     |      |      |      |         |      |      |      |      |
| LoadInfo: TR  |       |      |      |     |      |      |      |         |      |      |      |      |
| <b>Loads:</b>   |       |      |      |     |      |      |      |         |      |      |      |      |
|   | LSet  | Fact | From | To  | Step | proj | inp1 | inp2    | inp3 | inp4 | inp5 | inp6 |
| nodal point load  |       |      |      |     |      |      | Fx   | Fy      | Fz   | Mx   | My   | Mz   |
| F   | TR_10 | 1    | 143  | 143 | 1    |      | 0.00 | -800.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F   | TR_10 | 1    | 175  | 175 | 1    |      | 0.00 | -800.00 | 0.00 | 0.00 | 0.00 | 0.00 |

Description: 5 Loads  
5.2 Load Cases

Project No.

Designer: VKS Infratech Management Pvt. Ltd.



RM Bridge Professional Engineering Software

project Arunachal Extradosed 63m+260m+63m

6/03/2022

|   |       |      |      |     |      |      |      |         |      |      |      |      |
|---|-------|------|------|-----|------|------|------|---------|------|------|------|------|
| <b>load case:</b> TR_11<br>Form Traveller Weight - Stage-11 |       |      |      |     |      |      |      |         |      |      |      |      |
| Duration: PERMANENT   |       |      |      |     |      |      |      |         |      |      |      |      |
| LoadInfo: TR  |       |      |      |     |      |      |      |         |      |      |      |      |
| <b>Loads:</b>   |       |      |      |     |      |      |      |         |      |      |      |      |
|   | LSet  | Fact | From | To  | Step | proj | inp1 | inp2    | inp3 | inp4 | inp5 | inp6 |
| nodal point load  |       |      |      |     |      |      | Fx   | Fy      | Fz   | Mx   | My   | Mz   |
| F   | TR_11 | 1    | 144  | 144 | 1    |      | 0.00 | -800.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F   | TR_11 | 1    | 174  | 174 | 1    |      | 0.00 | -800.00 | 0.00 | 0.00 | 0.00 | 0.00 |

|   |       |      |      |     |      |      |      |         |      |      |      |      |
|---|-------|------|------|-----|------|------|------|---------|------|------|------|------|
| <b>load case:</b> TR_12<br>Form Traveller Weight - Stage-12 |       |      |      |     |      |      |      |         |      |      |      |      |
| Duration: PERMANENT   |       |      |      |     |      |      |      |         |      |      |      |      |
| LoadInfo: TR  |       |      |      |     |      |      |      |         |      |      |      |      |
| <b>Loads:</b>   |       |      |      |     |      |      |      |         |      |      |      |      |
|   | LSet  | Fact | From | To  | Step | proj | inp1 | inp2    | inp3 | inp4 | inp5 | inp6 |
| nodal point load  |       |      |      |     |      |      | Fx   | Fy      | Fz   | Mx   | My   | Mz   |
| F   | TR_12 | 1    | 145  | 145 | 1    |      | 0.00 | -800.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F   | TR_12 | 1    | 173  | 173 | 1    |      | 0.00 | -800.00 | 0.00 | 0.00 | 0.00 | 0.00 |

|   |       |      |      |     |      |      |      |         |      |      |      |      |
|---|-------|------|------|-----|------|------|------|---------|------|------|------|------|
| <b>load case:</b> TR_13<br>Form Traveller Weight - Stage-13 |       |      |      |     |      |      |      |         |      |      |      |      |
| Duration: PERMANENT   |       |      |      |     |      |      |      |         |      |      |      |      |
| LoadInfo: TR  |       |      |      |     |      |      |      |         |      |      |      |      |
| <b>Loads:</b>   |       |      |      |     |      |      |      |         |      |      |      |      |
|   | LSet  | Fact | From | To  | Step | proj | inp1 | inp2    | inp3 | inp4 | inp5 | inp6 |
| nodal point load  |       |      |      |     |      |      | Fx   | Fy      | Fz   | Mx   | My   | Mz   |
| F   | TR_13 | 1    | 146  | 146 | 1    |      | 0.00 | -800.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F   | TR_13 | 1    | 172  | 172 | 1    |      | 0.00 | -800.00 | 0.00 | 0.00 | 0.00 | 0.00 |

|   |       |      |      |     |      |      |      |         |      |      |      |      |
|---|-------|------|------|-----|------|------|------|---------|------|------|------|------|
| <b>load case:</b> TR_14<br>Form Traveller Weight - Stage-14 |       |      |      |     |      |      |      |         |      |      |      |      |
| Duration: PERMANENT   |       |      |      |     |      |      |      |         |      |      |      |      |
| LoadInfo: TR  |       |      |      |     |      |      |      |         |      |      |      |      |
| <b>Loads:</b>   |       |      |      |     |      |      |      |         |      |      |      |      |
|   | LSet  | Fact | From | To  | Step | proj | inp1 | inp2    | inp3 | inp4 | inp5 | inp6 |
| nodal point load  |       |      |      |     |      |      | Fx   | Fy      | Fz   | Mx   | My   | Mz   |
| F   | TR_14 | 1    | 147  | 147 | 1    |      | 0.00 | -800.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F   | TR_14 | 1    | 171  | 171 | 1    |      | 0.00 | -800.00 | 0.00 | 0.00 | 0.00 | 0.00 |

|   |       |      |      |     |      |      |      |         |      |      |      |      |
|---|-------|------|------|-----|------|------|------|---------|------|------|------|------|
| <b>load case:</b> TR_15<br>Form Traveller Weight - Stage-15 |       |      |      |     |      |      |      |         |      |      |      |      |
| Duration: PERMANENT   |       |      |      |     |      |      |      |         |      |      |      |      |
| LoadInfo: TR  |       |      |      |     |      |      |      |         |      |      |      |      |
| <b>Loads:</b>   |       |      |      |     |      |      |      |         |      |      |      |      |
|   | LSet  | Fact | From | To  | Step | proj | inp1 | inp2    | inp3 | inp4 | inp5 | inp6 |
| nodal point load  |       |      |      |     |      |      | Fx   | Fy      | Fz   | Mx   | My   | Mz   |
| F   | TR_15 | 1    | 148  | 148 | 1    |      | 0.00 | -800.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F   | TR_15 | 1    | 170  | 170 | 1    |      | 0.00 | -800.00 | 0.00 | 0.00 | 0.00 | 0.00 |

Description: 5 Loads  
5.2 Load Cases

Project No.



|   |       |      |      |     |      |      |      |         |      |      |      |      |
|---|-------|------|------|-----|------|------|------|---------|------|------|------|------|
| <b>load case:</b> TR_16<br>Form Traveller Weight - Stage-16 |       |      |      |     |      |      |      |         |      |      |      |      |
| Duration: PERMANENT   |       |      |      |     |      |      |      |         |      |      |      |      |
| LoadInfo: TR  |       |      |      |     |      |      |      |         |      |      |      |      |
| <b>Loads:</b>   |       |      |      |     |      |      |      |         |      |      |      |      |
|   | LSet  | Fact | From | To  | Step | proj | inp1 | inp2    | inp3 | inp4 | inp5 | inp6 |
| nodal point load  |       |      |      |     |      |      | Fx   | Fy      | Fz   | Mx   | My   | Mz   |
| F   | TR_16 | 1    | 149  | 149 | 1    |      | 0.00 | -800.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F   | TR_16 | 1    | 169  | 169 | 1    |      | 0.00 | -800.00 | 0.00 | 0.00 | 0.00 | 0.00 |

|   |       |      |      |     |      |      |      |         |      |      |      |      |
|---|-------|------|------|-----|------|------|------|---------|------|------|------|------|
| <b>load case:</b> TR_17<br>Form Traveller Weight - Stage-17 |       |      |      |     |      |      |      |         |      |      |      |      |
| Duration: PERMANENT   |       |      |      |     |      |      |      |         |      |      |      |      |
| LoadInfo: TR  |       |      |      |     |      |      |      |         |      |      |      |      |
| <b>Loads:</b>   |       |      |      |     |      |      |      |         |      |      |      |      |
|   | LSet  | Fact | From | To  | Step | proj | inp1 | inp2    | inp3 | inp4 | inp5 | inp6 |
| nodal point load  |       |      |      |     |      |      | Fx   | Fy      | Fz   | Mx   | My   | Mz   |
| F   | TR_17 | 1    | 150  | 150 | 1    |      | 0.00 | -800.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F   | TR_17 | 1    | 168  | 168 | 1    |      | 0.00 | -800.00 | 0.00 | 0.00 | 0.00 | 0.00 |

|   |       |      |      |     |      |      |      |         |      |      |      |      |
|---|-------|------|------|-----|------|------|------|---------|------|------|------|------|
| <b>load case:</b> TR_18<br>Form Traveller Weight - Stage-18 |       |      |      |     |      |      |      |         |      |      |      |      |
| Duration: PERMANENT   |       |      |      |     |      |      |      |         |      |      |      |      |
| LoadInfo: TR  |       |      |      |     |      |      |      |         |      |      |      |      |
| <b>Loads:</b>   |       |      |      |     |      |      |      |         |      |      |      |      |
|   | LSet  | Fact | From | To  | Step | proj | inp1 | inp2    | inp3 | inp4 | inp5 | inp6 |
| nodal point load  |       |      |      |     |      |      | Fx   | Fy      | Fz   | Mx   | My   | Mz   |
| F   | TR_18 | 1    | 151  | 151 | 1    |      | 0.00 | -800.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F   | TR_18 | 1    | 167  | 167 | 1    |      | 0.00 | -800.00 | 0.00 | 0.00 | 0.00 | 0.00 |

|   |       |      |      |     |      |      |      |         |      |      |      |      |
|---|-------|------|------|-----|------|------|------|---------|------|------|------|------|
| <b>load case:</b> TR_19<br>Form Traveller Weight - Stage-19 |       |      |      |     |      |      |      |         |      |      |      |      |
| Duration: PERMANENT   |       |      |      |     |      |      |      |         |      |      |      |      |
| LoadInfo: TR  |       |      |      |     |      |      |      |         |      |      |      |      |
| <b>Loads:</b>   |       |      |      |     |      |      |      |         |      |      |      |      |
|   | LSet  | Fact | From | To  | Step | proj | inp1 | inp2    | inp3 | inp4 | inp5 | inp6 |
| nodal point load  |       |      |      |     |      |      | Fx   | Fy      | Fz   | Mx   | My   | Mz   |
| F   | TR_19 | 1    | 152  | 152 | 1    |      | 0.00 | -800.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F   | TR_19 | 1    | 166  | 166 | 1    |      | 0.00 | -800.00 | 0.00 | 0.00 | 0.00 | 0.00 |

|   |       |      |      |     |      |      |      |         |      |      |      |      |
|---|-------|------|------|-----|------|------|------|---------|------|------|------|------|
| <b>load case:</b> TR_20<br>Form Traveller Weight - Stage-20 |       |      |      |     |      |      |      |         |      |      |      |      |
| Duration: PERMANENT   |       |      |      |     |      |      |      |         |      |      |      |      |
| LoadInfo: TR  |       |      |      |     |      |      |      |         |      |      |      |      |
| <b>Loads:</b>   |       |      |      |     |      |      |      |         |      |      |      |      |
|   | LSet  | Fact | From | To  | Step | proj | inp1 | inp2    | inp3 | inp4 | inp5 | inp6 |
| nodal point load  |       |      |      |     |      |      | Fx   | Fy      | Fz   | Mx   | My   | Mz   |
| F   | TR_20 | 1    | 153  | 153 | 1    |      | 0.00 | -800.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F   | TR_20 | 1    | 165  | 165 | 1    |      | 0.00 | -800.00 | 0.00 | 0.00 | 0.00 | 0.00 |



|   |       |      |      |     |      |      |      |         |      |      |      |      |
|---|-------|------|------|-----|------|------|------|---------|------|------|------|------|
| <b>load case:</b> TR_21<br>Form Traveller Weight - Stage-21 |       |      |      |     |      |      |      |         |      |      |      |      |
| Duration: PERMANENT   |       |      |      |     |      |      |      |         |      |      |      |      |
| LoadInfo: TR  |       |      |      |     |      |      |      |         |      |      |      |      |
| <b>Loads:</b>   |       |      |      |     |      |      |      |         |      |      |      |      |
|   | LSet  | Fact | From | To  | Step | proj | inp1 | inp2    | inp3 | inp4 | inp5 | inp6 |
| nodal point load  |       |      |      |     |      |      | Fx   | Fy      | Fz   | Mx   | My   | Mz   |
| F   | TR_21 | 1    | 154  | 154 | 1    |      | 0.00 | -800.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F   | TR_21 | 1    | 164  | 164 | 1    |      | 0.00 | -800.00 | 0.00 | 0.00 | 0.00 | 0.00 |

|   |       |      |      |     |      |      |      |         |      |      |      |      |
|---|-------|------|------|-----|------|------|------|---------|------|------|------|------|
| <b>load case:</b> TR_22<br>Form Traveller Weight - Stage-22 |       |      |      |     |      |      |      |         |      |      |      |      |
| Duration: PERMANENT   |       |      |      |     |      |      |      |         |      |      |      |      |
| LoadInfo: TR  |       |      |      |     |      |      |      |         |      |      |      |      |
| <b>Loads:</b>   |       |      |      |     |      |      |      |         |      |      |      |      |
|   | LSet  | Fact | From | To  | Step | proj | inp1 | inp2    | inp3 | inp4 | inp5 | inp6 |
| nodal point load  |       |      |      |     |      |      | Fx   | Fy      | Fz   | Mx   | My   | Mz   |
| F   | TR_22 | 1    | 155  | 155 | 1    |      | 0.00 | -800.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F   | TR_22 | 1    | 163  | 163 | 1    |      | 0.00 | -800.00 | 0.00 | 0.00 | 0.00 | 0.00 |

|   |       |      |      |     |      |      |      |         |      |      |      |      |
|---|-------|------|------|-----|------|------|------|---------|------|------|------|------|
| <b>load case:</b> TR_23<br>Form Traveller Weight - Stage-23 |       |      |      |     |      |      |      |         |      |      |      |      |
| Duration: PERMANENT   |       |      |      |     |      |      |      |         |      |      |      |      |
| LoadInfo: TR  |       |      |      |     |      |      |      |         |      |      |      |      |
| <b>Loads:</b>   |       |      |      |     |      |      |      |         |      |      |      |      |
|   | LSet  | Fact | From | To  | Step | proj | inp1 | inp2    | inp3 | inp4 | inp5 | inp6 |
| nodal point load  |       |      |      |     |      |      | Fx   | Fy      | Fz   | Mx   | My   | Mz   |
| F   | TR_23 | 1    | 156  | 156 | 1    |      | 0.00 | -800.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F   | TR_23 | 1    | 162  | 162 | 1    |      | 0.00 | -800.00 | 0.00 | 0.00 | 0.00 | 0.00 |

|   |       |      |      |     |      |      |      |         |      |      |      |      |
|---|-------|------|------|-----|------|------|------|---------|------|------|------|------|
| <b>load case:</b> TR_24<br>Form Traveller Weight - Stage-24 |       |      |      |     |      |      |      |         |      |      |      |      |
| Duration: PERMANENT   |       |      |      |     |      |      |      |         |      |      |      |      |
| LoadInfo: TR  |       |      |      |     |      |      |      |         |      |      |      |      |
| <b>Loads:</b>   |       |      |      |     |      |      |      |         |      |      |      |      |
|   | LSet  | Fact | From | To  | Step | proj | inp1 | inp2    | inp3 | inp4 | inp5 | inp6 |
| nodal point load  |       |      |      |     |      |      | Fx   | Fy      | Fz   | Mx   | My   | Mz   |
| F   | TR_24 | 1    | 157  | 157 | 1    |      | 0.00 | -800.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F   | TR_24 | 1    | 161  | 161 | 1    |      | 0.00 | -800.00 | 0.00 | 0.00 | 0.00 | 0.00 |

|   |       |      |      |     |      |      |      |         |      |      |      |      |
|---|-------|------|------|-----|------|------|------|---------|------|------|------|------|
| <b>load case:</b> TR_25<br>Form Traveller Weight - Stage-25 |       |      |      |     |      |      |      |         |      |      |      |      |
| Duration: PERMANENT   |       |      |      |     |      |      |      |         |      |      |      |      |
| LoadInfo: TR  |       |      |      |     |      |      |      |         |      |      |      |      |
| <b>Loads:</b>   |       |      |      |     |      |      |      |         |      |      |      |      |
|   | LSet  | Fact | From | To  | Step | proj | inp1 | inp2    | inp3 | inp4 | inp5 | inp6 |
| nodal point load  |       |      |      |     |      |      | Fx   | Fy      | Fz   | Mx   | My   | Mz   |
| F   | TR_25 | 1    | 158  | 158 | 1    |      | 0.00 | -800.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F   | TR_25 | 1    | 160  | 160 | 1    |      | 0.00 | -800.00 | 0.00 | 0.00 | 0.00 | 0.00 |

## 5.2.3 Form Traveller Removal



|   |       |      |      |     |      |      |      |         |      |      |      |      |
|---|-------|------|------|-----|------|------|------|---------|------|------|------|------|
| <b>load case:</b> TR_00_R<br>Form Traveller Removal load - Stage-00 |       |      |      |     |      |      |      |         |      |      |      |      |
| Duration: PERMANENT   |       |      |      |     |      |      |      |         |      |      |      |      |
| LoadInfo: TR  |       |      |      |     |      |      |      |         |      |      |      |      |
| <b>Loads:</b>   |       |      |      |     |      |      |      |         |      |      |      |      |
|   | LSet  | Fact | From | To  | Step | proj | inp1 | inp2    | inp3 | inp4 | inp5 | inp6 |
| nodal point load  |       |      |      |     |      |      | Fx   | Fy      | Fz   | Mx   | My   | Mz   |
| F   | TR_00 | -1   | 133  | 133 | 1    |      | 0.00 | -800.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F   | TR_00 | -1   | 185  | 185 | 1    |      | 0.00 | -800.00 | 0.00 | 0.00 | 0.00 | 0.00 |

|   |       |      |      |     |      |      |      |         |      |      |      |      |
|---|-------|------|------|-----|------|------|------|---------|------|------|------|------|
| <b>load case:</b> TR_01_R<br>Form Traveller Removal load - Stage-01 |       |      |      |     |      |      |      |         |      |      |      |      |
| Duration: PERMANENT   |       |      |      |     |      |      |      |         |      |      |      |      |
| LoadInfo: TR  |       |      |      |     |      |      |      |         |      |      |      |      |
| <b>Loads:</b>   |       |      |      |     |      |      |      |         |      |      |      |      |
|   | LSet  | Fact | From | To  | Step | proj | inp1 | inp2    | inp3 | inp4 | inp5 | inp6 |
| nodal point load  |       |      |      |     |      |      | Fx   | Fy      | Fz   | Mx   | My   | Mz   |
| F   | TR_01 | -1   | 134  | 134 | 1    |      | 0.00 | -800.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F   | TR_01 | -1   | 184  | 184 | 1    |      | 0.00 | -800.00 | 0.00 | 0.00 | 0.00 | 0.00 |

|   |       |      |      |     |      |      |      |         |      |      |      |      |
|---|-------|------|------|-----|------|------|------|---------|------|------|------|------|
| <b>load case:</b> TR_02_R<br>Form Traveller Removal load - Stage-02 |       |      |      |     |      |      |      |         |      |      |      |      |
| Duration: PERMANENT   |       |      |      |     |      |      |      |         |      |      |      |      |
| LoadInfo: TR  |       |      |      |     |      |      |      |         |      |      |      |      |
| <b>Loads:</b>   |       |      |      |     |      |      |      |         |      |      |      |      |
|   | LSet  | Fact | From | To  | Step | proj | inp1 | inp2    | inp3 | inp4 | inp5 | inp6 |
| nodal point load  |       |      |      |     |      |      | Fx   | Fy      | Fz   | Mx   | My   | Mz   |
| F   | TR_02 | -1   | 135  | 135 | 1    |      | 0.00 | -800.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F   | TR_02 | -1   | 183  | 183 | 1    |      | 0.00 | -800.00 | 0.00 | 0.00 | 0.00 | 0.00 |

|   |       |      |      |     |      |      |      |         |      |      |      |      |
|---|-------|------|------|-----|------|------|------|---------|------|------|------|------|
| <b>load case:</b> TR_03_R<br>Form Traveller Removal load - Stage-03 |       |      |      |     |      |      |      |         |      |      |      |      |
| Duration: PERMANENT   |       |      |      |     |      |      |      |         |      |      |      |      |
| LoadInfo: TR  |       |      |      |     |      |      |      |         |      |      |      |      |
| <b>Loads:</b>   |       |      |      |     |      |      |      |         |      |      |      |      |
|   | LSet  | Fact | From | To  | Step | proj | inp1 | inp2    | inp3 | inp4 | inp5 | inp6 |
| nodal point load  |       |      |      |     |      |      | Fx   | Fy      | Fz   | Mx   | My   | Mz   |
| F   | TR_03 | -1   | 136  | 136 | 1    |      | 0.00 | -800.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F   | TR_03 | -1   | 182  | 182 | 1    |      | 0.00 | -800.00 | 0.00 | 0.00 | 0.00 | 0.00 |

|   |       |      |      |     |      |      |      |         |      |      |      |      |
|---|-------|------|------|-----|------|------|------|---------|------|------|------|------|
| <b>load case:</b> TR_04_R<br>Form Traveller Removal load - Stage-04 |       |      |      |     |      |      |      |         |      |      |      |      |
| Duration: PERMANENT   |       |      |      |     |      |      |      |         |      |      |      |      |
| LoadInfo: TR  |       |      |      |     |      |      |      |         |      |      |      |      |
| <b>Loads:</b>   |       |      |      |     |      |      |      |         |      |      |      |      |
|   | LSet  | Fact | From | To  | Step | proj | inp1 | inp2    | inp3 | inp4 | inp5 | inp6 |
| nodal point load  |       |      |      |     |      |      | Fx   | Fy      | Fz   | Mx   | My   | Mz   |
| F   | TR_04 | -1   | 137  | 137 | 1    |      | 0.00 | -800.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F   | TR_04 | -1   | 181  | 181 | 1    |      | 0.00 | -800.00 | 0.00 | 0.00 | 0.00 | 0.00 |





|   |       |      |      |     |      |      |      |         |      |      |      |      |
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| <b>load case:</b> TR_05_R<br>Form Traveller Removal load - Stage-05 |       |      |      |     |      |      |      |         |      |      |      |      |
| Duration: PERMANENT   |       |      |      |     |      |      |      |         |      |      |      |      |
| LoadInfo: TR  |       |      |      |     |      |      |      |         |      |      |      |      |
| <b>Loads:</b>   |       |      |      |     |      |      |      |         |      |      |      |      |
|   | LSet  | Fact | From | To  | Step | proj | inp1 | inp2    | inp3 | inp4 | inp5 | inp6 |
| nodal point load  |       |      |      |     |      |      | Fx   | Fy      | Fz   | Mx   | My   | Mz   |
| F   | TR_05 | -1   | 138  | 138 | 1    |      | 0.00 | -800.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F   | TR_05 | -1   | 180  | 180 | 1    |      | 0.00 | -800.00 | 0.00 | 0.00 | 0.00 | 0.00 |

|   |       |      |      |     |      |      |      |         |      |      |      |      |
|---|-------|------|------|-----|------|------|------|---------|------|------|------|------|
| <b>load case:</b> TR_06_R<br>Form Traveller Removal load - Stage-06 |       |      |      |     |      |      |      |         |      |      |      |      |
| Duration: PERMANENT   |       |      |      |     |      |      |      |         |      |      |      |      |
| LoadInfo: TR  |       |      |      |     |      |      |      |         |      |      |      |      |
| <b>Loads:</b>   |       |      |      |     |      |      |      |         |      |      |      |      |
|   | LSet  | Fact | From | To  | Step | proj | inp1 | inp2    | inp3 | inp4 | inp5 | inp6 |
| nodal point load  |       |      |      |     |      |      | Fx   | Fy      | Fz   | Mx   | My   | Mz   |
| F   | TR_06 | -1   | 139  | 139 | 1    |      | 0.00 | -800.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F   | TR_06 | -1   | 179  | 179 | 1    |      | 0.00 | -800.00 | 0.00 | 0.00 | 0.00 | 0.00 |

|   |       |      |      |     |      |      |      |         |      |      |      |      |
|---|-------|------|------|-----|------|------|------|---------|------|------|------|------|
| <b>load case:</b> TR_07_R<br>Form Traveller Removal load - Stage-07 |       |      |      |     |      |      |      |         |      |      |      |      |
| Duration: PERMANENT   |       |      |      |     |      |      |      |         |      |      |      |      |
| LoadInfo: TR  |       |      |      |     |      |      |      |         |      |      |      |      |
| <b>Loads:</b>   |       |      |      |     |      |      |      |         |      |      |      |      |
|   | LSet  | Fact | From | To  | Step | proj | inp1 | inp2    | inp3 | inp4 | inp5 | inp6 |
| nodal point load  |       |      |      |     |      |      | Fx   | Fy      | Fz   | Mx   | My   | Mz   |
| F   | TR_07 | -1   | 140  | 140 | 1    |      | 0.00 | -800.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F   | TR_07 | -1   | 178  | 178 | 1    |      | 0.00 | -800.00 | 0.00 | 0.00 | 0.00 | 0.00 |

|   |       |      |      |     |      |      |      |         |      |      |      |      |
|---|-------|------|------|-----|------|------|------|---------|------|------|------|------|
| <b>load case:</b> TR_08_R<br>Form Traveller Removal load - Stage-08 |       |      |      |     |      |      |      |         |      |      |      |      |
| Duration: PERMANENT   |       |      |      |     |      |      |      |         |      |      |      |      |
| LoadInfo: TR  |       |      |      |     |      |      |      |         |      |      |      |      |
| <b>Loads:</b>   |       |      |      |     |      |      |      |         |      |      |      |      |
|   | LSet  | Fact | From | To  | Step | proj | inp1 | inp2    | inp3 | inp4 | inp5 | inp6 |
| nodal point load  |       |      |      |     |      |      | Fx   | Fy      | Fz   | Mx   | My   | Mz   |
| F   | TR_08 | -1   | 141  | 141 | 1    |      | 0.00 | -800.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F   | TR_08 | -1   | 177  | 177 | 1    |      | 0.00 | -800.00 | 0.00 | 0.00 | 0.00 | 0.00 |

|   |       |      |      |     |      |      |      |         |      |      |      |      |
|---|-------|------|------|-----|------|------|------|---------|------|------|------|------|
| <b>load case:</b> TR_09_R<br>Form Traveller Removal load - Stage-09 |       |      |      |     |      |      |      |         |      |      |      |      |
| Duration: PERMANENT   |       |      |      |     |      |      |      |         |      |      |      |      |
| LoadInfo: TR  |       |      |      |     |      |      |      |         |      |      |      |      |
| <b>Loads:</b>   |       |      |      |     |      |      |      |         |      |      |      |      |
|   | LSet  | Fact | From | To  | Step | proj | inp1 | inp2    | inp3 | inp4 | inp5 | inp6 |
| nodal point load  |       |      |      |     |      |      | Fx   | Fy      | Fz   | Mx   | My   | Mz   |
| F   | TR_09 | -1   | 142  | 142 | 1    |      | 0.00 | -800.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F   | TR_09 | -1   | 176  | 176 | 1    |      | 0.00 | -800.00 | 0.00 | 0.00 | 0.00 | 0.00 |



|   |       |      |      |     |      |      |      |         |      |      |      |      |
|---|-------|------|------|-----|------|------|------|---------|------|------|------|------|
| <b>load case:</b> TR_10_R<br>Form Traveller Removal load - Stage-10 |       |      |      |     |      |      |      |         |      |      |      |      |
| Duration: PERMANENT   |       |      |      |     |      |      |      |         |      |      |      |      |
| LoadInfo: TR  |       |      |      |     |      |      |      |         |      |      |      |      |
| <b>Loads:</b>   |       |      |      |     |      |      |      |         |      |      |      |      |
|   | LSet  | Fact | From | To  | Step | proj | inp1 | inp2    | inp3 | inp4 | inp5 | inp6 |
| nodal point load  |       |      |      |     |      |      | Fx   | Fy      | Fz   | Mx   | My   | Mz   |
| F   | TR_10 | -1   | 143  | 143 | 1    |      | 0.00 | -800.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F   | TR_10 | -1   | 175  | 175 | 1    |      | 0.00 | -800.00 | 0.00 | 0.00 | 0.00 | 0.00 |

|   |       |      |      |     |      |      |      |         |      |      |      |      |
|---|-------|------|------|-----|------|------|------|---------|------|------|------|------|
| <b>load case:</b> TR_11_R<br>Form Traveller Removal load - Stage-11 |       |      |      |     |      |      |      |         |      |      |      |      |
| Duration: PERMANENT   |       |      |      |     |      |      |      |         |      |      |      |      |
| LoadInfo: TR  |       |      |      |     |      |      |      |         |      |      |      |      |
| <b>Loads:</b>   |       |      |      |     |      |      |      |         |      |      |      |      |
|   | LSet  | Fact | From | To  | Step | proj | inp1 | inp2    | inp3 | inp4 | inp5 | inp6 |
| nodal point load  |       |      |      |     |      |      | Fx   | Fy      | Fz   | Mx   | My   | Mz   |
| F   | TR_11 | -1   | 144  | 144 | 1    |      | 0.00 | -800.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F   | TR_11 | -1   | 174  | 174 | 1    |      | 0.00 | -800.00 | 0.00 | 0.00 | 0.00 | 0.00 |

|   |       |      |      |     |      |      |      |         |      |      |      |      |
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| <b>load case:</b> TR_12_R<br>Form Traveller Removal load - Stage-12 |       |      |      |     |      |      |      |         |      |      |      |      |
| Duration: PERMANENT   |       |      |      |     |      |      |      |         |      |      |      |      |
| LoadInfo: TR  |       |      |      |     |      |      |      |         |      |      |      |      |
| <b>Loads:</b>   |       |      |      |     |      |      |      |         |      |      |      |      |
|   | LSet  | Fact | From | To  | Step | proj | inp1 | inp2    | inp3 | inp4 | inp5 | inp6 |
| nodal point load  |       |      |      |     |      |      | Fx   | Fy      | Fz   | Mx   | My   | Mz   |
| F   | TR_12 | -1   | 145  | 145 | 1    |      | 0.00 | -800.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F   | TR_12 | -1   | 173  | 173 | 1    |      | 0.00 | -800.00 | 0.00 | 0.00 | 0.00 | 0.00 |

|   |       |      |      |     |      |      |      |         |      |      |      |      |
|---|-------|------|------|-----|------|------|------|---------|------|------|------|------|
| <b>load case:</b> TR_13_R<br>Form Traveller Removal load - Stage-13 |       |      |      |     |      |      |      |         |      |      |      |      |
| Duration: PERMANENT   |       |      |      |     |      |      |      |         |      |      |      |      |
| LoadInfo: TR  |       |      |      |     |      |      |      |         |      |      |      |      |
| <b>Loads:</b>   |       |      |      |     |      |      |      |         |      |      |      |      |
|   | LSet  | Fact | From | To  | Step | proj | inp1 | inp2    | inp3 | inp4 | inp5 | inp6 |
| nodal point load  |       |      |      |     |      |      | Fx   | Fy      | Fz   | Mx   | My   | Mz   |
| F   | TR_13 | -1   | 146  | 146 | 1    |      | 0.00 | -800.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F   | TR_13 | -1   | 172  | 172 | 1    |      | 0.00 | -800.00 | 0.00 | 0.00 | 0.00 | 0.00 |

|   |       |      |      |     |      |      |      |         |      |      |      |      |
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| <b>load case:</b> TR_14_R<br>Form Traveller Removal load - Stage-14 |       |      |      |     |      |      |      |         |      |      |      |      |
| Duration: PERMANENT   |       |      |      |     |      |      |      |         |      |      |      |      |
| LoadInfo: TR  |       |      |      |     |      |      |      |         |      |      |      |      |
| <b>Loads:</b>   |       |      |      |     |      |      |      |         |      |      |      |      |
|   | LSet  | Fact | From | To  | Step | proj | inp1 | inp2    | inp3 | inp4 | inp5 | inp6 |
| nodal point load  |       |      |      |     |      |      | Fx   | Fy      | Fz   | Mx   | My   | Mz   |
| F   | TR_14 | -1   | 147  | 147 | 1    |      | 0.00 | -800.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F   | TR_14 | -1   | 171  | 171 | 1    |      | 0.00 | -800.00 | 0.00 | 0.00 | 0.00 | 0.00 |



|   |       |      |      |     |      |      |      |         |      |      |      |      |
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| <b>load case:</b> TR_15_R<br>Form Traveller Removal load - Stage-15 |       |      |      |     |      |      |      |         |      |      |      |      |
| Duration: PERMANENT   |       |      |      |     |      |      |      |         |      |      |      |      |
| LoadInfo: TR  |       |      |      |     |      |      |      |         |      |      |      |      |
| <b>Loads:</b>   |       |      |      |     |      |      |      |         |      |      |      |      |
|   | LSet  | Fact | From | To  | Step | proj | inp1 | inp2    | inp3 | inp4 | inp5 | inp6 |
| nodal point load  |       |      |      |     |      |      | Fx   | Fy      | Fz   | Mx   | My   | Mz   |
| F   | TR_15 | -1   | 148  | 148 | 1    |      | 0.00 | -800.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F   | TR_15 | -1   | 170  | 170 | 1    |      | 0.00 | -800.00 | 0.00 | 0.00 | 0.00 | 0.00 |

|   |       |      |      |     |      |      |      |         |      |      |      |      |
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| <b>load case:</b> TR_16_R<br>Form Traveller Removal load - Stage-16 |       |      |      |     |      |      |      |         |      |      |      |      |
| Duration: PERMANENT   |       |      |      |     |      |      |      |         |      |      |      |      |
| LoadInfo: TR  |       |      |      |     |      |      |      |         |      |      |      |      |
| <b>Loads:</b>   |       |      |      |     |      |      |      |         |      |      |      |      |
|   | LSet  | Fact | From | To  | Step | proj | inp1 | inp2    | inp3 | inp4 | inp5 | inp6 |
| nodal point load  |       |      |      |     |      |      | Fx   | Fy      | Fz   | Mx   | My   | Mz   |
| F   | TR_16 | -1   | 149  | 149 | 1    |      | 0.00 | -800.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F   | TR_16 | -1   | 169  | 169 | 1    |      | 0.00 | -800.00 | 0.00 | 0.00 | 0.00 | 0.00 |

|   |       |      |      |     |      |      |      |         |      |      |      |      |
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| <b>load case:</b> TR_17_R<br>Form Traveller Removal load - Stage-17 |       |      |      |     |      |      |      |         |      |      |      |      |
| Duration: PERMANENT   |       |      |      |     |      |      |      |         |      |      |      |      |
| LoadInfo: TR  |       |      |      |     |      |      |      |         |      |      |      |      |
| <b>Loads:</b>   |       |      |      |     |      |      |      |         |      |      |      |      |
|   | LSet  | Fact | From | To  | Step | proj | inp1 | inp2    | inp3 | inp4 | inp5 | inp6 |
| nodal point load  |       |      |      |     |      |      | Fx   | Fy      | Fz   | Mx   | My   | Mz   |
| F   | TR_17 | -1   | 150  | 150 | 1    |      | 0.00 | -800.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F   | TR_17 | -1   | 168  | 168 | 1    |      | 0.00 | -800.00 | 0.00 | 0.00 | 0.00 | 0.00 |

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| <b>load case:</b> TR_18_R<br>Form Traveller Removal load - Stage-18 |       |      |      |     |      |      |      |         |      |      |      |      |
| Duration: PERMANENT   |       |      |      |     |      |      |      |         |      |      |      |      |
| LoadInfo: TR  |       |      |      |     |      |      |      |         |      |      |      |      |
| <b>Loads:</b>   |       |      |      |     |      |      |      |         |      |      |      |      |
|   | LSet  | Fact | From | To  | Step | proj | inp1 | inp2    | inp3 | inp4 | inp5 | inp6 |
| nodal point load  |       |      |      |     |      |      | Fx   | Fy      | Fz   | Mx   | My   | Mz   |
| F   | TR_18 | -1   | 151  | 151 | 1    |      | 0.00 | -800.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F   | TR_18 | -1   | 167  | 167 | 1    |      | 0.00 | -800.00 | 0.00 | 0.00 | 0.00 | 0.00 |

|   |       |      |      |     |      |      |      |         |      |      |      |      |
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| <b>load case:</b> TR_19_R<br>Form Traveller Removal load - Stage-19 |       |      |      |     |      |      |      |         |      |      |      |      |
| Duration: PERMANENT   |       |      |      |     |      |      |      |         |      |      |      |      |
| LoadInfo: TR  |       |      |      |     |      |      |      |         |      |      |      |      |
| <b>Loads:</b>   |       |      |      |     |      |      |      |         |      |      |      |      |
|   | LSet  | Fact | From | To  | Step | proj | inp1 | inp2    | inp3 | inp4 | inp5 | inp6 |
| nodal point load  |       |      |      |     |      |      | Fx   | Fy      | Fz   | Mx   | My   | Mz   |
| F   | TR_19 | -1   | 152  | 152 | 1    |      | 0.00 | -800.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F   | TR_19 | -1   | 166  | 166 | 1    |      | 0.00 | -800.00 | 0.00 | 0.00 | 0.00 | 0.00 |



|   |       |      |      |     |      |      |      |         |      |      |      |      |
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| <b>load case:</b> TR_20_R<br>Form Traveller Removal load - Stage-20 |       |      |      |     |      |      |      |         |      |      |      |      |
| Duration: PERMANENT   |       |      |      |     |      |      |      |         |      |      |      |      |
| LoadInfo: TR  |       |      |      |     |      |      |      |         |      |      |      |      |
| <b>Loads:</b>   |       |      |      |     |      |      |      |         |      |      |      |      |
|   | LSet  | Fact | From | To  | Step | proj | inp1 | inp2    | inp3 | inp4 | inp5 | inp6 |
| nodal point load  |       |      |      |     |      |      | Fx   | Fy      | Fz   | Mx   | My   | Mz   |
| F   | TR 20 | -1   | 153  | 153 | 1    |      | 0.00 | -800.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F   | TR 20 | -1   | 165  | 165 | 1    |      | 0.00 | -800.00 | 0.00 | 0.00 | 0.00 | 0.00 |

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| <b>load case:</b> TR_21_R<br>Form Traveller Removal load - Stage-21 |       |      |      |     |      |      |      |         |      |      |      |      |
| Duration: PERMANENT   |       |      |      |     |      |      |      |         |      |      |      |      |
| LoadInfo: TR  |       |      |      |     |      |      |      |         |      |      |      |      |
| <b>Loads:</b>   |       |      |      |     |      |      |      |         |      |      |      |      |
|   | LSet  | Fact | From | To  | Step | proj | inp1 | inp2    | inp3 | inp4 | inp5 | inp6 |
| nodal point load  |       |      |      |     |      |      | Fx   | Fy      | Fz   | Mx   | My   | Mz   |
| F   | TR 21 | -1   | 154  | 154 | 1    |      | 0.00 | -800.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F   | TR 21 | -1   | 164  | 164 | 1    |      | 0.00 | -800.00 | 0.00 | 0.00 | 0.00 | 0.00 |

|   |       |      |      |     |      |      |      |         |      |      |      |      |
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| <b>load case:</b> TR_22_R<br>Form Traveller Removal load - Stage-22 |       |      |      |     |      |      |      |         |      |      |      |      |
| Duration: PERMANENT   |       |      |      |     |      |      |      |         |      |      |      |      |
| LoadInfo: TR  |       |      |      |     |      |      |      |         |      |      |      |      |
| <b>Loads:</b>   |       |      |      |     |      |      |      |         |      |      |      |      |
|   | LSet  | Fact | From | To  | Step | proj | inp1 | inp2    | inp3 | inp4 | inp5 | inp6 |
| nodal point load  |       |      |      |     |      |      | Fx   | Fy      | Fz   | Mx   | My   | Mz   |
| F   | TR 22 | -1   | 155  | 155 | 1    |      | 0.00 | -800.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F   | TR 22 | -1   | 163  | 163 | 1    |      | 0.00 | -800.00 | 0.00 | 0.00 | 0.00 | 0.00 |

|   |       |      |      |     |      |      |      |         |      |      |      |      |
|---|-------|------|------|-----|------|------|------|---------|------|------|------|------|
| <b>load case:</b> TR_23_R<br>Form Traveller Removal load - Stage-23 |       |      |      |     |      |      |      |         |      |      |      |      |
| Duration: PERMANENT   |       |      |      |     |      |      |      |         |      |      |      |      |
| LoadInfo: TR  |       |      |      |     |      |      |      |         |      |      |      |      |
| <b>Loads:</b>   |       |      |      |     |      |      |      |         |      |      |      |      |
|   | LSet  | Fact | From | To  | Step | proj | inp1 | inp2    | inp3 | inp4 | inp5 | inp6 |
| nodal point load  |       |      |      |     |      |      | Fx   | Fy      | Fz   | Mx   | My   | Mz   |
| F   | TR 23 | -1   | 156  | 156 | 1    |      | 0.00 | -800.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F   | TR 23 | -1   | 162  | 162 | 1    |      | 0.00 | -800.00 | 0.00 | 0.00 | 0.00 | 0.00 |

|   |       |      |      |     |      |      |      |         |      |      |      |      |
|---|-------|------|------|-----|------|------|------|---------|------|------|------|------|
| <b>load case:</b> TR_24_R<br>Form Traveller Removal load - Stage-24 |       |      |      |     |      |      |      |         |      |      |      |      |
| Duration: PERMANENT   |       |      |      |     |      |      |      |         |      |      |      |      |
| LoadInfo: TR  |       |      |      |     |      |      |      |         |      |      |      |      |
| <b>Loads:</b>   |       |      |      |     |      |      |      |         |      |      |      |      |
|   | LSet  | Fact | From | To  | Step | proj | inp1 | inp2    | inp3 | inp4 | inp5 | inp6 |
| nodal point load  |       |      |      |     |      |      | Fx   | Fy      | Fz   | Mx   | My   | Mz   |
| F   | TR 24 | -1   | 157  | 157 | 1    |      | 0.00 | -800.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F   | TR 24 | -1   | 161  | 161 | 1    |      | 0.00 | -800.00 | 0.00 | 0.00 | 0.00 | 0.00 |



|   |       |      |      |     |      |      |      |         |      |      |      |      |
|---|-------|------|------|-----|------|------|------|---------|------|------|------|------|
| <b>load case:</b> TR_25_R<br>Form Traveller Removal load - Stage-25 |       |      |      |     |      |      |      |         |      |      |      |      |
| Duration: PERMANENT   |       |      |      |     |      |      |      |         |      |      |      |      |
| LoadInfo: TR  |       |      |      |     |      |      |      |         |      |      |      |      |
| <b>Loads:</b>   |       |      |      |     |      |      |      |         |      |      |      |      |
|   | LSet  | Fact | From | To  | Step | proj | inp1 | inp2    | inp3 | inp4 | inp5 | inp6 |
| nodal point load  |       |      |      |     |      |      | Fx   | Fy      | Fz   | Mx   | My   | Mz   |
| F   | TR 25 | -1   | 158  | 158 | 1    |      | 0.00 | -800.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| F   | TR 25 | -1   | 160  | 160 | 1    |      | 0.00 | -800.00 | 0.00 | 0.00 | 0.00 | 0.00 |

## 5.2.4 Wet Concrete weight

|   |       |      |      |     |      |      |        |      |      |      |      |      |
|---|-------|------|------|-----|------|------|--------|------|------|------|------|------|
| <b>load case:</b> WC_00<br>Wet Concrete Weight - Stage-00 |       |      |      |     |      |      |        |      |      |      |      |      |
| Duration: PERMANENT                                       |       |      |      |     |      |      |        |      |      |      |      |      |
| LoadInfo: WC  |       |      |      |     |      |      |        |      |      |      |      |      |
| <b>Loads:</b>   |       |      |      |     |      |      |        |      |      |      |      |      |
|   | LSet  | Fact | From | To  | Step | proj | inp1   | inp2 | inp3 | inp4 | inp5 | inp6 |
| self weight as nodal point load (e.g. equipment load)     |       |      |      |     |      |      | Node   | Gam  | Ex   | Ey   | Ez   |      |
| FSY   | WC 00 | 1    | 133  | 133 | 1    |      | 133.00 | 0.00 | 0.00 | 0.00 | 0.00 |      |
| FSY   | WC 00 | 1    | 184  | 184 | 1    |      | 185.00 | 0.00 | 0.00 | 0.00 | 0.00 |      |

|   |       |      |      |     |      |      |        |      |      |      |      |      |
|---|-------|------|------|-----|------|------|--------|------|------|------|------|------|
| <b>load case:</b> WC_01<br>Wet Concrete Weight - Stage-01 |       |      |      |     |      |      |        |      |      |      |      |      |
| Duration: PERMANENT                                       |       |      |      |     |      |      |        |      |      |      |      |      |
| LoadInfo: WC  |       |      |      |     |      |      |        |      |      |      |      |      |
| <b>Loads:</b>   |       |      |      |     |      |      |        |      |      |      |      |      |
|   | LSet  | Fact | From | To  | Step | proj | inp1   | inp2 | inp3 | inp4 | inp5 | inp6 |
| self weight as nodal point load (e.g. equipment load)     |       |      |      |     |      |      | Node   | Gam  | Ex   | Ey   | Ez   |      |
| FSY   | WC 01 | 1    | 134  | 134 | 1    |      | 134.00 | 0.00 | 0.00 | 0.00 | 0.00 |      |
| FSY   | WC 01 | 1    | 183  | 183 | 1    |      | 184.00 | 0.00 | 0.00 | 0.00 | 0.00 |      |

|   |       |      |      |     |      |      |        |      |      |      |      |      |
|---|-------|------|------|-----|------|------|--------|------|------|------|------|------|
| <b>load case:</b> WC_02<br>Wet Concrete Weight - Stage-02 |       |      |      |     |      |      |        |      |      |      |      |      |
| Duration: PERMANENT                                       |       |      |      |     |      |      |        |      |      |      |      |      |
| LoadInfo: WC  |       |      |      |     |      |      |        |      |      |      |      |      |
| <b>Loads:</b>   |       |      |      |     |      |      |        |      |      |      |      |      |
|   | LSet  | Fact | From | To  | Step | proj | inp1   | inp2 | inp3 | inp4 | inp5 | inp6 |
| self weight as nodal point load (e.g. equipment load)     |       |      |      |     |      |      | Node   | Gam  | Ex   | Ey   | Ez   |      |
| FSY   | WC 02 | 1    | 135  | 135 | 1    |      | 135.00 | 0.00 | 0.00 | 0.00 | 0.00 |      |
| FSY   | WC 02 | 1    | 182  | 182 | 1    |      | 183.00 | 0.00 | 0.00 | 0.00 | 0.00 |      |

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|   |       |      |      |     |      |      |        |      |      |      |      |      |
|---|-------|------|------|-----|------|------|--------|------|------|------|------|------|
| <b>load case:</b> WC_03<br>Wet Concrete Weight - Stage-03 |       |      |      |     |      |      |        |      |      |      |      |      |
| Duration: PERMANENT                                       |       |      |      |     |      |      |        |      |      |      |      |      |
| LoadInfo: WC  |       |      |      |     |      |      |        |      |      |      |      |      |
| <b>Loads:</b>   |       |      |      |     |      |      |        |      |      |      |      |      |
|   | LSet  | Fact | From | To  | Step | proj | inp1   | inp2 | inp3 | inp4 | inp5 | inp6 |
| self weight as nodal point load (e.g. equipment load)     |       |      |      |     |      |      | Node   | Gam  | Ex   | Ey   | Ez   |      |
| FSY   | WC_03 | 1    | 136  | 136 | 1    |      | 136.00 | 0.00 | 0.00 | 0.00 | 0.00 |      |
| FSY   | WC_03 | 1    | 181  | 181 | 1    |      | 182.00 | 0.00 | 0.00 | 0.00 | 0.00 |      |

|   |       |      |      |     |      |      |        |      |      |      |      |      |
|---|-------|------|------|-----|------|------|--------|------|------|------|------|------|
| <b>load case:</b> WC_04<br>Wet Concrete Weight - Stage-04 |       |      |      |     |      |      |        |      |      |      |      |      |
| Duration: PERMANENT                                       |       |      |      |     |      |      |        |      |      |      |      |      |
| LoadInfo: WC  |       |      |      |     |      |      |        |      |      |      |      |      |
| <b>Loads:</b>   |       |      |      |     |      |      |        |      |      |      |      |      |
|   | LSet  | Fact | From | To  | Step | proj | inp1   | inp2 | inp3 | inp4 | inp5 | inp6 |
| self weight as nodal point load (e.g. equipment load)     |       |      |      |     |      |      | Node   | Gam  | Ex   | Ey   | Ez   |      |
| FSY   | WC_04 | 1    | 137  | 137 | 1    |      | 137.00 | 0.00 | 0.00 | 0.00 | 0.00 |      |
| FSY   | WC_04 | 1    | 180  | 180 | 1    |      | 181.00 | 0.00 | 0.00 | 0.00 | 0.00 |      |

|   |       |      |      |     |      |      |        |      |      |      |      |      |
|---|-------|------|------|-----|------|------|--------|------|------|------|------|------|
| <b>load case:</b> WC_05<br>Wet Concrete Weight - Stage-05 |       |      |      |     |      |      |        |      |      |      |      |      |
| Duration: PERMANENT                                       |       |      |      |     |      |      |        |      |      |      |      |      |
| LoadInfo: WC  |       |      |      |     |      |      |        |      |      |      |      |      |
| <b>Loads:</b>   |       |      |      |     |      |      |        |      |      |      |      |      |
|   | LSet  | Fact | From | To  | Step | proj | inp1   | inp2 | inp3 | inp4 | inp5 | inp6 |
| self weight as nodal point load (e.g. equipment load)     |       |      |      |     |      |      | Node   | Gam  | Ex   | Ey   | Ez   |      |
| FSY   | WC_05 | 1    | 138  | 138 | 1    |      | 138.00 | 0.00 | 0.00 | 0.00 | 0.00 |      |
| FSY   | WC_05 | 1    | 179  | 179 | 1    |      | 180.00 | 0.00 | 0.00 | 0.00 | 0.00 |      |

|   |       |      |      |     |      |      |        |      |      |      |      |      |
|---|-------|------|------|-----|------|------|--------|------|------|------|------|------|
| <b>load case:</b> WC_06<br>Wet Concrete Weight - Stage-06 |       |      |      |     |      |      |        |      |      |      |      |      |
| Duration: PERMANENT                                       |       |      |      |     |      |      |        |      |      |      |      |      |
| LoadInfo: WC  |       |      |      |     |      |      |        |      |      |      |      |      |
| <b>Loads:</b>   |       |      |      |     |      |      |        |      |      |      |      |      |
|   | LSet  | Fact | From | To  | Step | proj | inp1   | inp2 | inp3 | inp4 | inp5 | inp6 |
| self weight as nodal point load (e.g. equipment load)     |       |      |      |     |      |      | Node   | Gam  | Ex   | Ey   | Ez   |      |
| FSY   | WC_06 | 1    | 139  | 139 | 1    |      | 139.00 | 0.00 | 0.00 | 0.00 | 0.00 |      |
| FSY   | WC_06 | 1    | 178  | 178 | 1    |      | 179.00 | 0.00 | 0.00 | 0.00 | 0.00 |      |

|   |       |      |      |     |      |      |        |      |      |      |      |      |
|---|-------|------|------|-----|------|------|--------|------|------|------|------|------|
| <b>load case:</b> WC_07<br>Wet Concrete Weight - Stage-07 |       |      |      |     |      |      |        |      |      |      |      |      |
| Duration: PERMANENT                                       |       |      |      |     |      |      |        |      |      |      |      |      |
| LoadInfo: WC  |       |      |      |     |      |      |        |      |      |      |      |      |
| <b>Loads:</b>   |       |      |      |     |      |      |        |      |      |      |      |      |
|   | LSet  | Fact | From | To  | Step | proj | inp1   | inp2 | inp3 | inp4 | inp5 | inp6 |
| self weight as nodal point load (e.g. equipment load)     |       |      |      |     |      |      | Node   | Gam  | Ex   | Ey   | Ez   |      |
| FSY   | WC_07 | 1    | 140  | 140 | 1    |      | 140.00 | 0.00 | 0.00 | 0.00 | 0.00 |      |
| FSY   | WC_07 | 1    | 177  | 177 | 1    |      | 178.00 | 0.00 | 0.00 | 0.00 | 0.00 |      |

Description: 5 Loads  
5.2 Load Cases

Project No.

Designer: VKS Infratech Management Pvt. Ltd.



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|   |       |      |      |     |      |      |        |      |      |      |      |      |
|---|-------|------|------|-----|------|------|--------|------|------|------|------|------|
| <b>load case:</b> WC_08<br>Wet Concrete Weight - Stage-08 |       |      |      |     |      |      |        |      |      |      |      |      |
| Duration: PERMANENT                                       |       |      |      |     |      |      |        |      |      |      |      |      |
| LoadInfo: WC  |       |      |      |     |      |      |        |      |      |      |      |      |
| <b>Loads:</b>   |       |      |      |     |      |      |        |      |      |      |      |      |
|   | LSet  | Fact | From | To  | Step | proj | inp1   | inp2 | inp3 | inp4 | inp5 | inp6 |
| self weight as nodal point load (e.g. equipment load)     |       |      |      |     |      |      | Node   | Gam  | Ex   | Ey   | Ez   |      |
| FSY   | WC_08 | 1    | 141  | 141 | 1    |      | 141.00 | 0.00 | 0.00 | 0.00 | 0.00 |      |
| FSY   | WC_08 | 1    | 176  | 176 | 1    |      | 177.00 | 0.00 | 0.00 | 0.00 | 0.00 |      |

|   |       |      |      |     |      |      |        |      |      |      |      |      |
|---|-------|------|------|-----|------|------|--------|------|------|------|------|------|
| <b>load case:</b> WC_09<br>Wet Concrete Weight - Stage-09 |       |      |      |     |      |      |        |      |      |      |      |      |
| Duration: PERMANENT                                       |       |      |      |     |      |      |        |      |      |      |      |      |
| LoadInfo: WC  |       |      |      |     |      |      |        |      |      |      |      |      |
| <b>Loads:</b>   |       |      |      |     |      |      |        |      |      |      |      |      |
|   | LSet  | Fact | From | To  | Step | proj | inp1   | inp2 | inp3 | inp4 | inp5 | inp6 |
| self weight as nodal point load (e.g. equipment load)     |       |      |      |     |      |      | Node   | Gam  | Ex   | Ey   | Ez   |      |
| FSY   | WC_09 | 1    | 142  | 142 | 1    |      | 142.00 | 0.00 | 0.00 | 0.00 | 0.00 |      |
| FSY   | WC_09 | 1    | 175  | 175 | 1    |      | 176.00 | 0.00 | 0.00 | 0.00 | 0.00 |      |

|   |       |      |      |     |      |      |        |      |      |      |      |      |
|---|-------|------|------|-----|------|------|--------|------|------|------|------|------|
| <b>load case:</b> WC_10<br>Wet Concrete Weight - Stage-10 |       |      |      |     |      |      |        |      |      |      |      |      |
| Duration: PERMANENT                                       |       |      |      |     |      |      |        |      |      |      |      |      |
| LoadInfo: WC  |       |      |      |     |      |      |        |      |      |      |      |      |
| <b>Loads:</b>   |       |      |      |     |      |      |        |      |      |      |      |      |
|   | LSet  | Fact | From | To  | Step | proj | inp1   | inp2 | inp3 | inp4 | inp5 | inp6 |
| self weight as nodal point load (e.g. equipment load)     |       |      |      |     |      |      | Node   | Gam  | Ex   | Ey   | Ez   |      |
| FSY   | WC_10 | 1    | 143  | 143 | 1    |      | 143.00 | 0.00 | 0.00 | 0.00 | 0.00 |      |
| FSY   | WC_10 | 1    | 174  | 174 | 1    |      | 175.00 | 0.00 | 0.00 | 0.00 | 0.00 |      |

|   |       |      |      |     |      |      |        |      |      |      |      |      |
|---|-------|------|------|-----|------|------|--------|------|------|------|------|------|
| <b>load case:</b> WC_11<br>Wet Concrete Weight - Stage-11 |       |      |      |     |      |      |        |      |      |      |      |      |
| Duration: PERMANENT                                       |       |      |      |     |      |      |        |      |      |      |      |      |
| LoadInfo: WC  |       |      |      |     |      |      |        |      |      |      |      |      |
| <b>Loads:</b>   |       |      |      |     |      |      |        |      |      |      |      |      |
|   | LSet  | Fact | From | To  | Step | proj | inp1   | inp2 | inp3 | inp4 | inp5 | inp6 |
| self weight as nodal point load (e.g. equipment load)     |       |      |      |     |      |      | Node   | Gam  | Ex   | Ey   | Ez   |      |
| FSY   | WC_11 | 1    | 144  | 144 | 1    |      | 144.00 | 0.00 | 0.00 | 0.00 | 0.00 |      |
| FSY   | WC_11 | 1    | 173  | 173 | 1    |      | 174.00 | 0.00 | 0.00 | 0.00 | 0.00 |      |

|   |       |      |      |     |      |      |        |      |      |      |      |      |
|---|-------|------|------|-----|------|------|--------|------|------|------|------|------|
| <b>load case:</b> WC_12<br>Wet Concrete Weight - Stage-12 |       |      |      |     |      |      |        |      |      |      |      |      |
| Duration: PERMANENT                                       |       |      |      |     |      |      |        |      |      |      |      |      |
| LoadInfo: WC  |       |      |      |     |      |      |        |      |      |      |      |      |
| <b>Loads:</b>   |       |      |      |     |      |      |        |      |      |      |      |      |
|   | LSet  | Fact | From | To  | Step | proj | inp1   | inp2 | inp3 | inp4 | inp5 | inp6 |
| self weight as nodal point load (e.g. equipment load)     |       |      |      |     |      |      | Node   | Gam  | Ex   | Ey   | Ez   |      |
| FSY   | WC_12 | 1    | 145  | 145 | 1    |      | 145.00 | 0.00 | 0.00 | 0.00 | 0.00 |      |
| FSY   | WC_12 | 1    | 172  | 172 | 1    |      | 173.00 | 0.00 | 0.00 | 0.00 | 0.00 |      |

Description: 5 Loads  
5.2 Load Cases

Project No.





|   |       |      |      |     |      |      |        |      |      |      |      |      |
|---|-------|------|------|-----|------|------|--------|------|------|------|------|------|
| <b>load case:</b> WC_13<br>Wet Concrete Weight - Stage-13 |       |      |      |     |      |      |        |      |      |      |      |      |
| Duration: PERMANENT                                       |       |      |      |     |      |      |        |      |      |      |      |      |
| LoadInfo: WC  |       |      |      |     |      |      |        |      |      |      |      |      |
| <b>Loads:</b>   |       |      |      |     |      |      |        |      |      |      |      |      |
|   | LSet  | Fact | From | To  | Step | proj | inp1   | inp2 | inp3 | inp4 | inp5 | inp6 |
| self weight as nodal point load (e.g. equipment load)     |       |      |      |     |      |      | Node   | Gam  | Ex   | Ey   | Ez   |      |
| FSY   | WC 13 | 1    | 146  | 146 | 1    |      | 146.00 | 0.00 | 0.00 | 0.00 | 0.00 |      |
| FSY   | WC 13 | 1    | 171  | 171 | 1    |      | 172.00 | 0.00 | 0.00 | 0.00 | 0.00 |      |

|   |       |      |      |     |      |      |        |      |      |      |      |      |
|---|-------|------|------|-----|------|------|--------|------|------|------|------|------|
| <b>load case:</b> WC_14<br>Wet Concrete Weight - Stage-14 |       |      |      |     |      |      |        |      |      |      |      |      |
| Duration: PERMANENT                                       |       |      |      |     |      |      |        |      |      |      |      |      |
| LoadInfo: WC  |       |      |      |     |      |      |        |      |      |      |      |      |
| <b>Loads:</b>   |       |      |      |     |      |      |        |      |      |      |      |      |
|   | LSet  | Fact | From | To  | Step | proj | inp1   | inp2 | inp3 | inp4 | inp5 | inp6 |
| self weight as nodal point load (e.g. equipment load)     |       |      |      |     |      |      | Node   | Gam  | Ex   | Ey   | Ez   |      |
| FSY   | WC 14 | 1    | 147  | 147 | 1    |      | 147.00 | 0.00 | 0.00 | 0.00 | 0.00 |      |
| FSY   | WC 14 | 1    | 170  | 170 | 1    |      | 171.00 | 0.00 | 0.00 | 0.00 | 0.00 |      |

|   |       |      |      |     |      |      |        |      |      |      |      |      |
|---|-------|------|------|-----|------|------|--------|------|------|------|------|------|
| <b>load case:</b> WC_15<br>Wet Concrete Weight - Stage-15 |       |      |      |     |      |      |        |      |      |      |      |      |
| Duration: PERMANENT                                       |       |      |      |     |      |      |        |      |      |      |      |      |
| LoadInfo: WC  |       |      |      |     |      |      |        |      |      |      |      |      |
| <b>Loads:</b>   |       |      |      |     |      |      |        |      |      |      |      |      |
|   | LSet  | Fact | From | To  | Step | proj | inp1   | inp2 | inp3 | inp4 | inp5 | inp6 |
| self weight as nodal point load (e.g. equipment load)     |       |      |      |     |      |      | Node   | Gam  | Ex   | Ey   | Ez   |      |
| FSY   | WC 15 | 1    | 148  | 148 | 1    |      | 148.00 | 0.00 | 0.00 | 0.00 | 0.00 |      |
| FSY   | WC 15 | 1    | 169  | 169 | 1    |      | 170.00 | 0.00 | 0.00 | 0.00 | 0.00 |      |

|   |       |      |      |     |      |      |        |      |      |      |      |      |
|---|-------|------|------|-----|------|------|--------|------|------|------|------|------|
| <b>load case:</b> WC_16<br>Wet Concrete Weight - Stage-16 |       |      |      |     |      |      |        |      |      |      |      |      |
| Duration: PERMANENT                                       |       |      |      |     |      |      |        |      |      |      |      |      |
| LoadInfo: WC  |       |      |      |     |      |      |        |      |      |      |      |      |
| <b>Loads:</b>   |       |      |      |     |      |      |        |      |      |      |      |      |
|   | LSet  | Fact | From | To  | Step | proj | inp1   | inp2 | inp3 | inp4 | inp5 | inp6 |
| self weight as nodal point load (e.g. equipment load)     |       |      |      |     |      |      | Node   | Gam  | Ex   | Ey   | Ez   |      |
| FSY   | WC 16 | 1    | 149  | 149 | 1    |      | 149.00 | 0.00 | 0.00 | 0.00 | 0.00 |      |
| FSY   | WC 16 | 1    | 168  | 168 | 1    |      | 169.00 | 0.00 | 0.00 | 0.00 | 0.00 |      |

|   |       |      |      |     |      |      |        |      |      |      |      |      |
|---|-------|------|------|-----|------|------|--------|------|------|------|------|------|
| <b>load case:</b> WC_17<br>Wet Concrete Weight - Stage-17 |       |      |      |     |      |      |        |      |      |      |      |      |
| Duration: PERMANENT                                       |       |      |      |     |      |      |        |      |      |      |      |      |
| LoadInfo: WC  |       |      |      |     |      |      |        |      |      |      |      |      |
| <b>Loads:</b>   |       |      |      |     |      |      |        |      |      |      |      |      |
|   | LSet  | Fact | From | To  | Step | proj | inp1   | inp2 | inp3 | inp4 | inp5 | inp6 |
| self weight as nodal point load (e.g. equipment load)     |       |      |      |     |      |      | Node   | Gam  | Ex   | Ey   | Ez   |      |
| FSY   | WC 17 | 1    | 150  | 150 | 1    |      | 150.00 | 0.00 | 0.00 | 0.00 | 0.00 |      |
| FSY   | WC 17 | 1    | 167  | 167 | 1    |      | 168.00 | 0.00 | 0.00 | 0.00 | 0.00 |      |

Designer: VKS Infratech Management Pvt. Ltd.



RM Bridge Professional Engineering Software

project Arunachal Extradosed 63m+260m+63m

6/03/2022

|   |       |      |      |     |      |      |        |      |      |      |      |      |
|---|-------|------|------|-----|------|------|--------|------|------|------|------|------|
| <b>load case:</b> WC_18<br>Wet Concrete Weight - Stage-18 |       |      |      |     |      |      |        |      |      |      |      |      |
| Duration: PERMANENT                                       |       |      |      |     |      |      |        |      |      |      |      |      |
| LoadInfo: WC  |       |      |      |     |      |      |        |      |      |      |      |      |
| <b>Loads:</b>   |       |      |      |     |      |      |        |      |      |      |      |      |
|   | LSet  | Fact | From | To  | Step | proj | inp1   | inp2 | inp3 | inp4 | inp5 | inp6 |
| self weight as nodal point load (e.g. equipment load)     |       |      |      |     |      |      | Node   | Gam  | Ex   | Ey   | Ez   |      |
| FSY   | WC 18 | 1    | 151  | 151 | 1    |      | 151.00 | 0.00 | 0.00 | 0.00 | 0.00 |      |
| FSY   | WC 18 | 1    | 166  | 166 | 1    |      | 167.00 | 0.00 | 0.00 | 0.00 | 0.00 |      |

|   |       |      |      |     |      |      |        |      |      |      |      |      |
|---|-------|------|------|-----|------|------|--------|------|------|------|------|------|
| <b>load case:</b> WC_19<br>Wet Concrete Weight - Stage-19 |       |      |      |     |      |      |        |      |      |      |      |      |
| Duration: PERMANENT                                       |       |      |      |     |      |      |        |      |      |      |      |      |
| LoadInfo: WC  |       |      |      |     |      |      |        |      |      |      |      |      |
| <b>Loads:</b>   |       |      |      |     |      |      |        |      |      |      |      |      |
|   | LSet  | Fact | From | To  | Step | proj | inp1   | inp2 | inp3 | inp4 | inp5 | inp6 |
| self weight as nodal point load (e.g. equipment load)     |       |      |      |     |      |      | Node   | Gam  | Ex   | Ey   | Ez   |      |
| FSY   | WC 19 | 1    | 152  | 152 | 1    |      | 152.00 | 0.00 | 0.00 | 0.00 | 0.00 |      |
| FSY   | WC 19 | 1    | 165  | 165 | 1    |      | 166.00 | 0.00 | 0.00 | 0.00 | 0.00 |      |

|   |       |      |      |     |      |      |        |      |      |      |      |      |
|---|-------|------|------|-----|------|------|--------|------|------|------|------|------|
| <b>load case:</b> WC_20<br>Wet Concrete Weight - Stage-20 |       |      |      |     |      |      |        |      |      |      |      |      |
| Duration: PERMANENT                                       |       |      |      |     |      |      |        |      |      |      |      |      |
| LoadInfo: WC  |       |      |      |     |      |      |        |      |      |      |      |      |
| <b>Loads:</b>   |       |      |      |     |      |      |        |      |      |      |      |      |
|   | LSet  | Fact | From | To  | Step | proj | inp1   | inp2 | inp3 | inp4 | inp5 | inp6 |
| self weight as nodal point load (e.g. equipment load)     |       |      |      |     |      |      | Node   | Gam  | Ex   | Ey   | Ez   |      |
| FSY   | WC 20 | 1    | 153  | 153 | 1    |      | 153.00 | 0.00 | 0.00 | 0.00 | 0.00 |      |
| FSY   | WC 20 | 1    | 164  | 164 | 1    |      | 165.00 | 0.00 | 0.00 | 0.00 | 0.00 |      |

|   |       |      |      |     |      |      |        |      |      |      |      |      |
|---|-------|------|------|-----|------|------|--------|------|------|------|------|------|
| <b>load case:</b> WC_21<br>Wet Concrete Weight - Stage-21 |       |      |      |     |      |      |        |      |      |      |      |      |
| Duration: PERMANENT                                       |       |      |      |     |      |      |        |      |      |      |      |      |
| LoadInfo: WC  |       |      |      |     |      |      |        |      |      |      |      |      |
| <b>Loads:</b>   |       |      |      |     |      |      |        |      |      |      |      |      |
|   | LSet  | Fact | From | To  | Step | proj | inp1   | inp2 | inp3 | inp4 | inp5 | inp6 |
| self weight as nodal point load (e.g. equipment load)     |       |      |      |     |      |      | Node   | Gam  | Ex   | Ey   | Ez   |      |
| FSY   | WC 21 | 1    | 154  | 154 | 1    |      | 154.00 | 0.00 | 0.00 | 0.00 | 0.00 |      |
| FSY   | WC 21 | 1    | 163  | 163 | 1    |      | 164.00 | 0.00 | 0.00 | 0.00 | 0.00 |      |

|   |       |      |      |     |      |      |        |      |      |      |      |      |
|---|-------|------|------|-----|------|------|--------|------|------|------|------|------|
| <b>load case:</b> WC_22<br>Wet Concrete Weight - Stage-22 |       |      |      |     |      |      |        |      |      |      |      |      |
| Duration: PERMANENT                                       |       |      |      |     |      |      |        |      |      |      |      |      |
| LoadInfo: WC  |       |      |      |     |      |      |        |      |      |      |      |      |
| <b>Loads:</b>   |       |      |      |     |      |      |        |      |      |      |      |      |
|   | LSet  | Fact | From | To  | Step | proj | inp1   | inp2 | inp3 | inp4 | inp5 | inp6 |
| self weight as nodal point load (e.g. equipment load)     |       |      |      |     |      |      | Node   | Gam  | Ex   | Ey   | Ez   |      |
| FSY   | WC 22 | 1    | 155  | 155 | 1    |      | 155.00 | 0.00 | 0.00 | 0.00 | 0.00 |      |
| FSY   | WC 22 | 1    | 162  | 162 | 1    |      | 163.00 | 0.00 | 0.00 | 0.00 | 0.00 |      |

Description: 5 Loads  
5.2 Load Cases

Project No.



|   |       |      |      |     |      |      |        |      |      |      |      |      |
|---|-------|------|------|-----|------|------|--------|------|------|------|------|------|
| <b>load case:</b> WC_23<br>Wet Concrete Weight - Stage-23 |       |      |      |     |      |      |        |      |      |      |      |      |
| Duration: PERMANENT                                       |       |      |      |     |      |      |        |      |      |      |      |      |
| LoadInfo: WC  |       |      |      |     |      |      |        |      |      |      |      |      |
| <b>Loads:</b>   |       |      |      |     |      |      |        |      |      |      |      |      |
|   | LSet  | Fact | From | To  | Step | proj | inp1   | inp2 | inp3 | inp4 | inp5 | inp6 |
| self weight as nodal point load (e.g. equipment load)     |       |      |      |     |      |      | Node   | Gam  | Ex   | Ey   | Ez   |      |
| FSY   | WC 23 | 1    | 156  | 156 | 1    |      | 156.00 | 0.00 | 0.00 | 0.00 | 0.00 |      |
| FSY   | WC 23 | 1    | 161  | 161 | 1    |      | 162.00 | 0.00 | 0.00 | 0.00 | 0.00 |      |

|   |       |      |      |     |      |      |        |      |      |      |      |      |
|---|-------|------|------|-----|------|------|--------|------|------|------|------|------|
| <b>load case:</b> WC_24<br>Wet Concrete Weight - Stage-24 |       |      |      |     |      |      |        |      |      |      |      |      |
| Duration: PERMANENT                                       |       |      |      |     |      |      |        |      |      |      |      |      |
| LoadInfo: WC  |       |      |      |     |      |      |        |      |      |      |      |      |
| <b>Loads:</b>   |       |      |      |     |      |      |        |      |      |      |      |      |
|   | LSet  | Fact | From | To  | Step | proj | inp1   | inp2 | inp3 | inp4 | inp5 | inp6 |
| self weight as nodal point load (e.g. equipment load)     |       |      |      |     |      |      | Node   | Gam  | Ex   | Ey   | Ez   |      |
| FSY   | WC 24 | 1    | 157  | 157 | 1    |      | 157.00 | 0.00 | 0.00 | 0.00 | 0.00 |      |
| FSY   | WC 24 | 1    | 160  | 160 | 1    |      | 161.00 | 0.00 | 0.00 | 0.00 | 0.00 |      |

|   |       |      |      |     |      |      |        |      |      |      |      |      |
|---|-------|------|------|-----|------|------|--------|------|------|------|------|------|
| <b>load case:</b> WC_25<br>Wet Concrete Weight - Stage-25 |       |      |      |     |      |      |        |      |      |      |      |      |
| Duration: PERMANENT                                       |       |      |      |     |      |      |        |      |      |      |      |      |
| LoadInfo: WC  |       |      |      |     |      |      |        |      |      |      |      |      |
| <b>Loads:</b>   |       |      |      |     |      |      |        |      |      |      |      |      |
|   | LSet  | Fact | From | To  | Step | proj | inp1   | inp2 | inp3 | inp4 | inp5 | inp6 |
| self weight as nodal point load (e.g. equipment load)     |       |      |      |     |      |      | Node   | Gam  | Ex   | Ey   | Ez   |      |
| FSY   | WC 25 | 1    | 158  | 158 | 1    |      | 158.00 | 0.00 | 0.00 | 0.00 | 0.00 |      |
| FSY   | WC 25 | 1    | 159  | 159 | 1    |      | 160.00 | 0.00 | 0.00 | 0.00 | 0.00 |      |

## 5.2.5 Prestressing Force Application

|  |         |      |      |      |      |      |       |      |      |      |      |      |
|--|---------|------|------|------|------|------|-------|------|------|------|------|------|
| <b>load case:</b> PS_00<br>Prestressing Force Application - Stage-00 |         |      |      |      |      |      |       |      |      |      |      |      |
| Duration: PERMANENT  |         |      |      |      |      |      |       |      |      |      |      |      |
| LoadInfo: PS   |         |      |      |      |      |      |       |      |      |      |      |      |
| <b>Loads:</b>  |         |      |      |      |      |      |       |      |      |      |      |      |
|  | LSet    | Fact | From | To   | Step | proj | inp1  | inp2 | inp3 | inp4 | inp5 | inp6 |
| pre/post tensioning (increment force)                                |         |      |      |      |      |      | Force |      |      |      |      |      |
| TEND0  | no LSet |      | 1001 | 1007 | 1    | 0.00 |       |      |      |      |      |      |
| TEND0  | no LSet |      | 3001 | 3007 | 1    | 0.00 |       |      |      |      |      |      |



|  |         |      |      |     |      |       |      |      |      |      |      |      |
|--|---------|------|------|-----|------|-------|------|------|------|------|------|------|
| <b>load case:</b> PS_01<br>Prestressing Force Application - Stage-01 |         |      |      |     |      |       |      |      |      |      |      |      |
| Duration: PERMANENT  |         |      |      |     |      |       |      |      |      |      |      |      |
| LoadInfo: PS   |         |      |      |     |      |       |      |      |      |      |      |      |
| <b>Loads:</b>  |         |      |      |     |      |       |      |      |      |      |      |      |
|  | LSet    | Fact | From | To  | Step | proj  | inp1 | inp2 | inp3 | inp4 | inp5 | inp6 |
| pre/post tensioning (increment force)                                |         |      |      |     |      | Force |      |      |      |      |      |      |
| TEND0  | no LSet |      | 101  | 101 | 1    | 0.00  |      |      |      |      |      |      |
| TEND0  | no LSet |      | 201  | 201 | 1    | 0.00  |      |      |      |      |      |      |

|  |         |      |      |     |      |       |      |      |      |      |      |      |
|--|---------|------|------|-----|------|-------|------|------|------|------|------|------|
| <b>load case:</b> PS_02<br>Prestressing Force Application - Stage-02 |         |      |      |     |      |       |      |      |      |      |      |      |
| Duration: PERMANENT  |         |      |      |     |      |       |      |      |      |      |      |      |
| LoadInfo: PS   |         |      |      |     |      |       |      |      |      |      |      |      |
| <b>Loads:</b>  |         |      |      |     |      |       |      |      |      |      |      |      |
|  | LSet    | Fact | From | To  | Step | proj  | inp1 | inp2 | inp3 | inp4 | inp5 | inp6 |
| pre/post tensioning (increment force)                                |         |      |      |     |      | Force |      |      |      |      |      |      |
| TEND0  | no LSet |      | 102  | 102 | 1    | 0.00  |      |      |      |      |      |      |
| TEND0  | no LSet |      | 202  | 202 | 1    | 0.00  |      |      |      |      |      |      |

|  |         |      |      |     |      |       |      |      |      |      |      |      |
|--|---------|------|------|-----|------|-------|------|------|------|------|------|------|
| <b>load case:</b> PS_03<br>Prestressing Force Application - Stage-03 |         |      |      |     |      |       |      |      |      |      |      |      |
| Duration: PERMANENT  |         |      |      |     |      |       |      |      |      |      |      |      |
| LoadInfo: PS   |         |      |      |     |      |       |      |      |      |      |      |      |
| <b>Loads:</b>  |         |      |      |     |      |       |      |      |      |      |      |      |
|  | LSet    | Fact | From | To  | Step | proj  | inp1 | inp2 | inp3 | inp4 | inp5 | inp6 |
| pre/post tensioning (increment force)                                |         |      |      |     |      | Force |      |      |      |      |      |      |
| TEND0  | no LSet |      | 103  | 103 | 1    | 0.00  |      |      |      |      |      |      |
| TEND0  | no LSet |      | 203  | 203 | 1    | 0.00  |      |      |      |      |      |      |

|  |         |      |      |     |      |       |      |      |      |      |      |      |
|--|---------|------|------|-----|------|-------|------|------|------|------|------|------|
| <b>load case:</b> PS_04<br>Prestressing Force Application - Stage-04 |         |      |      |     |      |       |      |      |      |      |      |      |
| Duration: PERMANENT  |         |      |      |     |      |       |      |      |      |      |      |      |
| LoadInfo: PS   |         |      |      |     |      |       |      |      |      |      |      |      |
| <b>Loads:</b>  |         |      |      |     |      |       |      |      |      |      |      |      |
|  | LSet    | Fact | From | To  | Step | proj  | inp1 | inp2 | inp3 | inp4 | inp5 | inp6 |
| pre/post tensioning (increment force)                                |         |      |      |     |      | Force |      |      |      |      |      |      |
| TEND0  | no LSet |      | 104  | 104 | 1    | 0.00  |      |      |      |      |      |      |
| TEND0  | no LSet |      | 204  | 204 | 1    | 0.00  |      |      |      |      |      |      |

|  |         |      |      |     |      |       |      |      |      |      |      |      |
|--|---------|------|------|-----|------|-------|------|------|------|------|------|------|
| <b>load case:</b> PS_05<br>Prestressing Force Application - Stage-05 |         |      |      |     |      |       |      |      |      |      |      |      |
| Duration: PERMANENT  |         |      |      |     |      |       |      |      |      |      |      |      |
| LoadInfo: PS   |         |      |      |     |      |       |      |      |      |      |      |      |
| <b>Loads:</b>  |         |      |      |     |      |       |      |      |      |      |      |      |
|  | LSet    | Fact | From | To  | Step | proj  | inp1 | inp2 | inp3 | inp4 | inp5 | inp6 |
| pre/post tensioning (increment force)                                |         |      |      |     |      | Force |      |      |      |      |      |      |
| TEND0  | no LSet |      | 105  | 105 | 1    | 0.00  |      |      |      |      |      |      |
| TEND0  | no LSet |      | 205  | 205 | 1    | 0.00  |      |      |      |      |      |      |



|  |         |      |      |     |      |       |      |      |      |      |      |      |
|--|---------|------|------|-----|------|-------|------|------|------|------|------|------|
| <b>load case:</b> PS_06<br>Prestressing Force Application - Stage-06 |         |      |      |     |      |       |      |      |      |      |      |      |
| Duration: PERMANENT  |         |      |      |     |      |       |      |      |      |      |      |      |
| LoadInfo: PS   |         |      |      |     |      |       |      |      |      |      |      |      |
| <b>Loads:</b>  |         |      |      |     |      |       |      |      |      |      |      |      |
|  | LSet    | Fact | From | To  | Step | proj  | inp1 | inp2 | inp3 | inp4 | inp5 | inp6 |
| pre/post tensioning (increment force)                                |         |      |      |     |      | Force |      |      |      |      |      |      |
| TEND0  | no LSet |      | 106  | 106 | 1    | 0.00  |      |      |      |      |      |      |
| TEND0  | no LSet |      | 206  | 206 | 1    | 0.00  |      |      |      |      |      |      |

|  |         |      |      |     |      |       |      |      |      |      |      |      |
|--|---------|------|------|-----|------|-------|------|------|------|------|------|------|
| <b>load case:</b> PS_07<br>Prestressing Force Application - Stage-07 |         |      |      |     |      |       |      |      |      |      |      |      |
| Duration: PERMANENT  |         |      |      |     |      |       |      |      |      |      |      |      |
| LoadInfo: PS   |         |      |      |     |      |       |      |      |      |      |      |      |
| <b>Loads:</b>  |         |      |      |     |      |       |      |      |      |      |      |      |
|  | LSet    | Fact | From | To  | Step | proj  | inp1 | inp2 | inp3 | inp4 | inp5 | inp6 |
| pre/post tensioning (increment force)                                |         |      |      |     |      | Force |      |      |      |      |      |      |
| TEND0  | no LSet |      | 107  | 107 | 1    | 0.00  |      |      |      |      |      |      |
| TEND0  | no LSet |      | 207  | 207 | 1    | 0.00  |      |      |      |      |      |      |

|  |         |      |      |     |      |       |      |      |      |      |      |      |
|--|---------|------|------|-----|------|-------|------|------|------|------|------|------|
| <b>load case:</b> PS_08<br>Prestressing Force Application - Stage-08 |         |      |      |     |      |       |      |      |      |      |      |      |
| Duration: PERMANENT  |         |      |      |     |      |       |      |      |      |      |      |      |
| LoadInfo: PS   |         |      |      |     |      |       |      |      |      |      |      |      |
| <b>Loads:</b>  |         |      |      |     |      |       |      |      |      |      |      |      |
|  | LSet    | Fact | From | To  | Step | proj  | inp1 | inp2 | inp3 | inp4 | inp5 | inp6 |
| pre/post tensioning (increment force)                                |         |      |      |     |      | Force |      |      |      |      |      |      |
| TEND0  | no LSet |      | 108  | 108 | 1    | 0.00  |      |      |      |      |      |      |
| TEND0  | no LSet |      | 208  | 208 | 1    | 0.00  |      |      |      |      |      |      |

|  |         |      |      |     |      |       |      |      |      |      |      |      |
|--|---------|------|------|-----|------|-------|------|------|------|------|------|------|
| <b>load case:</b> PS_10<br>Prestressing Force Application - Stage-10 |         |      |      |     |      |       |      |      |      |      |      |      |
| Duration: PERMANENT  |         |      |      |     |      |       |      |      |      |      |      |      |
| LoadInfo: PS   |         |      |      |     |      |       |      |      |      |      |      |      |
| <b>Loads:</b>  |         |      |      |     |      |       |      |      |      |      |      |      |
|  | LSet    | Fact | From | To  | Step | proj  | inp1 | inp2 | inp3 | inp4 | inp5 | inp6 |
| pre/post tensioning (increment force)                                |         |      |      |     |      | Force |      |      |      |      |      |      |
| TEND0  | no LSet |      | 110  | 110 | 1    | 0.00  |      |      |      |      |      |      |
| TEND0  | no LSet |      | 210  | 210 | 1    | 0.00  |      |      |      |      |      |      |

|  |         |      |      |     |      |       |      |      |      |      |      |      |
|--|---------|------|------|-----|------|-------|------|------|------|------|------|------|
| <b>load case:</b> PS_12<br>Prestressing Force Application - Stage-12 |         |      |      |     |      |       |      |      |      |      |      |      |
| Duration: PERMANENT  |         |      |      |     |      |       |      |      |      |      |      |      |
| LoadInfo: PS   |         |      |      |     |      |       |      |      |      |      |      |      |
| <b>Loads:</b>  |         |      |      |     |      |       |      |      |      |      |      |      |
|  | LSet    | Fact | From | To  | Step | proj  | inp1 | inp2 | inp3 | inp4 | inp5 | inp6 |
| pre/post tensioning (increment force)                                |         |      |      |     |      | Force |      |      |      |      |      |      |
| TEND0  | no LSet |      | 112  | 112 | 1    | 0.00  |      |      |      |      |      |      |
| TEND0  | no LSet |      | 212  | 212 | 1    | 0.00  |      |      |      |      |      |      |



|  |         |      |      |     |      |       |      |      |      |      |      |      |
|--|---------|------|------|-----|------|-------|------|------|------|------|------|------|
| <b>load case:</b> PS_14<br>Prestressing Force Application - Stage-14 |         |      |      |     |      |       |      |      |      |      |      |      |
| Duration: PERMANENT  |         |      |      |     |      |       |      |      |      |      |      |      |
| LoadInfo: PS   |         |      |      |     |      |       |      |      |      |      |      |      |
| <b>Loads:</b>  |         |      |      |     |      |       |      |      |      |      |      |      |
|  | LSet    | Fact | From | To  | Step | proj  | inp1 | inp2 | inp3 | inp4 | inp5 | inp6 |
| pre/post tensioning (increment force)                                |         |      |      |     |      | Force |      |      |      |      |      |      |
| TEND0  | no LSet |      | 114  | 114 | 1    | 0.00  |      |      |      |      |      |      |
| TEND0  | no LSet |      | 214  | 214 | 1    | 0.00  |      |      |      |      |      |      |

|  |         |      |      |     |      |       |      |      |      |      |      |      |
|--|---------|------|------|-----|------|-------|------|------|------|------|------|------|
| <b>load case:</b> PS_16<br>Prestressing Force Application - Stage-16 |         |      |      |     |      |       |      |      |      |      |      |      |
| Duration: PERMANENT  |         |      |      |     |      |       |      |      |      |      |      |      |
| LoadInfo: PS   |         |      |      |     |      |       |      |      |      |      |      |      |
| <b>Loads:</b>  |         |      |      |     |      |       |      |      |      |      |      |      |
|  | LSet    | Fact | From | To  | Step | proj  | inp1 | inp2 | inp3 | inp4 | inp5 | inp6 |
| pre/post tensioning (increment force)                                |         |      |      |     |      | Force |      |      |      |      |      |      |
| TEND0  | no LSet |      | 116  | 116 | 1    | 0.00  |      |      |      |      |      |      |
| TEND0  | no LSet |      | 216  | 216 | 1    | 0.00  |      |      |      |      |      |      |

|  |         |      |      |     |      |       |      |      |      |      |      |      |
|--|---------|------|------|-----|------|-------|------|------|------|------|------|------|
| <b>load case:</b> PS_18<br>Prestressing Force Application - Stage-17 |         |      |      |     |      |       |      |      |      |      |      |      |
| Duration: PERMANENT  |         |      |      |     |      |       |      |      |      |      |      |      |
| LoadInfo: PS   |         |      |      |     |      |       |      |      |      |      |      |      |
| <b>Loads:</b>  |         |      |      |     |      |       |      |      |      |      |      |      |
|  | LSet    | Fact | From | To  | Step | proj  | inp1 | inp2 | inp3 | inp4 | inp5 | inp6 |
| pre/post tensioning (increment force)                                |         |      |      |     |      | Force |      |      |      |      |      |      |
| TEND0  | no LSet |      | 118  | 118 | 1    | 0.00  |      |      |      |      |      |      |
| TEND0  | no LSet |      | 218  | 218 | 1    | 0.00  |      |      |      |      |      |      |

|  |         |      |      |     |      |       |      |      |      |      |      |      |
|--|---------|------|------|-----|------|-------|------|------|------|------|------|------|
| <b>load case:</b> PS_20<br>Prestressing Force Application - Stage-20 |         |      |      |     |      |       |      |      |      |      |      |      |
| Duration: PERMANENT  |         |      |      |     |      |       |      |      |      |      |      |      |
| LoadInfo: PS   |         |      |      |     |      |       |      |      |      |      |      |      |
| <b>Loads:</b>  |         |      |      |     |      |       |      |      |      |      |      |      |
|  | LSet    | Fact | From | To  | Step | proj  | inp1 | inp2 | inp3 | inp4 | inp5 | inp6 |
| pre/post tensioning (increment force)                                |         |      |      |     |      | Force |      |      |      |      |      |      |
| TEND0  | no LSet |      | 120  | 120 | 1    | 0.00  |      |      |      |      |      |      |
| TEND0  | no LSet |      | 220  | 220 | 1    | 0.00  |      |      |      |      |      |      |

|  |         |      |      |     |      |       |      |      |      |      |      |      |
|--|---------|------|------|-----|------|-------|------|------|------|------|------|------|
| <b>load case:</b> PS_22<br>Prestressing Force Application - Stage-22 |         |      |      |     |      |       |      |      |      |      |      |      |
| Duration: PERMANENT  |         |      |      |     |      |       |      |      |      |      |      |      |
| LoadInfo: PS   |         |      |      |     |      |       |      |      |      |      |      |      |
| <b>Loads:</b>  |         |      |      |     |      |       |      |      |      |      |      |      |
|  | LSet    | Fact | From | To  | Step | proj  | inp1 | inp2 | inp3 | inp4 | inp5 | inp6 |
| pre/post tensioning (increment force)                                |         |      |      |     |      | Force |      |      |      |      |      |      |
| TEND0  | no LSet |      | 122  | 122 | 1    | 0.00  |      |      |      |      |      |      |
| TEND0  | no LSet |      | 222  | 222 | 1    | 0.00  |      |      |      |      |      |      |



|  |         |      |      |     |      |       |      |      |      |      |      |      |
|--|---------|------|------|-----|------|-------|------|------|------|------|------|------|
| <b>load case:</b> PS_24<br>Prestressing Force Application - Stage-24 |         |      |      |     |      |       |      |      |      |      |      |      |
| Duration: PERMANENT  |         |      |      |     |      |       |      |      |      |      |      |      |
| LoadInfo: PS   |         |      |      |     |      |       |      |      |      |      |      |      |
| <b>Loads:</b>  |         |      |      |     |      |       |      |      |      |      |      |      |
|  | LSet    | Fact | From | To  | Step | proj  | inp1 | inp2 | inp3 | inp4 | inp5 | inp6 |
| pre/post tensioning (increment force)                                |         |      |      |     |      | Force |      |      |      |      |      |      |
| TEND0  | no LSet |      | 124  | 124 | 1    | 0.00  |      |      |      |      |      |      |
| TEND0  | no LSet |      | 224  | 224 | 1    | 0.00  |      |      |      |      |      |      |

|  |         |      |      |      |      |       |      |      |      |      |      |      |
|--|---------|------|------|------|------|-------|------|------|------|------|------|------|
| <b>load case:</b> PS_26<br>Prestressing Force Application - Stage-26 |         |      |      |      |      |       |      |      |      |      |      |      |
| Duration: PERMANENT  |         |      |      |      |      |       |      |      |      |      |      |      |
| LoadInfo: PS   |         |      |      |      |      |       |      |      |      |      |      |      |
| <b>Loads:</b>  |         |      |      |      |      |       |      |      |      |      |      |      |
|  | LSet    | Fact | From | To   | Step | proj  | inp1 | inp2 | inp3 | inp4 | inp5 | inp6 |
| pre/post tensioning (increment force)                                |         |      |      |      |      | Force |      |      |      |      |      |      |
| TEND0  | no LSet |      | 2001 | 2012 | 1    | 0.00  |      |      |      |      |      |      |
| TEND0  | no LSet |      | 125  | 131  | 1    | 0.00  |      |      |      |      |      |      |
| TEND0  | no LSet |      | 225  | 231  | 1    | 0.00  |      |      |      |      |      |      |

## 5.2.6 Empty Load Cases for Creep and Shrinkage

RM Software require Empty Load case Definition to calculate Creep and shrinkage. Following Load Cases were Defined.

CS\_PIER - For C&S calculation for Construction stage STG\_PIER  
 CS\_00 To CS\_27 - For C&S calculation for Construction stage STG\_00 To STG\_27  
 CS\_100 -For C&S calculation for 100years after construction

## 5.2.7 Stay Force Application During Construction

|  |      |      |       |      |      |      |        |      |      |      |      |      |
|--|------|------|-------|------|------|------|--------|------|------|------|------|------|
| <b>load case:</b> CST_BS_09<br>Stay force Application Back Span - Stage-09 |      |      |       |      |      |      |        |      |      |      |      |      |
| Duration: PERMANENT  |      |      |       |      |      |      |        |      |      |      |      |      |
| LoadInfo: CAB  |      |      |       |      |      |      |        |      |      |      |      |      |
| <b>Loads:</b>  |      |      |       |      |      |      |        |      |      |      |      |      |
|  | LSet | Fact | From  | To   | Step | proj | inp1   | inp2 | inp3 | inp4 | inp5 | inp6 |
| cable shortening defined by force  |      |      |       |      |      |      | Fx     |      |      |      |      |      |
| FX0  | FX0  | 1103 | 37179 | 1103 | 1103 | 1    | 100.00 |      |      |      |      |      |
| cable shortening defined by force  |      |      |       |      |      |      | Fx     |      |      |      |      |      |
| FX0  | FX0  | 1203 | 37179 | 1203 | 1203 | 1    | 100.00 |      |      |      |      |      |
| cable shortening defined by force  |      |      |       |      |      |      | Fx     |      |      |      |      |      |
| FX0  | FX0  | 1703 | 37179 | 1703 | 1703 | 1    | 100.00 |      |      |      |      |      |
| cable shortening defined by force  |      |      |       |      |      |      | Fx     |      |      |      |      |      |
| FX0  | FX0  | 1803 | 37179 | 1803 | 1803 | 1    | 100.00 |      |      |      |      |      |



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|   |      |      |       |      |      |      |        |      |      |      |      |      |
|---|------|------|-------|------|------|------|--------|------|------|------|------|------|
| <b>load case:</b> CST_MS_09                 |      |      |       |      |      |      |        |      |      |      |      |      |
| Stay force Application Main Span - Stage-09 |      |      |       |      |      |      |        |      |      |      |      |      |
| Duration: PERMANENT                         |      |      |       |      |      |      |        |      |      |      |      |      |
| LoadInfo: CAB                               |      |      |       |      |      |      |        |      |      |      |      |      |
| <b>Loads:</b>                               |      |      |       |      |      |      |        |      |      |      |      |      |
|   | LSet | Fact | From  | To   | Step | proj | inp1   | inp2 | inp3 | inp4 | inp5 | inp6 |
| cable shortening defined by force           |      |      |       |      |      |      | Fx     |      |      |      |      |      |
| FX0   | FX0  | 1303 | 97078 | 1303 | 1303 | 1    | 100.00 |      |      |      |      |      |
| cable shortening defined by force           |      |      |       |      |      |      | Fx     |      |      |      |      |      |
| FX0   | FX0  | 1403 | 97078 | 1403 | 1403 | 1    | 100.00 |      |      |      |      |      |
| cable shortening defined by force           |      |      |       |      |      |      | Fx     |      |      |      |      |      |
| FX0   | FX0  | 1503 | 97078 | 1503 | 1503 | 1    | 100.00 |      |      |      |      |      |
| cable shortening defined by force           |      |      |       |      |      |      | Fx     |      |      |      |      |      |
| FX0   | FX0  | 1603 | 97078 | 1603 | 1603 | 1    | 100.00 |      |      |      |      |      |

|   |      |      |       |      |      |      |        |      |      |      |      |      |
|---|------|------|-------|------|------|------|--------|------|------|------|------|------|
| <b>load case:</b> CST_BS_11                 |      |      |       |      |      |      |        |      |      |      |      |      |
| Stay force Application Back Span - Stage-11 |      |      |       |      |      |      |        |      |      |      |      |      |
| Duration: PERMANENT                         |      |      |       |      |      |      |        |      |      |      |      |      |
| LoadInfo: CAB                               |      |      |       |      |      |      |        |      |      |      |      |      |
| <b>Loads:</b>                               |      |      |       |      |      |      |        |      |      |      |      |      |
|   | LSet | Fact | From  | To   | Step | proj | inp1   | inp2 | inp3 | inp4 | inp5 | inp6 |
| cable shortening defined by force           |      |      |       |      |      |      | Fx     |      |      |      |      |      |
| FX0   | FX0  | 1104 | 20151 | 1104 | 1104 | 1    | 100.00 |      |      |      |      |      |
| cable shortening defined by force           |      |      |       |      |      |      | Fx     |      |      |      |      |      |
| FX0   | FX0  | 1204 | 20151 | 1204 | 1204 | 1    | 100.00 |      |      |      |      |      |
| cable shortening defined by force           |      |      |       |      |      |      | Fx     |      |      |      |      |      |
| FX0   | FX0  | 1704 | 20151 | 1704 | 1704 | 1    | 100.00 |      |      |      |      |      |
| cable shortening defined by force           |      |      |       |      |      |      | Fx     |      |      |      |      |      |
| FX0   | FX0  | 1804 | 20151 | 1804 | 1804 | 1    | 100.00 |      |      |      |      |      |

|   |      |      |       |      |      |      |        |      |      |      |      |      |
|---|------|------|-------|------|------|------|--------|------|------|------|------|------|
| <b>load case:</b> CST_MS_11                 |      |      |       |      |      |      |        |      |      |      |      |      |
| Stay force Application Main Span - Stage-11 |      |      |       |      |      |      |        |      |      |      |      |      |
| Duration: PERMANENT                         |      |      |       |      |      |      |        |      |      |      |      |      |
| LoadInfo: CAB                               |      |      |       |      |      |      |        |      |      |      |      |      |
| <b>Loads:</b>                               |      |      |       |      |      |      |        |      |      |      |      |      |
|   | LSet | Fact | From  | To   | Step | proj | inp1   | inp2 | inp3 | inp4 | inp5 | inp6 |
| cable shortening defined by force           |      |      |       |      |      |      | Fx     |      |      |      |      |      |
| FX0   | FX0  | 1304 | 32466 | 1304 | 1304 | 1    | 100.00 |      |      |      |      |      |
| cable shortening defined by force           |      |      |       |      |      |      | Fx     |      |      |      |      |      |
| FX0   | FX0  | 1404 | 32466 | 1404 | 1404 | 1    | 100.00 |      |      |      |      |      |
| cable shortening defined by force           |      |      |       |      |      |      | Fx     |      |      |      |      |      |
| FX0   | FX0  | 1504 | 32466 | 1504 | 1504 | 1    | 100.00 |      |      |      |      |      |
| cable shortening defined by force           |      |      |       |      |      |      | Fx     |      |      |      |      |      |
| FX0   | FX0  | 1604 | 32466 | 1604 | 1604 | 1    | 100.00 |      |      |      |      |      |

Description: 5 Loads  
5.2 Load Cases

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|  |      |      |       |      |      |      |        |      |      |      |      |      |
|--|------|------|-------|------|------|------|--------|------|------|------|------|------|
| <b>load case:</b> CST_BS_13<br>Stay force Application Back Span - Stage-13 |      |      |       |      |      |      |        |      |      |      |      |      |
| Duration: PERMANENT  |      |      |       |      |      |      |        |      |      |      |      |      |
| LoadInfo: CAB  |      |      |       |      |      |      |        |      |      |      |      |      |
| <b>Loads:</b>  |      |      |       |      |      |      |        |      |      |      |      |      |
|  | LSet | Fact | From  | To   | Step | proj | inp1   | inp2 | inp3 | inp4 | inp5 | inp6 |
| cable shortening defined by force  |      |      |       |      |      |      | Fx     |      |      |      |      |      |
| FX0  | FX0  | 1105 | 01887 | 1105 | 1105 | 1    | 100.00 |      |      |      |      |      |
| cable shortening defined by force  |      |      |       |      |      |      | Fx     |      |      |      |      |      |
| FX0  | FX0  | 1205 | 01887 | 1205 | 1205 | 1    | 100.00 |      |      |      |      |      |
| cable shortening defined by force  |      |      |       |      |      |      | Fx     |      |      |      |      |      |
| FX0  | FX0  | 1705 | 01887 | 1705 | 1705 | 1    | 100.00 |      |      |      |      |      |
| cable shortening defined by force  |      |      |       |      |      |      | Fx     |      |      |      |      |      |
| FX0  | FX0  | 1805 | 01887 | 1805 | 1805 | 1    | 100.00 |      |      |      |      |      |

|  |      |      |       |      |      |      |        |      |      |      |      |      |
|--|------|------|-------|------|------|------|--------|------|------|------|------|------|
| <b>load case:</b> CST_MS_13<br>Stay force Application Main Span - Stage-13 |      |      |       |      |      |      |        |      |      |      |      |      |
| Duration: PERMANENT  |      |      |       |      |      |      |        |      |      |      |      |      |
| LoadInfo: CAB  |      |      |       |      |      |      |        |      |      |      |      |      |
| <b>Loads:</b>  |      |      |       |      |      |      |        |      |      |      |      |      |
|  | LSet | Fact | From  | To   | Step | proj | inp1   | inp2 | inp3 | inp4 | inp5 | inp6 |
| cable shortening defined by force  |      |      |       |      |      |      | Fx     |      |      |      |      |      |
| FX0  | FX0  | 1305 | 25488 | 1305 | 1305 | 1    | 100.00 |      |      |      |      |      |
| cable shortening defined by force  |      |      |       |      |      |      | Fx     |      |      |      |      |      |
| FX0  | FX0  | 1405 | 25488 | 1405 | 1405 | 1    | 100.00 |      |      |      |      |      |
| cable shortening defined by force  |      |      |       |      |      |      | Fx     |      |      |      |      |      |
| FX0  | FX0  | 1505 | 25488 | 1505 | 1505 | 1    | 100.00 |      |      |      |      |      |
| cable shortening defined by force  |      |      |       |      |      |      | Fx     |      |      |      |      |      |
| FX0  | FX0  | 1605 | 25488 | 1605 | 1605 | 1    | 100.00 |      |      |      |      |      |

|  |      |      |       |      |      |      |        |      |      |      |      |      |
|--|------|------|-------|------|------|------|--------|------|------|------|------|------|
| <b>load case:</b> CST_BS_15<br>Stay force Application Back Span - Stage-15 |      |      |       |      |      |      |        |      |      |      |      |      |
| Duration: PERMANENT  |      |      |       |      |      |      |        |      |      |      |      |      |
| LoadInfo: CAB  |      |      |       |      |      |      |        |      |      |      |      |      |
| <b>Loads:</b>  |      |      |       |      |      |      |        |      |      |      |      |      |
|  | LSet | Fact | From  | To   | Step | proj | inp1   | inp2 | inp3 | inp4 | inp5 | inp6 |
| cable shortening defined by force  |      |      |       |      |      |      | Fx     |      |      |      |      |      |
| FX0  | FX0  | 1106 | 71519 | 1106 | 1106 | 1    | 100.00 |      |      |      |      |      |
| cable shortening defined by force  |      |      |       |      |      |      | Fx     |      |      |      |      |      |
| FX0  | FX0  | 1206 | 71519 | 1206 | 1206 | 1    | 100.00 |      |      |      |      |      |
| cable shortening defined by force  |      |      |       |      |      |      | Fx     |      |      |      |      |      |
| FX0  | FX0  | 1706 | 71519 | 1706 | 1706 | 1    | 100.00 |      |      |      |      |      |
| cable shortening defined by force  |      |      |       |      |      |      | Fx     |      |      |      |      |      |
| FX0  | FX0  | 1806 | 71519 | 1806 | 1806 | 1    | 100.00 |      |      |      |      |      |

Description: 5 Loads  
5.2 Load Cases

Project No.

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|  |      |      |       |      |      |      |        |      |      |      |      |      |
|--|------|------|-------|------|------|------|--------|------|------|------|------|------|
| <b>load case:</b> CST_MS_15<br>Stay force Application Main Span - Stage-15 |      |      |       |      |      |      |        |      |      |      |      |      |
| Duration: PERMANENT  |      |      |       |      |      |      |        |      |      |      |      |      |
| LoadInfo: CAB  |      |      |       |      |      |      |        |      |      |      |      |      |
| <b>Loads:</b>  |      |      |       |      |      |      |        |      |      |      |      |      |
|  | LSet | Fact | From  | To   | Step | proj | inp1   | inp2 | inp3 | inp4 | inp5 | inp6 |
| cable shortening defined by force  |      |      |       |      |      |      | Fx     |      |      |      |      |      |
| FX0  | FX0  | 1306 | 52686 | 1306 | 1306 | 1    | 100.00 |      |      |      |      |      |
| cable shortening defined by force  |      |      |       |      |      |      | Fx     |      |      |      |      |      |
| FX0  | FX0  | 1406 | 52686 | 1406 | 1406 | 1    | 100.00 |      |      |      |      |      |
| cable shortening defined by force  |      |      |       |      |      |      | Fx     |      |      |      |      |      |
| FX0  | FX0  | 1506 | 52686 | 1506 | 1506 | 1    | 100.00 |      |      |      |      |      |
| cable shortening defined by force  |      |      |       |      |      |      | Fx     |      |      |      |      |      |
| FX0  | FX0  | 1606 | 52686 | 1606 | 1606 | 1    | 100.00 |      |      |      |      |      |

|  |      |      |       |      |      |      |        |      |      |      |      |      |
|--|------|------|-------|------|------|------|--------|------|------|------|------|------|
| <b>load case:</b> CST_BS_17<br>Stay force Application Back Span - Stage-17 |      |      |       |      |      |      |        |      |      |      |      |      |
| Duration: PERMANENT  |      |      |       |      |      |      |        |      |      |      |      |      |
| LoadInfo: CAB  |      |      |       |      |      |      |        |      |      |      |      |      |
| <b>Loads:</b>  |      |      |       |      |      |      |        |      |      |      |      |      |
|  | LSet | Fact | From  | To   | Step | proj | inp1   | inp2 | inp3 | inp4 | inp5 | inp6 |
| cable shortening defined by force  |      |      |       |      |      |      | Fx     |      |      |      |      |      |
| FX0  | FX0  | 1107 | 74615 | 1107 | 1107 | 1    | 100.00 |      |      |      |      |      |
| cable shortening defined by force  |      |      |       |      |      |      | Fx     |      |      |      |      |      |
| FX0  | FX0  | 1207 | 74615 | 1207 | 1207 | 1    | 100.00 |      |      |      |      |      |
| cable shortening defined by force  |      |      |       |      |      |      | Fx     |      |      |      |      |      |
| FX0  | FX0  | 1707 | 74615 | 1707 | 1707 | 1    | 100.00 |      |      |      |      |      |
| cable shortening defined by force  |      |      |       |      |      |      | Fx     |      |      |      |      |      |
| FX0  | FX0  | 1807 | 74615 | 1807 | 1807 | 1    | 100.00 |      |      |      |      |      |

|  |      |      |       |      |      |      |        |      |      |      |      |      |
|--|------|------|-------|------|------|------|--------|------|------|------|------|------|
| <b>load case:</b> CST_MS_17<br>Stay force Application Main Span - Stage-17 |      |      |       |      |      |      |        |      |      |      |      |      |
| Duration: PERMANENT  |      |      |       |      |      |      |        |      |      |      |      |      |
| LoadInfo: CAB  |      |      |       |      |      |      |        |      |      |      |      |      |
| <b>Loads:</b>  |      |      |       |      |      |      |        |      |      |      |      |      |
|  | LSet | Fact | From  | To   | Step | proj | inp1   | inp2 | inp3 | inp4 | inp5 | inp6 |
| cable shortening defined by force  |      |      |       |      |      |      | Fx     |      |      |      |      |      |
| FX0  | FX0  | 1307 | 94271 | 1307 | 1307 | 1    | 100.00 |      |      |      |      |      |
| cable shortening defined by force  |      |      |       |      |      |      | Fx     |      |      |      |      |      |
| FX0  | FX0  | 1407 | 94271 | 1407 | 1407 | 1    | 100.00 |      |      |      |      |      |
| cable shortening defined by force  |      |      |       |      |      |      | Fx     |      |      |      |      |      |
| FX0  | FX0  | 1507 | 94271 | 1507 | 1507 | 1    | 100.00 |      |      |      |      |      |
| cable shortening defined by force  |      |      |       |      |      |      | Fx     |      |      |      |      |      |
| FX0  | FX0  | 1607 | 94271 | 1607 | 1607 | 1    | 100.00 |      |      |      |      |      |

Description: 5 Loads  
5.2 Load Cases

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Designer: VKS Infratech Management Pvt. Ltd.



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|   |      |      |       |      |      |      |        |      |      |      |      |      |
|---|------|------|-------|------|------|------|--------|------|------|------|------|------|
| <b>load case:</b> CST_BS_19                 |      |      |       |      |      |      |        |      |      |      |      |      |
| Stay force Application Back Span - Stage-19 |      |      |       |      |      |      |        |      |      |      |      |      |
| Duration: PERMANENT                         |      |      |       |      |      |      |        |      |      |      |      |      |
| LoadInfo: CAB                               |      |      |       |      |      |      |        |      |      |      |      |      |
| <b>Loads:</b>                               |      |      |       |      |      |      |        |      |      |      |      |      |
|   | LSet | Fact | From  | To   | Step | proj | inp1   | inp2 | inp3 | inp4 | inp5 | inp6 |
| cable shortening defined by force           |      |      |       |      |      |      | Fx     |      |      |      |      |      |
| FX0   | FX0  | 1108 | 15630 | 1108 | 1108 | 1    | 100.00 |      |      |      |      |      |
| cable shortening defined by force           |      |      |       |      |      |      | Fx     |      |      |      |      |      |
| FX0   | FX0  | 1208 | 15630 | 1208 | 1208 | 1    | 100.00 |      |      |      |      |      |
| cable shortening defined by force           |      |      |       |      |      |      | Fx     |      |      |      |      |      |
| FX0   | FX0  | 1708 | 15630 | 1708 | 1708 | 1    | 100.00 |      |      |      |      |      |
| cable shortening defined by force           |      |      |       |      |      |      | Fx     |      |      |      |      |      |
| FX0   | FX0  | 1808 | 15630 | 1808 | 1808 | 1    | 100.00 |      |      |      |      |      |

|   |      |      |       |      |      |      |        |      |      |      |      |      |
|---|------|------|-------|------|------|------|--------|------|------|------|------|------|
| <b>load case:</b> CST_MS_19                 |      |      |       |      |      |      |        |      |      |      |      |      |
| Stay force Application Main Span - Stage-19 |      |      |       |      |      |      |        |      |      |      |      |      |
| Duration: PERMANENT                         |      |      |       |      |      |      |        |      |      |      |      |      |
| LoadInfo: CAB                               |      |      |       |      |      |      |        |      |      |      |      |      |
| <b>Loads:</b>                               |      |      |       |      |      |      |        |      |      |      |      |      |
|   | LSet | Fact | From  | To   | Step | proj | inp1   | inp2 | inp3 | inp4 | inp5 | inp6 |
| cable shortening defined by force           |      |      |       |      |      |      | Fx     |      |      |      |      |      |
| FX0   | FX0  | 1308 | 85654 | 1308 | 1308 | 1    | 100.00 |      |      |      |      |      |
| cable shortening defined by force           |      |      |       |      |      |      | Fx     |      |      |      |      |      |
| FX0   | FX0  | 1408 | 85654 | 1408 | 1408 | 1    | 100.00 |      |      |      |      |      |
| cable shortening defined by force           |      |      |       |      |      |      | Fx     |      |      |      |      |      |
| FX0   | FX0  | 1508 | 85654 | 1508 | 1508 | 1    | 100.00 |      |      |      |      |      |
| cable shortening defined by force           |      |      |       |      |      |      | Fx     |      |      |      |      |      |
| FX0   | FX0  | 1608 | 85654 | 1608 | 1608 | 1    | 100.00 |      |      |      |      |      |

|   |      |      |       |      |      |      |        |      |      |      |      |      |
|---|------|------|-------|------|------|------|--------|------|------|------|------|------|
| <b>load case:</b> CST_BS_21                 |      |      |       |      |      |      |        |      |      |      |      |      |
| Stay force Application Back Span - Stage-21 |      |      |       |      |      |      |        |      |      |      |      |      |
| Duration: PERMANENT                         |      |      |       |      |      |      |        |      |      |      |      |      |
| LoadInfo: CAB                               |      |      |       |      |      |      |        |      |      |      |      |      |
| <b>Loads:</b>                               |      |      |       |      |      |      |        |      |      |      |      |      |
|   | LSet | Fact | From  | To   | Step | proj | inp1   | inp2 | inp3 | inp4 | inp5 | inp6 |
| cable shortening defined by force           |      |      |       |      |      |      | Fx     |      |      |      |      |      |
| FX0   | FX0  | 1109 | 87607 | 1109 | 1109 | 1    | 100.00 |      |      |      |      |      |
| cable shortening defined by force           |      |      |       |      |      |      | Fx     |      |      |      |      |      |
| FX0   | FX0  | 1209 | 87607 | 1209 | 1209 | 1    | 100.00 |      |      |      |      |      |
| cable shortening defined by force           |      |      |       |      |      |      | Fx     |      |      |      |      |      |
| FX0   | FX0  | 1709 | 87607 | 1709 | 1709 | 1    | 100.00 |      |      |      |      |      |
| cable shortening defined by force           |      |      |       |      |      |      | Fx     |      |      |      |      |      |
| FX0   | FX0  | 1809 | 87607 | 1809 | 1809 | 1    | 100.00 |      |      |      |      |      |

Description: 5 Loads  
5.2 Load Cases

Project No.

Designer: VKS Infratech Management Pvt. Ltd.



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|---|------|------|-------|------|------|------|--------|------|------|------|------|------|
| <b>load case:</b> CST_MS_21                 |      |      |       |      |      |      |        |      |      |      |      |      |
| Stay force Application Main Span - Stage-21 |      |      |       |      |      |      |        |      |      |      |      |      |
| Duration: PERMANENT                         |      |      |       |      |      |      |        |      |      |      |      |      |
| LoadInfo: CAB                               |      |      |       |      |      |      |        |      |      |      |      |      |
| <b>Loads:</b>                               |      |      |       |      |      |      |        |      |      |      |      |      |
|   | LSet | Fact | From  | To   | Step | proj | inp1   | inp2 | inp3 | inp4 | inp5 | inp6 |
| cable shortening defined by force           |      |      |       |      |      |      | Fx     |      |      |      |      |      |
| FX0   | FX0  | 1309 | 85874 | 1309 | 1309 | 1    | 100.00 |      |      |      |      |      |
| cable shortening defined by force           |      |      |       |      |      |      | Fx     |      |      |      |      |      |
| FX0   | FX0  | 1409 | 85874 | 1409 | 1409 | 1    | 100.00 |      |      |      |      |      |
| cable shortening defined by force           |      |      |       |      |      |      | Fx     |      |      |      |      |      |
| FX0   | FX0  | 1509 | 85874 | 1509 | 1509 | 1    | 100.00 |      |      |      |      |      |
| cable shortening defined by force           |      |      |       |      |      |      | Fx     |      |      |      |      |      |
| FX0   | FX0  | 1609 | 85874 | 1609 | 1609 | 1    | 100.00 |      |      |      |      |      |

|   |      |      |       |      |      |      |        |      |      |      |      |      |
|---|------|------|-------|------|------|------|--------|------|------|------|------|------|
| <b>load case:</b> CST_BS_23                 |      |      |       |      |      |      |        |      |      |      |      |      |
| Stay force Application Back Span - Stage-23 |      |      |       |      |      |      |        |      |      |      |      |      |
| Duration: PERMANENT                         |      |      |       |      |      |      |        |      |      |      |      |      |
| LoadInfo: CAB                               |      |      |       |      |      |      |        |      |      |      |      |      |
| <b>Loads:</b>                               |      |      |       |      |      |      |        |      |      |      |      |      |
|   | LSet | Fact | From  | To   | Step | proj | inp1   | inp2 | inp3 | inp4 | inp5 | inp6 |
| cable shortening defined by force           |      |      |       |      |      |      | Fx     |      |      |      |      |      |
| FX0   | FX0  | 1110 | 07622 | 1110 | 1110 | 1    | 100.00 |      |      |      |      |      |
| cable shortening defined by force           |      |      |       |      |      |      | Fx     |      |      |      |      |      |
| FX0   | FX0  | 1210 | 07622 | 1210 | 1210 | 1    | 100.00 |      |      |      |      |      |
| cable shortening defined by force           |      |      |       |      |      |      | Fx     |      |      |      |      |      |
| FX0   | FX0  | 1710 | 07622 | 1710 | 1710 | 1    | 100.00 |      |      |      |      |      |
| cable shortening defined by force           |      |      |       |      |      |      | Fx     |      |      |      |      |      |
| FX0   | FX0  | 1810 | 07622 | 1810 | 1810 | 1    | 100.00 |      |      |      |      |      |

|   |      |      |       |      |      |      |        |      |      |      |      |      |
|---|------|------|-------|------|------|------|--------|------|------|------|------|------|
| <b>load case:</b> CST_MS_23                 |      |      |       |      |      |      |        |      |      |      |      |      |
| Stay force Application Main Span - Stage-23 |      |      |       |      |      |      |        |      |      |      |      |      |
| Duration: PERMANENT                         |      |      |       |      |      |      |        |      |      |      |      |      |
| LoadInfo: CAB                               |      |      |       |      |      |      |        |      |      |      |      |      |
| <b>Loads:</b>                               |      |      |       |      |      |      |        |      |      |      |      |      |
|   | LSet | Fact | From  | To   | Step | proj | inp1   | inp2 | inp3 | inp4 | inp5 | inp6 |
| cable shortening defined by force           |      |      |       |      |      |      | Fx     |      |      |      |      |      |
| FX0   | FX0  | 1310 | 98487 | 1310 | 1310 | 1    | 100.00 |      |      |      |      |      |
| cable shortening defined by force           |      |      |       |      |      |      | Fx     |      |      |      |      |      |
| FX0   | FX0  | 1410 | 98487 | 1410 | 1410 | 1    | 100.00 |      |      |      |      |      |
| cable shortening defined by force           |      |      |       |      |      |      | Fx     |      |      |      |      |      |
| FX0   | FX0  | 1510 | 98487 | 1510 | 1510 | 1    | 100.00 |      |      |      |      |      |
| cable shortening defined by force           |      |      |       |      |      |      | Fx     |      |      |      |      |      |
| FX0   | FX0  | 1610 | 98487 | 1610 | 1610 | 1    | 100.00 |      |      |      |      |      |

Description: 5 Loads  
5.2 Load Cases

Project No.

Designer: VKS Infratech Management Pvt. Ltd.



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|--|----------|-------|------|------|------|------|--------|------|------|------|------|------|
| <b>load case:</b> CST_BS_25<br>Stay force Application Back Span - Stage-25 |          |       |      |      |      |      |        |      |      |      |      |      |
| Duration: PERMANENT  |          |       |      |      |      |      |        |      |      |      |      |      |
| LoadInfo: CAB  |          |       |      |      |      |      |        |      |      |      |      |      |
| <b>Loads:</b>  |          |       |      |      |      |      |        |      |      |      |      |      |
|  | LSet     | Fact  | From | To   | Step | proj | inp1   | inp2 | inp3 | inp4 | inp5 | inp6 |
| cable shortening defined by force  |          |       |      |      |      |      | Fx     |      |      |      |      |      |
| FX0  | FX0 1111 | 46772 | 1111 | 1111 | 1    |      | 100.00 |      |      |      |      |      |
| cable shortening defined by force  |          |       |      |      |      |      | Fx     |      |      |      |      |      |
| FX0  | FX0 1211 | 46772 | 1211 | 1211 | 1    |      | 100.00 |      |      |      |      |      |
| cable shortening defined by force  |          |       |      |      |      |      | Fx     |      |      |      |      |      |
| FX0  | FX0 1711 | 46772 | 1711 | 1711 | 1    |      | 100.00 |      |      |      |      |      |
| cable shortening defined by force  |          |       |      |      |      |      | Fx     |      |      |      |      |      |
| FX0  | FX0 1811 | 46772 | 1811 | 1811 | 1    |      | 100.00 |      |      |      |      |      |

|  |          |       |      |      |      |      |        |      |      |      |      |      |
|--|----------|-------|------|------|------|------|--------|------|------|------|------|------|
| <b>load case:</b> CST_MS_25<br>Stay force Application Main Span - Stage-25 |          |       |      |      |      |      |        |      |      |      |      |      |
| Duration: PERMANENT  |          |       |      |      |      |      |        |      |      |      |      |      |
| LoadInfo: CAB  |          |       |      |      |      |      |        |      |      |      |      |      |
| <b>Loads:</b>  |          |       |      |      |      |      |        |      |      |      |      |      |
|  | LSet     | Fact  | From | To   | Step | proj | inp1   | inp2 | inp3 | inp4 | inp5 | inp6 |
| cable shortening defined by force  |          |       |      |      |      |      | Fx     |      |      |      |      |      |
| FX0  | FX0 1311 | 14972 | 1311 | 1311 | 1    |      | 100.00 |      |      |      |      |      |
| cable shortening defined by force  |          |       |      |      |      |      | Fx     |      |      |      |      |      |
| FX0  | FX0 1411 | 14972 | 1411 | 1411 | 1    |      | 100.00 |      |      |      |      |      |
| cable shortening defined by force  |          |       |      |      |      |      | Fx     |      |      |      |      |      |
| FX0  | FX0 1511 | 14972 | 1511 | 1511 | 1    |      | 100.00 |      |      |      |      |      |
| cable shortening defined by force  |          |       |      |      |      |      | Fx     |      |      |      |      |      |
| FX0  | FX0 1611 | 14972 | 1611 | 1611 | 1    |      | 100.00 |      |      |      |      |      |

## 5.2.8 Tie Down Force Application During Construction

|   |          |       |      |      |      |      |        |      |      |      |      |      |
|---|----------|-------|------|------|------|------|--------|------|------|------|------|------|
| <b>load case:</b> TDS_01<br>Tie Down Force Application - Stage-12 |          |       |      |      |      |      |        |      |      |      |      |      |
| Duration: PERMANENT   |          |       |      |      |      |      |        |      |      |      |      |      |
| LoadInfo: CAB   |          |       |      |      |      |      |        |      |      |      |      |      |
| <b>Loads:</b>   |          |       |      |      |      |      |        |      |      |      |      |      |
|   | LSet     | Fact  | From | To   | Step | proj | inp1   | inp2 | inp3 | inp4 | inp5 | inp6 |
| cable shortening defined by force                                 |          |       |      |      |      |      | Fx     |      |      |      |      |      |
| FX0   | FX0 5201 | 85592 | 5201 | 5201 | 1    |      | 100.00 |      |      |      |      |      |
| cable shortening defined by force                                 |          |       |      |      |      |      | Fx     |      |      |      |      |      |
| FX0   | FX0 5301 | 85592 | 5301 | 5301 | 1    |      | 100.00 |      |      |      |      |      |
| cable shortening defined by force                                 |          |       |      |      |      |      | Fx     |      |      |      |      |      |
| FX0   | FX0 6201 | 85592 | 6201 | 6201 | 1    |      | 100.00 |      |      |      |      |      |
| cable shortening defined by force                                 |          |       |      |      |      |      | Fx     |      |      |      |      |      |
| FX0   | FX0 6301 | 85592 | 6301 | 6301 | 1    |      | 100.00 |      |      |      |      |      |

Description: 5 Loads  
5.2 Load Cases

Project No.



|   |          |       |      |      |      |      |        |      |      |      |      |      |
|---|----------|-------|------|------|------|------|--------|------|------|------|------|------|
| <b>load case:</b> TDS_02<br>Tie Down Force Application - Stage-16 |          |       |      |      |      |      |        |      |      |      |      |      |
| Duration: PERMANENT   |          |       |      |      |      |      |        |      |      |      |      |      |
| LoadInfo: CAB   |          |       |      |      |      |      |        |      |      |      |      |      |
| <b>Loads:</b>   |          |       |      |      |      |      |        |      |      |      |      |      |
|   | LSet     | Fact  | From | To   | Step | proj | inp1   | inp2 | inp3 | inp4 | inp5 | inp6 |
| cable shortening defined by force                                 |          |       |      |      |      |      | Fx     |      |      |      |      |      |
| FX0   | FX0 5202 | 40782 | 5202 | 5202 | 1    |      | 100.00 |      |      |      |      |      |
| cable shortening defined by force                                 |          |       |      |      |      |      | Fx     |      |      |      |      |      |
| FX0   | FX0 5302 | 40782 | 5302 | 5302 | 1    |      | 100.00 |      |      |      |      |      |
| cable shortening defined by force                                 |          |       |      |      |      |      | Fx     |      |      |      |      |      |
| FX0   | FX0 6202 | 40782 | 6202 | 6202 | 1    |      | 100.00 |      |      |      |      |      |
| cable shortening defined by force                                 |          |       |      |      |      |      | Fx     |      |      |      |      |      |
| FX0   | FX0 6302 | 40782 | 6302 | 6302 | 1    |      | 100.00 |      |      |      |      |      |

|   |          |       |      |      |      |      |        |      |      |      |      |      |
|---|----------|-------|------|------|------|------|--------|------|------|------|------|------|
| <b>load case:</b> TDS_03<br>Tie Down Force Application - Stage-20 |          |       |      |      |      |      |        |      |      |      |      |      |
| Duration: PERMANENT   |          |       |      |      |      |      |        |      |      |      |      |      |
| LoadInfo: CAB   |          |       |      |      |      |      |        |      |      |      |      |      |
| <b>Loads:</b>   |          |       |      |      |      |      |        |      |      |      |      |      |
|   | LSet     | Fact  | From | To   | Step | proj | inp1   | inp2 | inp3 | inp4 | inp5 | inp6 |
| cable shortening defined by force                                 |          |       |      |      |      |      | Fx     |      |      |      |      |      |
| FX0   | FX0 5203 | 73258 | 5203 | 5203 | 1    |      | 100.00 |      |      |      |      |      |
| cable shortening defined by force                                 |          |       |      |      |      |      | Fx     |      |      |      |      |      |
| FX0   | FX0 5303 | 73258 | 5303 | 5303 | 1    |      | 100.00 |      |      |      |      |      |
| cable shortening defined by force                                 |          |       |      |      |      |      | Fx     |      |      |      |      |      |
| FX0   | FX0 6203 | 73258 | 6203 | 6203 | 1    |      | 100.00 |      |      |      |      |      |
| cable shortening defined by force                                 |          |       |      |      |      |      | Fx     |      |      |      |      |      |
| FX0   | FX0 6303 | 73258 | 6303 | 6303 | 1    |      | 100.00 |      |      |      |      |      |

|   |          |       |      |      |      |      |        |      |      |      |      |      |
|---|----------|-------|------|------|------|------|--------|------|------|------|------|------|
| <b>load case:</b> TDS_04<br>Tie Down Force Application - Stage-24 |          |       |      |      |      |      |        |      |      |      |      |      |
| Duration: PERMANENT   |          |       |      |      |      |      |        |      |      |      |      |      |
| LoadInfo: CAB   |          |       |      |      |      |      |        |      |      |      |      |      |
| <b>Loads:</b>   |          |       |      |      |      |      |        |      |      |      |      |      |
|   | LSet     | Fact  | From | To   | Step | proj | inp1   | inp2 | inp3 | inp4 | inp5 | inp6 |
| cable shortening defined by force                                 |          |       |      |      |      |      | Fx     |      |      |      |      |      |
| FX0   | FX0 5204 | 05312 | 5204 | 5204 | 1    |      | 100.00 |      |      |      |      |      |
| cable shortening defined by force                                 |          |       |      |      |      |      | Fx     |      |      |      |      |      |
| FX0   | FX0 5304 | 05312 | 5304 | 5304 | 1    |      | 100.00 |      |      |      |      |      |
| cable shortening defined by force                                 |          |       |      |      |      |      | Fx     |      |      |      |      |      |
| FX0   | FX0 6204 | 05312 | 6204 | 6204 | 1    |      | 100.00 |      |      |      |      |      |
| cable shortening defined by force                                 |          |       |      |      |      |      | Fx     |      |      |      |      |      |
| FX0   | FX0 6304 | 05312 | 6304 | 6304 | 1    |      | 100.00 |      |      |      |      |      |

## 5.2.9 Stay Force Application After Clousure

Description: 5 Loads  
5.2 Load Cases

Project No.



Designer: VKS Infratech Management Pvt. Ltd.



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|  |      |      |       |      |      |      |        |      |      |      |      |      |
|--|------|------|-------|------|------|------|--------|------|------|------|------|------|
| <b>load case:</b> CSTF_BS_03<br>Final Stay Cable Force Application - Stage-26c |      |      |       |      |      |      |        |      |      |      |      |      |
| Duration: PERMANENT  |      |      |       |      |      |      |        |      |      |      |      |      |
| LoadInfo: CAB  |      |      |       |      |      |      |        |      |      |      |      |      |
| <b>Loads:</b>  |      |      |       |      |      |      |        |      |      |      |      |      |
|  | LSet | Fact | From  | To   | Step | proj | inp1   | inp2 | inp3 | inp4 | inp5 | inp6 |
| cable shortening defined by force  |      |      |       |      |      |      | Fx     |      |      |      |      |      |
| FX0  | FX0  | 1103 | 93868 | 1103 | 1103 | 1    | 100.00 |      |      |      |      |      |
| cable shortening defined by force  |      |      |       |      |      |      | Fx     |      |      |      |      |      |
| FX0  | FX0  | 1203 | 93868 | 1203 | 1203 | 1    | 100.00 |      |      |      |      |      |
| cable shortening defined by force  |      |      |       |      |      |      | Fx     |      |      |      |      |      |
| FX0  | FX0  | 1703 | 93868 | 1703 | 1703 | 1    | 100.00 |      |      |      |      |      |
| cable shortening defined by force  |      |      |       |      |      |      | Fx     |      |      |      |      |      |
| FX0  | FX0  | 1804 | 93868 | 1804 | 1804 | 1    | 100.00 |      |      |      |      |      |

|  |      |      |        |      |      |      |        |      |      |      |      |      |
|--|------|------|--------|------|------|------|--------|------|------|------|------|------|
| <b>load case:</b> CSTF_MS_03<br>Final Stay Cable Force Application - Stage-26c |      |      |        |      |      |      |        |      |      |      |      |      |
| Duration: PERMANENT  |      |      |        |      |      |      |        |      |      |      |      |      |
| LoadInfo: CAB  |      |      |        |      |      |      |        |      |      |      |      |      |
| <b>Loads:</b>  |      |      |        |      |      |      |        |      |      |      |      |      |
|  | LSet | Fact | From   | To   | Step | proj | inp1   | inp2 | inp3 | inp4 | inp5 | inp6 |
| cable shortening defined by force  |      |      |        |      |      |      | Fx     |      |      |      |      |      |
| FX0  | FX0  | 1303 | 079784 | 1303 | 1303 | 1    | 100.00 |      |      |      |      |      |
| cable shortening defined by force  |      |      |        |      |      |      | Fx     |      |      |      |      |      |
| FX0  | FX0  | 1403 | 079784 | 1403 | 1403 | 1    | 100.00 |      |      |      |      |      |
| cable shortening defined by force  |      |      |        |      |      |      | Fx     |      |      |      |      |      |
| FX0  | FX0  | 1503 | 079784 | 1503 | 1503 | 1    | 100.00 |      |      |      |      |      |
| cable shortening defined by force  |      |      |        |      |      |      | Fx     |      |      |      |      |      |
| FX0  | FX0  | 1603 | 079784 | 1603 | 1603 | 1    | 100.00 |      |      |      |      |      |

|  |      |      |       |      |      |      |        |      |      |      |      |      |
|--|------|------|-------|------|------|------|--------|------|------|------|------|------|
| <b>load case:</b> CSTF_BS_04<br>Final Stay Cable Force Application - Stage-26c |      |      |       |      |      |      |        |      |      |      |      |      |
| Duration: PERMANENT  |      |      |       |      |      |      |        |      |      |      |      |      |
| LoadInfo: CAB  |      |      |       |      |      |      |        |      |      |      |      |      |
| <b>Loads:</b>  |      |      |       |      |      |      |        |      |      |      |      |      |
|  | LSet | Fact | From  | To   | Step | proj | inp1   | inp2 | inp3 | inp4 | inp5 | inp6 |
| cable shortening defined by force  |      |      |       |      |      |      | Fx     |      |      |      |      |      |
| FX0  | FX0  | 1104 | 99980 | 1104 | 1104 | 1    | 100.00 |      |      |      |      |      |
| cable shortening defined by force  |      |      |       |      |      |      | Fx     |      |      |      |      |      |
| FX0  | FX0  | 1204 | 99980 | 1204 | 1204 | 1    | 100.00 |      |      |      |      |      |
| cable shortening defined by force  |      |      |       |      |      |      | Fx     |      |      |      |      |      |
| FX0  | FX0  | 1704 | 99980 | 1704 | 1704 | 1    | 100.00 |      |      |      |      |      |
| cable shortening defined by force  |      |      |       |      |      |      | Fx     |      |      |      |      |      |
| FX0  | FX0  | 1804 | 99980 | 1804 | 1804 | 1    | 100.00 |      |      |      |      |      |

Description: 5 Loads  
5.2 Load Cases

Project No.

Designer: VKS Infratech Management Pvt. Ltd.



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project Arunachal Extradosed 63m+260m+63m

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|  |      |      |       |      |      |      |        |      |      |      |      |      |
|--|------|------|-------|------|------|------|--------|------|------|------|------|------|
| <b>load case:</b> CSTF_MS_04<br>Final Stay Cable Force Application - Stage-26c |      |      |       |      |      |      |        |      |      |      |      |      |
| Duration: PERMANENT  |      |      |       |      |      |      |        |      |      |      |      |      |
| LoadInfo: CAB  |      |      |       |      |      |      |        |      |      |      |      |      |
| <b>Loads:</b>  |      |      |       |      |      |      |        |      |      |      |      |      |
|  | LSet | Fact | From  | To   | Step | proj | inp1   | inp2 | inp3 | inp4 | inp5 | inp6 |
| cable shortening defined by force  |      |      |       |      |      |      | Fx     |      |      |      |      |      |
| FX0  | FX0  | 1304 | 08529 | 1304 | 1304 | 1    | 100.00 |      |      |      |      |      |
| cable shortening defined by force  |      |      |       |      |      |      | Fx     |      |      |      |      |      |
| FX0  | FX0  | 1404 | 08529 | 1404 | 1404 | 1    | 100.00 |      |      |      |      |      |
| cable shortening defined by force  |      |      |       |      |      |      | Fx     |      |      |      |      |      |
| FX0  | FX0  | 1504 | 08529 | 1504 | 1504 | 1    | 100.00 |      |      |      |      |      |
| cable shortening defined by force  |      |      |       |      |      |      | Fx     |      |      |      |      |      |
| FX0  | FX0  | 1604 | 08529 | 1604 | 1604 | 1    | 100.00 |      |      |      |      |      |

|  |      |      |       |      |      |      |        |      |      |      |      |      |
|--|------|------|-------|------|------|------|--------|------|------|------|------|------|
| <b>load case:</b> CSTF_BS_05<br>Final Stay Cable Force Application - Stage-26c |      |      |       |      |      |      |        |      |      |      |      |      |
| Duration: PERMANENT  |      |      |       |      |      |      |        |      |      |      |      |      |
| LoadInfo: CAB  |      |      |       |      |      |      |        |      |      |      |      |      |
| <b>Loads:</b>  |      |      |       |      |      |      |        |      |      |      |      |      |
|  | LSet | Fact | From  | To   | Step | proj | inp1   | inp2 | inp3 | inp4 | inp5 | inp6 |
| cable shortening defined by force  |      |      |       |      |      |      | Fx     |      |      |      |      |      |
| FX0  | FX0  | 1105 | 80971 | 1105 | 1105 | 1    | 100.00 |      |      |      |      |      |
| cable shortening defined by force  |      |      |       |      |      |      | Fx     |      |      |      |      |      |
| FX0  | FX0  | 1205 | 80971 | 1205 | 1205 | 1    | 100.00 |      |      |      |      |      |
| cable shortening defined by force  |      |      |       |      |      |      | Fx     |      |      |      |      |      |
| FX0  | FX0  | 1705 | 80971 | 1705 | 1705 | 1    | 100.00 |      |      |      |      |      |
| cable shortening defined by force  |      |      |       |      |      |      | Fx     |      |      |      |      |      |
| FX0  | FX0  | 1805 | 80971 | 1805 | 1805 | 1    | 100.00 |      |      |      |      |      |

|  |      |      |       |      |      |      |        |      |      |      |      |      |
|--|------|------|-------|------|------|------|--------|------|------|------|------|------|
| <b>load case:</b> CSTF_MS_05<br>Final Stay Cable Force Application - Stage-26c |      |      |       |      |      |      |        |      |      |      |      |      |
| Duration: PERMANENT  |      |      |       |      |      |      |        |      |      |      |      |      |
| LoadInfo: CAB  |      |      |       |      |      |      |        |      |      |      |      |      |
| <b>Loads:</b>  |      |      |       |      |      |      |        |      |      |      |      |      |
|  | LSet | Fact | From  | To   | Step | proj | inp1   | inp2 | inp3 | inp4 | inp5 | inp6 |
| cable shortening defined by force  |      |      |       |      |      |      | Fx     |      |      |      |      |      |
| FX0  | FX0  | 1305 | 38402 | 1305 | 1305 | 1    | 100.00 |      |      |      |      |      |
| cable shortening defined by force  |      |      |       |      |      |      | Fx     |      |      |      |      |      |
| FX0  | FX0  | 1405 | 38402 | 1405 | 1405 | 1    | 100.00 |      |      |      |      |      |
| cable shortening defined by force  |      |      |       |      |      |      | Fx     |      |      |      |      |      |
| FX0  | FX0  | 1505 | 38402 | 1505 | 1505 | 1    | 100.00 |      |      |      |      |      |
| cable shortening defined by force  |      |      |       |      |      |      | Fx     |      |      |      |      |      |
| FX0  | FX0  | 1605 | 38402 | 1605 | 1605 | 1    | 100.00 |      |      |      |      |      |

Description: 5 Loads  
5.2 Load Cases

Project No.

Designer: VKS Infratech Management Pvt. Ltd.

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|  |      |      |       |      |      |      |        |      |      |      |      |      |
|--|------|------|-------|------|------|------|--------|------|------|------|------|------|
| <b>load case:</b> CSTF_BS_06<br>Final Stay Cable Force Application - Stage-26c |      |      |       |      |      |      |        |      |      |      |      |      |
| Duration: PERMANENT  |      |      |       |      |      |      |        |      |      |      |      |      |
| LoadInfo: CAB  |      |      |       |      |      |      |        |      |      |      |      |      |
| <b>Loads:</b>  |      |      |       |      |      |      |        |      |      |      |      |      |
|  | LSet | Fact | From  | To   | Step | proj | inp1   | inp2 | inp3 | inp4 | inp5 | inp6 |
| cable shortening defined by force  |      |      |       |      |      |      | Fx     |      |      |      |      |      |
| FX0  | FX0  | 1106 | 56304 | 1106 | 1106 | 1    | 100.00 |      |      |      |      |      |
| cable shortening defined by force  |      |      |       |      |      |      | Fx     |      |      |      |      |      |
| FX0  | FX0  | 1206 | 56304 | 1206 | 1206 | 1    | 100.00 |      |      |      |      |      |
| cable shortening defined by force  |      |      |       |      |      |      | Fx     |      |      |      |      |      |
| FX0  | FX0  | 1706 | 56304 | 1706 | 1706 | 1    | 100.00 |      |      |      |      |      |
| cable shortening defined by force  |      |      |       |      |      |      | Fx     |      |      |      |      |      |
| FX0  | FX0  | 1806 | 56304 | 1806 | 1806 | 1    | 100.00 |      |      |      |      |      |

|  |      |      |       |      |      |      |        |      |      |      |      |      |
|--|------|------|-------|------|------|------|--------|------|------|------|------|------|
| <b>load case:</b> CSTF_MS_06<br>Final Stay Cable Force Application - Stage-26c |      |      |       |      |      |      |        |      |      |      |      |      |
| Duration: PERMANENT  |      |      |       |      |      |      |        |      |      |      |      |      |
| LoadInfo: CAB  |      |      |       |      |      |      |        |      |      |      |      |      |
| <b>Loads:</b>  |      |      |       |      |      |      |        |      |      |      |      |      |
|  | LSet | Fact | From  | To   | Step | proj | inp1   | inp2 | inp3 | inp4 | inp5 | inp6 |
| cable shortening defined by force  |      |      |       |      |      |      | Fx     |      |      |      |      |      |
| FX0  | FX0  | 1306 | 24138 | 1306 | 1306 | 1    | 100.00 |      |      |      |      |      |
| cable shortening defined by force  |      |      |       |      |      |      | Fx     |      |      |      |      |      |
| FX0  | FX0  | 1406 | 24138 | 1406 | 1406 | 1    | 100.00 |      |      |      |      |      |
| cable shortening defined by force  |      |      |       |      |      |      | Fx     |      |      |      |      |      |
| FX0  | FX0  | 1506 | 24138 | 1506 | 1506 | 1    | 100.00 |      |      |      |      |      |
| cable shortening defined by force  |      |      |       |      |      |      | Fx     |      |      |      |      |      |
| FX0  | FX0  | 1606 | 24138 | 1606 | 1606 | 1    | 100.00 |      |      |      |      |      |

|  |      |      |       |      |      |      |        |      |      |      |      |      |
|--|------|------|-------|------|------|------|--------|------|------|------|------|------|
| <b>load case:</b> CSTF_BS_07<br>Final Stay Cable Force Application - Stage-26c |      |      |       |      |      |      |        |      |      |      |      |      |
| Duration: PERMANENT  |      |      |       |      |      |      |        |      |      |      |      |      |
| LoadInfo: CAB  |      |      |       |      |      |      |        |      |      |      |      |      |
| <b>Loads:</b>  |      |      |       |      |      |      |        |      |      |      |      |      |
|  | LSet | Fact | From  | To   | Step | proj | inp1   | inp2 | inp3 | inp4 | inp5 | inp6 |
| cable shortening defined by force  |      |      |       |      |      |      | Fx     |      |      |      |      |      |
| FX0  | FX0  | 1107 | 05183 | 1107 | 1107 | 1    | 100.00 |      |      |      |      |      |
| cable shortening defined by force  |      |      |       |      |      |      | Fx     |      |      |      |      |      |
| FX0  | FX0  | 1207 | 05183 | 1207 | 1207 | 1    | 100.00 |      |      |      |      |      |
| cable shortening defined by force  |      |      |       |      |      |      | Fx     |      |      |      |      |      |
| FX0  | FX0  | 1707 | 05183 | 1707 | 1707 | 1    | 100.00 |      |      |      |      |      |
| cable shortening defined by force  |      |      |       |      |      |      | Fx     |      |      |      |      |      |
| FX0  | FX0  | 1807 | 05183 | 1807 | 1807 | 1    | 100.00 |      |      |      |      |      |

Description: 5 Loads  
5.2 Load Cases

Project No.

Designer: VKS Infratech Management Pvt. Ltd.



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|  |          |       |      |      |      |      |        |      |      |      |      |      |
|--|----------|-------|------|------|------|------|--------|------|------|------|------|------|
| <b>load case:</b> CSTF_MS_07<br>Final Stay Cable Force Application - Stage-26c |          |       |      |      |      |      |        |      |      |      |      |      |
| Duration: PERMANENT  |          |       |      |      |      |      |        |      |      |      |      |      |
| LoadInfo: CAB  |          |       |      |      |      |      |        |      |      |      |      |      |
| <b>Loads:</b>  |          |       |      |      |      |      |        |      |      |      |      |      |
|  | LSet     | Fact  | From | To   | Step | proj | inp1   | inp2 | inp3 | inp4 | inp5 | inp6 |
| cable shortening defined by force  |          |       |      |      |      |      | Fx     |      |      |      |      |      |
| FX0  | FX0 1307 | 38783 | 1307 | 1307 | 1    |      | 100.00 |      |      |      |      |      |
| cable shortening defined by force  |          |       |      |      |      |      | Fx     |      |      |      |      |      |
| FX0  | FX0 1407 | 38783 | 1407 | 1407 | 1    |      | 100.00 |      |      |      |      |      |
| cable shortening defined by force  |          |       |      |      |      |      | Fx     |      |      |      |      |      |
| FX0  | FX0 1507 | 38783 | 1507 | 1507 | 1    |      | 100.00 |      |      |      |      |      |
| cable shortening defined by force  |          |       |      |      |      |      | Fx     |      |      |      |      |      |
| FX0  | FX0 1607 | 38783 | 1607 | 1607 | 1    |      | 100.00 |      |      |      |      |      |

|  |          |       |      |      |      |      |        |      |      |      |      |      |
|--|----------|-------|------|------|------|------|--------|------|------|------|------|------|
| <b>load case:</b> CSTF_BS_08<br>Final Stay Cable Force Application - Stage-26c |          |       |      |      |      |      |        |      |      |      |      |      |
| Duration: PERMANENT  |          |       |      |      |      |      |        |      |      |      |      |      |
| LoadInfo: CAB  |          |       |      |      |      |      |        |      |      |      |      |      |
| <b>Loads:</b>  |          |       |      |      |      |      |        |      |      |      |      |      |
|  | LSet     | Fact  | From | To   | Step | proj | inp1   | inp2 | inp3 | inp4 | inp5 | inp6 |
| cable shortening defined by force  |          |       |      |      |      |      | Fx     |      |      |      |      |      |
| FX0  | FX0 1108 | 84798 | 1108 | 1108 | 1    |      | 100.00 |      |      |      |      |      |
| cable shortening defined by force  |          |       |      |      |      |      | Fx     |      |      |      |      |      |
| FX0  | FX0 1208 | 84798 | 1208 | 1208 | 1    |      | 100.00 |      |      |      |      |      |
| cable shortening defined by force  |          |       |      |      |      |      | Fx     |      |      |      |      |      |
| FX0  | FX0 1708 | 84798 | 1708 | 1708 | 1    |      | 100.00 |      |      |      |      |      |
| cable shortening defined by force  |          |       |      |      |      |      | Fx     |      |      |      |      |      |
| FX0  | FX0 1808 | 84798 | 1808 | 1808 | 1    |      | 100.00 |      |      |      |      |      |

|  |          |       |      |      |      |      |        |      |      |      |      |      |
|--|----------|-------|------|------|------|------|--------|------|------|------|------|------|
| <b>load case:</b> CSTF_MS_08<br>Final Stay Cable Force Application - Stage-26c |          |       |      |      |      |      |        |      |      |      |      |      |
| Duration: PERMANENT  |          |       |      |      |      |      |        |      |      |      |      |      |
| LoadInfo: CAB  |          |       |      |      |      |      |        |      |      |      |      |      |
| <b>Loads:</b>  |          |       |      |      |      |      |        |      |      |      |      |      |
|  | LSet     | Fact  | From | To   | Step | proj | inp1   | inp2 | inp3 | inp4 | inp5 | inp6 |
| cable shortening defined by force  |          |       |      |      |      |      | Fx     |      |      |      |      |      |
| FX0  | FX0 1308 | 20966 | 1308 | 1308 | 1    |      | 100.00 |      |      |      |      |      |
| cable shortening defined by force  |          |       |      |      |      |      | Fx     |      |      |      |      |      |
| FX0  | FX0 1408 | 20966 | 1408 | 1408 | 1    |      | 100.00 |      |      |      |      |      |
| cable shortening defined by force  |          |       |      |      |      |      | Fx     |      |      |      |      |      |
| FX0  | FX0 1508 | 20966 | 1508 | 1508 | 1    |      | 100.00 |      |      |      |      |      |
| cable shortening defined by force  |          |       |      |      |      |      | Fx     |      |      |      |      |      |
| FX0  | FX0 1608 | 20966 | 1608 | 1608 | 1    |      | 100.00 |      |      |      |      |      |

Description: 5 Loads  
5.2 Load Cases

Project No.

Designer: VKS Infratech Management Pvt. Ltd.



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|  |      |      |       |      |      |      |        |      |      |      |      |      |
|--|------|------|-------|------|------|------|--------|------|------|------|------|------|
| <b>load case:</b> CSTF_BS_09<br>Final Stay Cable Force Application - Stage-26c |      |      |       |      |      |      |        |      |      |      |      |      |
| Duration: PERMANENT  |      |      |       |      |      |      |        |      |      |      |      |      |
| LoadInfo: CAB  |      |      |       |      |      |      |        |      |      |      |      |      |
| <b>Loads:</b>  |      |      |       |      |      |      |        |      |      |      |      |      |
|  | LSet | Fact | From  | To   | Step | proj | inp1   | inp2 | inp3 | inp4 | inp5 | inp6 |
| cable shortening defined by force  |      |      |       |      |      |      | Fx     |      |      |      |      |      |
| FX0  | FX0  | 1109 | 55200 | 1109 | 1109 | 1    | 100.00 |      |      |      |      |      |
| cable shortening defined by force  |      |      |       |      |      |      | Fx     |      |      |      |      |      |
| FX0  | FX0  | 1209 | 55200 | 1209 | 1209 | 1    | 100.00 |      |      |      |      |      |
| cable shortening defined by force  |      |      |       |      |      |      | Fx     |      |      |      |      |      |
| FX0  | FX0  | 1709 | 55200 | 1709 | 1709 | 1    | 100.00 |      |      |      |      |      |
| cable shortening defined by force  |      |      |       |      |      |      | Fx     |      |      |      |      |      |
| FX0  | FX0  | 1809 | 55200 | 1809 | 1809 | 1    | 100.00 |      |      |      |      |      |

|  |      |      |       |      |      |      |        |      |      |      |      |      |
|--|------|------|-------|------|------|------|--------|------|------|------|------|------|
| <b>load case:</b> CSTF_MS_09<br>Final Stay Cable Force Application - Stage-26c |      |      |       |      |      |      |        |      |      |      |      |      |
| Duration: PERMANENT  |      |      |       |      |      |      |        |      |      |      |      |      |
| LoadInfo: CAB  |      |      |       |      |      |      |        |      |      |      |      |      |
| <b>Loads:</b>  |      |      |       |      |      |      |        |      |      |      |      |      |
|  | LSet | Fact | From  | To   | Step | proj | inp1   | inp2 | inp3 | inp4 | inp5 | inp6 |
| cable shortening defined by force  |      |      |       |      |      |      | Fx     |      |      |      |      |      |
| FX0  | FX0  | 1309 | 37386 | 1309 | 1309 | 1    | 100.00 |      |      |      |      |      |
| cable shortening defined by force  |      |      |       |      |      |      | Fx     |      |      |      |      |      |
| FX0  | FX0  | 1409 | 37386 | 1409 | 1409 | 1    | 100.00 |      |      |      |      |      |
| cable shortening defined by force  |      |      |       |      |      |      | Fx     |      |      |      |      |      |
| FX0  | FX0  | 1509 | 37386 | 1509 | 1509 | 1    | 100.00 |      |      |      |      |      |
| cable shortening defined by force  |      |      |       |      |      |      | Fx     |      |      |      |      |      |
| FX0  | FX0  | 1609 | 37386 | 1609 | 1609 | 1    | 100.00 |      |      |      |      |      |

|  |      |      |       |      |      |      |        |      |      |      |      |      |
|--|------|------|-------|------|------|------|--------|------|------|------|------|------|
| <b>load case:</b> CSTF_BS_10<br>Final Stay Cable Force Application - Stage-26c |      |      |       |      |      |      |        |      |      |      |      |      |
| Duration: PERMANENT  |      |      |       |      |      |      |        |      |      |      |      |      |
| LoadInfo: CAB  |      |      |       |      |      |      |        |      |      |      |      |      |
| <b>Loads:</b>  |      |      |       |      |      |      |        |      |      |      |      |      |
|  | LSet | Fact | From  | To   | Step | proj | inp1   | inp2 | inp3 | inp4 | inp5 | inp6 |
| cable shortening defined by force  |      |      |       |      |      |      | Fx     |      |      |      |      |      |
| FX0  | FX0  | 1110 | 02593 | 1110 | 1110 | 1    | 100.00 |      |      |      |      |      |
| cable shortening defined by force  |      |      |       |      |      |      | Fx     |      |      |      |      |      |
| FX0  | FX0  | 1210 | 02593 | 1210 | 1210 | 1    | 100.00 |      |      |      |      |      |
| cable shortening defined by force  |      |      |       |      |      |      | Fx     |      |      |      |      |      |
| FX0  | FX0  | 1710 | 02593 | 1710 | 1710 | 1    | 100.00 |      |      |      |      |      |
| cable shortening defined by force  |      |      |       |      |      |      | Fx     |      |      |      |      |      |
| FX0  | FX0  | 1810 | 02593 | 1810 | 1810 | 1    | 100.00 |      |      |      |      |      |

Description: 5 Loads  
5.2 Load Cases

Project No.



|  |      |      |       |      |      |      |        |      |      |      |      |      |
|--|------|------|-------|------|------|------|--------|------|------|------|------|------|
| <b>load case:</b> CSTF_MS_10<br>Final Stay Cable Force Application - Stage-26c |      |      |       |      |      |      |        |      |      |      |      |      |
| Duration: PERMANENT  |      |      |       |      |      |      |        |      |      |      |      |      |
| LoadInfo: CAB  |      |      |       |      |      |      |        |      |      |      |      |      |
| <b>Loads:</b>  |      |      |       |      |      |      |        |      |      |      |      |      |
|  | LSet | Fact | From  | To   | Step | proj | inp1   | inp2 | inp3 | inp4 | inp5 | inp6 |
| cable shortening defined by force  |      |      |       |      |      |      | Fx     |      |      |      |      |      |
| FX0  | FX0  | 1310 | 03170 | 1310 | 1310 | 1    | 100.00 |      |      |      |      |      |
| cable shortening defined by force  |      |      |       |      |      |      | Fx     |      |      |      |      |      |
| FX0  | FX0  | 1410 | 03170 | 1410 | 1410 | 1    | 100.00 |      |      |      |      |      |
| cable shortening defined by force  |      |      |       |      |      |      | Fx     |      |      |      |      |      |
| FX0  | FX0  | 1510 | 03170 | 1510 | 1510 | 1    | 100.00 |      |      |      |      |      |
| cable shortening defined by force  |      |      |       |      |      |      | Fx     |      |      |      |      |      |
| FX0  | FX0  | 1610 | 03170 | 1610 | 1610 | 1    | 100.00 |      |      |      |      |      |

|  |      |      |       |      |      |      |        |      |      |      |      |      |
|--|------|------|-------|------|------|------|--------|------|------|------|------|------|
| <b>load case:</b> CSTF_BS_11<br>Final Stay Cable Force Application - Stage-26c |      |      |       |      |      |      |        |      |      |      |      |      |
| Duration: PERMANENT  |      |      |       |      |      |      |        |      |      |      |      |      |
| LoadInfo: CAB  |      |      |       |      |      |      |        |      |      |      |      |      |
| <b>Loads:</b>  |      |      |       |      |      |      |        |      |      |      |      |      |
|  | LSet | Fact | From  | To   | Step | proj | inp1   | inp2 | inp3 | inp4 | inp5 | inp6 |
| cable shortening defined by force  |      |      |       |      |      |      | Fx     |      |      |      |      |      |
| FX0  | FX0  | 1111 | 27357 | 1111 | 1111 | 1    | 100.00 |      |      |      |      |      |
| cable shortening defined by force  |      |      |       |      |      |      | Fx     |      |      |      |      |      |
| FX0  | FX0  | 1211 | 27357 | 1211 | 1211 | 1    | 100.00 |      |      |      |      |      |
| cable shortening defined by force  |      |      |       |      |      |      | Fx     |      |      |      |      |      |
| FX0  | FX0  | 1711 | 27357 | 1711 | 1711 | 1    | 100.00 |      |      |      |      |      |
| cable shortening defined by force  |      |      |       |      |      |      | Fx     |      |      |      |      |      |
| FX0  | FX0  | 1811 | 27357 | 1811 | 1811 | 1    | 100.00 |      |      |      |      |      |

|  |      |      |       |      |      |      |        |      |      |      |      |      |
|--|------|------|-------|------|------|------|--------|------|------|------|------|------|
| <b>load case:</b> CSTF_MS_11<br>Final Stay Cable Force Application - Stage-26c |      |      |       |      |      |      |        |      |      |      |      |      |
| Duration: PERMANENT  |      |      |       |      |      |      |        |      |      |      |      |      |
| LoadInfo: CAB  |      |      |       |      |      |      |        |      |      |      |      |      |
| <b>Loads:</b>  |      |      |       |      |      |      |        |      |      |      |      |      |
|  | LSet | Fact | From  | To   | Step | proj | inp1   | inp2 | inp3 | inp4 | inp5 | inp6 |
| cable shortening defined by force  |      |      |       |      |      |      | Fx     |      |      |      |      |      |
| FX0  | FX0  | 1311 | 36796 | 1311 | 1311 | 1    | 100.00 |      |      |      |      |      |
| cable shortening defined by force  |      |      |       |      |      |      | Fx     |      |      |      |      |      |
| FX0  | FX0  | 1411 | 36796 | 1411 | 1411 | 1    | 100.00 |      |      |      |      |      |
| cable shortening defined by force  |      |      |       |      |      |      | Fx     |      |      |      |      |      |
| FX0  | FX0  | 1511 | 36796 | 1511 | 1511 | 1    | 100.00 |      |      |      |      |      |
| cable shortening defined by force  |      |      |       |      |      |      | Fx     |      |      |      |      |      |
| FX0  | FX0  | 1611 | 36796 | 1611 | 1611 | 1    | 100.00 |      |      |      |      |      |

## 5.2.10 SIDL

Description: 5 Loads  
5.2 Load Cases

Project No.



|   |         |      |      |     |      |      |      |       |      |      |       |      |
|---|---------|------|------|-----|------|------|------|-------|------|------|-------|------|
| <b>load case:</b> SD<br>Weight of Crash Barrier And Railing |         |      |      |     |      |      |      |       |      |      |       |      |
| Duration: PERMANENT   |         |      |      |     |      |      |      |       |      |      |       |      |
| LoadInfo: SD  |         |      |      |     |      |      |      |       |      |      |       |      |
| <b>Loads:</b>   |         |      |      |     |      |      |      |       |      |      |       |      |
|   | LSet    | Fact | From | To  | Step | proj | inp1 | inp2  | inp3 | inp4 | inp5  | inp6 |
| eccentric uniform load (global) plus member eccentricity    |         |      |      |     |      | p    | Qx   | Qy    | Qz   | Ey   | Ez    |      |
| QEXG  | no LSet |      | 101  | 216 | 1    | 0.00 | 0.00 | -7.50 | 0.00 | 0.00 | 6.45  |      |
| QEXG  | no LSet |      | 101  | 216 | 1    | 0.00 | 0.00 | -2.00 | 0.00 | 0.00 | -4.50 |      |
| QEXG  | no LSet |      | 101  | 216 | 1    | 0.00 | 0.00 | -7.50 | 0.00 | 0.00 | -6.45 |      |

|   |         |      |      |     |      |      |      |       |      |      |      |      |
|---|---------|------|------|-----|------|------|------|-------|------|------|------|------|
| <b>load case:</b> SDS<br>Weight of Wearing Course |         |      |      |     |      |      |      |       |      |      |      |      |
| Duration: PERMANENT                               |         |      |      |     |      |      |      |       |      |      |      |      |
| LoadInfo: SDS                                     |         |      |      |     |      |      |      |       |      |      |      |      |
| <b>Loads:</b>                                     |         |      |      |     |      |      |      |       |      |      |      |      |
|   | LSet    | Fact | From | To  | Step | proj | inp1 | inp2  | inp3 | inp4 | inp5 | inp6 |
| centric uniform load (global)                     |         |      |      |     |      | p    | Qx   | Qy    | Qz   |      |      |      |
| QG  | no LSet |      | 101  | 216 | 1    | 4.00 | 0.00 | -1.88 | 0.00 |      |      |      |

## 5.2.11 Overall Temperature

|   |         |      |      |     |      |      |          |       |      |      |      |      |
|---|---------|------|------|-----|------|------|----------|-------|------|------|------|------|
| <b>load case:</b> OT+28<br>Uniform Temperature Rise |         |      |      |     |      |      |          |       |      |      |      |      |
| Duration: NONPERMANENT                              |         |      |      |     |      |      |          |       |      |      |      |      |
| LoadInfo:   |         |      |      |     |      |      |          |       |      |      |      |      |
| <b>Loads:</b>                                       |         |      |      |     |      |      |          |       |      |      |      |      |
|   | LSet    | Fact | From | To  | Step | proj | inp1     | inp2  | inp3 | inp4 | inp5 | inp6 |
| temperature   |         |      |      |     |      |      | Alpha    | DT-G  | DT-Y | H-Y  | DT-Z | H-Z  |
| T   | no LSet |      | 101  | 216 | 1    |      | 0.00e+00 | 32.00 | 0.00 | 0.00 | 0.00 | 0.00 |

|   |         |      |      |     |      |      |          |        |      |      |      |      |
|---|---------|------|------|-----|------|------|----------|--------|------|------|------|------|
| <b>load case:</b> OT-28<br>Uniform Temperature Fall |         |      |      |     |      |      |          |        |      |      |      |      |
| Duration: NONPERMANENT                              |         |      |      |     |      |      |          |        |      |      |      |      |
| LoadInfo:   |         |      |      |     |      |      |          |        |      |      |      |      |
| <b>Loads:</b>                                       |         |      |      |     |      |      |          |        |      |      |      |      |
|   | LSet    | Fact | From | To  | Step | proj | inp1     | inp2   | inp3 | inp4 | inp5 | inp6 |
| temperature   |         |      |      |     |      |      | Alpha    | DT-G   | DT-Y | H-Y  | DT-Z | H-Z  |
| T   | no LSet |      | 101  | 216 | 1    |      | 0.00e+00 | -32.00 | 0.00 | 0.00 | 0.00 | 0.00 |

## 5.2.12 Temperature Gradient



|   |         |      |      |     |      |      |      |      |      |      |      |      |
|---|---------|------|------|-----|------|------|------|------|------|------|------|------|
| <b>load case:</b> TPR<br>Differential Temperature Rise Case |         |      |      |     |      |      |      |      |      |      |      |      |
| Duration: NONPERMANENT                                      |         |      |      |     |      |      |      |      |      |      |      |      |
| LoadInfo:   |         |      |      |     |      |      |      |      |      |      |      |      |
| <b>Loads:</b>   |         |      |      |     |      |      |      |      |      |      |      |      |
|   | LSet    | Fact | From | To  | Step | proj | inp1 | inp2 | inp3 | inp4 | inp5 | inp6 |
| TNLIN   | no LSet |      | 101  | 216 | 1    | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

|   |         |      |      |     |      |      |      |      |      |      |      |      |
|---|---------|------|------|-----|------|------|------|------|------|------|------|------|
| <b>load case:</b> TPF<br>Differential Temperature Fall Case |         |      |      |     |      |      |      |      |      |      |      |      |
| Duration: NONPERMANENT                                      |         |      |      |     |      |      |      |      |      |      |      |      |
| LoadInfo:   |         |      |      |     |      |      |      |      |      |      |      |      |
| <b>Loads:</b>   |         |      |      |     |      |      |      |      |      |      |      |      |
|   | LSet    | Fact | From | To  | Step | proj | inp1 | inp2 | inp3 | inp4 | inp5 | inp6 |
| TNLIN   | no LSet |      | 101  | 216 | 1    | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

### 5.2.13 Diffretial Settlement

|   |         |      |      |      |      |      |      |      |      |      |      |      |
|---|---------|------|------|------|------|------|------|------|------|------|------|------|
| <b>load case:</b> DFST-1<br>Settlement of Support 1 |         |      |      |      |      |      |      |      |      |      |      |      |
| Duration: NONPERMANENT                              |         |      |      |      |      |      |      |      |      |      |      |      |
| LoadInfo:   |         |      |      |      |      |      |      |      |      |      |      |      |
| <b>Loads:</b>                                       |         |      |      |      |      |      |      |      |      |      |      |      |
|   | LSet    | Fact | From | To   | Step | proj | inp1 | inp2 | inp3 | inp4 | inp5 | inp6 |
| prescribed displacement, begin. node (global)       |         |      |      |      |      | p    | Vx   | Vy   | Vz   | Rx   | Ry   | Rz   |
| DGB   | no LSet |      | 1000 | 1000 | 1    | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 |

|   |         |      |      |      |      |      |      |      |      |      |      |      |
|---|---------|------|------|------|------|------|------|------|------|------|------|------|
| <b>load case:</b> DFST-2<br>Settlement of Support 2 |         |      |      |      |      |      |      |      |      |      |      |      |
| Duration: NONPERMANENT                              |         |      |      |      |      |      |      |      |      |      |      |      |
| LoadInfo:   |         |      |      |      |      |      |      |      |      |      |      |      |
| <b>Loads:</b>                                       |         |      |      |      |      |      |      |      |      |      |      |      |
|   | LSet    | Fact | From | To   | Step | proj | inp1 | inp2 | inp3 | inp4 | inp5 | inp6 |
| prescribed displacement, begin. node (global)       |         |      |      |      |      | p    | Vx   | Vy   | Vz   | Rx   | Ry   | Rz   |
| DGB   | no LSet |      | 2000 | 2000 | 1    | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 |

|   |         |      |      |      |      |      |      |      |      |      |      |      |
|---|---------|------|------|------|------|------|------|------|------|------|------|------|
| <b>load case:</b> DFST-3<br>Settlement of Support 3 |         |      |      |      |      |      |      |      |      |      |      |      |
| Duration: NONPERMANENT                              |         |      |      |      |      |      |      |      |      |      |      |      |
| LoadInfo:   |         |      |      |      |      |      |      |      |      |      |      |      |
| <b>Loads:</b>                                       |         |      |      |      |      |      |      |      |      |      |      |      |
|   | LSet    | Fact | From | To   | Step | proj | inp1 | inp2 | inp3 | inp4 | inp5 | inp6 |
| prescribed displacement, begin. node (global)       |         |      |      |      |      | p    | Vx   | Vy   | Vz   | Rx   | Ry   | Rz   |
| DGB   | no LSet |      | 3000 | 3000 | 1    | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 |





|   |         |      |      |      |      |      |      |      |      |      |      |      |
|---|---------|------|------|------|------|------|------|------|------|------|------|------|
| <b>load case:</b> DFST-4<br>Settlement of Support 4 |         |      |      |      |      |      |      |      |      |      |      |      |
| Duration: NONPERMANENT                              |         |      |      |      |      |      |      |      |      |      |      |      |
| LoadInfo:   |         |      |      |      |      |      |      |      |      |      |      |      |
| <b>Loads:</b>                                       |         |      |      |      |      |      |      |      |      |      |      |      |
|   | LSet    | Fact | From | To   | Step | proj | inp1 | inp2 | inp3 | inp4 | inp5 | inp6 |
| prescribed displacement, begin. node (global)       |         |      |      |      |      | p    | Vx   | Vy   | Vz   | Rx   | Ry   | Rz   |
| DGB   | no LSet |      | 4000 | 4000 | 1    | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 |

## 5.2.14 Wind Load

|   |         |      |      |      |      |      |      |      |      |      |      |      |
|---|---------|------|------|------|------|------|------|------|------|------|------|------|
| <b>load case:</b> Wind_P_T<br>Wind Load on Pylon Transverse |         |      |      |      |      |      |      |      |      |      |      |      |
| Duration: NONPERMANENT                                      |         |      |      |      |      |      |      |      |      |      |      |      |
| LoadInfo:   |         |      |      |      |      |      |      |      |      |      |      |      |
| <b>Loads:</b>   |         |      |      |      |      |      |      |      |      |      |      |      |
|   | LSet    | Fact | From | To   | Step | proj | inp1 | inp2 | inp3 | inp4 | inp5 | inp6 |
| trapezoidal line load (global)                              |         |      |      |      |      |      |      |      |      |      |      |      |
| TG  | no LSet |      | 2101 | 2101 | 1    | 9.00 | 0.00 | 0.00 | 1.49 | 0.00 | 0.00 | 1.49 |
| TG  | no LSet |      | 2102 | 2102 | 1    | 9.00 | 0.00 | 0.00 | 1.49 | 0.00 | 0.00 | 1.49 |
| TG  | no LSet |      | 2103 | 2103 | 1    | 9.00 | 0.00 | 0.00 | 1.49 | 0.00 | 0.00 | 1.49 |
| TG  | no LSet |      | 2104 | 2104 | 1    | 9.00 | 0.00 | 0.00 | 1.49 | 0.00 | 0.00 | 1.52 |
| TG  | no LSet |      | 2105 | 2105 | 1    | 9.00 | 0.00 | 0.00 | 1.52 | 0.00 | 0.00 | 1.68 |
| TG  | no LSet |      | 2106 | 2106 | 1    | 9.00 | 0.00 | 0.00 | 1.68 | 0.00 | 0.00 | 1.84 |
| TG  | no LSet |      | 2107 | 2107 | 1    | 9.00 | 0.00 | 0.00 | 1.84 | 0.00 | 0.00 | 1.98 |
| TG  | no LSet |      | 2108 | 2108 | 1    | 9.00 | 0.00 | 0.00 | 1.98 | 0.00 | 0.00 | 2.10 |
| TG  | no LSet |      | 2109 | 2109 | 1    | 9.00 | 0.00 | 0.00 | 2.10 | 0.00 | 0.00 | 2.20 |
| TG  | no LSet |      | 2110 | 2110 | 1    | 9.00 | 0.00 | 0.00 | 2.20 | 0.00 | 0.00 | 2.30 |
| TG  | no LSet |      | 2111 | 2111 | 1    | 9.00 | 0.00 | 0.00 | 2.30 | 0.00 | 0.00 | 2.39 |
| TG  | no LSet |      | 2112 | 2112 | 1    | 9.00 | 0.00 | 0.00 | 2.39 | 0.00 | 0.00 | 2.47 |
| TG  | no LSet |      | 2113 | 2113 | 1    | 9.00 | 0.00 | 0.00 | 2.47 | 0.00 | 0.00 | 2.53 |
| TG  | no LSet |      | 2114 | 2114 | 1    | 9.00 | 0.00 | 0.00 | 2.53 | 0.00 | 0.00 | 2.60 |
| TG  | no LSet |      | 2115 | 2115 | 1    | 9.00 | 0.00 | 0.00 | 2.60 | 0.00 | 0.00 | 2.66 |
| TG  | no LSet |      | 2116 | 2116 | 1    | 9.00 | 0.00 | 0.00 | 2.66 | 0.00 | 0.00 | 2.72 |
| TG  | no LSet |      | 2117 | 2117 | 1    | 9.00 | 0.00 | 0.00 | 2.72 | 0.00 | 0.00 | 2.73 |
| TG  | no LSet |      | 2118 | 2118 | 1    | 9.00 | 0.00 | 0.00 | 2.73 | 0.00 | 0.00 | 2.78 |
| TG  | no LSet |      | 2119 | 2119 | 1    | 9.00 | 0.00 | 0.00 | 2.78 | 0.00 | 0.00 | 2.82 |
| TG  | no LSet |      | 2120 | 2120 | 1    | 9.00 | 0.00 | 0.00 | 2.82 | 0.00 | 0.00 | 2.86 |
| TG  | no LSet |      | 2121 | 2121 | 1    | 9.00 | 0.00 | 0.00 | 2.86 | 0.00 | 0.00 | 2.91 |
| TG  | no LSet |      | 2122 | 2122 | 1    | 9.00 | 0.00 | 0.00 | 2.91 | 0.00 | 0.00 | 2.95 |
| TG  | no LSet |      | 2123 | 2123 | 1    | 9.00 | 0.00 | 0.00 | 2.95 | 0.00 | 0.00 | 3.00 |
| TG  | no LSet |      | 2124 | 2124 | 1    | 9.00 | 0.00 | 0.00 | 3.00 | 0.00 | 0.00 | 3.04 |
| TG  | no LSet |      | 2125 | 2125 | 1    | 9.00 | 0.00 | 0.00 | 3.04 | 0.00 | 0.00 | 3.08 |
| TG  | no LSet |      | 2126 | 2126 | 1    | 9.00 | 0.00 | 0.00 | 3.08 | 0.00 | 0.00 | 3.12 |
| TG  | no LSet |      | 2127 | 2127 | 1    | 9.00 | 0.00 | 0.00 | 3.12 | 0.00 | 0.00 | 3.17 |
| TG  | no LSet |      | 2128 | 2128 | 1    | 9.00 | 0.00 | 0.00 | 3.17 | 0.00 | 0.00 | 3.17 |
| TG  | no LSet |      | 2129 | 2129 | 1    | 9.00 | 0.00 | 0.00 | 3.17 | 0.00 | 0.00 | 3.18 |
| TG  | no LSet |      | 2130 | 2130 | 1    | 9.00 | 0.00 | 0.00 | 3.18 | 0.00 | 0.00 | 3.19 |
| TG  | no LSet |      | 2131 | 2131 | 1    | 9.00 | 0.00 | 0.00 | 3.19 | 0.00 | 0.00 | 3.20 |
| TG  | no LSet |      | 2132 | 2132 | 1    | 9.00 | 0.00 | 0.00 | 3.20 | 0.00 | 0.00 | 3.20 |
| TG  | no LSet |      | 2133 | 2133 | 1    | 9.00 | 0.00 | 0.00 | 3.20 | 0.00 | 0.00 | 3.22 |
| TG  | no LSet |      | 2134 | 2134 | 1    | 9.00 | 0.00 | 0.00 | 3.22 | 0.00 | 0.00 | 3.22 |
| TG  | no LSet |      | 2135 | 2135 | 1    | 9.00 | 0.00 | 0.00 | 3.22 | 0.00 | 0.00 | 3.23 |
| TG  | no LSet |      | 2136 | 2136 | 1    | 9.00 | 0.00 | 0.00 | 3.23 | 0.00 | 0.00 | 3.24 |
| TG  | no LSet |      | 2137 | 2137 | 1    | 9.00 | 0.00 | 0.00 | 3.24 | 0.00 | 0.00 | 3.25 |
| TG  | no LSet |      | 2138 | 2138 | 1    | 9.00 | 0.00 | 0.00 | 3.25 | 0.00 | 0.00 | 3.25 |
| TG  | no LSet |      | 2139 | 2139 | 1    | 9.00 | 0.00 | 0.00 | 3.25 | 0.00 | 0.00 | 3.27 |
| TG  | no LSet |      | 2140 | 2140 | 1    | 9.00 | 0.00 | 0.00 | 3.27 | 0.00 | 0.00 | 3.27 |
| TG  | no LSet |      | 2141 | 2141 | 1    | 9.00 | 0.00 | 0.00 | 3.27 | 0.00 | 0.00 | 3.28 |
| TG  | no LSet |      | 2142 | 2142 | 1    | 9.00 | 0.00 | 0.00 | 3.28 | 0.00 | 0.00 | 3.29 |
| TG  | no LSet |      | 2143 | 2143 | 1    | 9.00 | 0.00 | 0.00 | 3.29 | 0.00 | 0.00 | 3.30 |
| TG  | no LSet |      | 2144 | 2144 | 1    | 9.00 | 0.00 | 0.00 | 3.30 | 0.00 | 0.00 | 3.31 |

Description: 5 Loads  
5.2 Load Cases

Project No.



| <b>load case:</b> Wind_P_T<br>Wind Load on Pylon Transverse |         |      |      |      |      |      |      |      |      |      |      |      |
|---|---------|------|------|------|------|------|------|------|------|------|------|------|
| Duration: NONPERMANENT                                      |         |      |      |      |      |      |      |      |      |      |      |      |
| LoadInfo:   |         |      |      |      |      |      |      |      |      |      |      |      |
| <b>Loads:</b>   |         |      |      |      |      |      |      |      |      |      |      |      |
|   | LSet    | Fact | From | To   | Step | proj | inp1 | inp2 | inp3 | inp4 | inp5 | inp6 |
| TG  | no LSet |      | 2145 | 2145 | 1    | 9.00 | 0.00 | 0.00 | 3.31 | 0.00 | 0.00 | 3.32 |
| TG  | no LSet |      | 2201 | 2201 | 1    | 9.00 | 0.00 | 0.00 | 1.49 | 0.00 | 0.00 | 1.49 |
| TG  | no LSet |      | 2202 | 2202 | 1    | 9.00 | 0.00 | 0.00 | 1.49 | 0.00 | 0.00 | 1.49 |
| TG  | no LSet |      | 2203 | 2203 | 1    | 9.00 | 0.00 | 0.00 | 1.49 | 0.00 | 0.00 | 1.49 |
| TG  | no LSet |      | 2204 | 2204 | 1    | 9.00 | 0.00 | 0.00 | 1.49 | 0.00 | 0.00 | 1.52 |
| TG  | no LSet |      | 2205 | 2205 | 1    | 9.00 | 0.00 | 0.00 | 1.52 | 0.00 | 0.00 | 1.68 |
| TG  | no LSet |      | 2206 | 2206 | 1    | 9.00 | 0.00 | 0.00 | 1.68 | 0.00 | 0.00 | 1.84 |
| TG  | no LSet |      | 2207 | 2207 | 1    | 9.00 | 0.00 | 0.00 | 1.84 | 0.00 | 0.00 | 1.98 |
| TG  | no LSet |      | 2208 | 2208 | 1    | 9.00 | 0.00 | 0.00 | 1.98 | 0.00 | 0.00 | 2.10 |
| TG  | no LSet |      | 2209 | 2209 | 1    | 9.00 | 0.00 | 0.00 | 2.10 | 0.00 | 0.00 | 2.20 |
| TG  | no LSet |      | 2210 | 2210 | 1    | 9.00 | 0.00 | 0.00 | 2.20 | 0.00 | 0.00 | 2.30 |
| TG  | no LSet |      | 2211 | 2211 | 1    | 9.00 | 0.00 | 0.00 | 2.30 | 0.00 | 0.00 | 2.39 |
| TG  | no LSet |      | 2212 | 2212 | 1    | 9.00 | 0.00 | 0.00 | 2.39 | 0.00 | 0.00 | 2.47 |
| TG  | no LSet |      | 2213 | 2213 | 1    | 9.00 | 0.00 | 0.00 | 2.47 | 0.00 | 0.00 | 2.53 |
| TG  | no LSet |      | 2214 | 2214 | 1    | 9.00 | 0.00 | 0.00 | 2.53 | 0.00 | 0.00 | 2.60 |
| TG  | no LSet |      | 2215 | 2215 | 1    | 9.00 | 0.00 | 0.00 | 2.60 | 0.00 | 0.00 | 2.66 |
| TG  | no LSet |      | 2216 | 2216 | 1    | 9.00 | 0.00 | 0.00 | 2.66 | 0.00 | 0.00 | 2.72 |
| TG  | no LSet |      | 2217 | 2217 | 1    | 9.00 | 0.00 | 0.00 | 2.72 | 0.00 | 0.00 | 2.73 |
| TG  | no LSet |      | 2218 | 2218 | 1    | 9.00 | 0.00 | 0.00 | 2.73 | 0.00 | 0.00 | 2.78 |
| TG  | no LSet |      | 2219 | 2219 | 1    | 9.00 | 0.00 | 0.00 | 2.78 | 0.00 | 0.00 | 2.82 |
| TG  | no LSet |      | 2220 | 2220 | 1    | 9.00 | 0.00 | 0.00 | 2.82 | 0.00 | 0.00 | 2.86 |
| TG  | no LSet |      | 2221 | 2221 | 1    | 9.00 | 0.00 | 0.00 | 2.86 | 0.00 | 0.00 | 2.91 |
| TG  | no LSet |      | 2222 | 2222 | 1    | 9.00 | 0.00 | 0.00 | 2.91 | 0.00 | 0.00 | 2.95 |
| TG  | no LSet |      | 2223 | 2223 | 1    | 9.00 | 0.00 | 0.00 | 2.95 | 0.00 | 0.00 | 3.00 |
| TG  | no LSet |      | 2224 | 2224 | 1    | 9.00 | 0.00 | 0.00 | 3.00 | 0.00 | 0.00 | 3.04 |
| TG  | no LSet |      | 2225 | 2225 | 1    | 9.00 | 0.00 | 0.00 | 3.04 | 0.00 | 0.00 | 3.08 |
| TG  | no LSet |      | 2226 | 2226 | 1    | 9.00 | 0.00 | 0.00 | 3.08 | 0.00 | 0.00 | 3.12 |
| TG  | no LSet |      | 2227 | 2227 | 1    | 9.00 | 0.00 | 0.00 | 3.12 | 0.00 | 0.00 | 3.17 |
| TG  | no LSet |      | 2228 | 2228 | 1    | 9.00 | 0.00 | 0.00 | 3.17 | 0.00 | 0.00 | 3.17 |
| TG  | no LSet |      | 2229 | 2229 | 1    | 9.00 | 0.00 | 0.00 | 3.17 | 0.00 | 0.00 | 3.18 |
| TG  | no LSet |      | 2230 | 2230 | 1    | 9.00 | 0.00 | 0.00 | 3.18 | 0.00 | 0.00 | 3.19 |
| TG  | no LSet |      | 2231 | 2231 | 1    | 9.00 | 0.00 | 0.00 | 3.19 | 0.00 | 0.00 | 3.20 |
| TG  | no LSet |      | 2232 | 2232 | 1    | 9.00 | 0.00 | 0.00 | 3.20 | 0.00 | 0.00 | 3.20 |
| TG  | no LSet |      | 2233 | 2233 | 1    | 9.00 | 0.00 | 0.00 | 3.20 | 0.00 | 0.00 | 3.22 |
| TG  | no LSet |      | 2234 | 2234 | 1    | 9.00 | 0.00 | 0.00 | 3.22 | 0.00 | 0.00 | 3.22 |
| TG  | no LSet |      | 2235 | 2235 | 1    | 9.00 | 0.00 | 0.00 | 3.22 | 0.00 | 0.00 | 3.23 |
| TG  | no LSet |      | 2236 | 2236 | 1    | 9.00 | 0.00 | 0.00 | 3.23 | 0.00 | 0.00 | 3.24 |
| TG  | no LSet |      | 2237 | 2237 | 1    | 9.00 | 0.00 | 0.00 | 3.24 | 0.00 | 0.00 | 3.25 |
| TG  | no LSet |      | 2238 | 2238 | 1    | 9.00 | 0.00 | 0.00 | 3.25 | 0.00 | 0.00 | 3.25 |
| TG  | no LSet |      | 2239 | 2239 | 1    | 9.00 | 0.00 | 0.00 | 3.25 | 0.00 | 0.00 | 3.27 |
| TG  | no LSet |      | 2240 | 2240 | 1    | 9.00 | 0.00 | 0.00 | 3.27 | 0.00 | 0.00 | 3.27 |
| TG  | no LSet |      | 2241 | 2241 | 1    | 9.00 | 0.00 | 0.00 | 3.27 | 0.00 | 0.00 | 3.28 |
| TG  | no LSet |      | 2242 | 2242 | 1    | 9.00 | 0.00 | 0.00 | 3.28 | 0.00 | 0.00 | 3.29 |
| TG  | no LSet |      | 2243 | 2243 | 1    | 9.00 | 0.00 | 0.00 | 3.29 | 0.00 | 0.00 | 3.30 |
| TG  | no LSet |      | 2244 | 2244 | 1    | 9.00 | 0.00 | 0.00 | 3.30 | 0.00 | 0.00 | 3.31 |
| TG  | no LSet |      | 2245 | 2245 | 1    | 9.00 | 0.00 | 0.00 | 3.31 | 0.00 | 0.00 | 3.32 |
| TG  | no LSet |      | 3101 | 3101 | 1    | 9.00 | 0.00 | 0.00 | 1.49 | 0.00 | 0.00 | 1.49 |
| TG  | no LSet |      | 3102 | 3102 | 1    | 9.00 | 0.00 | 0.00 | 1.49 | 0.00 | 0.00 | 1.49 |
| TG  | no LSet |      | 3103 | 3103 | 1    | 9.00 | 0.00 | 0.00 | 1.49 | 0.00 | 0.00 | 1.49 |
| TG  | no LSet |      | 3104 | 3104 | 1    | 9.00 | 0.00 | 0.00 | 1.49 | 0.00 | 0.00 | 1.52 |
| TG  | no LSet |      | 3105 | 3105 | 1    | 9.00 | 0.00 | 0.00 | 1.52 | 0.00 | 0.00 | 1.68 |
| TG  | no LSet |      | 3106 | 3106 | 1    | 9.00 | 0.00 | 0.00 | 1.68 | 0.00 | 0.00 | 1.84 |
| TG  | no LSet |      | 3107 | 3107 | 1    | 9.00 | 0.00 | 0.00 | 1.84 | 0.00 | 0.00 | 1.98 |
| TG  | no LSet |      | 3108 | 3108 | 1    | 9.00 | 0.00 | 0.00 | 1.98 | 0.00 | 0.00 | 2.10 |
| TG  | no LSet |      | 3109 | 3109 | 1    | 9.00 | 0.00 | 0.00 | 2.10 | 0.00 | 0.00 | 2.20 |
| TG  | no LSet |      | 3110 | 3110 | 1    | 9.00 | 0.00 | 0.00 | 2.20 | 0.00 | 0.00 | 2.30 |
| TG  | no LSet |      | 3111 | 3111 | 1    | 9.00 | 0.00 | 0.00 | 2.30 | 0.00 | 0.00 | 2.39 |

Description: 5 Loads  
5.2 Load Cases

Project No.



| <b>load case:</b> Wind_P_T<br>Wind Load on Pylon Transverse |         |      |      |      |      |      |      |      |      |      |      |      |
|---|---------|------|------|------|------|------|------|------|------|------|------|------|
| Duration: NONPERMANENT                                      |         |      |      |      |      |      |      |      |      |      |      |      |
| LoadInfo:   |         |      |      |      |      |      |      |      |      |      |      |      |
| <b>Loads:</b>   |         |      |      |      |      |      |      |      |      |      |      |      |
|   | LSet    | Fact | From | To   | Step | proj | inp1 | inp2 | inp3 | inp4 | inp5 | inp6 |
| TG  | no LSet |      | 3112 | 3112 | 1    | 9.00 | 0.00 | 0.00 | 2.39 | 0.00 | 0.00 | 2.47 |
| TG  | no LSet |      | 3113 | 3113 | 1    | 9.00 | 0.00 | 0.00 | 2.47 | 0.00 | 0.00 | 2.53 |
| TG  | no LSet |      | 3114 | 3114 | 1    | 9.00 | 0.00 | 0.00 | 2.53 | 0.00 | 0.00 | 2.60 |
| TG  | no LSet |      | 3115 | 3115 | 1    | 9.00 | 0.00 | 0.00 | 2.60 | 0.00 | 0.00 | 2.66 |
| TG  | no LSet |      | 3116 | 3116 | 1    | 9.00 | 0.00 | 0.00 | 2.66 | 0.00 | 0.00 | 2.72 |
| TG  | no LSet |      | 3117 | 3117 | 1    | 9.00 | 0.00 | 0.00 | 2.72 | 0.00 | 0.00 | 2.73 |
| TG  | no LSet |      | 3118 | 3118 | 1    | 9.00 | 0.00 | 0.00 | 2.73 | 0.00 | 0.00 | 2.78 |
| TG  | no LSet |      | 3119 | 3119 | 1    | 9.00 | 0.00 | 0.00 | 2.78 | 0.00 | 0.00 | 2.82 |
| TG  | no LSet |      | 3120 | 3120 | 1    | 9.00 | 0.00 | 0.00 | 2.82 | 0.00 | 0.00 | 2.86 |
| TG  | no LSet |      | 3121 | 3121 | 1    | 9.00 | 0.00 | 0.00 | 2.86 | 0.00 | 0.00 | 2.91 |
| TG  | no LSet |      | 3122 | 3122 | 1    | 9.00 | 0.00 | 0.00 | 2.91 | 0.00 | 0.00 | 2.95 |
| TG  | no LSet |      | 3123 | 3123 | 1    | 9.00 | 0.00 | 0.00 | 2.95 | 0.00 | 0.00 | 3.00 |
| TG  | no LSet |      | 3124 | 3124 | 1    | 9.00 | 0.00 | 0.00 | 3.00 | 0.00 | 0.00 | 3.04 |
| TG  | no LSet |      | 3125 | 3125 | 1    | 9.00 | 0.00 | 0.00 | 3.04 | 0.00 | 0.00 | 3.08 |
| TG  | no LSet |      | 3126 | 3126 | 1    | 9.00 | 0.00 | 0.00 | 3.08 | 0.00 | 0.00 | 3.12 |
| TG  | no LSet |      | 3127 | 3127 | 1    | 9.00 | 0.00 | 0.00 | 3.12 | 0.00 | 0.00 | 3.17 |
| TG  | no LSet |      | 3128 | 3128 | 1    | 9.00 | 0.00 | 0.00 | 3.17 | 0.00 | 0.00 | 3.17 |
| TG  | no LSet |      | 3129 | 3129 | 1    | 9.00 | 0.00 | 0.00 | 3.17 | 0.00 | 0.00 | 3.18 |
| TG  | no LSet |      | 3130 | 3130 | 1    | 9.00 | 0.00 | 0.00 | 3.18 | 0.00 | 0.00 | 3.19 |
| TG  | no LSet |      | 3131 | 3131 | 1    | 9.00 | 0.00 | 0.00 | 3.19 | 0.00 | 0.00 | 3.20 |
| TG  | no LSet |      | 3132 | 3132 | 1    | 9.00 | 0.00 | 0.00 | 3.20 | 0.00 | 0.00 | 3.20 |
| TG  | no LSet |      | 3133 | 3133 | 1    | 9.00 | 0.00 | 0.00 | 3.20 | 0.00 | 0.00 | 3.22 |
| TG  | no LSet |      | 3134 | 3134 | 1    | 9.00 | 0.00 | 0.00 | 3.22 | 0.00 | 0.00 | 3.22 |
| TG  | no LSet |      | 3135 | 3135 | 1    | 9.00 | 0.00 | 0.00 | 3.22 | 0.00 | 0.00 | 3.23 |
| TG  | no LSet |      | 3136 | 3136 | 1    | 9.00 | 0.00 | 0.00 | 3.23 | 0.00 | 0.00 | 3.24 |
| TG  | no LSet |      | 3137 | 3137 | 1    | 9.00 | 0.00 | 0.00 | 3.24 | 0.00 | 0.00 | 3.25 |
| TG  | no LSet |      | 3138 | 3138 | 1    | 9.00 | 0.00 | 0.00 | 3.25 | 0.00 | 0.00 | 3.25 |
| TG  | no LSet |      | 3139 | 3139 | 1    | 9.00 | 0.00 | 0.00 | 3.25 | 0.00 | 0.00 | 3.27 |
| TG  | no LSet |      | 3140 | 3140 | 1    | 9.00 | 0.00 | 0.00 | 3.27 | 0.00 | 0.00 | 3.27 |
| TG  | no LSet |      | 3141 | 3141 | 1    | 9.00 | 0.00 | 0.00 | 3.27 | 0.00 | 0.00 | 3.28 |
| TG  | no LSet |      | 3142 | 3142 | 1    | 9.00 | 0.00 | 0.00 | 3.28 | 0.00 | 0.00 | 3.29 |
| TG  | no LSet |      | 3143 | 3143 | 1    | 9.00 | 0.00 | 0.00 | 3.29 | 0.00 | 0.00 | 3.30 |
| TG  | no LSet |      | 3144 | 3144 | 1    | 9.00 | 0.00 | 0.00 | 3.30 | 0.00 | 0.00 | 3.31 |
| TG  | no LSet |      | 3145 | 3145 | 1    | 9.00 | 0.00 | 0.00 | 3.31 | 0.00 | 0.00 | 3.32 |
| TG  | no LSet |      | 3201 | 3201 | 1    | 9.00 | 0.00 | 0.00 | 1.49 | 0.00 | 0.00 | 1.49 |
| TG  | no LSet |      | 3202 | 3202 | 1    | 9.00 | 0.00 | 0.00 | 1.49 | 0.00 | 0.00 | 1.49 |
| TG  | no LSet |      | 3203 | 3203 | 1    | 9.00 | 0.00 | 0.00 | 1.49 | 0.00 | 0.00 | 1.49 |
| TG  | no LSet |      | 3204 | 3204 | 1    | 9.00 | 0.00 | 0.00 | 1.49 | 0.00 | 0.00 | 1.52 |
| TG  | no LSet |      | 3205 | 3205 | 1    | 9.00 | 0.00 | 0.00 | 1.52 | 0.00 | 0.00 | 1.68 |
| TG  | no LSet |      | 3206 | 3206 | 1    | 9.00 | 0.00 | 0.00 | 1.68 | 0.00 | 0.00 | 1.84 |
| TG  | no LSet |      | 3207 | 3207 | 1    | 9.00 | 0.00 | 0.00 | 1.84 | 0.00 | 0.00 | 1.98 |
| TG  | no LSet |      | 3208 | 3208 | 1    | 9.00 | 0.00 | 0.00 | 1.98 | 0.00 | 0.00 | 2.10 |
| TG  | no LSet |      | 3209 | 3209 | 1    | 9.00 | 0.00 | 0.00 | 2.10 | 0.00 | 0.00 | 2.20 |
| TG  | no LSet |      | 3210 | 3210 | 1    | 9.00 | 0.00 | 0.00 | 2.20 | 0.00 | 0.00 | 2.30 |
| TG  | no LSet |      | 3211 | 3211 | 1    | 9.00 | 0.00 | 0.00 | 2.30 | 0.00 | 0.00 | 2.39 |
| TG  | no LSet |      | 3212 | 3212 | 1    | 9.00 | 0.00 | 0.00 | 2.39 | 0.00 | 0.00 | 2.47 |
| TG  | no LSet |      | 3213 | 3213 | 1    | 9.00 | 0.00 | 0.00 | 2.47 | 0.00 | 0.00 | 2.53 |
| TG  | no LSet |      | 3214 | 3214 | 1    | 9.00 | 0.00 | 0.00 | 2.53 | 0.00 | 0.00 | 2.60 |
| TG  | no LSet |      | 3215 | 3215 | 1    | 9.00 | 0.00 | 0.00 | 2.60 | 0.00 | 0.00 | 2.66 |
| TG  | no LSet |      | 3216 | 3216 | 1    | 9.00 | 0.00 | 0.00 | 2.66 | 0.00 | 0.00 | 2.72 |
| TG  | no LSet |      | 3217 | 3217 | 1    | 9.00 | 0.00 | 0.00 | 2.72 | 0.00 | 0.00 | 2.73 |
| TG  | no LSet |      | 3218 | 3218 | 1    | 9.00 | 0.00 | 0.00 | 2.73 | 0.00 | 0.00 | 2.78 |
| TG  | no LSet |      | 3219 | 3219 | 1    | 9.00 | 0.00 | 0.00 | 2.78 | 0.00 | 0.00 | 2.82 |
| TG  | no LSet |      | 3220 | 3220 | 1    | 9.00 | 0.00 | 0.00 | 2.82 | 0.00 | 0.00 | 2.86 |
| TG  | no LSet |      | 3221 | 3221 | 1    | 9.00 | 0.00 | 0.00 | 2.86 | 0.00 | 0.00 | 2.91 |
| TG  | no LSet |      | 3222 | 3222 | 1    | 9.00 | 0.00 | 0.00 | 2.91 | 0.00 | 0.00 | 2.95 |
| TG  | no LSet |      | 3223 | 3223 | 1    | 9.00 | 0.00 | 0.00 | 2.95 | 0.00 | 0.00 | 3.00 |

Description: 5 Loads  
5.2 Load Cases

Project No.



| <b>load case:</b> Wind_P_T<br>Wind Load on Pylon Transverse |         |      |      |      |      |      |      |      |      |      |      |      |
|---|---------|------|------|------|------|------|------|------|------|------|------|------|
| Duration: NONPERMANENT                                      |         |      |      |      |      |      |      |      |      |      |      |      |
| LoadInfo:   |         |      |      |      |      |      |      |      |      |      |      |      |
| <b>Loads:</b>   |         |      |      |      |      |      |      |      |      |      |      |      |
|   | LSet    | Fact | From | To   | Step | proj | inp1 | inp2 | inp3 | inp4 | inp5 | inp6 |
| TG  | no LSet |      | 3224 | 3224 | 1    | 9.00 | 0.00 | 0.00 | 3.00 | 0.00 | 0.00 | 3.04 |
| TG  | no LSet |      | 3225 | 3225 | 1    | 9.00 | 0.00 | 0.00 | 3.04 | 0.00 | 0.00 | 3.08 |
| TG  | no LSet |      | 3226 | 3226 | 1    | 9.00 | 0.00 | 0.00 | 3.08 | 0.00 | 0.00 | 3.12 |
| TG  | no LSet |      | 3227 | 3227 | 1    | 9.00 | 0.00 | 0.00 | 3.12 | 0.00 | 0.00 | 3.17 |
| TG  | no LSet |      | 3228 | 3228 | 1    | 9.00 | 0.00 | 0.00 | 3.17 | 0.00 | 0.00 | 3.17 |
| TG  | no LSet |      | 3229 | 3229 | 1    | 9.00 | 0.00 | 0.00 | 3.17 | 0.00 | 0.00 | 3.18 |
| TG  | no LSet |      | 3230 | 3230 | 1    | 9.00 | 0.00 | 0.00 | 3.18 | 0.00 | 0.00 | 3.19 |
| TG  | no LSet |      | 3231 | 3231 | 1    | 9.00 | 0.00 | 0.00 | 3.19 | 0.00 | 0.00 | 3.20 |
| TG  | no LSet |      | 3232 | 3232 | 1    | 9.00 | 0.00 | 0.00 | 3.20 | 0.00 | 0.00 | 3.20 |
| TG  | no LSet |      | 3233 | 3233 | 1    | 9.00 | 0.00 | 0.00 | 3.20 | 0.00 | 0.00 | 3.22 |
| TG  | no LSet |      | 3234 | 3234 | 1    | 9.00 | 0.00 | 0.00 | 3.22 | 0.00 | 0.00 | 3.22 |
| TG  | no LSet |      | 3235 | 3235 | 1    | 9.00 | 0.00 | 0.00 | 3.22 | 0.00 | 0.00 | 3.23 |
| TG  | no LSet |      | 3236 | 3236 | 1    | 9.00 | 0.00 | 0.00 | 3.23 | 0.00 | 0.00 | 3.24 |
| TG  | no LSet |      | 3237 | 3237 | 1    | 9.00 | 0.00 | 0.00 | 3.24 | 0.00 | 0.00 | 3.25 |
| TG  | no LSet |      | 3238 | 3238 | 1    | 9.00 | 0.00 | 0.00 | 3.25 | 0.00 | 0.00 | 3.25 |
| TG  | no LSet |      | 3239 | 3239 | 1    | 9.00 | 0.00 | 0.00 | 3.25 | 0.00 | 0.00 | 3.27 |
| TG  | no LSet |      | 3240 | 3240 | 1    | 9.00 | 0.00 | 0.00 | 3.27 | 0.00 | 0.00 | 3.27 |
| TG  | no LSet |      | 3241 | 3241 | 1    | 9.00 | 0.00 | 0.00 | 3.27 | 0.00 | 0.00 | 3.28 |
| TG  | no LSet |      | 3242 | 3242 | 1    | 9.00 | 0.00 | 0.00 | 3.28 | 0.00 | 0.00 | 3.29 |
| TG  | no LSet |      | 3243 | 3243 | 1    | 9.00 | 0.00 | 0.00 | 3.29 | 0.00 | 0.00 | 3.30 |
| TG  | no LSet |      | 3244 | 3244 | 1    | 9.00 | 0.00 | 0.00 | 3.30 | 0.00 | 0.00 | 3.31 |
| TG  | no LSet |      | 3245 | 3245 | 1    | 9.00 | 0.00 | 0.00 | 3.31 | 0.00 | 0.00 | 3.32 |

| <b>load case:</b> Wind_P_L<br>Wind Load on Pylon Longitudinal |         |      |      |      |      |      |      |      |      |      |      |      |
|---|---------|------|------|------|------|------|------|------|------|------|------|------|
| Duration: NONPERMANENT  |         |      |      |      |      |      |      |      |      |      |      |      |
| LoadInfo:   |         |      |      |      |      |      |      |      |      |      |      |      |
| <b>Loads:</b>   |         |      |      |      |      |      |      |      |      |      |      |      |
|   | LSet    | Fact | From | To   | Step | proj | inp1 | inp2 | inp3 | inp4 | inp5 | inp6 |
| trapezoidal line load (global)                                |         |      |      |      |      |      |      |      |      |      |      |      |
| TG  | no LSet |      | 2101 | 2101 | 1    | 5.00 | 1.29 | 0.00 | 0.00 | 1.29 | 0.00 | 0.00 |
| TG  | no LSet |      | 2102 | 2102 | 1    | 5.00 | 1.29 | 0.00 | 0.00 | 1.29 | 0.00 | 0.00 |
| TG  | no LSet |      | 2103 | 2103 | 1    | 5.00 | 1.29 | 0.00 | 0.00 | 1.29 | 0.00 | 0.00 |
| TG  | no LSet |      | 2104 | 2104 | 1    | 5.00 | 1.29 | 0.00 | 0.00 | 1.31 | 0.00 | 0.00 |
| TG  | no LSet |      | 2105 | 2105 | 1    | 5.00 | 1.31 | 0.00 | 0.00 | 1.45 | 0.00 | 0.00 |
| TG  | no LSet |      | 2106 | 2106 | 1    | 5.00 | 1.45 | 0.00 | 0.00 | 1.59 | 0.00 | 0.00 |
| TG  | no LSet |      | 2107 | 2107 | 1    | 5.00 | 1.59 | 0.00 | 0.00 | 1.71 | 0.00 | 0.00 |
| TG  | no LSet |      | 2108 | 2108 | 1    | 5.00 | 1.71 | 0.00 | 0.00 | 1.82 | 0.00 | 0.00 |
| TG  | no LSet |      | 2109 | 2109 | 1    | 5.00 | 1.82 | 0.00 | 0.00 | 1.90 | 0.00 | 0.00 |
| TG  | no LSet |      | 2110 | 2110 | 1    | 5.00 | 1.90 | 0.00 | 0.00 | 1.98 | 0.00 | 0.00 |
| TG  | no LSet |      | 2111 | 2111 | 1    | 5.00 | 1.98 | 0.00 | 0.00 | 2.06 | 0.00 | 0.00 |
| TG  | no LSet |      | 2112 | 2112 | 1    | 5.00 | 2.06 | 0.00 | 0.00 | 2.13 | 0.00 | 0.00 |
| TG  | no LSet |      | 2113 | 2113 | 1    | 5.00 | 2.13 | 0.00 | 0.00 | 2.19 | 0.00 | 0.00 |
| TG  | no LSet |      | 2114 | 2114 | 1    | 5.00 | 2.19 | 0.00 | 0.00 | 2.24 | 0.00 | 0.00 |
| TG  | no LSet |      | 2115 | 2115 | 1    | 5.00 | 2.24 | 0.00 | 0.00 | 2.30 | 0.00 | 0.00 |
| TG  | no LSet |      | 2116 | 2116 | 1    | 5.00 | 2.30 | 0.00 | 0.00 | 2.35 | 0.00 | 0.00 |
| TG  | no LSet |      | 2117 | 2117 | 1    | 5.00 | 2.35 | 0.00 | 0.00 | 2.36 | 0.00 | 0.00 |
| TG  | no LSet |      | 2118 | 2118 | 1    | 5.00 | 2.36 | 0.00 | 0.00 | 2.40 | 0.00 | 0.00 |
| TG  | no LSet |      | 2119 | 2119 | 1    | 5.00 | 2.40 | 0.00 | 0.00 | 2.43 | 0.00 | 0.00 |
| TG  | no LSet |      | 2120 | 2120 | 1    | 5.00 | 2.43 | 0.00 | 0.00 | 2.47 | 0.00 | 0.00 |
| TG  | no LSet |      | 2121 | 2121 | 1    | 5.00 | 2.47 | 0.00 | 0.00 | 2.51 | 0.00 | 0.00 |
| TG  | no LSet |      | 2122 | 2122 | 1    | 5.00 | 2.51 | 0.00 | 0.00 | 2.55 | 0.00 | 0.00 |
| TG  | no LSet |      | 2123 | 2123 | 1    | 5.00 | 2.55 | 0.00 | 0.00 | 2.59 | 0.00 | 0.00 |
| TG  | no LSet |      | 2124 | 2124 | 1    | 5.00 | 2.59 | 0.00 | 0.00 | 2.62 | 0.00 | 0.00 |
| TG  | no LSet |      | 2125 | 2125 | 1    | 5.00 | 2.62 | 0.00 | 0.00 | 2.66 | 0.00 | 0.00 |
| TG  | no LSet |      | 2126 | 2126 | 1    | 5.00 | 2.66 | 0.00 | 0.00 | 2.70 | 0.00 | 0.00 |
| TG  | no LSet |      | 2127 | 2127 | 1    | 5.00 | 2.70 | 0.00 | 0.00 | 2.73 | 0.00 | 0.00 |

Description: 5 Loads  
5.2 Load Cases

Project No.



| <b>load case:</b> Wind_P_L<br>Wind Load on Pylon Longitudinal |         |      |      |      |      |      |      |      |      |      |      |      |
|---|---------|------|------|------|------|------|------|------|------|------|------|------|
| Duration: NONPERMANENT  |         |      |      |      |      |      |      |      |      |      |      |      |
| LoadInfo:   |         |      |      |      |      |      |      |      |      |      |      |      |
| <b>Loads:</b>   |         |      |      |      |      |      |      |      |      |      |      |      |
|   | LSet    | Fact | From | To   | Step | proj | inp1 | inp2 | inp3 | inp4 | inp5 | inp6 |
| TG  | no LSet |      | 2128 | 2128 | 1    | 5.00 | 2.73 | 0.00 | 0.00 | 2.74 | 0.00 | 0.00 |
| TG  | no LSet |      | 2129 | 2129 | 1    | 5.00 | 2.74 | 0.00 | 0.00 | 2.75 | 0.00 | 0.00 |
| TG  | no LSet |      | 2130 | 2130 | 1    | 5.00 | 2.75 | 0.00 | 0.00 | 2.75 | 0.00 | 0.00 |
| TG  | no LSet |      | 2131 | 2131 | 1    | 5.00 | 2.75 | 0.00 | 0.00 | 2.76 | 0.00 | 0.00 |
| TG  | no LSet |      | 2132 | 2132 | 1    | 5.00 | 2.76 | 0.00 | 0.00 | 2.77 | 0.00 | 0.00 |
| TG  | no LSet |      | 2133 | 2133 | 1    | 5.00 | 2.77 | 0.00 | 0.00 | 2.78 | 0.00 | 0.00 |
| TG  | no LSet |      | 2134 | 2134 | 1    | 5.00 | 2.78 | 0.00 | 0.00 | 2.78 | 0.00 | 0.00 |
| TG  | no LSet |      | 2135 | 2135 | 1    | 5.00 | 2.78 | 0.00 | 0.00 | 2.79 | 0.00 | 0.00 |
| TG  | no LSet |      | 2136 | 2136 | 1    | 5.00 | 2.79 | 0.00 | 0.00 | 2.80 | 0.00 | 0.00 |
| TG  | no LSet |      | 2137 | 2137 | 1    | 5.00 | 2.80 | 0.00 | 0.00 | 2.81 | 0.00 | 0.00 |
| TG  | no LSet |      | 2138 | 2138 | 1    | 5.00 | 2.81 | 0.00 | 0.00 | 2.81 | 0.00 | 0.00 |
| TG  | no LSet |      | 2139 | 2139 | 1    | 5.00 | 2.81 | 0.00 | 0.00 | 2.82 | 0.00 | 0.00 |
| TG  | no LSet |      | 2140 | 2140 | 1    | 5.00 | 2.82 | 0.00 | 0.00 | 2.83 | 0.00 | 0.00 |
| TG  | no LSet |      | 2141 | 2141 | 1    | 5.00 | 2.83 | 0.00 | 0.00 | 2.84 | 0.00 | 0.00 |
| TG  | no LSet |      | 2142 | 2142 | 1    | 5.00 | 2.84 | 0.00 | 0.00 | 2.84 | 0.00 | 0.00 |
| TG  | no LSet |      | 2143 | 2143 | 1    | 5.00 | 2.84 | 0.00 | 0.00 | 2.85 | 0.00 | 0.00 |
| TG  | no LSet |      | 2144 | 2144 | 1    | 5.00 | 2.85 | 0.00 | 0.00 | 2.85 | 0.00 | 0.00 |
| TG  | no LSet |      | 2145 | 2145 | 1    | 5.00 | 2.85 | 0.00 | 0.00 | 2.87 | 0.00 | 0.00 |
| TG  | no LSet |      | 2201 | 2201 | 1    | 5.00 | 1.29 | 0.00 | 0.00 | 1.29 | 0.00 | 0.00 |
| TG  | no LSet |      | 2202 | 2202 | 1    | 5.00 | 1.29 | 0.00 | 0.00 | 1.29 | 0.00 | 0.00 |
| TG  | no LSet |      | 2203 | 2203 | 1    | 5.00 | 1.29 | 0.00 | 0.00 | 1.29 | 0.00 | 0.00 |
| TG  | no LSet |      | 2204 | 2204 | 1    | 5.00 | 1.29 | 0.00 | 0.00 | 1.31 | 0.00 | 0.00 |
| TG  | no LSet |      | 2205 | 2205 | 1    | 5.00 | 1.31 | 0.00 | 0.00 | 1.45 | 0.00 | 0.00 |
| TG  | no LSet |      | 2206 | 2206 | 1    | 5.00 | 1.45 | 0.00 | 0.00 | 1.59 | 0.00 | 0.00 |
| TG  | no LSet |      | 2207 | 2207 | 1    | 5.00 | 1.59 | 0.00 | 0.00 | 1.71 | 0.00 | 0.00 |
| TG  | no LSet |      | 2208 | 2208 | 1    | 5.00 | 1.71 | 0.00 | 0.00 | 1.82 | 0.00 | 0.00 |
| TG  | no LSet |      | 2209 | 2209 | 1    | 5.00 | 1.82 | 0.00 | 0.00 | 1.90 | 0.00 | 0.00 |
| TG  | no LSet |      | 2210 | 2210 | 1    | 5.00 | 1.90 | 0.00 | 0.00 | 1.98 | 0.00 | 0.00 |
| TG  | no LSet |      | 2211 | 2211 | 1    | 5.00 | 1.98 | 0.00 | 0.00 | 2.06 | 0.00 | 0.00 |
| TG  | no LSet |      | 2212 | 2212 | 1    | 5.00 | 2.06 | 0.00 | 0.00 | 2.13 | 0.00 | 0.00 |
| TG  | no LSet |      | 2213 | 2213 | 1    | 5.00 | 2.13 | 0.00 | 0.00 | 2.19 | 0.00 | 0.00 |
| TG  | no LSet |      | 2214 | 2214 | 1    | 5.00 | 2.19 | 0.00 | 0.00 | 2.24 | 0.00 | 0.00 |
| TG  | no LSet |      | 2215 | 2215 | 1    | 5.00 | 2.24 | 0.00 | 0.00 | 2.30 | 0.00 | 0.00 |
| TG  | no LSet |      | 2216 | 2216 | 1    | 5.00 | 2.30 | 0.00 | 0.00 | 2.35 | 0.00 | 0.00 |
| TG  | no LSet |      | 2217 | 2217 | 1    | 5.00 | 2.35 | 0.00 | 0.00 | 2.36 | 0.00 | 0.00 |
| TG  | no LSet |      | 2218 | 2218 | 1    | 5.00 | 2.36 | 0.00 | 0.00 | 2.40 | 0.00 | 0.00 |
| TG  | no LSet |      | 2219 | 2219 | 1    | 5.00 | 2.40 | 0.00 | 0.00 | 2.43 | 0.00 | 0.00 |
| TG  | no LSet |      | 2220 | 2220 | 1    | 5.00 | 2.43 | 0.00 | 0.00 | 2.47 | 0.00 | 0.00 |
| TG  | no LSet |      | 2221 | 2221 | 1    | 5.00 | 2.47 | 0.00 | 0.00 | 2.51 | 0.00 | 0.00 |
| TG  | no LSet |      | 2222 | 2222 | 1    | 5.00 | 2.51 | 0.00 | 0.00 | 2.55 | 0.00 | 0.00 |
| TG  | no LSet |      | 2223 | 2223 | 1    | 5.00 | 2.55 | 0.00 | 0.00 | 2.59 | 0.00 | 0.00 |
| TG  | no LSet |      | 2224 | 2224 | 1    | 5.00 | 2.59 | 0.00 | 0.00 | 2.62 | 0.00 | 0.00 |
| TG  | no LSet |      | 2225 | 2225 | 1    | 5.00 | 2.62 | 0.00 | 0.00 | 2.66 | 0.00 | 0.00 |
| TG  | no LSet |      | 2226 | 2226 | 1    | 5.00 | 2.66 | 0.00 | 0.00 | 2.70 | 0.00 | 0.00 |
| TG  | no LSet |      | 2227 | 2227 | 1    | 5.00 | 2.70 | 0.00 | 0.00 | 2.73 | 0.00 | 0.00 |
| TG  | no LSet |      | 2228 | 2228 | 1    | 5.00 | 2.73 | 0.00 | 0.00 | 2.74 | 0.00 | 0.00 |
| TG  | no LSet |      | 2229 | 2229 | 1    | 5.00 | 2.74 | 0.00 | 0.00 | 2.75 | 0.00 | 0.00 |
| TG  | no LSet |      | 2230 | 2230 | 1    | 5.00 | 2.75 | 0.00 | 0.00 | 2.75 | 0.00 | 0.00 |
| TG  | no LSet |      | 2231 | 2231 | 1    | 5.00 | 2.75 | 0.00 | 0.00 | 2.76 | 0.00 | 0.00 |
| TG  | no LSet |      | 2232 | 2232 | 1    | 5.00 | 2.76 | 0.00 | 0.00 | 2.77 | 0.00 | 0.00 |
| TG  | no LSet |      | 2233 | 2233 | 1    | 5.00 | 2.77 | 0.00 | 0.00 | 2.78 | 0.00 | 0.00 |
| TG  | no LSet |      | 2234 | 2234 | 1    | 5.00 | 2.78 | 0.00 | 0.00 | 2.78 | 0.00 | 0.00 |
| TG  | no LSet |      | 2235 | 2235 | 1    | 5.00 | 2.78 | 0.00 | 0.00 | 2.79 | 0.00 | 0.00 |
| TG  | no LSet |      | 2236 | 2236 | 1    | 5.00 | 2.79 | 0.00 | 0.00 | 2.80 | 0.00 | 0.00 |
| TG  | no LSet |      | 2237 | 2237 | 1    | 5.00 | 2.80 | 0.00 | 0.00 | 2.81 | 0.00 | 0.00 |
| TG  | no LSet |      | 2238 | 2238 | 1    | 5.00 | 2.81 | 0.00 | 0.00 | 2.81 | 0.00 | 0.00 |
| TG  | no LSet |      | 2239 | 2239 | 1    | 5.00 | 2.81 | 0.00 | 0.00 | 2.82 | 0.00 | 0.00 |

Description: 5 Loads  
5.2 Load Cases

Project No.



| <b>load case:</b> Wind_P_L<br>Wind Load on Pylon Longitudinal |         |      |      |      |      |      |      |      |      |      |      |      |
|---|---------|------|------|------|------|------|------|------|------|------|------|------|
| Duration: NONPERMANENT  |         |      |      |      |      |      |      |      |      |      |      |      |
| LoadInfo:   |         |      |      |      |      |      |      |      |      |      |      |      |
| <b>Loads:</b>   |         |      |      |      |      |      |      |      |      |      |      |      |
|   | LSet    | Fact | From | To   | Step | proj | inp1 | inp2 | inp3 | inp4 | inp5 | inp6 |
| TG  | no LSet |      | 2240 | 2240 | 1    | 5.00 | 2.82 | 0.00 | 0.00 | 2.83 | 0.00 | 0.00 |
| TG  | no LSet |      | 2241 | 2241 | 1    | 5.00 | 2.83 | 0.00 | 0.00 | 2.84 | 0.00 | 0.00 |
| TG  | no LSet |      | 2242 | 2242 | 1    | 5.00 | 2.84 | 0.00 | 0.00 | 2.84 | 0.00 | 0.00 |
| TG  | no LSet |      | 2243 | 2243 | 1    | 5.00 | 2.84 | 0.00 | 0.00 | 2.85 | 0.00 | 0.00 |
| TG  | no LSet |      | 2244 | 2244 | 1    | 5.00 | 2.85 | 0.00 | 0.00 | 2.85 | 0.00 | 0.00 |
| TG  | no LSet |      | 2245 | 2245 | 1    | 5.00 | 2.85 | 0.00 | 0.00 | 2.87 | 0.00 | 0.00 |
| TG  | no LSet |      | 3101 | 3101 | 1    | 5.00 | 1.29 | 0.00 | 0.00 | 1.29 | 0.00 | 0.00 |
| TG  | no LSet |      | 3102 | 3102 | 1    | 5.00 | 1.29 | 0.00 | 0.00 | 1.29 | 0.00 | 0.00 |
| TG  | no LSet |      | 3103 | 3103 | 1    | 5.00 | 1.29 | 0.00 | 0.00 | 1.29 | 0.00 | 0.00 |
| TG  | no LSet |      | 3104 | 3104 | 1    | 5.00 | 1.29 | 0.00 | 0.00 | 1.31 | 0.00 | 0.00 |
| TG  | no LSet |      | 3105 | 3105 | 1    | 5.00 | 1.31 | 0.00 | 0.00 | 1.45 | 0.00 | 0.00 |
| TG  | no LSet |      | 3106 | 3106 | 1    | 5.00 | 1.45 | 0.00 | 0.00 | 1.59 | 0.00 | 0.00 |
| TG  | no LSet |      | 3107 | 3107 | 1    | 5.00 | 1.59 | 0.00 | 0.00 | 1.71 | 0.00 | 0.00 |
| TG  | no LSet |      | 3108 | 3108 | 1    | 5.00 | 1.71 | 0.00 | 0.00 | 1.82 | 0.00 | 0.00 |
| TG  | no LSet |      | 3109 | 3109 | 1    | 5.00 | 1.82 | 0.00 | 0.00 | 1.90 | 0.00 | 0.00 |
| TG  | no LSet |      | 3110 | 3110 | 1    | 5.00 | 1.90 | 0.00 | 0.00 | 1.98 | 0.00 | 0.00 |
| TG  | no LSet |      | 3111 | 3111 | 1    | 5.00 | 1.98 | 0.00 | 0.00 | 2.06 | 0.00 | 0.00 |
| TG  | no LSet |      | 3112 | 3112 | 1    | 5.00 | 2.06 | 0.00 | 0.00 | 2.13 | 0.00 | 0.00 |
| TG  | no LSet |      | 3113 | 3113 | 1    | 5.00 | 2.13 | 0.00 | 0.00 | 2.19 | 0.00 | 0.00 |
| TG  | no LSet |      | 3114 | 3114 | 1    | 5.00 | 2.19 | 0.00 | 0.00 | 2.24 | 0.00 | 0.00 |
| TG  | no LSet |      | 3115 | 3115 | 1    | 5.00 | 2.24 | 0.00 | 0.00 | 2.30 | 0.00 | 0.00 |
| TG  | no LSet |      | 3116 | 3116 | 1    | 5.00 | 2.30 | 0.00 | 0.00 | 2.35 | 0.00 | 0.00 |
| TG  | no LSet |      | 3117 | 3117 | 1    | 5.00 | 2.35 | 0.00 | 0.00 | 2.36 | 0.00 | 0.00 |
| TG  | no LSet |      | 3118 | 3118 | 1    | 5.00 | 2.36 | 0.00 | 0.00 | 2.40 | 0.00 | 0.00 |
| TG  | no LSet |      | 3119 | 3119 | 1    | 5.00 | 2.40 | 0.00 | 0.00 | 2.43 | 0.00 | 0.00 |
| TG  | no LSet |      | 3120 | 3120 | 1    | 5.00 | 2.43 | 0.00 | 0.00 | 2.47 | 0.00 | 0.00 |
| TG  | no LSet |      | 3121 | 3121 | 1    | 5.00 | 2.47 | 0.00 | 0.00 | 2.51 | 0.00 | 0.00 |
| TG  | no LSet |      | 3122 | 3122 | 1    | 5.00 | 2.51 | 0.00 | 0.00 | 2.55 | 0.00 | 0.00 |
| TG  | no LSet |      | 3123 | 3123 | 1    | 5.00 | 2.55 | 0.00 | 0.00 | 2.59 | 0.00 | 0.00 |
| TG  | no LSet |      | 3124 | 3124 | 1    | 5.00 | 2.59 | 0.00 | 0.00 | 2.62 | 0.00 | 0.00 |
| TG  | no LSet |      | 3125 | 3125 | 1    | 5.00 | 2.62 | 0.00 | 0.00 | 2.66 | 0.00 | 0.00 |
| TG  | no LSet |      | 3126 | 3126 | 1    | 5.00 | 2.66 | 0.00 | 0.00 | 2.70 | 0.00 | 0.00 |
| TG  | no LSet |      | 3127 | 3127 | 1    | 5.00 | 2.70 | 0.00 | 0.00 | 2.73 | 0.00 | 0.00 |
| TG  | no LSet |      | 3128 | 3128 | 1    | 5.00 | 2.73 | 0.00 | 0.00 | 2.74 | 0.00 | 0.00 |
| TG  | no LSet |      | 3129 | 3129 | 1    | 5.00 | 2.74 | 0.00 | 0.00 | 2.75 | 0.00 | 0.00 |
| TG  | no LSet |      | 3130 | 3130 | 1    | 5.00 | 2.75 | 0.00 | 0.00 | 2.75 | 0.00 | 0.00 |
| TG  | no LSet |      | 3131 | 3131 | 1    | 5.00 | 2.75 | 0.00 | 0.00 | 2.76 | 0.00 | 0.00 |
| TG  | no LSet |      | 3132 | 3132 | 1    | 5.00 | 2.76 | 0.00 | 0.00 | 2.77 | 0.00 | 0.00 |
| TG  | no LSet |      | 3133 | 3133 | 1    | 5.00 | 2.77 | 0.00 | 0.00 | 2.78 | 0.00 | 0.00 |
| TG  | no LSet |      | 3134 | 3134 | 1    | 5.00 | 2.78 | 0.00 | 0.00 | 2.78 | 0.00 | 0.00 |
| TG  | no LSet |      | 3135 | 3135 | 1    | 5.00 | 2.78 | 0.00 | 0.00 | 2.79 | 0.00 | 0.00 |
| TG  | no LSet |      | 3136 | 3136 | 1    | 5.00 | 2.79 | 0.00 | 0.00 | 2.80 | 0.00 | 0.00 |
| TG  | no LSet |      | 3137 | 3137 | 1    | 5.00 | 2.80 | 0.00 | 0.00 | 2.81 | 0.00 | 0.00 |
| TG  | no LSet |      | 3138 | 3138 | 1    | 5.00 | 2.81 | 0.00 | 0.00 | 2.81 | 0.00 | 0.00 |
| TG  | no LSet |      | 3139 | 3139 | 1    | 5.00 | 2.81 | 0.00 | 0.00 | 2.82 | 0.00 | 0.00 |
| TG  | no LSet |      | 3140 | 3140 | 1    | 5.00 | 2.82 | 0.00 | 0.00 | 2.83 | 0.00 | 0.00 |
| TG  | no LSet |      | 3141 | 3141 | 1    | 5.00 | 2.83 | 0.00 | 0.00 | 2.84 | 0.00 | 0.00 |
| TG  | no LSet |      | 3142 | 3142 | 1    | 5.00 | 2.84 | 0.00 | 0.00 | 2.84 | 0.00 | 0.00 |
| TG  | no LSet |      | 3143 | 3143 | 1    | 5.00 | 2.84 | 0.00 | 0.00 | 2.85 | 0.00 | 0.00 |
| TG  | no LSet |      | 3144 | 3144 | 1    | 5.00 | 2.85 | 0.00 | 0.00 | 2.85 | 0.00 | 0.00 |
| TG  | no LSet |      | 3145 | 3145 | 1    | 5.00 | 2.85 | 0.00 | 0.00 | 2.87 | 0.00 | 0.00 |
| TG  | no LSet |      | 3201 | 3201 | 1    | 5.00 | 1.29 | 0.00 | 0.00 | 1.29 | 0.00 | 0.00 |
| TG  | no LSet |      | 3202 | 3202 | 1    | 5.00 | 1.29 | 0.00 | 0.00 | 1.29 | 0.00 | 0.00 |
| TG  | no LSet |      | 3203 | 3203 | 1    | 5.00 | 1.29 | 0.00 | 0.00 | 1.29 | 0.00 | 0.00 |
| TG  | no LSet |      | 3204 | 3204 | 1    | 5.00 | 1.29 | 0.00 | 0.00 | 1.31 | 0.00 | 0.00 |
| TG  | no LSet |      | 3205 | 3205 | 1    | 5.00 | 1.31 | 0.00 | 0.00 | 1.45 | 0.00 | 0.00 |
| TG  | no LSet |      | 3206 | 3206 | 1    | 5.00 | 1.45 | 0.00 | 0.00 | 1.59 | 0.00 | 0.00 |

Description: 5 Loads  
5.2 Load Cases

Project No.





| <b>load case:</b> Wind_P_L      |         |      |      |      |      |      |      |      |      |      |      |      |
|---------------------------------|---------|------|------|------|------|------|------|------|------|------|------|------|
| Wind Load on Pylon Longitudinal |         |      |      |      |      |      |      |      |      |      |      |      |
| Duration: NONPERMANENT          |         |      |      |      |      |      |      |      |      |      |      |      |
| LoadInfo:                       |         |      |      |      |      |      |      |      |      |      |      |      |
| <b>Loads:</b>                   |         |      |      |      |      |      |      |      |      |      |      |      |
|                                 | LSet    | Fact | From | To   | Step | proj | inp1 | inp2 | inp3 | inp4 | inp5 | inp6 |
| TG                              | no LSet |      | 3207 | 3207 | 1    | 5.00 | 1.59 | 0.00 | 0.00 | 1.71 | 0.00 | 0.00 |
| TG                              | no LSet |      | 3208 | 3208 | 1    | 5.00 | 1.71 | 0.00 | 0.00 | 1.82 | 0.00 | 0.00 |
| TG                              | no LSet |      | 3209 | 3209 | 1    | 5.00 | 1.82 | 0.00 | 0.00 | 1.90 | 0.00 | 0.00 |
| TG                              | no LSet |      | 3210 | 3210 | 1    | 5.00 | 1.90 | 0.00 | 0.00 | 1.98 | 0.00 | 0.00 |
| TG                              | no LSet |      | 3211 | 3211 | 1    | 5.00 | 1.98 | 0.00 | 0.00 | 2.06 | 0.00 | 0.00 |
| TG                              | no LSet |      | 3212 | 3212 | 1    | 5.00 | 2.06 | 0.00 | 0.00 | 2.13 | 0.00 | 0.00 |
| TG                              | no LSet |      | 3213 | 3213 | 1    | 5.00 | 2.13 | 0.00 | 0.00 | 2.19 | 0.00 | 0.00 |
| TG                              | no LSet |      | 3214 | 3214 | 1    | 5.00 | 2.19 | 0.00 | 0.00 | 2.24 | 0.00 | 0.00 |
| TG                              | no LSet |      | 3215 | 3215 | 1    | 5.00 | 2.24 | 0.00 | 0.00 | 2.30 | 0.00 | 0.00 |
| TG                              | no LSet |      | 3216 | 3216 | 1    | 5.00 | 2.30 | 0.00 | 0.00 | 2.35 | 0.00 | 0.00 |
| TG                              | no LSet |      | 3217 | 3217 | 1    | 5.00 | 2.35 | 0.00 | 0.00 | 2.36 | 0.00 | 0.00 |
| TG                              | no LSet |      | 3218 | 3218 | 1    | 5.00 | 2.36 | 0.00 | 0.00 | 2.40 | 0.00 | 0.00 |
| TG                              | no LSet |      | 3219 | 3219 | 1    | 5.00 | 2.40 | 0.00 | 0.00 | 2.43 | 0.00 | 0.00 |
| TG                              | no LSet |      | 3220 | 3220 | 1    | 5.00 | 2.43 | 0.00 | 0.00 | 2.47 | 0.00 | 0.00 |
| TG                              | no LSet |      | 3221 | 3221 | 1    | 5.00 | 2.47 | 0.00 | 0.00 | 2.51 | 0.00 | 0.00 |
| TG                              | no LSet |      | 3222 | 3222 | 1    | 5.00 | 2.51 | 0.00 | 0.00 | 2.55 | 0.00 | 0.00 |
| TG                              | no LSet |      | 3223 | 3223 | 1    | 5.00 | 2.55 | 0.00 | 0.00 | 2.59 | 0.00 | 0.00 |
| TG                              | no LSet |      | 3224 | 3224 | 1    | 5.00 | 2.59 | 0.00 | 0.00 | 2.62 | 0.00 | 0.00 |
| TG                              | no LSet |      | 3225 | 3225 | 1    | 5.00 | 2.62 | 0.00 | 0.00 | 2.66 | 0.00 | 0.00 |
| TG                              | no LSet |      | 3226 | 3226 | 1    | 5.00 | 2.66 | 0.00 | 0.00 | 2.70 | 0.00 | 0.00 |
| TG                              | no LSet |      | 3227 | 3227 | 1    | 5.00 | 2.70 | 0.00 | 0.00 | 2.73 | 0.00 | 0.00 |
| TG                              | no LSet |      | 3228 | 3228 | 1    | 5.00 | 2.73 | 0.00 | 0.00 | 2.74 | 0.00 | 0.00 |
| TG                              | no LSet |      | 3229 | 3229 | 1    | 5.00 | 2.74 | 0.00 | 0.00 | 2.75 | 0.00 | 0.00 |
| TG                              | no LSet |      | 3230 | 3230 | 1    | 5.00 | 2.75 | 0.00 | 0.00 | 2.75 | 0.00 | 0.00 |
| TG                              | no LSet |      | 3231 | 3231 | 1    | 5.00 | 2.75 | 0.00 | 0.00 | 2.76 | 0.00 | 0.00 |
| TG                              | no LSet |      | 3232 | 3232 | 1    | 5.00 | 2.76 | 0.00 | 0.00 | 2.77 | 0.00 | 0.00 |
| TG                              | no LSet |      | 3233 | 3233 | 1    | 5.00 | 2.77 | 0.00 | 0.00 | 2.78 | 0.00 | 0.00 |
| TG                              | no LSet |      | 3234 | 3234 | 1    | 5.00 | 2.78 | 0.00 | 0.00 | 2.78 | 0.00 | 0.00 |
| TG                              | no LSet |      | 3235 | 3235 | 1    | 5.00 | 2.78 | 0.00 | 0.00 | 2.79 | 0.00 | 0.00 |
| TG                              | no LSet |      | 3236 | 3236 | 1    | 5.00 | 2.79 | 0.00 | 0.00 | 2.80 | 0.00 | 0.00 |
| TG                              | no LSet |      | 3237 | 3237 | 1    | 5.00 | 2.80 | 0.00 | 0.00 | 2.81 | 0.00 | 0.00 |
| TG                              | no LSet |      | 3238 | 3238 | 1    | 5.00 | 2.81 | 0.00 | 0.00 | 2.81 | 0.00 | 0.00 |
| TG                              | no LSet |      | 3239 | 3239 | 1    | 5.00 | 2.81 | 0.00 | 0.00 | 2.82 | 0.00 | 0.00 |
| TG                              | no LSet |      | 3240 | 3240 | 1    | 5.00 | 2.82 | 0.00 | 0.00 | 2.83 | 0.00 | 0.00 |
| TG                              | no LSet |      | 3241 | 3241 | 1    | 5.00 | 2.83 | 0.00 | 0.00 | 2.84 | 0.00 | 0.00 |
| TG                              | no LSet |      | 3242 | 3242 | 1    | 5.00 | 2.84 | 0.00 | 0.00 | 2.84 | 0.00 | 0.00 |
| TG                              | no LSet |      | 3243 | 3243 | 1    | 5.00 | 2.84 | 0.00 | 0.00 | 2.85 | 0.00 | 0.00 |
| TG                              | no LSet |      | 3244 | 3244 | 1    | 5.00 | 2.85 | 0.00 | 0.00 | 2.85 | 0.00 | 0.00 |
| TG                              | no LSet |      | 3245 | 3245 | 1    | 5.00 | 2.85 | 0.00 | 0.00 | 2.87 | 0.00 | 0.00 |



|   |         |      |      |     |      |      |      |      |      |      |       |      |
|---|---------|------|------|-----|------|------|------|------|------|------|-------|------|
| <b>load case:</b> Wind_SS_T<br>Wind Load on Superstructure Transverse |         |      |      |     |      |      |      |      |      |      |       |      |
| Duration: NONPERMANENT  |         |      |      |     |      |      |      |      |      |      |       |      |
| LoadInfo:   |         |      |      |     |      |      |      |      |      |      |       |      |
| <b>Loads:</b>   |         |      |      |     |      |      |      |      |      |      |       |      |
|   | LSet    | Fact | From | To  | Step | proj | inp1 | inp2 | inp3 | inp4 | inp5  | inp6 |
| eccentric uniform load (global) plus member eccentricity              |         |      |      |     |      |      |      |      |      |      |       |      |
| QEZG  | no LSet |      | 101  | 216 | 1    | 8.00 | 0.00 | 0.00 | 1.99 | 0.00 | -5.00 |      |
| eccentric uniform load (global) plus member eccentricity              |         |      |      |     |      |      |      |      |      |      |       |      |
| QEYG  | no LSet |      | 101  | 216 | 1    | 0.00 | 0.00 | 0.00 | 2.19 | 0.55 | -6.00 |      |
| QEYG  | no LSet |      | 101  | 216 | 1    | 0.00 | 0.00 | 0.00 | 4.78 | 1.50 | 0.00  |      |

|   |         |      |      |     |      |      |      |      |      |      |      |      |
|---|---------|------|------|-----|------|------|------|------|------|------|------|------|
| <b>load case:</b> Wind_SS_L<br>Wind Load on Superstructure Longitudinal |         |      |      |     |      |      |      |      |      |      |      |      |
| Duration: NONPERMANENT  |         |      |      |     |      |      |      |      |      |      |      |      |
| LoadInfo:   |         |      |      |     |      |      |      |      |      |      |      |      |
| <b>Loads:</b>   |         |      |      |     |      |      |      |      |      |      |      |      |
|   | LSet    | Fact | From | To  | Step | proj | inp1 | inp2 | inp3 | inp4 | inp5 | inp6 |
| eccentric uniform load (global) plus member eccentricity                |         |      |      |     |      |      |      |      |      |      |      |      |
| QEXG  | no LSet |      | 101  | 216 | 1    | 8.00 | 0.00 | 0.00 | 0.50 | 0.00 | 0.00 |      |
| eccentric uniform load (global) plus member eccentricity                |         |      |      |     |      |      |      |      |      |      |      |      |
| QEXG  | no LSet |      | 101  | 216 | 1    | 0.00 | 1.19 | 0.00 | 0.00 | 1.50 | 0.00 |      |

|   |         |      |      |     |      |      |      |       |      |      |      |      |
|---|---------|------|------|-----|------|------|------|-------|------|------|------|------|
| <b>load case:</b> Wind_SS_V<br>Wind Load on Superstructure Vertical |         |      |      |     |      |      |      |       |      |      |      |      |
| Duration: NONPERMANENT  |         |      |      |     |      |      |      |       |      |      |      |      |
| LoadInfo:   |         |      |      |     |      |      |      |       |      |      |      |      |
| <b>Loads:</b>   |         |      |      |     |      |      |      |       |      |      |      |      |
|   | LSet    | Fact | From | To  | Step | proj | inp1 | inp2  | inp3 | inp4 | inp5 | inp6 |
| eccentric uniform load (global) plus member eccentricity            |         |      |      |     |      |      |      |       |      |      |      |      |
| QEXG  | no LSet |      | 101  | 216 | 1    | 4.00 | 0.00 | -1.00 | 0.00 | 0.00 | 0.00 |      |

## 5.2.15 Breaking Force

|  |         |      |      |     |      |      |      |      |      |      |      |      |
|--|---------|------|------|-----|------|------|------|------|------|------|------|------|
| <b>load case:</b> BR<br>Live Load Breaking Force         |         |      |      |     |      |      |      |      |      |      |      |      |
| Duration: NONPERMANENT                                   |         |      |      |     |      |      |      |      |      |      |      |      |
| LoadInfo:  |         |      |      |     |      |      |      |      |      |      |      |      |
| <b>Loads:</b>  |         |      |      |     |      |      |      |      |      |      |      |      |
|  | LSet    | Fact | From | To  | Step | proj | inp1 | inp2 | inp3 | inp4 | inp5 | inp6 |
| eccentric uniform load (global) plus member eccentricity |         |      |      |     |      |      |      |      |      |      |      |      |
| QEYG   | no LSet |      | 101  | 216 | 1    | 0.00 | 3.28 | 0.00 | 0.00 | 1.20 | 0.00 |      |

## 5.2.16 Mass For Seismic Calculation





|  |         |      |      |      |      |      |        |        |        |         |      |      |
|--|---------|------|------|------|------|------|--------|--------|--------|---------|------|------|
| <b>load case:</b> Mass                                   |         |      |      |      |      |      |        |        |        |         |      |      |
| Mass For Response Spectrum Calculation                   |         |      |      |      |      |      |        |        |        |         |      |      |
| Duration: NONPERMANENT                                   |         |      |      |      |      |      |        |        |        |         |      |      |
| LoadInfo:  |         |      |      |      |      |      |        |        |        |         |      |      |
| <b>Loads:</b>  |         |      |      |      |      |      |        |        |        |         |      |      |
|  | LSet    | Fact | From | To   | Step | proj | inp1   | inp2   | inp3   | inp4    | inp5 | inp6 |
| element uniform mass + eccentricity                      |         |      |      |      |      |      | g * mx | g * my | g * mz | g * lmx | ey   | ez   |
| ELMASE   | no LSet |      | 101  | 214  | 1    |      | 15.00  | 15.00  | 15.00  | 0.00    | 0.00 | 0.00 |
| ELMASE   | no LSet |      | 101  | 214  | 1    |      | 0.00   | 8.60   | 8.60   | 0.00    | 0.00 | 0.00 |
| self-weight mass with load - direction vector r normaliz |         |      |      |      |      |      | p      | Rx     | Ry     | Rz      | Gam  |      |
| G  | SW Pier | 1    | 2101 | 2145 | 1    | 0.00 | 0.00   | -1.00  | 0.00   | 0.00    |      |      |
| G  | SW Pier | 1    | 2201 | 2245 | 1    | 0.00 | 0.00   | -1.00  | 0.00   | 0.00    |      |      |
| G  | SW Pier | 1    | 3101 | 3145 | 1    | 0.00 | 0.00   | -1.00  | 0.00   | 0.00    |      |      |
| G  | SW Pier | 1    | 3201 | 3245 | 1    | 0.00 | 0.00   | -1.00  | 0.00   | 0.00    |      |      |
| self-weight mass with load - direction vector r normaliz |         |      |      |      |      |      | p      | Rx     | Ry     | Rz      | Gam  |      |
| G  | SW 01   | 1    | 133  | 133  | 1    | 0.00 | 0.00   | -1.00  | 0.00   | 0.00    |      |      |
| G  | SW 01   | 1    | 184  | 184  | 1    | 0.00 | 0.00   | -1.00  | 0.00   | 0.00    |      |      |
| self-weight mass with load - direction vector r normaliz |         |      |      |      |      |      | p      | Rx     | Ry     | Rz      | Gam  |      |
| G  | SW 02   | 1    | 134  | 134  | 1    | 0.00 | 0.00   | -1.00  | 0.00   | 0.00    |      |      |
| G  | SW 02   | 1    | 183  | 183  | 1    | 0.00 | 0.00   | -1.00  | 0.00   | 0.00    |      |      |
| self-weight mass with load - direction vector r normaliz |         |      |      |      |      |      | p      | Rx     | Ry     | Rz      | Gam  |      |
| G  | SW 03   | 1    | 135  | 135  | 1    | 0.00 | 0.00   | -1.00  | 0.00   | 0.00    |      |      |
| G  | SW 03   | 1    | 182  | 182  | 1    | 0.00 | 0.00   | -1.00  | 0.00   | 0.00    |      |      |
| self-weight mass with load - direction vector r normaliz |         |      |      |      |      |      | p      | Rx     | Ry     | Rz      | Gam  |      |
| G  | SW 04   | 1    | 136  | 136  | 1    | 0.00 | 0.00   | -1.00  | 0.00   | 0.00    |      |      |
| G  | SW 04   | 1    | 181  | 181  | 1    | 0.00 | 0.00   | -1.00  | 0.00   | 0.00    |      |      |
| self-weight mass with load - direction vector r normaliz |         |      |      |      |      |      | p      | Rx     | Ry     | Rz      | Gam  |      |
| G  | SW 05   | 1    | 137  | 137  | 1    | 0.00 | 0.00   | -1.00  | 0.00   | 0.00    |      |      |
| G  | SW 05   | 1    | 180  | 180  | 1    | 0.00 | 0.00   | -1.00  | 0.00   | 0.00    |      |      |
| G  | SW 05   | 1    | 1101 | 1801 | 100  | 0.00 | 0.00   | -1.00  | 0.00   | 0.00    |      |      |
| self-weight mass with load - direction vector r normaliz |         |      |      |      |      |      | p      | Rx     | Ry     | Rz      | Gam  |      |
| G  | SW 06   | 1    | 138  | 138  | 1    | 0.00 | 0.00   | -1.00  | 0.00   | 0.00    |      |      |
| G  | SW 06   | 1    | 179  | 179  | 1    | 0.00 | 0.00   | -1.00  | 0.00   | 0.00    |      |      |
| self-weight mass with load - direction vector r normaliz |         |      |      |      |      |      | p      | Rx     | Ry     | Rz      | Gam  |      |
| G  | SW 07   | 1    | 139  | 139  | 1    | 0.00 | 0.00   | -1.00  | 0.00   | 0.00    |      |      |
| G  | SW 07   | 1    | 178  | 178  | 1    | 0.00 | 0.00   | -1.00  | 0.00   | 0.00    |      |      |
| G  | SW 07   | 1    | 1102 | 1802 | 100  | 0.00 | 0.00   | -1.00  | 0.00   | 0.00    |      |      |
| self-weight mass with load - direction vector r normaliz |         |      |      |      |      |      | p      | Rx     | Ry     | Rz      | Gam  |      |
| G  | SW 08   | 1    | 140  | 140  | 1    | 0.00 | 0.00   | -1.00  | 0.00   | 0.00    |      |      |
| G  | SW 08   | 1    | 177  | 177  | 1    | 0.00 | 0.00   | -1.00  | 0.00   | 0.00    |      |      |
| self-weight mass with load - direction vector r normaliz |         |      |      |      |      |      | p      | Rx     | Ry     | Rz      | Gam  |      |
| G  | SW 09   | 1    | 141  | 141  | 1    | 0.00 | 0.00   | -1.00  | 0.00   | 0.00    |      |      |
| G  | SW 09   | 1    | 176  | 176  | 1    | 0.00 | 0.00   | -1.00  | 0.00   | 0.00    |      |      |
| G  | SW 09   | 1    | 1103 | 1803 | 100  | 0.00 | 0.00   | -1.00  | 0.00   | 0.00    |      |      |
| self-weight mass with load - direction vector r normaliz |         |      |      |      |      |      | p      | Rx     | Ry     | Rz      | Gam  |      |
| G  | SW 10   | 1    | 142  | 142  | 1    | 0.00 | 0.00   | -1.00  | 0.00   | 0.00    |      |      |
| G  | SW 10   | 1    | 175  | 175  | 1    | 0.00 | 0.00   | -1.00  | 0.00   | 0.00    |      |      |
| self-weight mass with load - direction vector r normaliz |         |      |      |      |      |      | p      | Rx     | Ry     | Rz      | Gam  |      |
| G  | SW 11   | 1    | 143  | 143  | 1    | 0.00 | 0.00   | -1.00  | 0.00   | 0.00    |      |      |
| G  | SW 11   | 1    | 174  | 174  | 1    | 0.00 | 0.00   | -1.00  | 0.00   | 0.00    |      |      |
| G  | SW 11   | 1    | 1104 | 1804 | 100  | 0.00 | 0.00   | -1.00  | 0.00   | 0.00    |      |      |
| self-weight mass with load - direction vector r normaliz |         |      |      |      |      |      | p      | Rx     | Ry     | Rz      | Gam  |      |
| G  | SW 12   | 1    | 144  | 144  | 1    | 0.00 | 0.00   | -1.00  | 0.00   | 0.00    |      |      |
| G  | SW 12   | 1    | 173  | 173  | 1    | 0.00 | 0.00   | -1.00  | 0.00   | 0.00    |      |      |
| self-weight mass with load - direction vector r normaliz |         |      |      |      |      |      | p      | Rx     | Ry     | Rz      | Gam  |      |
| G  | SW 13   | 1    | 145  | 145  | 1    | 0.00 | 0.00   | -1.00  | 0.00   | 0.00    |      |      |
| G  | SW 13   | 1    | 172  | 172  | 1    | 0.00 | 0.00   | -1.00  | 0.00   | 0.00    |      |      |
| G  | SW 13   | 1    | 1105 | 1805 | 100  | 0.00 | 0.00   | -1.00  | 0.00   | 0.00    |      |      |
| self-weight mass with load - direction vector r normaliz |         |      |      |      |      |      | p      | Rx     | Ry     | Rz      | Gam  |      |
| G  | SW 14   | 1    | 146  | 146  | 1    | 0.00 | 0.00   | -1.00  | 0.00   | 0.00    |      |      |
| G  | SW 14   | 1    | 171  | 171  | 1    | 0.00 | 0.00   | -1.00  | 0.00   | 0.00    |      |      |
| self-weight mass with load - direction vector r normaliz |         |      |      |      |      |      | p      | Rx     | Ry     | Rz      | Gam  |      |
| G  | SW 15   | 1    | 147  | 147  | 1    | 0.00 | 0.00   | -1.00  | 0.00   | 0.00    |      |      |

Description: 5 Loads  
5.2 Load Cases

Project No.



|  |       |      |      |      |      |      |      |       |      |      |      |      |
|--|-------|------|------|------|------|------|------|-------|------|------|------|------|
| <b>load case:</b> Mass                                   |       |      |      |      |      |      |      |       |      |      |      |      |
| Mass For Response Spectrum Calculation                   |       |      |      |      |      |      |      |       |      |      |      |      |
| Duration: NONPERMANENT                                   |       |      |      |      |      |      |      |       |      |      |      |      |
| LoadInfo:  |       |      |      |      |      |      |      |       |      |      |      |      |
| <b>Loads:</b>  |       |      |      |      |      |      |      |       |      |      |      |      |
|  | LSet  | Fact | From | To   | Step | proj | inp1 | inp2  | inp3 | inp4 | inp5 | inp6 |
| G  | SW 15 | 1    | 170  | 170  | 1    | 0.00 | 0.00 | -1.00 | 0.00 | 0.00 |      |      |
| G  | SW 15 | 1    | 1106 | 1806 | 100  | 0.00 | 0.00 | -1.00 | 0.00 | 0.00 |      |      |
| self-weight mass with load - direction vector r normaliz |       |      |      |      |      | p    | Rx   | Ry    | Rz   | Gam  |      |      |
| G  | SW 16 | 1    | 148  | 148  | 1    | 0.00 | 0.00 | -1.00 | 0.00 | 0.00 |      |      |
| G  | SW 16 | 1    | 169  | 169  | 1    | 0.00 | 0.00 | -1.00 | 0.00 | 0.00 |      |      |
| self-weight mass with load - direction vector r normaliz |       |      |      |      |      | p    | Rx   | Ry    | Rz   | Gam  |      |      |
| G  | SW 17 | 1    | 149  | 149  | 1    | 0.00 | 0.00 | -1.00 | 0.00 | 0.00 |      |      |
| G  | SW 17 | 1    | 168  | 168  | 1    | 0.00 | 0.00 | -1.00 | 0.00 | 0.00 |      |      |
| G  | SW 17 | 1    | 1107 | 1807 | 100  | 0.00 | 0.00 | -1.00 | 0.00 | 0.00 |      |      |
| self-weight mass with load - direction vector r normaliz |       |      |      |      |      | p    | Rx   | Ry    | Rz   | Gam  |      |      |
| G  | SW 18 | 1    | 150  | 150  | 1    | 0.00 | 0.00 | -1.00 | 0.00 | 0.00 |      |      |
| G  | SW 18 | 1    | 167  | 167  | 1    | 0.00 | 0.00 | -1.00 | 0.00 | 0.00 |      |      |
| self-weight mass with load - direction vector r normaliz |       |      |      |      |      | p    | Rx   | Ry    | Rz   | Gam  |      |      |
| G  | SW 19 | 1    | 151  | 151  | 1    | 0.00 | 0.00 | -1.00 | 0.00 | 0.00 |      |      |
| G  | SW 19 | 1    | 166  | 166  | 1    | 0.00 | 0.00 | -1.00 | 0.00 | 0.00 |      |      |
| G  | SW 19 | 1    | 1108 | 1808 | 100  | 0.00 | 0.00 | -1.00 | 0.00 | 0.00 |      |      |
| self-weight mass with load - direction vector r normaliz |       |      |      |      |      | p    | Rx   | Ry    | Rz   | Gam  |      |      |
| G  | SW 20 | 1    | 152  | 152  | 1    | 0.00 | 0.00 | -1.00 | 0.00 | 0.00 |      |      |
| G  | SW 20 | 1    | 165  | 165  | 1    | 0.00 | 0.00 | -1.00 | 0.00 | 0.00 |      |      |
| self-weight mass with load - direction vector r normaliz |       |      |      |      |      | p    | Rx   | Ry    | Rz   | Gam  |      |      |
| G  | SW 21 | 1    | 153  | 153  | 1    | 0.00 | 0.00 | -1.00 | 0.00 | 0.00 |      |      |
| G  | SW 21 | 1    | 164  | 164  | 1    | 0.00 | 0.00 | -1.00 | 0.00 | 0.00 |      |      |
| G  | SW 21 | 1    | 1109 | 1809 | 100  | 0.00 | 0.00 | -1.00 | 0.00 | 0.00 |      |      |
| self-weight mass with load - direction vector r normaliz |       |      |      |      |      | p    | Rx   | Ry    | Rz   | Gam  |      |      |
| G  | SW 22 | 1    | 154  | 154  | 1    | 0.00 | 0.00 | -1.00 | 0.00 | 0.00 |      |      |
| G  | SW 22 | 1    | 163  | 163  | 1    | 0.00 | 0.00 | -1.00 | 0.00 | 0.00 |      |      |
| self-weight mass with load - direction vector r normaliz |       |      |      |      |      | p    | Rx   | Ry    | Rz   | Gam  |      |      |
| G  | SW 23 | 1    | 155  | 155  | 1    | 0.00 | 0.00 | -1.00 | 0.00 | 0.00 |      |      |
| G  | SW 23 | 1    | 162  | 162  | 1    | 0.00 | 0.00 | -1.00 | 0.00 | 0.00 |      |      |
| G  | SW 23 | 1    | 1110 | 1810 | 100  | 0.00 | 0.00 | -1.00 | 0.00 | 0.00 |      |      |
| self-weight mass with load - direction vector r normaliz |       |      |      |      |      | p    | Rx   | Ry    | Rz   | Gam  |      |      |
| G  | SW 24 | 1    | 156  | 156  | 1    | 0.00 | 0.00 | -1.00 | 0.00 | 0.00 |      |      |
| G  | SW 24 | 1    | 161  | 161  | 1    | 0.00 | 0.00 | -1.00 | 0.00 | 0.00 |      |      |
| self-weight mass with load - direction vector r normaliz |       |      |      |      |      | p    | Rx   | Ry    | Rz   | Gam  |      |      |
| G  | SW 25 | 1    | 157  | 157  | 1    | 0.00 | 0.00 | -1.00 | 0.00 | 0.00 |      |      |
| G  | SW 25 | 1    | 160  | 160  | 1    | 0.00 | 0.00 | -1.00 | 0.00 | 0.00 |      |      |
| G  | SW 25 | 1    | 1111 | 1811 | 100  | 0.00 | 0.00 | -1.00 | 0.00 | 0.00 |      |      |

## 5.2.17 Load Combinations

| LF/SUP     | Rule      | Combinations |             |             |             |             |             |
|------------|-----------|--------------|-------------|-------------|-------------|-------------|-------------|
|            |           | (+) / (-)    | (+) / (-)   | (+) / (-)   | (+) / (-)   | (+) / (-)   | (+) / (-)   |
|            |           | Comb 1       | Comb 2      | Comb 3      | Comb 4      | Comb 5      | Comb 6      |
| SW_SUM     | SupAddLc  | 1.00 / 1.35  | 1.00 / 1.35 | 1.00 / 1.35 | 1.00 / 1.35 | 1.00 / 1.35 | 1.00 / 1.35 |
| WC_SUM     | SupAddLc  | 1.00 / 1.35  | 1.00 / 1.35 | 1.00 / 1.35 | 1.00 / 1.35 | 1.00 / 1.35 | 1.00 / 1.35 |
| TR_SUM     | SupAddLc  | 1.00 / 1.35  | 1.00 / 1.35 | 1.00 / 1.35 | 1.00 / 1.35 | 1.00 / 1.35 | 1.00 / 1.35 |
| SD_SUM     | SupAddLc  | 1.00 / 1.35  | 1.00 / 1.35 | 1.00 / 1.35 | 1.00 / 1.35 | 1.00 / 1.35 | 1.00 / 1.35 |
| SDS_SUM    | SupAddLc  | 1.00 / 1.75  | 1.00 / 1.75 | 1.00 / 1.75 | 1.00 / 1.75 | 1.00 / 1.75 | 1.00 / 1.75 |
| CS_SUM     | SupAddLc  | 1.00         | 1.00        | 1.00        | 1.00        | 1.00        | 1.00        |
| CS_100     | SupAddLc  |              | 1.00        |             | 1.00        |             | 1.00        |
| PS_SUM     | SupAddLc  | 1.00         | 1.00        | 1.00        | 1.00        | 1.00        | 1.00        |
| CAB_SUM    | SupAddLc  | 1.00         | 1.00        | 1.00        | 1.00        | 1.00        | 1.00        |
| DFST.sup   | SupAddSup |              |             |             |             |             |             |
| LL_Dyn.sup | SupAddSup | 1.50         | 1.50        | 1.15        | 1.15        | 1.15        | 1.15        |
| BR.sup     | SupAddSup | 1.50         | 1.50        | 1.15        | 1.15        | 1.15        | 1.15        |
| CF.sup     | SupAddSup | 1.50         | 1.50        | 1.15        | 1.15        | 1.15        | 1.15        |

 Description: 5 Loads  
5.2 Load Cases

Project No.



|                |           | Combinations   |                |                |                |                |                |
|----------------|-----------|----------------|----------------|----------------|----------------|----------------|----------------|
| LF/SUP         | Rule      | (+) / (-)      | (+) / (-)      | (+) / (-)      | (+) / (-)      | (+) / (-)      | (+) / (-)      |
| OT.sup         | SupAddSup | 0.90           | 0.90           | 1.50           | 1.50           | 0.90           | 0.90           |
| T-GRAD.sup     | SupAddSup | 0.90           | 0.90           | 1.50           | 1.50           | 0.90           | 0.90           |
| WIND.sup       | SupAddSup | 0.90           | 0.90           | 0.90           | 0.90           | 1.50           | 1.50           |
| Earthquake.sup | SupAddSup |                |                |                |                |                |                |
|                |           | ULS - Basic Co | ULS - Basic Co | ULS - Basic Co | ULS - Basic Co | ULS - Basic Co | ULS - Basic Co |

|                |           | Comb 7          | Comb 8          | Comb 9          | Comb 10         | Comb 11         | Comb 12         |
|----------------|-----------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| SW SUM         | SupAddLc  | 1.00 / 1.35     | 1.00 / 1.35     | 1.00 / 1.35     | 1.00 / 1.35     | 1.00 / 1.35     | 1.00 / 1.35     |
| WC SUM         | SupAddLc  | 1.00 / 1.35     | 1.00 / 1.35     | 1.00 / 1.35     | 1.00 / 1.35     | 1.00 / 1.35     | 1.00 / 1.35     |
| TR SUM         | SupAddLc  | 1.00 / 1.35     | 1.00 / 1.35     | 1.00 / 1.35     | 1.00 / 1.35     | 1.00 / 1.35     | 1.00 / 1.35     |
| SD SUM         | SupAddLc  | 1.00 / 1.35     | 1.00 / 1.35     | 1.00 / 1.35     | 1.00 / 1.35     | 1.00 / 1.35     | 1.00 / 1.35     |
| SDS SUM        | SupAddLc  | 1.00 / 1.75     | 1.00 / 1.75     | 1.00 / 1.75     | 1.00 / 1.75     | 1.00 / 1.75     | 1.00 / 1.75     |
| CS SUM         | SupAddLc  | 1.00            | 1.00            | 1.00            | 1.00            | 1.00            | 1.00            |
| CS 100         | SupAddLc  |                 | 1.00            |                 | 1.00            |                 | 1.00            |
| PS SUM         | SupAddLc  | 1.00            | 1.00            | 1.00            | 1.00            | 1.00            | 1.00            |
| CAB SUM        | SupAddLc  | 1.00            | 1.00            | 1.00            | 1.00            | 1.00            | 1.00            |
| DFST.sup       | SupAddSup |                 |                 |                 |                 |                 |                 |
| LL_Dyn.sup     | SupAddSup | 0.20            | 0.20            | 0.20            | 0.20            | 0.20            | 0.20            |
| BR.sup         | SupAddSup | 0.20            | 0.20            | 0.20            | 0.20            | 0.20            | 0.20            |
| CF.sup         | SupAddSup | 0.20            | 0.20            | 0.20            | 0.20            | 0.20            | 0.20            |
| OT.sup         | SupAddSup | 0.50            | 0.50            | 0.50            | 0.50            | 0.50            | 0.50            |
| T-GRAD.sup     | SupAddSup | 0.50            | 0.50            | 0.50            | 0.50            | 0.50            | 0.50            |
| WIND.sup       | SupAddSup |                 |                 |                 |                 |                 |                 |
| Earthquake.sup | SupAddSup | 1.50            | 1.50            | 0.50            | 0.50            | 0.38            | 0.38            |
|                |           | ULS - Seismic ( | ULS - Seismic ( | ULS - Seismic ( | ULS - Seismic ( | ULS - Seismic ( | ULS - Seismic ( |

|                |           | Comb 13        | Comb 14        | Comb 15        | Comb 16        | Comb 17        | Comb 18        |
|----------------|-----------|----------------|----------------|----------------|----------------|----------------|----------------|
| SW SUM         | SupAddLc  | 1.00           | 1.00           | 1.00           | 1.00           | 1.00           | 1.00           |
| WC SUM         | SupAddLc  | 1.00           | 1.00           | 1.00           | 1.00           | 1.00           | 1.00           |
| TR SUM         | SupAddLc  | 1.00           | 1.00           | 1.00           | 1.00           | 1.00           | 1.00           |
| SD SUM         | SupAddLc  | 1.00           | 1.00           | 1.00           | 1.00           | 1.00           | 1.00           |
| SDS SUM        | SupAddLc  | 1.00 / 1.20    | 1.00 / 1.20    | 1.00 / 1.20    | 1.00 / 1.20    | 1.00 / 1.20    | 1.00 / 1.20    |
| CS SUM         | SupAddLc  | 1.00           | 1.00           | 1.00           | 1.00           | 1.00           | 1.00           |
| CS 100         | SupAddLc  |                | 1.00           |                | 1.00           |                | 1.00           |
| PS SUM         | SupAddLc  | 0.90 / 1.10    | 0.90 / 1.10    | 0.90 / 1.10    | 0.90 / 1.10    | 0.90 / 1.10    | 0.90 / 1.10    |
| CAB SUM        | SupAddLc  | 0.90 / 1.10    | 0.90 / 1.10    | 0.90 / 1.10    | 0.90 / 1.10    | 0.90 / 1.10    | 0.90 / 1.10    |
| DFST.sup       | SupAddSup | 1.00           | 1.00           | 1.00           | 1.00           | 1.00           | 1.00           |
| LL_Dyn.sup     | SupAddSup | 1.00           | 1.00           | 0.75           | 0.75           | 0.75           | 0.75           |
| BR.sup         | SupAddSup | 1.00           | 1.00           | 0.75           | 0.75           | 0.75           | 0.75           |
| CF.sup         | SupAddSup | 1.00           | 1.00           | 0.75           | 0.75           | 0.75           | 0.75           |
| OT.sup         | SupAddSup | 0.60           | 0.60           | 0.60           | 0.60           | 1.00           | 1.00           |
| T-GRAD.sup     | SupAddSup | 0.60           | 0.60           | 0.60           | 0.60           | 1.00           | 1.00           |
| WIND.sup       | SupAddSup | 0.60           | 0.60           | 1.00           | 1.00           | 0.60           | 0.60           |
| Earthquake.sup | SupAddSup |                |                |                |                |                |                |
|                |           | SLS - Rare Con | SLS - Rare Con | SLS - Rare Con | SLS - Rare Con | SLS - Rare Con | SLS - Rare Con |

|            |           | Comb 19     | Comb 20     | Comb 21     | Comb 22     | Comb 23     | Comb 24     |
|------------|-----------|-------------|-------------|-------------|-------------|-------------|-------------|
| SW SUM     | SupAddLc  | 1.00        | 1.00        | 1.00        | 1.00        | 1.00        | 1.00        |
| WC SUM     | SupAddLc  | 1.00        | 1.00        | 1.00        | 1.00        | 1.00        | 1.00        |
| TR SUM     | SupAddLc  | 1.00        | 1.00        | 1.00        | 1.00        | 1.00        | 1.00        |
| SD SUM     | SupAddLc  | 1.00        | 1.00        | 1.00        | 1.00        | 1.00        | 1.00        |
| SDS SUM    | SupAddLc  | 1.00 / 1.20 | 1.00 / 1.20 | 1.00 / 1.20 | 1.00 / 1.20 | 1.00 / 1.20 | 1.00 / 1.20 |
| CS SUM     | SupAddLc  | 1.00        | 1.00        | 1.00        | 1.00        | 1.00        | 1.00        |
| CS 100     | SupAddLc  |             | 1.00        |             | 1.00        |             | 1.00        |
| PS SUM     | SupAddLc  | 0.90 / 1.10 | 0.90 / 1.10 | 0.90 / 1.10 | 0.90 / 1.10 | 0.90 / 1.10 | 0.90 / 1.10 |
| CAB SUM    | SupAddLc  | 0.90 / 1.10 | 0.90 / 1.10 | 0.90 / 1.10 | 0.90 / 1.10 | 0.90 / 1.10 | 0.90 / 1.10 |
| DFST.sup   | SupAddSup | 1.00        | 1.00        | 1.00        | 1.00        | 1.00        | 1.00        |
| LL_Dyn.sup | SupAddSup | 0.75        | 0.75        | 0.20        | 0.20        | 0.20        | 0.20        |
| BR.sup     | SupAddSup | 0.75        | 0.75        | 0.20        | 0.20        | 0.20        | 0.20        |
| CF.sup     | SupAddSup | 0.75        | 0.75        | 0.20        | 0.20        | 0.20        | 0.20        |
| OT.sup     | SupAddSup | 0.50        | 0.50        | 0.50        | 0.50        | 0.60        | 0.60        |
| T-GRAD.sup | SupAddSup | 0.50        | 0.50        | 0.50        | 0.50        | 0.60        | 0.60        |

Description: 5 Loads  
5.2 Load Cases

Project No.

Designer: VKS Infratech Management Pvt. Ltd.



RM Bridge Professional Engineering Software

project Arunachal Extradosed 63m+260m+63m

6/03/2022

|                |           | Combinations    |                 |                 |                 |                 |                 |
|----------------|-----------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| LF/SUP         | Rule      | (+) / (-)       | (+) / (-)       | (+) / (-)       | (+) / (-)       | (+) / (-)       | (+) / (-)       |
| WIND.sup       | SupAddSup | 0.50            | 0.50            | 0.60            | 0.60            | 0.50            | 0.50            |
| Earthquake.sup | SupAddSup |                 |                 |                 |                 |                 |                 |
|                |           | SLS - Freq. Cor | SLS - Freq. Cor | SLS - Freq. Cor | SLS - Freq. Cor | SLS - Freq. Cor | SLS - Freq. Cor |

|                |           | Comb 25        | Comb 26        | Comb 27       | Comb 28       | Comb 29       | Comb 30       |
|----------------|-----------|----------------|----------------|---------------|---------------|---------------|---------------|
| SW SUM         | SupAddLc  | 1.00           | 1.00           | 1.00          | 1.00          | 1.00          | 1.00          |
| WC SUM         | SupAddLc  | 1.00           | 1.00           | 1.00          | 1.00          | 1.00          | 1.00          |
| TR SUM         | SupAddLc  | 1.00           | 1.00           | 1.00          | 1.00          | 1.00          | 1.00          |
| SD SUM         | SupAddLc  | 1.00           | 1.00           | 1.00          | 1.00          | 1.00          | 1.00          |
| SDS SUM        | SupAddLc  | 1.00 / 1.20    | 1.00 / 1.20    | 1.00          | 1.00          | 1.00          | 1.00          |
| CS SUM         | SupAddLc  | 1.00           | 1.00           | 1.00          | 1.00          | 1.00          | 1.00          |
| CS 100         | SupAddLc  |                | 1.00           |               | 1.00          |               | 1.00          |
| PS SUM         | SupAddLc  | 0.90 / 1.10    | 0.90 / 1.10    | 1.00          | 1.00          | 1.00          | 1.00          |
| CAB SUM        | SupAddLc  | 0.90 / 1.10    | 0.90 / 1.10    | 1.00          | 1.00          | 1.00          | 1.00          |
| DFST.sup       | SupAddSup | 1.00           | 1.00           |               |               | 1.00          | 1.00          |
| LL_Dyn.sup     | SupAddSup |                |                | 1.00          | 1.00          | 1.00          | 1.00          |
| BR.sup         | SupAddSup |                |                | 1.00          | 1.00          | 1.00          | 1.00          |
| CF.sup         | SupAddSup |                |                | 1.00          | 1.00          | 1.00          | 1.00          |
| OT.sup         | SupAddSup | 0.50           | 0.50           |               |               | 1.00          | 1.00          |
| T-GRAD.sup     | SupAddSup | 0.50           | 0.50           |               |               | 1.00          | 1.00          |
| WIND.sup       | SupAddSup |                |                |               |               |               |               |
| Earthquake.sup | SupAddSup |                |                |               |               |               |               |
|                |           | SLS - Quasi Pe | SLS - Quasi Pe | FND Base Pres | FND Base Pres | FND Base Pres | FND Base Pres |

|                |           | Comb 31       | Comb 32       | Comb 33       | Comb 34       | Comb 35      | Comb 36      |
|----------------|-----------|---------------|---------------|---------------|---------------|--------------|--------------|
| SW SUM         | SupAddLc  | 1.00          | 1.00          | 1.00          | 1.00          | 1.35         | 1.35         |
| WC SUM         | SupAddLc  | 1.00          | 1.00          | 1.00          | 1.00          | 1.35         | 1.35         |
| TR SUM         | SupAddLc  | 1.00          | 1.00          | 1.00          | 1.00          | 1.35         | 1.35         |
| SD SUM         | SupAddLc  | 1.00          | 1.00          | 1.00          | 1.00          | 1.35         | 1.35         |
| SDS SUM        | SupAddLc  | 1.00          | 1.00          | 1.00          | 1.00          | 1.75         | 1.75         |
| CS SUM         | SupAddLc  | 1.00          | 1.00          | 1.00          | 1.00          | 1.00         | 1.00         |
| CS 100         | SupAddLc  |               | 1.00          |               | 1.00          |              | 1.00         |
| PS SUM         | SupAddLc  | 1.00          | 1.00          | 1.00          | 1.00          | 1.00         | 1.00         |
| CAB SUM        | SupAddLc  | 1.00          | 1.00          | 1.00          | 1.00          | 1.00         | 1.00         |
| DFST.sup       | SupAddSup |               |               |               |               | 1.00         | 1.00         |
| LL_Dyn.sup     | SupAddSup | 1.00          | 1.00          | 0.20          | 0.20          | 1.50         | 1.50         |
| BR.sup         | SupAddSup | 1.00          | 1.00          | 0.20          | 0.20          | 1.50         | 1.50         |
| CF.sup         | SupAddSup | 1.00          | 1.00          | 0.20          | 0.20          | 1.50         | 1.50         |
| OT.sup         | SupAddSup |               |               |               |               | 0.90         | 0.90         |
| T-GRAD.sup     | SupAddSup |               |               |               |               | 0.90         | 0.90         |
| WIND.sup       | SupAddSup | 1.00          | 1.00          |               |               | 0.90         | 0.90         |
| Earthquake.sup | SupAddSup |               |               | 0.45          | 0.45          |              |              |
|                |           | FND Base Pres | FND Base Pres | FND Base Pres | FND Base Pres | ULS FND Comt | ULS FND Comt |

|                |           | Comb 37 | Comb 38 | Comb 39 | Comb 40 | Comb 41 | Comb 42 |
|----------------|-----------|---------|---------|---------|---------|---------|---------|
| SW SUM         | SupAddLc  | 1.35    | 1.35    | 1.00    | 1.00    | 1.00    | 1.00    |
| WC SUM         | SupAddLc  | 1.35    | 1.35    | 1.00    | 1.00    | 1.00    | 1.00    |
| TR SUM         | SupAddLc  | 1.35    | 1.35    | 1.00    | 1.00    | 1.00    | 1.00    |
| SD SUM         | SupAddLc  | 1.35    | 1.35    | 1.00    | 1.00    | 1.00    | 1.00    |
| SDS SUM        | SupAddLc  | 1.75    | 1.75    | 1.00    | 1.00    | 1.00    | 1.00    |
| CS SUM         | SupAddLc  | 1.00    | 1.00    | 1.00    | 1.00    | 1.00    | 1.00    |
| CS 100         | SupAddLc  |         | 1.00    |         | 1.00    |         | 1.00    |
| PS SUM         | SupAddLc  | 1.00    | 1.00    | 1.00    | 1.00    | 1.00    | 1.00    |
| CAB SUM        | SupAddLc  | 1.00    | 1.00    | 1.00    | 1.00    | 1.00    | 1.00    |
| DFST.sup       | SupAddSup | 1.00    | 1.00    | 1.00    | 1.00    | 1.00    | 1.00    |
| LL_Dyn.sup     | SupAddSup | 1.15    | 1.15    | 1.30    | 1.30    | 1.00    | 1.00    |
| BR.sup         | SupAddSup | 1.15    | 1.15    | 1.30    | 1.30    | 1.00    | 1.00    |
| CF.sup         | SupAddSup | 1.15    | 1.15    | 1.30    | 1.30    | 1.00    | 1.00    |
| OT.sup         | SupAddSup | 0.90    | 0.90    | 0.80    | 0.80    | 0.80    | 0.80    |
| T-GRAD.sup     | SupAddSup | 0.90    | 0.90    | 0.80    | 0.80    | 0.80    | 0.80    |
| WIND.sup       | SupAddSup | 1.50    | 1.50    | 0.80    | 0.80    | 1.30    | 1.30    |
| Earthquake.sup | SupAddSup |         |         |         |         |         |         |

Description: 5 Loads  
5.2 Load Cases

Project No.



| LF/SUP         | Rule      | Combinations  |               |                  |             |                |             |
|----------------|-----------|---------------|---------------|------------------|-------------|----------------|-------------|
|                |           | (+) / (-)     | (+) / (-)     | (+) / (-)        | (+) / (-)   | (+) / (-)      | (+) / (-)   |
|                |           | ULS FND Com   | ULS FND Com   | ULS FND Com      | ULS FND Com | ULS FND Com    | ULS FND Com |
|                |           | Comb 43       | Comb 44       | Comb 45          | Comb 46     | Comb 47        | Comb 48     |
| SW_SUM         | SupAddLc  | 1.35          | 1.35          | 1.00             | 1.00 / 1.35 | 1.00 / 1.35    | 1.00 / 1.35 |
| WC_SUM         | SupAddLc  | 1.35          | 1.35          | 1.00             | 1.00 / 1.35 | 1.00 / 1.35    | 1.00 / 1.35 |
| TR_SUM         | SupAddLc  | 1.35          | 1.35          | 1.00             | 1.00 / 1.35 | 1.00 / 1.35    | 1.00 / 1.35 |
| SD_SUM         | SupAddLc  | 1.35          | 1.35          | 1.00             | 1.00 / 1.35 | 1.00 / 1.35    | 1.00 / 1.35 |
| SDS_SUM        | SupAddLc  | 1.75          | 1.75          | 1.00 / 1.20      | 1.00 / 1.75 | 1.00 / 1.75    | 1.00 / 1.75 |
| CS_SUM         | SupAddLc  | 1.00          | 1.00          | 1.00             | 1.00        | 1.00           | 1.00        |
| CS_100         | SupAddLc  |               | 1.00          |                  |             |                | 1.00        |
| PS_SUM         | SupAddLc  | 1.00          | 1.00          | 0.90 / 1.10      | 1.00        | 1.00           | 1.00        |
| CAB_SUM        | SupAddLc  | 1.00          | 1.00          | 0.90 / 1.10      | 1.00        | 1.00           | 1.00        |
| DFST.sup       | SupAddSup | 1.00          | 1.00          | 1.00             |             |                |             |
| LL_Dyn.sup     | SupAddSup | 0.20          | 0.20          | 1.00             |             | 1.15           | 1.15        |
| BR.sup         | SupAddSup | 0.20          | 0.20          | 1.00             |             | 1.15           | 1.15        |
| CF.sup         | SupAddSup | 0.20          | 0.20          | 1.00             |             | 1.15           | 1.15        |
| OT.sup         | SupAddSup | 0.50          | 0.50          |                  |             |                |             |
| T-GRAD.sup     | SupAddSup | 0.50          | 0.50          |                  |             | 1.50           | 1.50        |
| WIND.sup       | SupAddSup |               |               | 0.60             |             | 0.90           | 0.90        |
| Earthquake.sup | SupAddSup | 0.68          | 0.68          |                  |             |                |             |
|                |           | ULS FND Seisn | ULS FND Seisn | Trail Stress che |             | Prestress Only |             |

## 6 Stage Actions (Calculation Actions)

| Stage    | STG_PIER          |      |      | sum T   |      |      | from |      |      |
|----------|-------------------|------|------|---------|------|------|------|------|------|
|          | Pier Construction |      |      | delta T |      |      | to   |      |      |
|          | From              | To   | Step | From    | To   | Step | From | To   | Step |
| activate | 2000              | 2002 | 1    | 2101    | 2145 | 1    | 2201 | 2245 | 1    |
| activate | 3000              | 3002 | 1    | 3101    | 3145 | 1    | 3201 | 3245 | 1    |
| activate | 5000              | 5002 | 1    | 5004    | 5004 | 1    | 5005 | 5005 | 1    |
| activate | 6000              | 6002 | 1    | 6004    | 6004 | 1    | 6005 | 6005 | 1    |
| Stage    | STG_00            |      |      | sum T   |      |      | from |      |      |
|          |                   |      |      | delta T |      |      | to   |      |      |
|          | From              | To   | Step | From    | To   | Step | From | To   | Step |
| activate | 101               | 132  | 1    | 185     | 216  | 1    | 1000 | 1002 | 1    |
| activate | 2510              | 2514 | 1    | 2540    | 2544 | 1    | 3510 | 3514 | 1    |
| activate | 3540              | 3544 | 1    | 4000    | 4002 | 1    |      |      |      |
| Stage    | STG_01            |      |      | sum T   |      |      | from |      |      |
|          |                   |      |      | delta T |      |      | to   |      |      |
|          | From              | To   | Step | From    | To   | Step | From | To   | Step |
| activate | 133               | 133  | 1    | 184     | 184  | 1    |      |      |      |
| Stage    | STG_02            |      |      | sum T   |      |      | from |      |      |
|          |                   |      |      | delta T |      |      | to   |      |      |
|          | From              | To   | Step | From    | To   | Step | From | To   | Step |
| activate | 134               | 134  | 1    | 183     | 183  | 1    |      |      |      |
| Stage    | STG_03            |      |      | sum T   |      |      | from |      |      |
|          |                   |      |      | delta T |      |      | to   |      |      |
|          | From              | To   | Step | From    | To   | Step | From | To   | Step |
| activate | 135               | 135  | 1    | 182     | 182  | 1    |      |      |      |
| Stage    | STG_04            |      |      | sum T   |      |      | from |      |      |
|          |                   |      |      | delta T |      |      | to   |      |      |
|          | From              | To   | Step | From    | To   | Step | From | To   | Step |
| activate | 136               | 136  | 1    | 181     | 181  | 1    |      |      |      |
| Stage    | STG_05            |      |      | sum T   |      |      | from |      |      |
|          |                   |      |      | delta T |      |      | to   |      |      |
|          | From              | To   | Step | From    | To   | Step | From | To   | Step |
| activate | 137               | 137  | 1    | 180     | 180  | 1    |      |      |      |
| Stage    | STG_06            |      |      | sum T   |      |      | from |      |      |
|          |                   |      |      | delta T |      |      | to   |      |      |
|          | From              | To   | Step | From    | To   | Step | From | To   | Step |

Description: 6 Stage Actions (Calculation Actions)

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|          |        |      |      |      |      |         |      |      |            |
|----------|--------|------|------|------|------|---------|------|------|------------|
| activate | 138    | 138  | 1    | 179  | 179  | 1       |      |      |            |
| Stage    | STG_07 |      |      |      |      | sum T   | 98   | from | 6/6/2022   |
|          |        |      |      |      |      | delta T | 10   | to   | 6/16/2022  |
|          | From   | To   | Step | From | To   | Step    | From | To   | Step       |
| activate | 139    | 139  | 1    | 178  | 178  | 1       |      |      |            |
| Stage    | STG_08 |      |      |      |      | sum T   | 108  | from | 6/16/2022  |
|          |        |      |      |      |      | delta T | 10   | to   | 6/26/2022  |
|          | From   | To   | Step | From | To   | Step    | From | To   | Step       |
| activate | 140    | 140  | 1    | 177  | 177  | 1       |      |      |            |
| Stage    | STG_09 |      |      |      |      | sum T   | 118  | from | 6/26/2022  |
|          |        |      |      |      |      | delta T | 10   | to   | 7/6/2022   |
|          | From   | To   | Step | From | To   | Step    | From | To   | Step       |
| activate | 141    | 141  | 1    | 176  | 176  | 1       | 1103 | 1803 | 100        |
| Stage    | STG_10 |      |      |      |      | sum T   | 128  | from | 7/6/2022   |
|          |        |      |      |      |      | delta T | 10   | to   | 7/16/2022  |
|          | From   | To   | Step | From | To   | Step    | From | To   | Step       |
| activate | 142    | 142  | 1    | 175  | 175  | 1       |      |      |            |
| Stage    | STG_11 |      |      |      |      | sum T   | 138  | from | 7/16/2022  |
|          |        |      |      |      |      | delta T | 10   | to   | 7/26/2022  |
|          | From   | To   | Step | From | To   | Step    | From | To   | Step       |
| activate | 143    | 143  | 1    | 174  | 174  | 1       | 1104 | 1804 | 100        |
| Stage    | STG_12 |      |      |      |      | sum T   | 148  | from | 7/26/2022  |
|          |        |      |      |      |      | delta T | 10   | to   | 8/5/2022   |
|          | From   | To   | Step | From | To   | Step    | From | To   | Step       |
| activate | 144    | 144  | 1    | 173  | 173  | 1       | 5201 | 5201 | 1          |
| activate | 5301   | 5301 | 1    | 6201 | 6201 | 1       | 6301 | 6301 | 1          |
| Stage    | STG_13 |      |      |      |      | sum T   | 158  | from | 8/5/2022   |
|          |        |      |      |      |      | delta T | 10   | to   | 8/15/2022  |
|          | From   | To   | Step | From | To   | Step    | From | To   | Step       |
| activate | 145    | 145  | 1    | 172  | 172  | 1       | 1105 | 1805 | 100        |
| Stage    | STG_14 |      |      |      |      | sum T   | 168  | from | 8/15/2022  |
|          |        |      |      |      |      | delta T | 10   | to   | 8/25/2022  |
|          | From   | To   | Step | From | To   | Step    | From | To   | Step       |
| activate | 146    | 146  | 1    | 171  | 171  | 1       |      |      |            |
| Stage    | STG_15 |      |      |      |      | sum T   | 178  | from | 8/25/2022  |
|          |        |      |      |      |      | delta T | 10   | to   | 9/4/2022   |
|          | From   | To   | Step | From | To   | Step    | From | To   | Step       |
| activate | 147    | 147  | 1    | 170  | 170  | 1       | 1106 | 1806 | 100        |
| Stage    | STG_16 |      |      |      |      | sum T   | 188  | from | 9/4/2022   |
|          |        |      |      |      |      | delta T | 10   | to   | 9/14/2022  |
|          | From   | To   | Step | From | To   | Step    | From | To   | Step       |
| activate | 148    | 148  | 1    | 169  | 169  | 1       | 5202 | 5202 | 1          |
| activate | 5302   | 5302 | 1    | 6202 | 6202 | 1       | 6302 | 6302 | 1          |
| Stage    | STG_17 |      |      |      |      | sum T   | 198  | from | 9/14/2022  |
|          |        |      |      |      |      | delta T | 10   | to   | 9/24/2022  |
|          | From   | To   | Step | From | To   | Step    | From | To   | Step       |
| activate | 149    | 149  | 1    | 168  | 168  | 1       | 1107 | 1807 | 100        |
| Stage    | STG_18 |      |      |      |      | sum T   | 208  | from | 9/24/2022  |
|          |        |      |      |      |      | delta T | 10   | to   | 10/4/2022  |
|          | From   | To   | Step | From | To   | Step    | From | To   | Step       |
| activate | 150    | 150  | 1    | 167  | 167  | 1       |      |      |            |
| Stage    | STG_19 |      |      |      |      | sum T   | 218  | from | 10/4/2022  |
|          |        |      |      |      |      | delta T | 10   | to   | 10/14/2022 |
|          | From   | To   | Step | From | To   | Step    | From | To   | Step       |
| activate | 151    | 151  | 1    | 166  | 166  | 1       | 1108 | 1808 | 100        |
| Stage    | STG_20 |      |      |      |      | sum T   | 228  | from | 10/14/2022 |
|          |        |      |      |      |      | delta T | 10   | to   | 10/24/2022 |
|          | From   | To   | Step | From | To   | Step    | From | To   | Step       |
| activate | 152    | 152  | 1    | 165  | 165  | 1       | 5203 | 5203 | 1          |
| activate | 5303   | 5303 | 1    | 6203 | 6203 | 1       | 6303 | 6303 | 1          |
| Stage    | STG_21 |      |      |      |      | sum T   | 238  | from | 10/24/2022 |
|          |        |      |      |      |      | delta T | 10   | to   | 11/3/2022  |
|          | From   | To   | Step | From | To   | Step    | From | To   | Step       |
| activate | 153    | 153  | 1    | 164  | 164  | 1       | 1109 | 1809 | 100        |

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|          |   |      |      |         |       |      |            |
|----------|---|------|------|---------|-------|------|------------|
| Stage    | STG_22  |      |      | sum T   | 248   | from | 11/3/2022  |
|          |   |      |      | delta T | 10    | to   | 11/13/2022 |
| activate | From  | To   | Step | From    | To    | Step | From       |
|          | 154   | 154  | 1    | 163     | 163   | 1    | To         |
| Stage    | STG_23  |      |      | sum T   | 258   | from | 11/13/2022 |
|          |   |      |      | delta T | 10    | to   | 11/23/2022 |
| activate | From  | To   | Step | From    | To    | Step | From       |
|          | 155   | 155  | 1    | 162     | 162   | 1    | To         |
| Stage    | STG_24  |      |      | sum T   | 268   | from | 11/23/2022 |
|          |   |      |      | delta T | 10    | to   | 12/3/2022  |
| activate | From  | To   | Step | From    | To    | Step | From       |
|          | 156   | 156  | 1    | 161     | 161   | 1    | To         |
| activate | 5304  | 5304 | 1    | 6204    | 6204  | 1    | To         |
| Stage    | STG_25  |      |      | sum T   | 278   | from | 12/3/2022  |
|          |   |      |      | delta T | 10    | to   | 12/13/2022 |
| activate | From  | To   | Step | From    | To    | Step | From       |
|          | 157   | 157  | 1    | 160     | 160   | 1    | To         |
| Stage    | STG_26  |      |      | sum T   | 288   | from | 12/13/2022 |
|          |   |      |      | delta T | 28    | to   | 1/10/2023  |
| activate | From  | To   | Step | From    | To    | Step | From       |
|          | 158   | 158  | 1    | 159     | 159   | 1    | To         |
| Stage    | STG_26c   |      |      | sum T   | 316   | from | 1/10/2023  |
|          |   |      |      | delta T | 0     | to   | 1/10/2023  |
| Stage    | STG_27  |      |      | sum T   | 316   | from | 1/10/2023  |
|          |   |      |      | delta T | 28    | to   | 2/7/2023   |
| Stage    | STG_100   |      |      | sum T   | 344   | from | 2/7/2023   |
|          |   |      |      | delta T | 36500 | to   | 1/14/2123  |
| Stage    | Traffic   |      |      | sum T   | 36844 | from | 1/14/2123  |
|          |   |      |      | delta T | 0     | to   | 1/14/2123  |
| Stage    | Braking   |      |      | sum T   | 36844 | from | 1/14/2123  |
|          |   |      |      | delta T | 0     | to   | 1/14/2123  |
| Stage    | Wind  |      |      | sum T   | 36844 | from | 1/14/2123  |
|          |   |      |      | delta T | 0     | to   | 1/14/2123  |
| Stage    | OT  |      |      | sum T   | 36844 | from | 1/14/2123  |
|          | Over All Temperature  |      |      | delta T | 0     | to   | 1/14/2123  |
| Stage    | TEMP-GRAD   |      |      | sum T   | 36844 | from | 1/14/2123  |
|          |   |      |      | delta T | 0     | to   | 1/14/2123  |
| Stage    | DFST  |      |      | sum T   | 36844 | from | 1/14/2123  |
|          | Differential Settlements  |      |      | delta T | 0     | to   | 1/14/2123  |
| Stage    | SEISMIC   |      |      | sum T   | 36844 | from | 1/14/2123  |
|          | Seismic analysis  |      |      | delta T | 0     | to   | 1/14/2123  |
| Stage    | SUPCOMB   |      |      | sum T   | 36844 | from | 1/14/2123  |
|          | Various Load Combinations as Per IRC                            |      |      | delta T | 0     | to   | 1/14/2123  |
| Stage    | ULSCOMB   |      |      | sum T   | 36844 | from | 1/14/2123  |
|          | Combination For Ultimate Limit State Checks                     |      |      | delta T | 0     | to   | 1/14/2123  |
| Stage    | SLSCOMB   |      |      | sum T   | 36844 | from | 1/14/2123  |
|          | Combination For Serviciivity Limit State Checks                 |      |      | delta T | 0     | to   | 1/14/2123  |
| Stage    | FND_BP_COMB   |      |      | sum T   | 36844 | from | 1/14/2123  |
|          | Combination For Foundation Base Pressure Checks                 |      |      | delta T | 0     | to   | 1/14/2123  |
| Stage    | FND_ULS_COMB  |      |      | sum T   | 36844 | from | 1/14/2123  |
|          | Combination For Ultimate Limit State of Foundation Structural I |      |      | delta T | 0     | to   | 1/14/2123  |
| Stage    | ULS_CHECK   |      |      | sum T   | 36844 | from | 1/14/2123  |
|          |   |      |      | delta T | 0     | to   | 1/14/2123  |



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| Stage      | STG_PIER<br>Pier Construction |         |         |          |          | Start time | 0  |
|------------|-------------------------------|---------|---------|----------|----------|------------|----|
|            |                               |         |         |          |          | Duration   | 28 |
| Activation | From                          | To      | Step    |          |          |            |    |
|            | 2000                          | 2002    | 1       |          |          |            |    |
|            | 2101                          | 2145    | 1       |          |          |            |    |
|            | 2201                          | 2245    | 1       |          |          |            |    |
|            | 3000                          | 3002    | 1       |          |          |            |    |
|            | 3101                          | 3145    | 1       |          |          |            |    |
|            | 3201                          | 3245    | 1       |          |          |            |    |
|            | 5000                          | 5002    | 1       |          |          |            |    |
|            | 5004                          |         |         |          |          |            |    |
|            | 5005                          |         |         |          |          |            |    |
|            | 6000                          | 6002    | 1       |          |          |            |    |
|            | 6004                          |         |         |          |          |            |    |
|            | 6005                          |         |         |          |          |            |    |
| Action     | Input-1                       | Input-2 | Input-3 | Output-1 | Output-2 | dT         |    |
| Calc       | SW_PIER                       |         |         |          | *        |            |    |
| Creep      | 1                             |         |         | CS_Pier  | *        | 28         |    |

| Stage      | STG_00  |         |         |            |          | Start time | 28 |
|------------|---------|---------|---------|------------|----------|------------|----|
|            |         |         |         |            |          | Duration   | 10 |
| Activation | From    | To      | Step    |            |          |            |    |
|            | 101     | 132     | 1       |            |          |            |    |
|            | 185     | 216     | 1       |            |          |            |    |
|            | 1000    | 1002    | 1       |            |          |            |    |
|            | 2510    | 2514    | 1       |            |          |            |    |
|            | 2540    | 2544    | 1       |            |          |            |    |
|            | 3510    | 3514    | 1       |            |          |            |    |
|            | 3540    | 3544    | 1       |            |          |            |    |
|            | 4000    | 4002    | 1       |            |          |            |    |
| Action     | Input-1 | Input-2 | Input-3 | Output-1   | Output-2 | dT         |    |
| Calc       | SW_00   |         |         |            | *        |            |    |
| Calc       | TR_00   |         |         |            | *        |            |    |
| Calc       | WC_00   |         |         |            | *        |            |    |
| Stress     |         | CS00    |         |            | *        |            |    |
| Calc       | PS_00   |         |         |            | *        |            |    |
| Grout      |         | CS00    |         |            | *        |            |    |
| Creep      | 1       |         |         | CS_00      | *        |            |    |
| DgmSet     | STR_STG |         |         | SRT_STG_00 | *        |            |    |
| Lclnit     | STG_SUM |         |         | STG_SUM_00 | *        |            |    |
| Calc       | TR_00_R |         |         |            | *        |            |    |
| Calc       | WC_00_R |         |         |            | *        |            |    |

| Stage      | STG_01  |         |         |            |          | Start time | 38 |
|------------|---------|---------|---------|------------|----------|------------|----|
|            |         |         |         |            |          | Duration   | 10 |
| Activation | From    | To      | Step    |            |          |            |    |
|            | 133     |         |         |            |          |            |    |
|            | 184     |         |         |            |          |            |    |
| Action     | Input-1 | Input-2 | Input-3 | Output-1   | Output-2 | dT         |    |
| Calc       | SW_01   |         |         |            | *        |            |    |
| Calc       | TR_01   |         |         |            | *        |            |    |
| Calc       | WC_01   |         |         |            | *        |            |    |
| Stress     |         | CS01    |         |            | *        |            |    |
| Calc       | PS_01   |         |         |            | *        |            |    |
| Grout      |         | CS01    |         |            | *        |            |    |
| Creep      | 1       |         |         | CS_01      | *        |            |    |
| DgmSet     | STR_STG |         |         | SRT_STG_01 | *        |            |    |
| Lclnit     | STG_SUM |         |         | STG_SUM_01 | *        |            |    |
| Calc       | TR_01_R |         |         |            | *        |            |    |
| Calc       | WC_01_R |         |         |            | *        |            |    |

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| Stage      | STG_02  |         |         |            |          | Start time | 48       |
|------------|---------|---------|---------|------------|----------|------------|----------|
| Activation | From    | To      | Step    |            |          |            | Duration |
|            | 134     |         |         |            |          |            | 10       |
|            | 183     |         |         |            |          |            |          |
| Action     | Input-1 | Input-2 | Input-3 | Output-1   | Output-2 | dT         |          |
| Calc       | SW_02   |         |         |            | *        |            |          |
| Calc       | TR_02   |         |         |            | *        |            |          |
| Calc       | WC_02   |         |         |            | *        |            |          |
| Stress     |         | CS02    |         |            | *        |            |          |
| Calc       | PS_02   |         |         |            | *        |            |          |
| Grout      |         | CS02    |         |            | *        |            |          |
| Creep      | 1       |         |         | CS_02      | *        |            | 10       |
| DgmSet     | STR_STG |         |         | SRT_STG_02 |          |            |          |
| Lclnit     | STG_SUM |         |         | STG_SUM_02 |          |            |          |
| Calc       | TR_02_R |         |         |            | *        |            |          |
| Calc       | WC_02_R |         |         |            | *        |            |          |

| Stage      | STG_03  |         |         |            |          | Start time | 58       |
|------------|---------|---------|---------|------------|----------|------------|----------|
| Activation | From    | To      | Step    |            |          |            | Duration |
|            | 135     |         |         |            |          |            | 10       |
|            | 182     |         |         |            |          |            |          |
| Action     | Input-1 | Input-2 | Input-3 | Output-1   | Output-2 | dT         |          |
| Calc       | SW_03   |         |         |            | *        |            |          |
| Calc       | TR_03   |         |         |            | *        |            |          |
| Calc       | WC_03   |         |         |            | *        |            |          |
| Stress     |         | CS03    |         |            | *        |            |          |
| Calc       | PS_03   |         |         |            | *        |            |          |
| Grout      |         | CS03    |         |            | *        |            |          |
| Creep      | 1       |         |         | CS_03      | *        |            | 10       |
| DgmSet     | STR_STG |         |         | SRT_STG_03 |          |            |          |
| Lclnit     | STG_SUM |         |         | STG_SUM_03 |          |            |          |
| Calc       | TR_03_R |         |         |            | *        |            |          |
| Calc       | WC_03_R |         |         |            | *        |            |          |

| Stage      | STG_04  |         |         |            |          | Start time | 68       |
|------------|---------|---------|---------|------------|----------|------------|----------|
| Activation | From    | To      | Step    |            |          |            | Duration |
|            | 136     |         |         |            |          |            | 10       |
|            | 181     |         |         |            |          |            |          |
| Action     | Input-1 | Input-2 | Input-3 | Output-1   | Output-2 | dT         |          |
| Calc       | SW_04   |         |         |            | *        |            |          |
| Calc       | TR_04   |         |         |            | *        |            |          |
| Calc       | WC_04   |         |         |            | *        |            |          |
| Stress     |         | CS04    |         |            | *        |            |          |
| Calc       | PS_04   |         |         |            | *        |            |          |
| Grout      |         | CS04    |         |            | *        |            |          |
| Creep      | 1       |         |         | CS_04      | *        |            | 10       |
| DgmSet     | STR_STG |         |         | SRT_STG_04 |          |            |          |
| Lclnit     | STG_SUM |         |         | STG_SUM_04 |          |            |          |
| Calc       | TR_04_R |         |         |            | *        |            |          |
| Calc       | WC_04_R |         |         |            | *        |            |          |

| Stage      | STG_05  |         |         |          |          | Start time | 78       |
|------------|---------|---------|---------|----------|----------|------------|----------|
| Activation | From    | To      | Step    |          |          |            | Duration |
|            | 137     |         |         |          |          |            | 10       |
|            | 180     |         |         |          |          |            |          |
| Action     | Input-1 | Input-2 | Input-3 | Output-1 | Output-2 | dT         |          |
| Calc       | SW_05   |         |         |          | *        |            |          |

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|           |           |       |  |            |   |    |
|-----------|-----------|-------|--|------------|---|----|
| Calc      | TR_05     |       |  |            | * |    |
| Calc      | WC_05     |       |  |            | * |    |
| (Store)   | 105       |       |  | *          |   |    |
| (Calc)    | CST_BS_05 |       |  | *          |   |    |
| (Calc)    | CST_MS_05 |       |  | *          |   |    |
| Stress    |           | CS05  |  |            | * |    |
| Calc      | PS_05     |       |  |            | * |    |
| Grout     |           | CS05  |  |            | * |    |
| Creep     | 1         |       |  | CS_05      | * | 10 |
| DgmSet    | STR_STG   |       |  | SRT_STG_05 |   |    |
| Lclnit    | STG_SUM   |       |  | STG_SUM_05 |   |    |
| (Restart) | 105,105   | 0.001 |  |            | * |    |
| Calc      | TR_05_R   |       |  |            | * |    |
| Calc      | WC_05_R   |       |  |            | * |    |

|            |         |         |         |            |          |            |    |
|------------|---------|---------|---------|------------|----------|------------|----|
| Stage      | STG_06  |         |         |            |          | Start time | 88 |
|            |         |         |         |            |          | Duration   | 10 |
| Activation | From    | To      | Step    |            |          |            |    |
|            | 138     |         |         |            |          |            |    |
|            | 179     |         |         |            |          |            |    |
| Action     | Input-1 | Input-2 | Input-3 | Output-1   | Output-2 | dT         |    |
| Calc       | SW_06   |         |         |            | *        |            |    |
| Calc       | TR_06   |         |         |            | *        |            |    |
| Calc       | WC_06   |         |         |            | *        |            |    |
| Stress     |         | CS06    |         |            | *        |            |    |
| Calc       | PS_06   |         |         |            | *        |            |    |
| Grout      |         | CS06    |         |            | *        |            |    |
| Creep      | 1       |         |         | CS_06      | *        |            | 10 |
| DgmSet     | STR_STG |         |         | SRT_STG_06 |          |            |    |
| Lclnit     | STG_SUM |         |         | STG_SUM_06 |          |            |    |
| Calc       | TR_06_R |         |         |            | *        |            |    |
| Calc       | WC_06_R |         |         |            | *        |            |    |

|            |           |         |         |            |          |            |    |
|------------|-----------|---------|---------|------------|----------|------------|----|
| Stage      | STG_07    |         |         |            |          | Start time | 98 |
|            |           |         |         |            |          | Duration   | 10 |
| Activation | From      | To      | Step    |            |          |            |    |
|            | 139       |         |         |            |          |            |    |
|            | 178       |         |         |            |          |            |    |
| Action     | Input-1   | Input-2 | Input-3 | Output-1   | Output-2 | dT         |    |
| Calc       | SW_07     |         |         |            | *        |            |    |
| Calc       | TR_07     |         |         |            | *        |            |    |
| Calc       | WC_07     |         |         |            | *        |            |    |
| (Store)    | 107       |         |         | *          |          |            |    |
| (Calc)     | CST_BS_07 |         |         |            | *        |            |    |
| (Calc)     | CST_MS_07 |         |         |            | *        |            |    |
| Stress     |           | CS07    |         |            | *        |            |    |
| Calc       | PS_07     |         |         |            | *        |            |    |
| Grout      |           | CS07    |         |            | *        |            |    |
| Creep      | 1         |         |         | CS_07      | *        |            | 10 |
| DgmSet     | STR_STG   |         |         | SRT_STG_07 |          |            |    |
| Lclnit     | STG_SUM   |         |         | STG_SUM_07 |          |            |    |
| (Restart)  | 107,107   | 0.001   |         |            | *        |            |    |
| Calc       | TR_07_R   |         |         |            | *        |            |    |
| Calc       | WC_07_R   |         |         |            | *        |            |    |

|            |         |         |         |          |          |            |     |
|------------|---------|---------|---------|----------|----------|------------|-----|
| Stage      | STG_08  |         |         |          |          | Start time | 108 |
|            |         |         |         |          |          | Duration   | 10  |
| Activation | From    | To      | Step    |          |          |            |     |
|            | 140     |         |         |          |          |            |     |
|            | 177     |         |         |          |          |            |     |
| Action     | Input-1 | Input-2 | Input-3 | Output-1 | Output-2 | dT         |     |

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|        |         |      |  |            |   |    |
|--------|---------|------|--|------------|---|----|
| Calc   | SW_08   |      |  |            | * |    |
| Calc   | TR_08   |      |  |            | * |    |
| Calc   | WC_08   |      |  |            | * |    |
| Stress |         | CS08 |  |            | * |    |
| Calc   | PS_08   |      |  |            | * |    |
| Grout  |         | CS08 |  |            | * |    |
| Creep  | 1       |      |  | CS_08      | * | 10 |
| DgmSet | STR_STG |      |  | SRT_STG_08 |   |    |
| LcInit | STG_SUM |      |  | STG_SUM_08 |   |    |
| Calc   | TR_08_R |      |  |            | * |    |
| Calc   | WC_08_R |      |  |            | * |    |

|            |           |           |         |            |          |            |     |
|------------|-----------|-----------|---------|------------|----------|------------|-----|
| Stage      | STG_09    |           |         |            |          | Start time | 118 |
| Activation | From      | To        | Step    |            |          | Duration   | 10  |
|            | 141       |           |         |            |          |            |     |
|            | 176       |           |         |            |          |            |     |
|            | 1103      | 1803      | 100     |            |          |            |     |
| Action     | Input-1   | Input-2   | Input-3 | Output-1   | Output-2 | dT         |     |
| Calc       | SW_09     |           |         |            | *        |            |     |
| Calc       | TR_09     |           |         |            | *        |            |     |
| Calc       | WC_09     |           |         |            | *        |            |     |
| Store      | 109       |           |         | *          |          |            |     |
| Calc       | CST_BS_09 |           |         |            | *        |            |     |
| Calc       | CST_MS_09 |           |         |            | *        |            |     |
| (LcInit)   | CST_BS_09 |           |         | CST_09     |          |            |     |
| (LcAddLc)  | CST_09    | CST_MS_09 |         |            |          |            |     |
| (Stress)   |           | CS09      |         |            |          |            |     |
| (Calc)     | PS_09     |           |         |            | *        |            |     |
| (Grout)    |           | CS09      |         |            | *        |            |     |
| Creep      | 1         |           |         | CS_09      | *        |            | 10  |
| DgmSet     | STR_STG   |           |         | SRT_STG_09 |          |            |     |
| LcInit     | STG_SUM   |           |         | STG_SUM_09 |          |            |     |
| Restart    | 109,109   | 0.001     |         |            | *        |            |     |
| Calc       | TR_09_R   |           |         |            | *        |            |     |
| Calc       | WC_09_R   |           |         |            | *        |            |     |

|            |         |         |         |            |          |            |     |
|------------|---------|---------|---------|------------|----------|------------|-----|
| Stage      | STG_10  |         |         |            |          | Start time | 128 |
| Activation | From    | To      | Step    |            |          | Duration   | 10  |
|            | 142     |         |         |            |          |            |     |
|            | 175     |         |         |            |          |            |     |
| Action     | Input-1 | Input-2 | Input-3 | Output-1   | Output-2 | dT         |     |
| Calc       | SW_10   |         |         |            | *        |            |     |
| Calc       | TR_10   |         |         |            | *        |            |     |
| Calc       | WC_10   |         |         |            | *        |            |     |
| Stress     |         | CS10    |         |            | *        |            |     |
| Calc       | PS_10   |         |         |            | *        |            |     |
| Grout      |         | CS10    |         |            | *        |            |     |
| Creep      | 1       |         |         | CS_10      | *        |            | 10  |
| DgmSet     | STR_STG |         |         | SRT_STG_10 |          |            |     |
| LcInit     | STG_SUM |         |         | STG_SUM_10 |          |            |     |
| Calc       | TR_10_R |         |         |            | *        |            |     |
| Calc       | WC_10_R |         |         |            | *        |            |     |

|            |        |      |      |  |  |            |     |
|------------|--------|------|------|--|--|------------|-----|
| Stage      | STG_11 |      |      |  |  | Start time | 138 |
| Activation | From   | To   | Step |  |  | Duration   | 10  |
|            | 143    |      |      |  |  |            |     |
|            | 174    |      |      |  |  |            |     |
|            | 1104   | 1804 | 100  |  |  |            |     |

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| Action    | Input-1   | Input-2   | Input-3 | Output-1   | Output-2 | dT |
|-----------|-----------|-----------|---------|------------|----------|----|
| Calc      | SW_11     |           |         |            | *        |    |
| Calc      | TR_11     |           |         |            | *        |    |
| Calc      | WC_11     |           |         |            | *        |    |
| (Calc)    | TD_11     |           |         |            | *        |    |
| Store     | 111       |           |         | *          |          |    |
| Calc      | CST_BS_11 |           |         |            | *        |    |
| Calc      | CST_MS_11 |           |         |            | *        |    |
| (Lclnit)  | CST_BS_11 |           |         | CST_11     |          |    |
| (LcAddLc) | CST_11    | CST_MS_11 |         |            |          |    |
| (Stress)  |           | CS11      |         |            |          |    |
| (Calc)    | PS_11     |           |         |            | *        |    |
| (Grout)   |           | CS11      |         |            | *        |    |
| Creep     | 1         |           |         | CS_11      | *        | 10 |
| DgmSet    | STR_STG   |           |         | SRT_STG_11 |          |    |
| Lclnit    | STG_SUM   |           |         | STG_SUM_11 |          |    |
| Restart   | 111,111   | 0.001     |         |            | *        |    |
| Calc      | TR_11_R   |           |         |            | *        |    |
| Calc      | WC_11_R   |           |         |            | *        |    |

| Stage      | STG_12    |         |         | Start time |          | 148 |
|------------|-----------|---------|---------|------------|----------|-----|
|            |           |         |         | Duration   |          | 10  |
| Activation | From      | To      | Step    |            |          |     |
|            | 144       |         |         |            |          |     |
|            | 173       |         |         |            |          |     |
|            | 5201      |         |         |            |          |     |
|            | 5301      |         |         |            |          |     |
|            | 6201      |         |         |            |          |     |
|            | 6301      |         |         |            |          |     |
| Action     | Input-1   | Input-2 | Input-3 | Output-1   | Output-2 | dT  |
| Store      | 1012      |         |         | *          |          |     |
| Calc       | TDS_01    |         |         |            | *        |     |
| Restart    | 1012,1012 | 0.001   |         |            | *        |     |
| Lclnit     | STG_SUM   |         |         | SUM_TDS12  |          |     |
| Calc       | SW_12     |         |         |            | *        |     |
| Calc       | TR_12     |         |         |            | *        |     |
| Calc       | WC_12     |         |         |            | *        |     |
| Stress     |           | CS12    |         |            | *        |     |
| Calc       | PS_12     |         |         |            | *        |     |
| Grout      |           | CS12    |         |            | *        |     |
| Creep      | 1         |         |         | CS_12      | *        |     |
| DgmSet     | STR_STG   |         |         | SRT_STG_12 |          |     |
| Lclnit     | STG_SUM   |         |         | STG_SUM_12 |          |     |
| Calc       | TR_12_R   |         |         |            | *        |     |
| Calc       | WC_12_R   |         |         |            | *        |     |

| Stage      | STG_13    |         |         |          | Start time | 158 |
|------------|-----------|---------|---------|----------|------------|-----|
|            |           |         |         |          | Duration   | 10  |
| Activation | From      |         | To      | Step     |            |     |
|            | 145       |         |         |          |            |     |
|            | 172       |         |         |          |            |     |
|            | 1105      |         | 1805    | 100      |            |     |
| Action     | Input-1   | Input-2 | Input-3 | Output-1 | Output-2   | dT  |
| Calc       | SW_13     |         |         | *        | *          |     |
| Calc       | TR_13     |         |         |          | *          |     |
| Calc       | WC_13     |         |         |          | *          |     |
| Store      | 113       |         |         |          |            |     |
| Calc       | CST_BS_13 |         |         |          | *          |     |
| Calc       | CST_MS_13 |         |         |          | *          |     |
| (Stress)   |           | CS13    |         |          |            |     |
| (Calc)     | PS_13     |         |         |          | *          |     |
| (Grout)    |           | CS13    |         |          | *          |     |

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|         |         |       |  |            |   |    |
|---------|---------|-------|--|------------|---|----|
| Creep   | 1       |       |  | CS_13      | * | 10 |
| DgmSet  | STR_STG |       |  | SRT_STG_13 |   |    |
| Lclnit  | STG_SUM |       |  | STG_SUM_13 |   |    |
| Restart | 113,113 | 0.001 |  |            | * |    |
| Calc    | TR_13_R |       |  |            | * |    |
| Calc    | WC_13_R |       |  |            | * |    |

|                   |                |                |                |                 |                 |                |
|-------------------|----------------|----------------|----------------|-----------------|-----------------|----------------|
| <b>Stage</b>      | STG_14         |                |                |                 |                 | Start time 168 |
|                   |                |                |                |                 |                 | Duration 10    |
| <b>Activation</b> | <i>From</i>    | <i>To</i>      | <i>Step</i>    |                 |                 |                |
|                   | 146            |                |                |                 |                 |                |
|                   | 171            |                |                |                 |                 |                |
| <b>Action</b>     | <i>Input-1</i> | <i>Input-2</i> | <i>Input-3</i> | <i>Output-1</i> | <i>Output-2</i> | <i>dT</i>      |
| Calc              | SW_14          |                |                |                 | *               |                |
| Calc              | TR_14          |                |                |                 | *               |                |
| Calc              | WC_14          |                |                |                 | *               |                |
| Stress            |                | CS14           |                |                 | *               |                |
| Calc              | PS_14          |                |                |                 | *               |                |
| Grout             |                | CS14           |                |                 | *               |                |
| Creep             | 1              |                |                | CS_14           | *               | 10             |
| DgmSet            | STR_STG        |                |                | SRT_STG_14      |                 |                |
| Lclnit            | STG_SUM        |                |                | STG_SUM_14      |                 |                |
| Calc              | TR_14_R        |                |                |                 | *               |                |
| Calc              | WC_14_R        |                |                |                 | *               |                |

|                   |                |                |                |                 |                 |                |
|-------------------|----------------|----------------|----------------|-----------------|-----------------|----------------|
| <b>Stage</b>      | STG_15         |                |                |                 |                 | Start time 178 |
|                   |                |                |                |                 |                 | Duration 10    |
| <b>Activation</b> | <i>From</i>    | <i>To</i>      | <i>Step</i>    |                 |                 |                |
|                   | 147            |                |                |                 |                 |                |
|                   | 170            |                |                |                 |                 |                |
|                   | 1106           | 1806           | 100            |                 |                 |                |
| <b>Action</b>     | <i>Input-1</i> | <i>Input-2</i> | <i>Input-3</i> | <i>Output-1</i> | <i>Output-2</i> | <i>dT</i>      |
| Calc              | SW_15          |                |                |                 | *               |                |
| Calc              | TR_15          |                |                |                 | *               |                |
| Calc              | WC_15          |                |                |                 | *               |                |
| Store             | 115            |                |                | *               |                 |                |
| Calc              | CST_BS_15      |                |                |                 | *               |                |
| Calc              | CST_MS_15      |                |                |                 | *               |                |
| (Stress)          |                | CS15           |                |                 | *               |                |
| (Calc)            | PS_15          |                |                |                 | *               |                |
| (Grout)           |                | CS15           |                |                 | *               |                |
| Creep             | 1              |                |                | CS_15           | *               | 10             |
| DgmSet            | STR_STG        |                |                | SRT_STG_15      |                 |                |
| Lclnit            | STG_SUM        |                |                | STG_SUM_15      |                 |                |
| Restart           | 115,115        | 0.001          |                |                 | *               |                |
| Calc              | TR_15_R        |                |                |                 | *               |                |
| Calc              | WC_15_R        |                |                |                 | *               |                |

|                   |                |                |                |                 |                 |                |
|-------------------|----------------|----------------|----------------|-----------------|-----------------|----------------|
| <b>Stage</b>      | STG_16         |                |                |                 |                 | Start time 188 |
|                   |                |                |                |                 |                 | Duration 10    |
| <b>Activation</b> | <i>From</i>    | <i>To</i>      | <i>Step</i>    |                 |                 |                |
|                   | 148            |                |                |                 |                 |                |
|                   | 169            |                |                |                 |                 |                |
|                   | 5202           |                |                |                 |                 |                |
|                   | 5302           |                |                |                 |                 |                |
|                   | 6202           |                |                |                 |                 |                |
|                   | 6302           |                |                |                 |                 |                |
| <b>Action</b>     | <i>Input-1</i> | <i>Input-2</i> | <i>Input-3</i> | <i>Output-1</i> | <i>Output-2</i> | <i>dT</i>      |
| Store             | 1016           |                |                | *               |                 |                |
| Calc              | TDS_02         |                |                |                 | *               |                |
| Restart           | 1016,1016      | 0.001          |                |                 | *               |                |

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|        |         |      |  |            |   |    |
|--------|---------|------|--|------------|---|----|
| Lclnit | STG_SUM |      |  | SUM_TDS16  | * |    |
| Calc   | SW_16   |      |  |            | * |    |
| Calc   | TR_16   |      |  |            | * |    |
| Calc   | WC_16   |      |  |            | * |    |
| Stress |         | CS16 |  |            | * |    |
| Calc   | PS_16   |      |  |            | * |    |
| Grout  |         | CS16 |  |            | * |    |
| Creep  | 1       |      |  | CS_16      | * | 10 |
| DgmSet | STR_STG |      |  | SRT_STG_16 |   |    |
| Lclnit | STG_SUM |      |  | STG_SUM_16 |   |    |
| Calc   | TR_16_R |      |  |            | * |    |
| Calc   | WC_16_R |      |  |            | * |    |

|                   |                |                |                |                 |                 |            |     |
|-------------------|----------------|----------------|----------------|-----------------|-----------------|------------|-----|
| <b>Stage</b>      | STG_17         |                |                |                 |                 | Start time | 198 |
|                   |                |                |                |                 |                 | Duration   | 10  |
| <b>Activation</b> | <i>From</i>    | <i>To</i>      | <i>Step</i>    |                 |                 |            |     |
|                   | 149            |                |                |                 |                 |            |     |
|                   | 168            |                |                |                 |                 |            |     |
|                   | 1107           | 1807           | 100            |                 |                 |            |     |
| <b>Action</b>     | <i>Input-1</i> | <i>Input-2</i> | <i>Input-3</i> | <i>Output-1</i> | <i>Output-2</i> | <i>dT</i>  |     |
| Calc              | SW_17          |                |                |                 | *               |            |     |
| Calc              | TR_17          |                |                |                 | *               |            |     |
| Calc              | WC_17          |                |                |                 | *               |            |     |
| Store             | 117            |                |                | *               |                 |            |     |
| Calc              | CST_BS_17      |                |                |                 | *               |            |     |
| Calc              | CST_MS_17      |                |                |                 | *               |            |     |
| (Stress)          |                | CS17           |                |                 | *               |            |     |
| (Calc)            | PS_17          |                |                |                 | *               |            |     |
| (Grout)           |                | CS17           |                |                 | *               |            |     |
| Creep             | 1              |                |                | CS_17           | *               |            | 10  |
| DgmSet            | STR_STG        |                |                | SRT_STG_17      |                 |            |     |
| Lclnit            | STG_SUM        |                |                | STG_SUM_17      |                 |            |     |
| Restart           | 117,117        | 0.001          |                |                 | *               |            |     |
| Calc              | TR_17_R        |                |                |                 | *               |            |     |
| Calc              | WC_17_R        |                |                |                 | *               |            |     |

|                   |                |                |                |                 |                 |            |     |
|-------------------|----------------|----------------|----------------|-----------------|-----------------|------------|-----|
| <b>Stage</b>      | STG_18         |                |                |                 |                 | Start time | 208 |
|                   |                |                |                |                 |                 | Duration   | 10  |
| <b>Activation</b> | <i>From</i>    | <i>To</i>      | <i>Step</i>    |                 |                 |            |     |
|                   | 150            |                |                |                 |                 |            |     |
|                   | 167            |                |                |                 |                 |            |     |
| <b>Action</b>     | <i>Input-1</i> | <i>Input-2</i> | <i>Input-3</i> | <i>Output-1</i> | <i>Output-2</i> | <i>dT</i>  |     |
| Calc              | SW_18          |                |                |                 | *               |            |     |
| Calc              | TR_18          |                |                |                 | *               |            |     |
| Calc              | WC_18          |                |                |                 | *               |            |     |
| Stress            |                | CS18           |                |                 | *               |            |     |
| Calc              | PS_18          |                |                |                 | *               |            |     |
| Grout             |                | CS18           |                |                 | *               |            |     |
| Creep             | 1              |                |                | CS_18           | *               |            | 10  |
| DgmSet            | STR_STG        |                |                | SRT_STG_18      |                 |            |     |
| Lclnit            | STG_SUM        |                |                | STG_SUM_18      |                 |            |     |
| Calc              | TR_18_R        |                |                |                 | *               |            |     |
| Calc              | WC_18_R        |                |                |                 | *               |            |     |

|                   |                |                |                |                 |                 |            |     |
|-------------------|----------------|----------------|----------------|-----------------|-----------------|------------|-----|
| <b>Stage</b>      | STG_19         |                |                |                 |                 | Start time | 218 |
|                   |                |                |                |                 |                 | Duration   | 10  |
| <b>Activation</b> | <i>From</i>    | <i>To</i>      | <i>Step</i>    |                 |                 |            |     |
|                   | 151            |                |                |                 |                 |            |     |
|                   | 166            |                |                |                 |                 |            |     |
|                   | 1108           | 1808           | 100            |                 |                 |            |     |
| <b>Action</b>     | <i>Input-1</i> | <i>Input-2</i> | <i>Input-3</i> | <i>Output-1</i> | <i>Output-2</i> | <i>dT</i>  |     |

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|          |           |       |  |            |   |    |
|----------|-----------|-------|--|------------|---|----|
| Calc     | SW_19     |       |  |            | * |    |
| Calc     | TR_19     |       |  |            | * |    |
| Calc     | WC_19     |       |  |            | * |    |
| Store    | 119       |       |  | *          |   |    |
| Calc     | CST_BS_19 |       |  |            | * |    |
| Calc     | CST_MS_19 |       |  |            | * |    |
| (Stress) |           | CS19  |  |            | * |    |
| (Calc)   | PS_19     |       |  |            | * |    |
| (Grout)  |           | CS19  |  |            | * |    |
| Creep    | 1         |       |  | CS_19      | * | 10 |
| DgmSet   | STR_STG   |       |  | SRT_STG_19 |   |    |
| Lclnit   | STG_SUM   |       |  | STG_SUM_19 |   |    |
| Restart  | 119,119   | 0.001 |  |            | * |    |
| Calc     | TR_19_R   |       |  |            | * |    |
| Calc     | WC_19_R   |       |  |            | * |    |

|            |           |         |         |            |          |            |     |
|------------|-----------|---------|---------|------------|----------|------------|-----|
| Stage      | STG_20    |         |         |            |          | Start time | 228 |
|            |           |         |         |            |          | Duration   | 10  |
| Activation | From      | To      | Step    |            |          |            |     |
|            | 152       |         |         |            |          |            |     |
|            | 165       |         |         |            |          |            |     |
|            | 5203      |         |         |            |          |            |     |
|            | 5303      |         |         |            |          |            |     |
|            | 6203      |         |         |            |          |            |     |
|            | 6303      |         |         |            |          |            |     |
| Action     | Input-1   | Input-2 | Input-3 | Output-1   | Output-2 | dT         |     |
| Store      | 1020      |         |         | *          |          |            |     |
| Calc       | TDS_03    |         |         |            | *        |            |     |
| Restart    | 1020,1020 | 0.001   |         |            | *        |            |     |
| Lclnit     | STG_SUM   |         |         | SUM_TDS20  |          |            |     |
| Calc       | SW_20     |         |         |            | *        |            |     |
| Calc       | TR_20     |         |         |            | *        |            |     |
| Calc       | WC_20     |         |         |            | *        |            |     |
| Stress     |           | CS20    |         |            | *        |            |     |
| Calc       | PS_20     |         |         |            | *        |            |     |
| Grout      |           | CS20    |         |            | *        |            |     |
| Creep      | 1         |         |         | CS_20      | *        |            |     |
| DgmSet     | STR_STG   |         |         | SRT_STG_20 |          |            |     |
| Lclnit     | STG_SUM   |         |         | STG_SUM_20 |          |            |     |
| Calc       | TR_20_R   |         |         |            | *        |            |     |
| Calc       | WC_20_R   |         |         |            | *        |            |     |

|            |           |         |         |            |          |            |     |
|------------|-----------|---------|---------|------------|----------|------------|-----|
| Stage      | STG_21    |         |         |            |          | Start time | 238 |
|            |           |         |         |            |          | Duration   | 10  |
| Activation | From      | To      | Step    |            |          |            |     |
|            | 153       |         |         |            |          |            |     |
|            | 164       |         |         |            |          |            |     |
|            | 1109      | 1809    | 100     |            |          |            |     |
| Action     | Input-1   | Input-2 | Input-3 | Output-1   | Output-2 | dT         |     |
| Calc       | SW_21     |         |         |            | *        |            |     |
| Calc       | TR_21     |         |         |            | *        |            |     |
| Calc       | WC_21     |         |         |            | *        |            |     |
| Store      | 121       |         |         | *          |          |            |     |
| Calc       | CST_BS_21 |         |         |            | *        |            |     |
| Calc       | CST_MS_21 |         |         |            | *        |            |     |
| (Stress)   |           | CS21    |         |            | *        |            |     |
| (Calc)     | PS_21     |         |         |            | *        |            |     |
| (Grout)    |           | CS21    |         |            | *        |            |     |
| Creep      | 1         |         |         | CS_21      | *        |            |     |
| DgmSet     | STR_STG   |         |         | SRT_STG_21 |          |            |     |
| Lclnit     | STG_SUM   |         |         | STG_SUM_21 |          |            |     |
| Restart    | 121,121   | 0.001   |         |            | *        |            |     |

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|      |         |  |  |  |   |  |
|------|---------|--|--|--|---|--|
| Calc | TR_21_R |  |  |  | * |  |
| Calc | WC_21_R |  |  |  | * |  |

| Stage      | STG_22       |         |         |            |          | Start time | 248 |
|------------|--------------|---------|---------|------------|----------|------------|-----|
| Activation | From To Step |         |         |            |          | Duration   | 10  |
|            | 154          |         |         |            |          |            |     |
|            | 163          |         |         |            |          |            |     |
| Action     | Input-1      | Input-2 | Input-3 | Output-1   | Output-2 | dT         |     |
| Calc       | SW_22        |         |         |            | *        |            |     |
| Calc       | TR_22        |         |         |            | *        |            |     |
| Calc       | WC_22        |         |         |            | *        |            |     |
| Stress     |              | CS22    |         |            | *        |            |     |
| Calc       | PS_22        |         |         |            | *        |            |     |
| Grout      |              | CS22    |         |            | *        |            |     |
| Creep      | 1            |         |         | CS_22      | *        |            | 10  |
| DgmSet     | STR_STG      |         |         | SRT_STG_22 |          |            |     |
| Lclnit     | STG_SUM      |         |         | STG_SUM_22 |          |            |     |
| Calc       | TR_22_R      |         |         |            | *        |            |     |
| Calc       | WC_22_R      |         |         |            | *        |            |     |

| Stage      | STG_23       |         |         |            |          | Start time | 258 |
|------------|--------------|---------|---------|------------|----------|------------|-----|
| Activation | From To Step |         |         |            |          | Duration   | 10  |
|            | 155          |         |         |            |          |            |     |
|            | 162          |         |         |            |          |            |     |
|            | 1110         |         |         |            |          |            |     |
|            | 1810         |         |         |            |          |            |     |
|            | 100          |         |         |            |          |            |     |
| Action     | Input-1      | Input-2 | Input-3 | Output-1   | Output-2 | dT         |     |
| Calc       | SW_23        |         |         |            | *        |            |     |
| Calc       | TR_23        |         |         |            | *        |            |     |
| Calc       | WC_23        |         |         |            | *        |            |     |
| Store      | 123          |         |         | *          |          |            |     |
| Calc       | CST_BS_23    |         |         |            | *        |            |     |
| Calc       | CST_MS_23    |         |         |            | *        |            |     |
| (Stress)   |              | CS23    |         |            | *        |            |     |
| (Calc)     | PS_23        |         |         |            | *        |            |     |
| (Grout)    |              | CS23    |         |            | *        |            |     |
| Creep      | 1            |         |         | CS_23      | *        |            | 10  |
| DgmSet     | STR_STG      |         |         | SRT_STG_23 |          |            |     |
| Lclnit     | STG_SUM      |         |         | STG_SUM_23 |          |            |     |
| Restart    | 123,123      | 0.001   |         |            | *        |            |     |
| Calc       | TR_23_R      |         |         |            | *        |            |     |
| Calc       | WC_23_R      |         |         |            | *        |            |     |

| Stage      | STG_24       |         |         |           |          | Start time | 268 |
|------------|--------------|---------|---------|-----------|----------|------------|-----|
| Activation | From To Step |         |         |           |          | Duration   | 10  |
|            | 156          |         |         |           |          |            |     |
|            | 161          |         |         |           |          |            |     |
|            | 5204         |         |         |           |          |            |     |
|            | 5304         |         |         |           |          |            |     |
|            | 6204         |         |         |           |          |            |     |
|            | 6304         |         |         |           |          |            |     |
| Action     | Input-1      | Input-2 | Input-3 | Output-1  | Output-2 | dT         |     |
| Store      | 1024         |         |         | *         |          |            |     |
| Calc       | TDS_04       |         |         |           | *        |            |     |
| Restart    | 1024,1024    | 0.001   |         |           | *        |            |     |
| Lclnit     | STG_SUM      |         |         | SUM_TDS24 |          |            |     |
| Calc       | SW_24        |         |         |           | *        |            |     |
| Calc       | TR_24        |         |         |           | *        |            |     |
| Calc       | WC_24        |         |         |           | *        |            |     |

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|        |         |      |  |            |   |    |
|--------|---------|------|--|------------|---|----|
| Stress |         | CS24 |  |            |   |    |
| Calc   | PS_24   |      |  |            | * |    |
| Grout  |         | CS24 |  |            | * |    |
| Creep  | 1       |      |  | CS_24      | * | 10 |
| DgmSet | STR_STG |      |  | SRT_STG_24 |   |    |
| Lclnit | STG_SUM |      |  | STG_SUM_24 |   |    |
| Calc   | TR_24_R |      |  |            | * |    |
| (Calc) | WC_24_R |      |  |            | * |    |

|            |           |         |         |            |          |            |     |
|------------|-----------|---------|---------|------------|----------|------------|-----|
| Stage      | STG_25    |         |         |            |          | Start time | 278 |
|            |           |         |         |            |          | Duration   | 10  |
| Activation | From      | To      | Step    |            |          |            |     |
|            | 157       |         |         |            |          |            |     |
|            | 160       |         |         |            |          |            |     |
|            | 1111      | 1811    | 100     |            |          |            |     |
| Action     | Input-1   | Input-2 | Input-3 | Output-1   | Output-2 | dT         |     |
| Calc       | SW_25     |         |         |            | *        |            |     |
| Calc       | TR_25     |         |         |            | *        |            |     |
| Calc       | WC_25     |         |         |            | *        |            |     |
| Store      | 125       |         |         | *          |          |            |     |
| Calc       | CST_BS_25 |         |         |            | *        |            |     |
| Calc       | CST_MS_25 |         |         |            | *        |            |     |
| (Stress)   |           | CS25    |         |            | *        |            |     |
| (Calc)     | PS_25     |         |         |            | *        |            |     |
| (Grout)    |           | CS25    |         |            | *        |            |     |
| Creep      | 1         |         |         | CS_25      | *        |            | 10  |
| DgmSet     | STR_STG   |         |         | SRT_STG_25 |          |            |     |
| Lclnit     | STG_SUM   |         |         | STG_SUM_25 |          |            |     |
| Restart    | 125,125   | 0.001   |         |            | *        |            |     |
| Calc       | TR_25_R   |         |         |            | *        |            |     |
| Calc       | WC_25_R   |         |         |            | *        |            |     |

|            |         |         |         |            |          |            |     |
|------------|---------|---------|---------|------------|----------|------------|-----|
| Stage      | STG_26  |         |         |            |          | Start time | 288 |
|            |         |         |         |            |          | Duration   | 28  |
| Activation | From    | To      | Step    |            |          |            |     |
|            | 158     |         |         |            |          |            |     |
|            | 159     |         |         |            |          |            |     |
| Action     | Input-1 | Input-2 | Input-3 | Output-1   | Output-2 | dT         |     |
| Calc       | SW_26   |         |         |            | *        |            |     |
| Stress     |         | CS26    |         |            | *        |            |     |
| Calc       | PS_26   |         |         |            | *        |            |     |
| Grout      |         | CS26    |         |            | *        |            |     |
| Creep      | 1       |         |         | CS_26      | *        |            | 28  |
| DgmSet     | STR_STG |         |         | SRT_STG_26 |          |            |     |
| Lclnit     | STG SUM |         |         | STG SUM 26 |          |            |     |

|        |            |         |         |          |          |            |     |
|--------|------------|---------|---------|----------|----------|------------|-----|
| Stage  | STG_26c    |         |         |          |          | Start time | 316 |
|        |            |         |         |          |          | Duration   | 0   |
| Action | Input-1    | Input-2 | Input-3 | Output-1 | Output-2 | dT         |     |
| Store  | 300        |         |         | *        |          |            |     |
| Calc   | CSTF_BS_03 |         |         |          | *        |            |     |
| Calc   | CSTF_MS_03 |         |         |          | *        |            |     |
| Calc   | CSTF_BS_04 |         |         |          | *        |            |     |
| Calc   | CSTF_MS_04 |         |         |          | *        |            |     |
| Calc   | CSTF_BS_05 |         |         |          | *        |            |     |
| Calc   | CSTF_MS_05 |         |         |          | *        |            |     |
| Calc   | CSTF_BS_06 |         |         |          | *        |            |     |
| Calc   | CSTF_MS_06 |         |         |          | *        |            |     |
| Calc   | CSTF_BS_07 |         |         |          | *        |            |     |
| Calc   | CSTF_MS_07 |         |         |          | *        |            |     |
| Calc   | CSTF_BS_08 |         |         |          | *        |            |     |

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|         |            |            |  |             |   |  |
|---------|------------|------------|--|-------------|---|--|
| Calc    | CSTF_MS_08 |            |  |             | * |  |
| Calc    | CSTF_BS_09 |            |  |             | * |  |
| Calc    | CSTF_MS_09 |            |  |             | * |  |
| Calc    | CSTF_BS_10 |            |  |             | * |  |
| Calc    | CSTF_MS_10 |            |  |             | * |  |
| Calc    | CSTF_BS_11 |            |  |             | * |  |
| Calc    | CSTF_MS_11 |            |  |             | * |  |
| DgmSet  | STR_STG    |            |  | SRT_STG_26c |   |  |
| LcInit  | STG_SUM    |            |  | STG_SUM_26c |   |  |
| LcInit  | CSTF_BS_03 |            |  | CSTF_03     |   |  |
| LcAddLc | CSTF_03    | CSTF_MS_03 |  |             |   |  |
| LcInit  | CSTF_BS_04 |            |  | CSTF_04     |   |  |
| LcAddLc | CSTF_04    | CSTF_MS_04 |  |             |   |  |
| LcInit  | CSTF_BS_05 |            |  | CSTF_05     |   |  |
| LcAddLc | CSTF_05    | CSTF_MS_05 |  |             |   |  |
| LcInit  | CSTF_BS_06 |            |  | CSTF_06     |   |  |
| LcAddLc | CSTF_06    | CSTF_MS_06 |  |             |   |  |
| LcInit  | CSTF_BS_07 |            |  | CSTF_07     |   |  |
| LcAddLc | CSTF_07    | CSTF_MS_07 |  |             |   |  |
| LcInit  | CSTF_BS_08 |            |  | CSTF_08     |   |  |
| LcAddLc | CSTF_08    | CSTF_MS_08 |  |             |   |  |
| LcInit  | CSTF_BS_09 |            |  | CSTF_09     |   |  |
| LcAddLc | CSTF_09    | CSTF_MS_09 |  |             |   |  |
| LcInit  | CSTF_BS_10 |            |  | CSTF_10     |   |  |
| LcAddLc | CSTF_10    | CSTF_MS_10 |  |             |   |  |
| LcInit  | CSTF_BS_11 |            |  | CSTF_11     |   |  |
| LcAddLc | CSTF_11    | CSTF_MS_11 |  |             |   |  |


|        |         |         |         |            |            |     |
|--------|---------|---------|---------|------------|------------|-----|
| Stage  | STG_27  |         |         |            | Start time | 316 |
|        |         |         |         |            | Duration   | 28  |
| Action | Input-1 | Input-2 | Input-3 | Output-1   | Output-2   | dT  |
| Calc   | SD      |         |         |            | *          |     |
| Calc   | SDS     |         |         |            | *          |     |
| Creep  | 1       |         |         | CS_27      | *          | 28  |
| DgmSet | STR_STG |         |         | SRT_STG_27 |            |     |
| LcInit | STG_SUM |         |         | STG_SUM_27 |            |     |

|         |             |         |         |             |            |       |
|---------|-------------|---------|---------|-------------|------------|-------|
| Stage   | STG_100     |         |         |             | Start time | 344   |
|         |             |         |         |             | Duration   | 36500 |
| Action  | Input-1     | Input-2 | Input-3 | Output-1    | Output-2   | dT    |
| Creep   | 3           |         |         | CS_100      | *          | 36500 |
| DgmSet  | STR_STG     |         |         | SRT_STG_100 | *          |       |
| Restart | 300,300     | 0.01    |         |             | *          |       |
| LcAddLc | STG_SUM     | CS_100  | -1      |             |            |       |
| LcAddLc | CS_SUM      | CS_100  | -1      |             |            |       |
| LcInit  | STG_SUM     |         |         | STG_SUM_100 |            |       |
| LcAddLc | STG_SUM_100 | CS_100  |         |             |            |       |
| LcInit  | CS_SUM      |         |         | CS_SUM_100  |            |       |
| LcAddLc | CS_SUM_100  | CS_100  |         |             |            |       |
| DgmSet  | STR_STG_100 |         |         | *           |            |       |


|         |         |         |         |                |            |       |
|---------|---------|---------|---------|----------------|------------|-------|
| Stage   | Traffic |         |         |                | Start time | 36844 |
|         |         |         |         |                | Duration   | 0     |
| Action  | Input-1 | Input-2 | Input-3 | Output-1       | Output-2   | dT    |
| Infl    | 101     |         |         | *              | *          |       |
| Infl    | 102     |         |         | *              | *          |       |
| Infl    | 201     |         |         | *              | *          |       |
| Infl    | 202     |         |         | *              | *          |       |
| SupInit |         |         |         | CLA_LT_F11.sup |            |       |
| SupInit |         |         |         | CLA_LT_F12.sup |            |       |
| SupInit |         |         |         | CLA_LT_F13.sup |            |       |


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|---|----------------|----------------|--|----------------|-------------|--|---------|--|--|--|----------------|--|--|---------|--|--|--|----------------|--|--|---------|--|--|--|----------------|--|--|---------|--|--|--|----------------|--|--|---------|--|--|--|----------------|--|--|---------|--|--|--|----------------|--|--|---------|--|--|--|----------------|--|--|---------|--|--|--|----------------|--|--|---------|--|--|--|----------------|--|--|---------|--|--|--|----------------|--|--|---------|--|--|--|----------------|--|--|---------|--|--|--|----------------|--|--|---------|--|--|--|----------------|--|--|---------|--|--|--|----------------|--|--|---------|--|--|--|----------------|--|--|---------|--|--|--|----------------|--|--|---------|--|--|--|----------------|--|--|---------|--|--|--|----------------|--|--|-------|-----|----|--|----------------|---|--|-------|-----|----|--|----------------|---|--|-------|-----|----|--|----------------|---|--|-------|-----|----|--|----------------|---|--|-------|-----|----|--|----------------|---|--|-------|-----|----|--|----------------|---|--|-------|-----|----|--|----------------|---|--|-------|-----|----|--|----------------|---|--|-------|-----|----|--|----------------|---|--|-------|-----|----|--|----------------|---|--|-------|-----|----|--|----------------|---|--|-------|-----|----|--|----------------|---|--|-------|-----|----|--|----------------|---|--|-------|-----|----|--|----------------|---|--|-------|-----|----|--|----------------|---|--|-------|-----|----|--|----------------|---|--|-------|-----|----|--|----------------|---|--|-------|-----|----|--|----------------|---|--|-------|-----|----|--|----------------|---|--|-------|-----|----|--|----------------|---|--|-------|-----|----|--|----------------|---|--|---------|----------------|--|--|--------------|--|--|----------|--------------|----------------|--|--|--|--|----------|--------------|----------------|--|--|--|--|----------|--------------|----------------|--|--|--|--|----------|--------------|----------------|--|--|--|--|----------|--------------|----------------|--|--|--|--|----------|--------------|----------------|--|--|--|--|----------|--------------|----------------|--|--|--|--|----------|--------------|----------------|--|--|--|--|----------|--------------|----------------|--|--|--|--|----------|--------------|----------------|--|--|--|--|----------|--------------|----------------|--|--|--|--|----------|--------------|----------------|--|--|--|--|----------|--------------|----------------|--|--|--|--|----------|--------------|----------------|--|--|--|--|----------|--------------|----------------|--|--|--|--|----------|--------------|----------------|--|--|--|--|----------|--------------|----------------|--|--|--|--|----------|--------------|----------------|--|--|--|--|----------|--------------|----------------|--|--|--|--|----------|--------------|----------------|--|--|--|--|---------|----------------|--|--|--|--|--|---------|----------------|--|--|--|--|--|---------|----------------|--|--|--|--|--|---------|----------------|--|--|--|--|--|
| Designer: VKS Infratech Management Pvt. Ltd.  |                |                |  |                |             |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |         |                |  |  |              |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |
| RM Bridge Professional Engineering Software   |                |                |  |                |             |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |         |                |  |  |              |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |
| project Arunachal Extradosed 63m+260m+63m   |                |                |  |                | 6/03/2022   |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |         |                |  |  |              |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |
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<table><tr><td>SuplNit</td><td></td><td></td><td></td><td>CLA_LT_F14.sup</td><td></td><td></td></tr><tr><td>SuplNit</td><td></td><td></td><td></td><td>CLA_LT_F15.sup</td><td></td><td></td></tr><tr><td>SuplNit</td><td></td><td></td><td></td><td>CLA_LT_F16.sup</td><td></td><td></td></tr><tr><td>SuplNit</td><td></td><td></td><td></td><td>CLA_LT_F21.sup</td><td></td><td></td></tr><tr><td>SuplNit</td><td></td><td></td><td></td><td>CLA_LT_F22.sup</td><td></td><td></td></tr><tr><td>SuplNit</td><td></td><td></td><td></td><td>CLA_LT_F23.sup</td><td></td><td></td></tr><tr><td>SuplNit</td><td></td><td></td><td></td><td>CLA_LT_F24.sup</td><td></td><td></td></tr><tr><td>SuplNit</td><td></td><td></td><td></td><td>CLA_LT_F25.sup</td><td></td><td></td></tr><tr><td>SuplNit</td><td></td><td></td><td></td><td>CLA_LT_F31.sup</td><td></td><td></td></tr><tr><td>SuplNit</td><td></td><td></td><td></td><td>CLA_LT_F32.sup</td><td></td><td></td></tr><tr><td>SuplNit</td><td></td><td></td><td></td><td>CLA_LT_F33.sup</td><td></td><td></td></tr><tr><td>SuplNit</td><td></td><td></td><td></td><td>CLA_LT_F34.sup</td><td></td><td></td></tr><tr><td>SuplNit</td><td></td><td></td><td></td><td>CLA_LT_F41.sup</td><td></td><td></td></tr><tr><td>SuplNit</td><td></td><td></td><td></td><td>CLA_LT_F42.sup</td><td></td><td></td></tr><tr><td>SuplNit</td><td></td><td></td><td></td><td>CLA_LT_F43.sup</td><td></td><td></td></tr><tr><td>SuplNit</td><td></td><td></td><td></td><td>CLA_LT_F51.sup</td><td></td><td></td></tr><tr><td>SuplNit</td><td></td><td></td><td></td><td>CLA_LT_F52.sup</td><td></td><td></td></tr><tr><td>SuplNit</td><td></td><td></td><td></td><td>CLA_LT_F61.sup</td><td></td><td></td></tr><tr><td>LiveL</td><td>101</td><td>11</td><td></td><td>CLA_LT_F11.sup</td><td>*</td><td></td></tr><tr><td>LiveL</td><td>101</td><td>12</td><td></td><td>CLA_LT_F12.sup</td><td>*</td><td></td></tr><tr><td>LiveL</td><td>101</td><td>13</td><td></td><td>CLA_LT_F13.sup</td><td>*</td><td></td></tr><tr><td>LiveL</td><td>101</td><td>14</td><td></td><td>CLA_LT_F14.sup</td><td>*</td><td></td></tr><tr><td>LiveL</td><td>101</td><td>15</td><td></td><td>CLA_LT_F15.sup</td><td>*</td><td></td></tr><tr><td>LiveL</td><td>101</td><td>16</td><td></td><td>CLA_LT_F16.sup</td><td>*</td><td></td></tr><tr><td>LiveL</td><td>101</td><td>21</td><td></td><td>CLA_LT_F21.sup</td><td>*</td><td></td></tr><tr><td>LiveL</td><td>101</td><td>22</td><td></td><td>CLA_LT_F22.sup</td><td>*</td><td></td></tr><tr><td>LiveL</td><td>101</td><td>23</td><td></td><td>CLA_LT_F23.sup</td><td>*</td><td></td></tr><tr><td>LiveL</td><td>101</td><td>24</td><td></td><td>CLA_LT_F24.sup</td><td>*</td><td></td></tr><tr><td>LiveL</td><td>101</td><td>25</td><td></td><td>CLA_LT_F25.sup</td><td>*</td><td></td></tr><tr><td>LiveL</td><td>101</td><td>31</td><td></td><td>CLA_LT_F31.sup</td><td>*</td><td></td></tr><tr><td>LiveL</td><td>101</td><td>32</td><td></td><td>CLA_LT_F32.sup</td><td>*</td><td></td></tr><tr><td>LiveL</td><td>101</td><td>33</td><td></td><td>CLA_LT_F33.sup</td><td>*</td><td></td></tr><tr><td>LiveL</td><td>101</td><td>34</td><td></td><td>CLA_LT_F34.sup</td><td>*</td><td></td></tr><tr><td>LiveL</td><td>101</td><td>41</td><td></td><td>CLA_LT_F41.sup</td><td>*</td><td></td></tr><tr><td>LiveL</td><td>101</td><td>42</td><td></td><td>CLA_LT_F42.sup</td><td>*</td><td></td></tr><tr><td>LiveL</td><td>101</td><td>43</td><td></td><td>CLA_LT_F43.sup</td><td>*</td><td></td></tr><tr><td>LiveL</td><td>101</td><td>51</td><td></td><td>CLA_LT_F51.sup</td><td>*</td><td></td></tr><tr><td>LiveL</td><td>101</td><td>52</td><td></td><td>CLA_LT_F52.sup</td><td>*</td><td></td></tr><tr><td>LiveL</td><td>101</td><td>61</td><td></td><td>CLA_LT_F61.sup</td><td>*</td><td></td></tr><tr><td>SuplNit</td><td>CLA_LT_F11.sup</td><td></td><td></td><td>CLA_LT_F.sup</td><td></td><td></td></tr><tr><td>SupOrSup</td><td>CLA_LT_F.sup</td><td>CLA_LT_F12.sup</td><td></td><td></td><td></td><td></td></tr><tr><td>SupOrSup</td><td>CLA_LT_F.sup</td><td>CLA_LT_F13.sup</td><td></td><td></td><td></td><td></td></tr><tr><td>SupOrSup</td><td>CLA_LT_F.sup</td><td>CLA_LT_F14.sup</td><td></td><td></td><td></td><td></td></tr><tr><td>SupOrSup</td><td>CLA_LT_F.sup</td><td>CLA_LT_F15.sup</td><td></td><td></td><td></td><td></td></tr><tr><td>SupOrSup</td><td>CLA_LT_F.sup</td><td>CLA_LT_F16.sup</td><td></td><td></td><td></td><td></td></tr><tr><td>SupOrSup</td><td>CLA_LT_F.sup</td><td>CLA_LT_F21.sup</td><td></td><td></td><td></td><td></td></tr><tr><td>SupOrSup</td><td>CLA_LT_F.sup</td><td>CLA_LT_F22.sup</td><td></td><td></td><td></td><td></td></tr><tr><td>SupOrSup</td><td>CLA_LT_F.sup</td><td>CLA_LT_F23.sup</td><td></td><td></td><td></td><td></td></tr><tr><td>SupOrSup</td><td>CLA_LT_F.sup</td><td>CLA_LT_F24.sup</td><td></td><td></td><td></td><td></td></tr><tr><td>SupOrSup</td><td>CLA_LT_F.sup</td><td>CLA_LT_F25.sup</td><td></td><td></td><td></td><td></td></tr><tr><td>SupOrSup</td><td>CLA_LT_F.sup</td><td>CLA_LT_F31.sup</td><td></td><td></td><td></td><td></td></tr><tr><td>SupOrSup</td><td>CLA_LT_F.sup</td><td>CLA_LT_F32.sup</td><td></td><td></td><td></td><td></td></tr><tr><td>SupOrSup</td><td>CLA_LT_F.sup</td><td>CLA_LT_F33.sup</td><td></td><td></td><td></td><td></td></tr><tr><td>SupOrSup</td><td>CLA_LT_F.sup</td><td>CLA_LT_F34.sup</td><td></td><td></td><td></td><td></td></tr><tr><td>SupOrSup</td><td>CLA_LT_F.sup</td><td>CLA_LT_F41.sup</td><td></td><td></td><td></td><td></td></tr><tr><td>SupOrSup</td><td>CLA_LT_F.sup</td><td>CLA_LT_F42.sup</td><td></td><td></td><td></td><td></td></tr><tr><td>SupOrSup</td><td>CLA_LT_F.sup</td><td>CLA_LT_F43.sup</td><td></td><td></td><td></td><td></td></tr><tr><td>SupOrSup</td><td>CLA_LT_F.sup</td><td>CLA_LT_F51.sup</td><td></td><td></td><td></td><td></td></tr><tr><td>SupOrSup</td><td>CLA_LT_F.sup</td><td>CLA_LT_F52.sup</td><td></td><td></td><td></td><td></td></tr><tr><td>SupOrSup</td><td>CLA_LT_F.sup</td><td>CLA_LT_F61.sup</td><td></td><td></td><td></td><td></td></tr><tr><td>(GoDel)</td><td>CLA_LT_F11.sup</td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>(GoDel)</td><td>CLA_LT_F12.sup</td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>(GoDel)</td><td>CLA_LT_F13.sup</td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>(GoDel)</td><td>CLA_LT_F14.sup</td><td></td><td></td><td></td><td></td><td></td></tr></table> |                |                |  |                |             |  | SuplNit |  |  |  | CLA_LT_F14.sup |  |  | SuplNit |  |  |  | CLA_LT_F15.sup |  |  | SuplNit |  |  |  | CLA_LT_F16.sup |  |  | SuplNit |  |  |  | CLA_LT_F21.sup |  |  | SuplNit |  |  |  | CLA_LT_F22.sup |  |  | SuplNit |  |  |  | CLA_LT_F23.sup |  |  | SuplNit |  |  |  | CLA_LT_F24.sup |  |  | SuplNit |  |  |  | CLA_LT_F25.sup |  |  | SuplNit |  |  |  | CLA_LT_F31.sup |  |  | SuplNit |  |  |  | CLA_LT_F32.sup |  |  | SuplNit |  |  |  | CLA_LT_F33.sup |  |  | SuplNit |  |  |  | CLA_LT_F34.sup |  |  | SuplNit |  |  |  | CLA_LT_F41.sup |  |  | SuplNit |  |  |  | CLA_LT_F42.sup |  |  | SuplNit |  |  |  | CLA_LT_F43.sup |  |  | SuplNit |  |  |  | CLA_LT_F51.sup |  |  | SuplNit |  |  |  | CLA_LT_F52.sup |  |  | SuplNit |  |  |  | CLA_LT_F61.sup |  |  | LiveL | 101 | 11 |  | CLA_LT_F11.sup | * |  | LiveL | 101 | 12 |  | CLA_LT_F12.sup | * |  | LiveL | 101 | 13 |  | CLA_LT_F13.sup | * |  | LiveL | 101 | 14 |  | CLA_LT_F14.sup | * |  | LiveL | 101 | 15 |  | CLA_LT_F15.sup | * |  | LiveL | 101 | 16 |  | CLA_LT_F16.sup | * |  | LiveL | 101 | 21 |  | CLA_LT_F21.sup | * |  | LiveL | 101 | 22 |  | CLA_LT_F22.sup | * |  | LiveL | 101 | 23 |  | CLA_LT_F23.sup | * |  | LiveL | 101 | 24 |  | CLA_LT_F24.sup | * |  | LiveL | 101 | 25 |  | CLA_LT_F25.sup | * |  | LiveL | 101 | 31 |  | CLA_LT_F31.sup | * |  | LiveL | 101 | 32 |  | CLA_LT_F32.sup | * |  | LiveL | 101 | 33 |  | CLA_LT_F33.sup | * |  | LiveL | 101 | 34 |  | CLA_LT_F34.sup | * |  | LiveL | 101 | 41 |  | CLA_LT_F41.sup | * |  | LiveL | 101 | 42 |  | CLA_LT_F42.sup | * |  | LiveL | 101 | 43 |  | CLA_LT_F43.sup | * |  | LiveL | 101 | 51 |  | CLA_LT_F51.sup | * |  | LiveL | 101 | 52 |  | CLA_LT_F52.sup | * |  | LiveL | 101 | 61 |  | CLA_LT_F61.sup | * |  | SuplNit | CLA_LT_F11.sup |  |  | CLA_LT_F.sup |  |  | SupOrSup | CLA_LT_F.sup | CLA_LT_F12.sup |  |  |  |  | SupOrSup | CLA_LT_F.sup | CLA_LT_F13.sup |  |  |  |  | SupOrSup | CLA_LT_F.sup | CLA_LT_F14.sup |  |  |  |  | SupOrSup | CLA_LT_F.sup | CLA_LT_F15.sup |  |  |  |  | SupOrSup | CLA_LT_F.sup | CLA_LT_F16.sup |  |  |  |  | SupOrSup | CLA_LT_F.sup | CLA_LT_F21.sup |  |  |  |  | SupOrSup | CLA_LT_F.sup | CLA_LT_F22.sup |  |  |  |  | SupOrSup | CLA_LT_F.sup | CLA_LT_F23.sup |  |  |  |  | SupOrSup | CLA_LT_F.sup | CLA_LT_F24.sup |  |  |  |  | SupOrSup | CLA_LT_F.sup | CLA_LT_F25.sup |  |  |  |  | SupOrSup | CLA_LT_F.sup | CLA_LT_F31.sup |  |  |  |  | SupOrSup | CLA_LT_F.sup | CLA_LT_F32.sup |  |  |  |  | SupOrSup | CLA_LT_F.sup | CLA_LT_F33.sup |  |  |  |  | SupOrSup | CLA_LT_F.sup | CLA_LT_F34.sup |  |  |  |  | SupOrSup | CLA_LT_F.sup | CLA_LT_F41.sup |  |  |  |  | SupOrSup | CLA_LT_F.sup | CLA_LT_F42.sup |  |  |  |  | SupOrSup | CLA_LT_F.sup | CLA_LT_F43.sup |  |  |  |  | SupOrSup | CLA_LT_F.sup | CLA_LT_F51.sup |  |  |  |  | SupOrSup | CLA_LT_F.sup | CLA_LT_F52.sup |  |  |  |  | SupOrSup | CLA_LT_F.sup | CLA_LT_F61.sup |  |  |  |  | (GoDel) | CLA_LT_F11.sup |  |  |  |  |  | (GoDel) | CLA_LT_F12.sup |  |  |  |  |  | (GoDel) | CLA_LT_F13.sup |  |  |  |  |  | (GoDel) | CLA_LT_F14.sup |  |  |  |  |  |
| SuplNit   |                |                |  | CLA_LT_F14.sup |             |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |         |                |  |  |              |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |
| SuplNit   |                |                |  | CLA_LT_F15.sup |             |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |         |                |  |  |              |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |
| SuplNit   |                |                |  | CLA_LT_F16.sup |             |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |         |                |  |  |              |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |
| SuplNit   |                |                |  | CLA_LT_F21.sup |             |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |         |                |  |  |              |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |
| SuplNit   |                |                |  | CLA_LT_F22.sup |             |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |         |                |  |  |              |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |
| SuplNit   |                |                |  | CLA_LT_F23.sup |             |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |         |                |  |  |              |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |
| SuplNit   |                |                |  | CLA_LT_F24.sup |             |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |         |                |  |  |              |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |
| SuplNit   |                |                |  | CLA_LT_F25.sup |             |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |         |                |  |  |              |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |
| SuplNit   |                |                |  | CLA_LT_F31.sup |             |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |         |                |  |  |              |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |
| SuplNit   |                |                |  | CLA_LT_F32.sup |             |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |         |                |  |  |              |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |
| SuplNit   |                |                |  | CLA_LT_F33.sup |             |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |         |                |  |  |              |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |
| SuplNit   |                |                |  | CLA_LT_F34.sup |             |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |         |                |  |  |              |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |
| SuplNit   |                |                |  | CLA_LT_F41.sup |             |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |         |                |  |  |              |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |
| SuplNit   |                |                |  | CLA_LT_F42.sup |             |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |         |                |  |  |              |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |
| SuplNit   |                |                |  | CLA_LT_F43.sup |             |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |         |                |  |  |              |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |
| SuplNit   |                |                |  | CLA_LT_F51.sup |             |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |         |                |  |  |              |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |
| SuplNit   |                |                |  | CLA_LT_F52.sup |             |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |         |                |  |  |              |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |
| SuplNit   |                |                |  | CLA_LT_F61.sup |             |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |         |                |  |  |              |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |
| LiveL   | 101            | 11             |  | CLA_LT_F11.sup | *           |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |         |                |  |  |              |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |
| LiveL   | 101            | 12             |  | CLA_LT_F12.sup | *           |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |         |                |  |  |              |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |
| LiveL   | 101            | 13             |  | CLA_LT_F13.sup | *           |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |         |                |  |  |              |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |
| LiveL   | 101            | 14             |  | CLA_LT_F14.sup | *           |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |         |                |  |  |              |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |
| LiveL   | 101            | 15             |  | CLA_LT_F15.sup | *           |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |         |                |  |  |              |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |
| LiveL   | 101            | 16             |  | CLA_LT_F16.sup | *           |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |         |                |  |  |              |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |
| LiveL   | 101            | 21             |  | CLA_LT_F21.sup | *           |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |         |                |  |  |              |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |
| LiveL   | 101            | 22             |  | CLA_LT_F22.sup | *           |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |         |                |  |  |              |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |
| LiveL   | 101            | 23             |  | CLA_LT_F23.sup | *           |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |         |                |  |  |              |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |
| LiveL   | 101            | 24             |  | CLA_LT_F24.sup | *           |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |         |                |  |  |              |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |
| LiveL   | 101            | 25             |  | CLA_LT_F25.sup | *           |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |         |                |  |  |              |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |
| LiveL   | 101            | 31             |  | CLA_LT_F31.sup | *           |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |         |                |  |  |              |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |
| LiveL   | 101            | 32             |  | CLA_LT_F32.sup | *           |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |         |                |  |  |              |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |
| LiveL   | 101            | 33             |  | CLA_LT_F33.sup | *           |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |         |                |  |  |              |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |
| LiveL   | 101            | 34             |  | CLA_LT_F34.sup | *           |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |         |                |  |  |              |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |
| LiveL   | 101            | 41             |  | CLA_LT_F41.sup | *           |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |         |                |  |  |              |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |
| LiveL   | 101            | 42             |  | CLA_LT_F42.sup | *           |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |         |                |  |  |              |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |
| LiveL   | 101            | 43             |  | CLA_LT_F43.sup | *           |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |         |                |  |  |              |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |
| LiveL   | 101            | 51             |  | CLA_LT_F51.sup | *           |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |         |                |  |  |              |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |
| LiveL   | 101            | 52             |  | CLA_LT_F52.sup | *           |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |         |                |  |  |              |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |
| LiveL   | 101            | 61             |  | CLA_LT_F61.sup | *           |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |         |                |  |  |              |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |
| SuplNit   | CLA_LT_F11.sup |                |  | CLA_LT_F.sup   |             |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |         |                |  |  |              |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |
| SupOrSup  | CLA_LT_F.sup   | CLA_LT_F12.sup |  |                |             |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |         |                |  |  |              |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |
| SupOrSup  | CLA_LT_F.sup   | CLA_LT_F13.sup |  |                |             |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |         |                |  |  |              |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |
| SupOrSup  | CLA_LT_F.sup   | CLA_LT_F14.sup |  |                |             |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |         |                |  |  |              |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |
| SupOrSup  | CLA_LT_F.sup   | CLA_LT_F15.sup |  |                |             |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |         |                |  |  |              |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |
| SupOrSup  | CLA_LT_F.sup   | CLA_LT_F16.sup |  |                |             |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |         |                |  |  |              |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |
| SupOrSup  | CLA_LT_F.sup   | CLA_LT_F21.sup |  |                |             |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |         |                |  |  |              |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |
| SupOrSup  | CLA_LT_F.sup   | CLA_LT_F22.sup |  |                |             |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |         |                |  |  |              |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |
| SupOrSup  | CLA_LT_F.sup   | CLA_LT_F23.sup |  |                |             |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |         |                |  |  |              |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |
| SupOrSup  | CLA_LT_F.sup   | CLA_LT_F24.sup |  |                |             |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |         |                |  |  |              |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |
| SupOrSup  | CLA_LT_F.sup   | CLA_LT_F25.sup |  |                |             |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |         |                |  |  |              |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |
| SupOrSup  | CLA_LT_F.sup   | CLA_LT_F31.sup |  |                |             |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |         |                |  |  |              |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |
| SupOrSup  | CLA_LT_F.sup   | CLA_LT_F32.sup |  |                |             |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |         |                |  |  |              |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |
| SupOrSup  | CLA_LT_F.sup   | CLA_LT_F33.sup |  |                |             |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |         |                |  |  |              |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |
| SupOrSup  | CLA_LT_F.sup   | CLA_LT_F34.sup |  |                |             |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |         |                |  |  |              |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |
| SupOrSup  | CLA_LT_F.sup   | CLA_LT_F41.sup |  |                |             |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |         |                |  |  |              |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |
| SupOrSup  | CLA_LT_F.sup   | CLA_LT_F42.sup |  |                |             |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |         |                |  |  |              |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |
| SupOrSup  | CLA_LT_F.sup   | CLA_LT_F43.sup |  |                |             |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |         |                |  |  |              |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |
| SupOrSup  | CLA_LT_F.sup   | CLA_LT_F51.sup |  |                |             |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |         |                |  |  |              |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |
| SupOrSup  | CLA_LT_F.sup   | CLA_LT_F52.sup |  |                |             |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |         |                |  |  |              |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |
| SupOrSup  | CLA_LT_F.sup   | CLA_LT_F61.sup |  |                |             |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |         |                |  |  |              |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |
| (GoDel)   | CLA_LT_F11.sup |                |  |                |             |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |         |                |  |  |              |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |
| (GoDel)   | CLA_LT_F12.sup |                |  |                |             |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |         |                |  |  |              |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |
| (GoDel)   | CLA_LT_F13.sup |                |  |                |             |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |         |                |  |  |              |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |
| (GoDel)   | CLA_LT_F14.sup |                |  |                |             |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |         |                |  |  |              |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |
| Description: 6 Stage Actions (Calculation Actions)  |                |                |  |                | Project No. |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |         |                |  |  |              |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |
| Page : 120  |                |                |  |                |             |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |       |     |    |  |                |   |  |         |                |  |  |              |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |          |              |                |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |

|          |                |                |                |
|----------|----------------|----------------|----------------|
| (GoDel)  | CLA_LT_F15.sup |                |                |
| (GoDel)  | CLA_LT_F16.sup |                |                |
| (GoDel)  | CLA_LT_F21.sup |                |                |
| (GoDel)  | CLA_LT_F22.sup |                |                |
| (GoDel)  | CLA_LT_F23.sup |                |                |
| (GoDel)  | CLA_LT_F24.sup |                |                |
| (GoDel)  | CLA_LT_F25.sup |                |                |
| (GoDel)  | CLA_LT_F31.sup |                |                |
| (GoDel)  | CLA_LT_F32.sup |                |                |
| (GoDel)  | CLA_LT_F33.sup |                |                |
| (GoDel)  | CLA_LT_F34.sup |                |                |
| (GoDel)  | CLA_LT_F41.sup |                |                |
| (GoDel)  | CLA_LT_F42.sup |                |                |
| (GoDel)  | CLA_LT_F43.sup |                |                |
| (GoDel)  | CLA_LT_F51.sup |                |                |
| (GoDel)  | CLA_LT_F52.sup |                |                |
| (GoDel)  | CLA_LT_F61.sup |                |                |
| SupInit  |                |                | CLA_LT_R11.sup |
| SupInit  |                |                | CLA_LT_R12.sup |
| SupInit  |                |                | CLA_LT_R13.sup |
| SupInit  |                |                | CLA_LT_R14.sup |
| SupInit  |                |                | CLA_LT_R15.sup |
| SupInit  |                |                | CLA_LT_R16.sup |
| SupInit  |                |                | CLA_LT_R21.sup |
| SupInit  |                |                | CLA_LT_R22.sup |
| SupInit  |                |                | CLA_LT_R23.sup |
| SupInit  |                |                | CLA_LT_R24.sup |
| SupInit  |                |                | CLA_LT_R25.sup |
| SupInit  |                |                | CLA_LT_R31.sup |
| SupInit  |                |                | CLA_LT_R32.sup |
| SupInit  |                |                | CLA_LT_R33.sup |
| SupInit  |                |                | CLA_LT_R34.sup |
| SupInit  |                |                | CLA_LT_R41.sup |
| SupInit  |                |                | CLA_LT_R42.sup |
| SupInit  |                |                | CLA_LT_R43.sup |
| SupInit  |                |                | CLA_LT_R51.sup |
| SupInit  |                |                | CLA_LT_R52.sup |
| SupInit  |                |                | CLA_LT_R61.sup |
| LiveL    | 101            | 111            | CLA_LT_R11.sup |
| LiveL    | 101            | 112            | CLA_LT_R12.sup |
| LiveL    | 101            | 113            | CLA_LT_R13.sup |
| LiveL    | 101            | 114            | CLA_LT_R14.sup |
| LiveL    | 101            | 115            | CLA_LT_R15.sup |
| LiveL    | 101            | 116            | CLA_LT_R16.sup |
| LiveL    | 101            | 121            | CLA_LT_R21.sup |
| LiveL    | 101            | 122            | CLA_LT_R22.sup |
| LiveL    | 101            | 123            | CLA_LT_R23.sup |
| LiveL    | 101            | 124            | CLA_LT_R24.sup |
| LiveL    | 101            | 125            | CLA_LT_R25.sup |
| LiveL    | 101            | 131            | CLA_LT_R31.sup |
| LiveL    | 101            | 132            | CLA_LT_R32.sup |
| LiveL    | 101            | 133            | CLA_LT_R33.sup |
| LiveL    | 101            | 134            | CLA_LT_R34.sup |
| LiveL    | 101            | 141            | CLA_LT_R41.sup |
| LiveL    | 101            | 142            | CLA_LT_R42.sup |
| LiveL    | 101            | 143            | CLA_LT_R43.sup |
| LiveL    | 101            | 151            | CLA_LT_R51.sup |
| LiveL    | 101            | 152            | CLA_LT_R52.sup |
| LiveL    | 101            | 161            | CLA_LT_R61.sup |
| SupInit  | CLA_LT_R11.sup |                | CLA_LT_R.sup   |
| SupOrSup | CLA_LT_R.sup   | CLA_LT_R12.sup |                |
| SupOrSup | CLA_LT_R.sup   | CLA_LT_R13.sup |                |
| SupOrSup | CLA_LT_R.sup   | CLA_LT_R14.sup |                |
| SupOrSup | CLA LT R.sup   | CLA LT R15.sup |                |


|  |                                   |  |                |             |  |
|--|-----------------------------------|--|----------------|-------------|--|
| Designer: VKS Infratech Management Pvt. Ltd.       |                                   |  |                |             |  |
| RM Bridge Professional Engineering Software        |                                   |  |                |             |  |
| project  | Arunachal Extradosed 63m+260m+63m |  |                | 6/03/2022   |  |
| SupOrSup   | CLA_LT_R.sup                      | CLA_LT_R16.st  |                |             |  |
| SupOrSup   | CLA_LT_R.sup                      | CLA_LT_R21.st  |                |             |  |
| SupOrSup   | CLA_LT_R.sup                      | CLA_LT_R22.st  |                |             |  |
| SupOrSup   | CLA_LT_R.sup                      | CLA_LT_R23.st  |                |             |  |
| SupOrSup   | CLA_LT_R.sup                      | CLA_LT_R24.st  |                |             |  |
| SupOrSup   | CLA_LT_R.sup                      | CLA_LT_R25.st  |                |             |  |
| SupOrSup   | CLA_LT_R.sup                      | CLA_LT_R31.st  |                |             |  |
| SupOrSup   | CLA_LT_R.sup                      | CLA_LT_R32.st  |                |             |  |
| SupOrSup   | CLA_LT_R.sup                      | CLA_LT_R33.st  |                |             |  |
| SupOrSup   | CLA_LT_R.sup                      | CLA_LT_R34.st  |                |             |  |
| SupOrSup   | CLA_LT_R.sup                      | CLA_LT_R41.st  |                |             |  |
| SupOrSup   | CLA_LT_R.sup                      | CLA_LT_R42.st  |                |             |  |
| SupOrSup   | CLA_LT_R.sup                      | CLA_LT_R43.st  |                |             |  |
| SupOrSup   | CLA_LT_R.sup                      | CLA_LT_R51.st  |                |             |  |
| SupOrSup   | CLA_LT_R.sup                      | CLA_LT_R52.st  |                |             |  |
| SupOrSup   | CLA_LT_R.sup                      | CLA_LT_R61.st  |                |             |  |
| (GoDel)  | CLA_LT_R11.sup                    |  |                |             |  |
| (GoDel)  | CLA_LT_R12.sup                    |  |                |             |  |
| (GoDel)  | CLA_LT_R13.sup                    |  |                |             |  |
| (GoDel)  | CLA_LT_R14.sup                    |  |                |             |  |
| (GoDel)  | CLA_LT_R15.sup                    |  |                |             |  |
| (GoDel)  | CLA_LT_R16.sup                    |  |                |             |  |
| (GoDel)  | CLA_LT_R21.sup                    |  |                |             |  |
| (GoDel)  | CLA_LT_R22.sup                    |  |                |             |  |
| (GoDel)  | CLA_LT_R23.sup                    |  |                |             |  |
| (GoDel)  | CLA_LT_R24.sup                    |  |                |             |  |
| (GoDel)  | CLA_LT_R25.sup                    |  |                |             |  |
| (GoDel)  | CLA_LT_R31.sup                    |  |                |             |  |
| (GoDel)  | CLA_LT_R32.sup                    |  |                |             |  |
| (GoDel)  | CLA_LT_R33.sup                    |  |                |             |  |
| (GoDel)  | CLA_LT_R34.sup                    |  |                |             |  |
| (GoDel)  | CLA_LT_R41.sup                    |  |                |             |  |
| (GoDel)  | CLA_LT_R42.sup                    |  |                |             |  |
| (GoDel)  | CLA_LT_R43.sup                    |  |                |             |  |
| (GoDel)  | CLA_LT_R51.sup                    |  |                |             |  |
| (GoDel)  | CLA_LT_R52.sup                    |  |                |             |  |
| (GoDel)  | CLA_LT_R61.sup                    |  |                |             |  |
| SuplNit  | CLA_LT_F.sup                      |  | CLA_LT.sup     |             |  |
| SupOrSup   | CLA_LT.sup                        | CLA_LT_R.sup   |                |             |  |
| SuplNit  |                                   |  | CLA_RT_F11.sup |             |  |
| SuplNit  |                                   |  | CLA_RT_F12.sup |             |  |
| SuplNit  |                                   |  | CLA_RT_F13.sup |             |  |
| SuplNit  |                                   |  | CLA_RT_F14.sup |             |  |
| SuplNit  |                                   |  | CLA_RT_F15.sup |             |  |
| SuplNit  |                                   |  | CLA_RT_F16.sup |             |  |
| SuplNit  |                                   |  | CLA_RT_F21.sup |             |  |
| SuplNit  |                                   |  | CLA_RT_F22.sup |             |  |
| SuplNit  |                                   |  | CLA_RT_F23.sup |             |  |
| SuplNit  |                                   |  | CLA_RT_F24.sup |             |  |
| SuplNit  |                                   |  | CLA_RT_F25.sup |             |  |
| SuplNit  |                                   |  | CLA_RT_F31.sup |             |  |
| SuplNit  |                                   |  | CLA_RT_F32.sup |             |  |
| SuplNit  |                                   |  | CLA_RT_F33.sup |             |  |
| SuplNit  |                                   |  | CLA_RT_F34.sup |             |  |
| SuplNit  |                                   |  | CLA_RT_F41.sup |             |  |
| SuplNit  |                                   |  | CLA_RT_F42.sup |             |  |
| SuplNit  |                                   |  | CLA_RT_F43.sup |             |  |
| SuplNit  |                                   |  | CLA_RT_F51.sup |             |  |
| SuplNit  |                                   |  | CLA_RT_F52.sup |             |  |
| SuplNit  |                                   |  | CLA_RT_F61.sup |             |  |
| LiveL  | 102                               | 11   | CLA_RT_F11.sup | *           |  |
| LiveL  | 102                               | 12   | CLA_RT_F12.sup | *           |  |
| LiveL  | 102                               | 13   | CLA_RT_F13.sup | *           |  |
| LiveL  | 102                               | 14   | CLA_RT_F14.sup | *           |  |
| Description: 6 Stage Actions (Calculation Actions) |                                   |  |                | Project No. |  |
| Page : 122   |                                   |  |                |             |  |


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|---|--|--|--|--|-----------|--|
| Designer: VKS Infratech Management Pvt. Ltd.  |  |  |  |  |           |  |
| RM Bridge Professional Engineering Software   |  |  |  |  |           |  |
| project Arunachal Extradosed 63m+260m+63m   |  |  |  |  | 6/03/2022 |  |
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| Designer: VKS Infratech Management Pvt. Ltd.  |  |  |  |  |           |  |
| RM Bridge Professional Engineering Software   |  |  |  |  |           |  |
| project Arunachal Extradosed 63m+260m+63m   |  |  |  |  | 6/03/2022 |  |
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|  |                                   |  |                |             |  |
|--|-----------------------------------|--|----------------|-------------|--|
| Designer: VKS Infratech Management Pvt. Ltd.       |                                   |  |                |             |  |
| RM Bridge Professional Engineering Software        |                                   |  |                |             |  |
| project  | Arunachal Extradosed 63m+260m+63m |  |                | 6/03/2022   |  |
| SupOrSup   | SRW_LT_F.sup                      | SRW_LT_F13.s   |                |             |  |
| SupOrSup   | SRW_LT_F.sup                      | SRW_LT_F14.s   |                |             |  |
| SupOrSup   | SRW_LT_F.sup                      | SRW_LT_F15.s   |                |             |  |
| SupOrSup   | SRW_LT_F.sup                      | SRW_LT_F16.s   |                |             |  |
| SupOrSup   | SRW_LT_F.sup                      | SRW_LT_F21.s   |                |             |  |
| SupOrSup   | SRW_LT_F.sup                      | SRW_LT_F22.s   |                |             |  |
| SupOrSup   | SRW_LT_F.sup                      | SRW_LT_F23.s   |                |             |  |
| SupOrSup   | SRW_LT_F.sup                      | SRW_LT_F24.s   |                |             |  |
| SupOrSup   | SRW_LT_F.sup                      | SRW_LT_F25.s   |                |             |  |
| SupOrSup   | SRW_LT_F.sup                      | SRW_LT_F31.s   |                |             |  |
| SupOrSup   | SRW_LT_F.sup                      | SRW_LT_F32.s   |                |             |  |
| SupOrSup   | SRW_LT_F.sup                      | SRW_LT_F33.s   |                |             |  |
| SupOrSup   | SRW_LT_F.sup                      | SRW_LT_F34.s   |                |             |  |
| SupOrSup   | SRW_LT_F.sup                      | SRW_LT_F41.s   |                |             |  |
| SupOrSup   | SRW_LT_F.sup                      | SRW_LT_F42.s   |                |             |  |
| SupOrSup   | SRW_LT_F.sup                      | SRW_LT_F43.s   |                |             |  |
| SupOrSup   | SRW_LT_F.sup                      | SRW_LT_F51.s   |                |             |  |
| SupOrSup   | SRW_LT_F.sup                      | SRW_LT_F52.s   |                |             |  |
| SupOrSup   | SRW_LT_F.sup                      | SRW_LT_F61.s   |                |             |  |
| (GoDel)  | SRW_LT_F11.sup                    |  |                |             |  |
| (GoDel)  | SRW_LT_F12.sup                    |  |                |             |  |
| (GoDel)  | SRW_LT_F13.sup                    |  |                |             |  |
| (GoDel)  | SRW_LT_F14.sup                    |  |                |             |  |
| (GoDel)  | SRW_LT_F15.sup                    |  |                |             |  |
| (GoDel)  | SRW_LT_F16.sup                    |  |                |             |  |
| (GoDel)  | SRW_LT_F21.sup                    |  |                |             |  |
| (GoDel)  | SRW_LT_F22.sup                    |  |                |             |  |
| (GoDel)  | SRW_LT_F23.sup                    |  |                |             |  |
| (GoDel)  | SRW_LT_F24.sup                    |  |                |             |  |
| (GoDel)  | SRW_LT_F25.sup                    |  |                |             |  |
| (GoDel)  | SRW_LT_F31.sup                    |  |                |             |  |
| (GoDel)  | SRW_LT_F32.sup                    |  |                |             |  |
| (GoDel)  | SRW_LT_F33.sup                    |  |                |             |  |
| (GoDel)  | SRW_LT_F34.sup                    |  |                |             |  |
| (GoDel)  | SRW_LT_F41.sup                    |  |                |             |  |
| (GoDel)  | SRW_LT_F42.sup                    |  |                |             |  |
| (GoDel)  | SRW_LT_F43.sup                    |  |                |             |  |
| (GoDel)  | SRW_LT_F51.sup                    |  |                |             |  |
| (GoDel)  | SRW_LT_F52.sup                    |  |                |             |  |
| (GoDel)  | SRW_LT_F61.sup                    |  |                |             |  |
| SupInit  |                                   |  | SRW_LT_R11.sup |             |  |
| SupInit  |                                   |  | SRW_LT_R12.sup |             |  |
| SupInit  |                                   |  | SRW_LT_R13.sup |             |  |
| SupInit  |                                   |  | SRW_LT_R14.sup |             |  |
| SupInit  |                                   |  | SRW_LT_R15.sup |             |  |
| SupInit  |                                   |  | SRW_LT_R16.sup |             |  |
| SupInit  |                                   |  | SRW_LT_R21.sup |             |  |
| SupInit  |                                   |  | SRW_LT_R22.sup |             |  |
| SupInit  |                                   |  | SRW_LT_R23.sup |             |  |
| SupInit  |                                   |  | SRW_LT_R24.sup |             |  |
| SupInit  |                                   |  | SRW_LT_R25.sup |             |  |
| SupInit  |                                   |  | SRW_LT_R31.sup |             |  |
| SupInit  |                                   |  | SRW_LT_R32.sup |             |  |
| SupInit  |                                   |  | SRW_LT_R33.sup |             |  |
| SupInit  |                                   |  | SRW_LT_R34.sup |             |  |
| SupInit  |                                   |  | SRW_LT_R41.sup |             |  |
| SupInit  |                                   |  | SRW_LT_R42.sup |             |  |
| SupInit  |                                   |  | SRW_LT_R43.sup |             |  |
| SupInit  |                                   |  | SRW_LT_R51.sup |             |  |
| SupInit  |                                   |  | SRW_LT_R52.sup |             |  |
| SupInit  |                                   |  | SRW_LT_R61.sup |             |  |
| LiveL  | 201                               | 311  | SRW_LT_R11.sup | *           |  |
| LiveL  | 201                               | 312  | SRW_LT_R12.sup | *           |  |
| LiveL  | 201                               | 313  | SRW_LT_R13.sup | *           |  |
| Description: 6 Stage Actions (Calculation Actions) |                                   |  |                | Project No. |  |
|  |                                   |  |                |             |  |
|  |                                   |  | Page :         | 126         |  |

|  |  |  |            |             |  |
|--|--|--|------------|-------------|--|
| Designer: VKS Infratech Management Pvt. Ltd.       |  |  |            |             |  |
| RM Bridge Professional Engineering Software        |  |  |            |             |  |
| project  | Arunachal Extradosed 63m+260m+63m  |  |            | 6/03/2022   |  |
|  | <div><div>LiveL</div><div>201</div><div>314</div><div>SRW_LT_R14.sup</div><div>*</div></div> <div><div>LiveL</div><div>201</div><div>315</div><div>SRW_LT_R15.sup</div><div>*</div></div> <div><div>LiveL</div><div>201</div><div>316</div><div>SRW_LT_R16.sup</div><div>*</div></div> <div><div>LiveL</div><div>201</div><div>321</div><div>SRW_LT_R21.sup</div><div>*</div></div> <div><div>LiveL</div><div>201</div><div>322</div><div>SRW_LT_R22.sup</div><div>*</div></div> <div><div>LiveL</div><div>201</div><div>323</div><div>SRW_LT_R23.sup</div><div>*</div></div> <div><div>LiveL</div><div>201</div><div>324</div><div>SRW_LT_R24.sup</div><div>*</div></div> <div><div>LiveL</div><div>201</div><div>325</div><div>SRW_LT_R25.sup</div><div>*</div></div> <div><div>LiveL</div><div>201</div><div>331</div><div>SRW_LT_R31.sup</div><div>*</div></div> <div><div>LiveL</div><div>201</div><div>332</div><div>SRW_LT_R32.sup</div><div>*</div></div> <div><div>LiveL</div><div>201</div><div>333</div><div>SRW_LT_R33.sup</div><div>*</div></div> <div><div>LiveL</div><div>201</div><div>334</div><div>SRW_LT_R34.sup</div><div>*</div></div> <div><div>LiveL</div><div>201</div><div>341</div><div>SRW_LT_R41.sup</div><div>*</div></div> <div><div>LiveL</div><div>201</div><div>342</div><div>SRW_LT_R42.sup</div><div>*</div></div> <div><div>LiveL</div><div>201</div><div>343</div><div>SRW_LT_R43.sup</div><div>*</div></div> <div><div>LiveL</div><div>201</div><div>351</div><div>SRW_LT_R51.sup</div><div>*</div></div> <div><div>LiveL</div><div>201</div><div>352</div><div>SRW_LT_R52.sup</div><div>*</div></div> <div><div>LiveL</div><div>201</div><div>361</div><div>SRW_LT_R61.sup</div><div>*</div></div> <div><div>SupInit</div><div>SRW_LT_R11.sup</div><div></div><div>SRW_LT_R.sup</div><div></div></div> <div><div>SupOrSup</div><div>SRW_LT_R.sup</div><div>SRW_LT_R12.s</div><div></div><div></div></div> <div><div>SupOrSup</div><div>SRW_LT_R.sup</div><div>SRW_LT_R13.s</div><div></div><div></div></div> <div><div>SupOrSup</div><div>SRW_LT_R.sup</div><div>SRW_LT_R14.s</div><div></div><div></div></div> <div><div>SupOrSup</div><div>SRW_LT_R.sup</div><div>SRW_LT_R15.s</div><div></div><div></div></div> <div><div>SupOrSup</div><div>SRW_LT_R.sup</div><div>SRW_LT_R16.s</div><div></div><div></div></div> <div><div>SupOrSup</div><div>SRW_LT_R.sup</div><div>SRW_LT_R21.s</div><div></div><div></div></div> <div><div>SupOrSup</div><div>SRW_LT_R.sup</div><div>SRW_LT_R22.s</div><div></div><div></div></div> <div><div>SupOrSup</div><div>SRW_LT_R.sup</div><div>SRW_LT_R23.s</div><div></div><div></div></div> <div><div>SupOrSup</div><div>SRW_LT_R.sup</div><div>SRW_LT_R24.s</div><div></div><div></div></div> <div><div>SupOrSup</div><div>SRW_LT_R.sup</div><div>SRW_LT_R25.s</div><div></div><div></div></div> <div><div>SupOrSup</div><div>SRW_LT_R.sup</div><div>SRW_LT_R31.s</div><div></div><div></div></div> <div><div>SupOrSup</div><div>SRW_LT_R.sup</div><div>SRW_LT_R32.s</div><div></div><div></div></div> <div><div>SupOrSup</div><div>SRW_LT_R.sup</div><div>SRW_LT_R33.s</div><div></div><div></div></div> <div><div>SupOrSup</div><div>SRW_LT_R.sup</div><div>SRW_LT_R34.s</div><div></div><div></div></div> <div><div>SupOrSup</div><div>SRW_LT_R.sup</div><div>SRW_LT_R41.s</div><div></div><div></div></div> <div><div>SupOrSup</div><div>SRW_LT_R.sup</div><div>SRW_LT_R42.s</div><div></div><div></div></div> <div><div>SupOrSup</div><div>SRW_LT_R.sup</div><div>SRW_LT_R43.s</div><div></div><div></div></div> <div><div>SupOrSup</div><div>SRW_LT_R.sup</div><div>SRW_LT_R51.s</div><div></div><div></div></div> <div><div>SupOrSup</div><div>SRW_LT_R.sup</div><div>SRW_LT_R52.s</div><div></div><div></div></div> <div><div>SupOrSup</div><div>SRW_LT_R.sup</div><div>SRW_LT_R61.s</div><div></div><div></div></div> <div><div>(GoDel)</div><div>SRW_LT_R11.sup</div><div></div><div></div><div></div></div> <div><div>(GoDel)</div><div>SRW_LT_R12.sup</div><div></div><div></div><div></div></div> <div><div>(GoDel)</div><div>SRW_LT_R13.sup</div><div></div><div></div><div></div></div> <div><div>(GoDel)</div><div>SRW_LT_R14.sup</div><div></div><div></div><div></div></div> <div><div>(GoDel)</div><div>SRW_LT_R15.sup</div><div></div><div></div><div></div></div> <div><div>(GoDel)</div><div>SRW_LT_R16.sup</div><div></div><div></div><div></div></div> <div><div>(GoDel)</div><div>SRW_LT_R21.sup</div><div></div><div></div><div></div></div> <div><div>(GoDel)</div><div>SRW_LT_R22.sup</div><div></div><div></div><div></div></div> <div><div>(GoDel)</div><div>SRW_LT_R23.sup</div><div></div><div></div><div></div></div> <div><div>(GoDel)</div><div>SRW_LT_R24.sup</div><div></div><div></div><div></div></div> <div><div>(GoDel)</div><div>SRW_LT_R25.sup</div><div></div><div></div><div></div></div> <div><div>(GoDel)</div><div>SRW_LT_R31.sup</div><div></div><div></div><div></div></div> <div><div>(GoDel)</div><div>SRW_LT_R32.sup</div><div></div><div></div><div></div></div> <div><div>(GoDel)</div><div>SRW_LT_R33.sup</div><div></div><div></div><div></div></div> <div><div>(GoDel)</div><div>SRW_LT_R34.sup</div><div></div><div></div><div></div></div> <div><div>(GoDel)</div><div>SRW_LT_R41.sup</div><div></div><div></div><div></div></div> <div><div>(GoDel)</div><div>SRW_LT_R42.sup</div><div></div><div></div><div></div></div> <div><div>(GoDel)</div><div>SRW_LT_R43.sup</div><div></div><div></div><div></div></div> <div><div>(GoDel)</div><div>SRW_LT_R51.sup</div><div></div><div></div><div></div></div> <div><div>(GoDel)</div><div>SRW_LT_R52.sup</div><div></div><div></div><div></div></div> <div><div>(GoDel)</div><div>SRW_LT_R61.sup</div><div></div><div></div><div></div></div> <div><div>SupInit</div><div>SRW_LT_F.sup</div><div></div><div>SRW_LT.sup</div><div></div></div> <div><div>SupOrSup</div><div>SRW_LT.sup</div><div>SRW_LT_R.sup</div><div></div><div></div></div> <div><div>SupInit</div><div></div><div></div><div>SRW_RT_F11.sup</div><div></div></div> <div><div>SupInit</div><div></div><div></div><div>SRW_RT_F12.sup</div><div></div></div> |  |            |             |  |
| Description: 6 Stage Actions (Calculation Actions) |  |  |            | Project No. |  |
|  |  |  | Page : 127 |             |  |

|  |                |              |  |                |             |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |         |                |  |  |              |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |
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| Designer: VKS Infratech Management Pvt. Ltd.   |                |              |  |                |             |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |         |                |  |  |              |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |
| RM Bridge Professional Engineering Software  |                |              |  |                |             |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |         |                |  |  |              |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |
| project Arunachal Extradosed 63m+260m+63m  |                |              |  |                | 6/03/2022   |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |         |                |  |  |              |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |
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<table><tr><td>SuplNit</td><td></td><td></td><td></td><td>SRW_RT_F13.sup</td><td></td><td></td></tr><tr><td>SuplNit</td><td></td><td></td><td></td><td>SRW_RT_F14.sup</td><td></td><td></td></tr><tr><td>SuplNit</td><td></td><td></td><td></td><td>SRW_RT_F15.sup</td><td></td><td></td></tr><tr><td>SuplNit</td><td></td><td></td><td></td><td>SRW_RT_F16.sup</td><td></td><td></td></tr><tr><td>SuplNit</td><td></td><td></td><td></td><td>SRW_RT_F21.sup</td><td></td><td></td></tr><tr><td>SuplNit</td><td></td><td></td><td></td><td>SRW_RT_F22.sup</td><td></td><td></td></tr><tr><td>SuplNit</td><td></td><td></td><td></td><td>SRW_RT_F23.sup</td><td></td><td></td></tr><tr><td>SuplNit</td><td></td><td></td><td></td><td>SRW_RT_F24.sup</td><td></td><td></td></tr><tr><td>SuplNit</td><td></td><td></td><td></td><td>SRW_RT_F25.sup</td><td></td><td></td></tr><tr><td>SuplNit</td><td></td><td></td><td></td><td>SRW_RT_F31.sup</td><td></td><td></td></tr><tr><td>SuplNit</td><td></td><td></td><td></td><td>SRW_RT_F32.sup</td><td></td><td></td></tr><tr><td>SuplNit</td><td></td><td></td><td></td><td>SRW_RT_F33.sup</td><td></td><td></td></tr><tr><td>SuplNit</td><td></td><td></td><td></td><td>SRW_RT_F34.sup</td><td></td><td></td></tr><tr><td>SuplNit</td><td></td><td></td><td></td><td>SRW_RT_F41.sup</td><td></td><td></td></tr><tr><td>SuplNit</td><td></td><td></td><td></td><td>SRW_RT_F42.sup</td><td></td><td></td></tr><tr><td>SuplNit</td><td></td><td></td><td></td><td>SRW_RT_F43.sup</td><td></td><td></td></tr><tr><td>SuplNit</td><td></td><td></td><td></td><td>SRW_RT_F51.sup</td><td></td><td></td></tr><tr><td>SuplNit</td><td></td><td></td><td></td><td>SRW_RT_F52.sup</td><td></td><td></td></tr><tr><td>SuplNit</td><td></td><td></td><td></td><td>SRW_RT_F61.sup</td><td></td><td></td></tr><tr><td>LiveL</td><td>202</td><td>211</td><td></td><td>SRW_RT_F11.sup</td><td>*</td><td></td></tr><tr><td>LiveL</td><td>202</td><td>212</td><td></td><td>SRW_RT_F12.sup</td><td>*</td><td></td></tr><tr><td>LiveL</td><td>202</td><td>213</td><td></td><td>SRW_RT_F13.sup</td><td>*</td><td></td></tr><tr><td>LiveL</td><td>202</td><td>214</td><td></td><td>SRW_RT_F14.sup</td><td>*</td><td></td></tr><tr><td>LiveL</td><td>202</td><td>215</td><td></td><td>SRW_RT_F15.sup</td><td>*</td><td></td></tr><tr><td>LiveL</td><td>202</td><td>216</td><td></td><td>SRW_RT_F16.sup</td><td>*</td><td></td></tr><tr><td>LiveL</td><td>202</td><td>221</td><td></td><td>SRW_RT_F21.sup</td><td>*</td><td></td></tr><tr><td>LiveL</td><td>202</td><td>222</td><td></td><td>SRW_RT_F22.sup</td><td>*</td><td></td></tr><tr><td>LiveL</td><td>202</td><td>223</td><td></td><td>SRW_RT_F23.sup</td><td>*</td><td></td></tr><tr><td>LiveL</td><td>202</td><td>224</td><td></td><td>SRW_RT_F24.sup</td><td>*</td><td></td></tr><tr><td>LiveL</td><td>202</td><td>225</td><td></td><td>SRW_RT_F25.sup</td><td>*</td><td></td></tr><tr><td>LiveL</td><td>202</td><td>231</td><td></td><td>SRW_RT_F31.sup</td><td>*</td><td></td></tr><tr><td>LiveL</td><td>202</td><td>232</td><td></td><td>SRW_RT_F32.sup</td><td>*</td><td></td></tr><tr><td>LiveL</td><td>202</td><td>233</td><td></td><td>SRW_RT_F33.sup</td><td>*</td><td></td></tr><tr><td>LiveL</td><td>202</td><td>234</td><td></td><td>SRW_RT_F34.sup</td><td>*</td><td></td></tr><tr><td>LiveL</td><td>202</td><td>241</td><td></td><td>SRW_RT_F41.sup</td><td>*</td><td></td></tr><tr><td>LiveL</td><td>202</td><td>242</td><td></td><td>SRW_RT_F42.sup</td><td>*</td><td></td></tr><tr><td>LiveL</td><td>202</td><td>243</td><td></td><td>SRW_RT_F43.sup</td><td>*</td><td></td></tr><tr><td>LiveL</td><td>202</td><td>251</td><td></td><td>SRW_RT_F51.sup</td><td>*</td><td></td></tr><tr><td>LiveL</td><td>202</td><td>252</td><td></td><td>SRW_RT_F52.sup</td><td>*</td><td></td></tr><tr><td>LiveL</td><td>202</td><td>261</td><td></td><td>SRW_RT_F61.sup</td><td>*</td><td></td></tr><tr><td>SuplNit</td><td>SRW_RT_F11.sup</td><td></td><td></td><td>SRW_RT_F.sup</td><td></td><td></td></tr><tr><td>SupOrSup</td><td>SRW_RT_F.sup</td><td>SRW_RT_F12.s</td><td></td><td></td><td></td><td></td></tr><tr><td>SupOrSup</td><td>SRW_RT_F.sup</td><td>SRW_RT_F13.s</td><td></td><td></td><td></td><td></td></tr><tr><td>SupOrSup</td><td>SRW_RT_F.sup</td><td>SRW_RT_F14.s</td><td></td><td></td><td></td><td></td></tr><tr><td>SupOrSup</td><td>SRW_RT_F.sup</td><td>SRW_RT_F15.s</td><td></td><td></td><td></td><td></td></tr><tr><td>SupOrSup</td><td>SRW_RT_F.sup</td><td>SRW_RT_F16.s</td><td></td><td></td><td></td><td></td></tr><tr><td>SupOrSup</td><td>SRW_RT_F.sup</td><td>SRW_RT_F21.s</td><td></td><td></td><td></td><td></td></tr><tr><td>SupOrSup</td><td>SRW_RT_F.sup</td><td>SRW_RT_F22.s</td><td></td><td></td><td></td><td></td></tr><tr><td>SupOrSup</td><td>SRW_RT_F.sup</td><td>SRW_RT_F23.s</td><td></td><td></td><td></td><td></td></tr><tr><td>SupOrSup</td><td>SRW_RT_F.sup</td><td>SRW_RT_F24.s</td><td></td><td></td><td></td><td></td></tr><tr><td>SupOrSup</td><td>SRW_RT_F.sup</td><td>SRW_RT_F25.s</td><td></td><td></td><td></td><td></td></tr><tr><td>SupOrSup</td><td>SRW_RT_F.sup</td><td>SRW_RT_F31.s</td><td></td><td></td><td></td><td></td></tr><tr><td>SupOrSup</td><td>SRW_RT_F.sup</td><td>SRW_RT_F32.s</td><td></td><td></td><td></td><td></td></tr><tr><td>SupOrSup</td><td>SRW_RT_F.sup</td><td>SRW_RT_F33.s</td><td></td><td></td><td></td><td></td></tr><tr><td>SupOrSup</td><td>SRW_RT_F.sup</td><td>SRW_RT_F34.s</td><td></td><td></td><td></td><td></td></tr><tr><td>SupOrSup</td><td>SRW_RT_F.sup</td><td>SRW_RT_F41.s</td><td></td><td></td><td></td><td></td></tr><tr><td>SupOrSup</td><td>SRW_RT_F.sup</td><td>SRW_RT_F42.s</td><td></td><td></td><td></td><td></td></tr><tr><td>SupOrSup</td><td>SRW_RT_F.sup</td><td>SRW_RT_F43.s</td><td></td><td></td><td></td><td></td></tr><tr><td>SupOrSup</td><td>SRW_RT_F.sup</td><td>SRW_RT_F51.s</td><td></td><td></td><td></td><td></td></tr><tr><td>SupOrSup</td><td>SRW_RT_F.sup</td><td>SRW_RT_F52.s</td><td></td><td></td><td></td><td></td></tr><tr><td>SupOrSup</td><td>SRW_RT_F.sup</td><td>SRW_RT_F61.s</td><td></td><td></td><td></td><td></td></tr><tr><td>(GoDel)</td><td>SRW_RT_F11.sup</td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>(GoDel)</td><td>SRW_RT_F12.sup</td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>(GoDel)</td><td>SRW_RT_F13.sup</td><td></td><td></td><td></td><td></td><td></td></tr></table> |                |              |  |                |             |  | SuplNit |  |  |  | SRW_RT_F13.sup |  |  | SuplNit |  |  |  | SRW_RT_F14.sup |  |  | SuplNit |  |  |  | SRW_RT_F15.sup |  |  | SuplNit |  |  |  | SRW_RT_F16.sup |  |  | SuplNit |  |  |  | SRW_RT_F21.sup |  |  | SuplNit |  |  |  | SRW_RT_F22.sup |  |  | SuplNit |  |  |  | SRW_RT_F23.sup |  |  | SuplNit |  |  |  | SRW_RT_F24.sup |  |  | SuplNit |  |  |  | SRW_RT_F25.sup |  |  | SuplNit |  |  |  | SRW_RT_F31.sup |  |  | SuplNit |  |  |  | SRW_RT_F32.sup |  |  | SuplNit |  |  |  | SRW_RT_F33.sup |  |  | SuplNit |  |  |  | SRW_RT_F34.sup |  |  | SuplNit |  |  |  | SRW_RT_F41.sup |  |  | SuplNit |  |  |  | SRW_RT_F42.sup |  |  | SuplNit |  |  |  | SRW_RT_F43.sup |  |  | SuplNit |  |  |  | SRW_RT_F51.sup |  |  | SuplNit |  |  |  | SRW_RT_F52.sup |  |  | SuplNit |  |  |  | SRW_RT_F61.sup |  |  | LiveL | 202 | 211 |  | SRW_RT_F11.sup | * |  | LiveL | 202 | 212 |  | SRW_RT_F12.sup | * |  | LiveL | 202 | 213 |  | SRW_RT_F13.sup | * |  | LiveL | 202 | 214 |  | SRW_RT_F14.sup | * |  | LiveL | 202 | 215 |  | SRW_RT_F15.sup | * |  | LiveL | 202 | 216 |  | SRW_RT_F16.sup | * |  | LiveL | 202 | 221 |  | SRW_RT_F21.sup | * |  | LiveL | 202 | 222 |  | SRW_RT_F22.sup | * |  | LiveL | 202 | 223 |  | SRW_RT_F23.sup | * |  | LiveL | 202 | 224 |  | SRW_RT_F24.sup | * |  | LiveL | 202 | 225 |  | SRW_RT_F25.sup | * |  | LiveL | 202 | 231 |  | SRW_RT_F31.sup | * |  | LiveL | 202 | 232 |  | SRW_RT_F32.sup | * |  | LiveL | 202 | 233 |  | SRW_RT_F33.sup | * |  | LiveL | 202 | 234 |  | SRW_RT_F34.sup | * |  | LiveL | 202 | 241 |  | SRW_RT_F41.sup | * |  | LiveL | 202 | 242 |  | SRW_RT_F42.sup | * |  | LiveL | 202 | 243 |  | SRW_RT_F43.sup | * |  | LiveL | 202 | 251 |  | SRW_RT_F51.sup | * |  | LiveL | 202 | 252 |  | SRW_RT_F52.sup | * |  | LiveL | 202 | 261 |  | SRW_RT_F61.sup | * |  | SuplNit | SRW_RT_F11.sup |  |  | SRW_RT_F.sup |  |  | SupOrSup | SRW_RT_F.sup | SRW_RT_F12.s |  |  |  |  | SupOrSup | SRW_RT_F.sup | SRW_RT_F13.s |  |  |  |  | SupOrSup | SRW_RT_F.sup | SRW_RT_F14.s |  |  |  |  | SupOrSup | SRW_RT_F.sup | SRW_RT_F15.s |  |  |  |  | SupOrSup | SRW_RT_F.sup | SRW_RT_F16.s |  |  |  |  | SupOrSup | SRW_RT_F.sup | SRW_RT_F21.s |  |  |  |  | SupOrSup | SRW_RT_F.sup | SRW_RT_F22.s |  |  |  |  | SupOrSup | SRW_RT_F.sup | SRW_RT_F23.s |  |  |  |  | SupOrSup | SRW_RT_F.sup | SRW_RT_F24.s |  |  |  |  | SupOrSup | SRW_RT_F.sup | SRW_RT_F25.s |  |  |  |  | SupOrSup | SRW_RT_F.sup | SRW_RT_F31.s |  |  |  |  | SupOrSup | SRW_RT_F.sup | SRW_RT_F32.s |  |  |  |  | SupOrSup | SRW_RT_F.sup | SRW_RT_F33.s |  |  |  |  | SupOrSup | SRW_RT_F.sup | SRW_RT_F34.s |  |  |  |  | SupOrSup | SRW_RT_F.sup | SRW_RT_F41.s |  |  |  |  | SupOrSup | SRW_RT_F.sup | SRW_RT_F42.s |  |  |  |  | SupOrSup | SRW_RT_F.sup | SRW_RT_F43.s |  |  |  |  | SupOrSup | SRW_RT_F.sup | SRW_RT_F51.s |  |  |  |  | SupOrSup | SRW_RT_F.sup | SRW_RT_F52.s |  |  |  |  | SupOrSup | SRW_RT_F.sup | SRW_RT_F61.s |  |  |  |  | (GoDel) | SRW_RT_F11.sup |  |  |  |  |  | (GoDel) | SRW_RT_F12.sup |  |  |  |  |  | (GoDel) | SRW_RT_F13.sup |  |  |  |  |  |
| SuplNit  |                |              |  | SRW_RT_F13.sup |             |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |         |                |  |  |              |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |
| SuplNit  |                |              |  | SRW_RT_F14.sup |             |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |         |                |  |  |              |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |
| SuplNit  |                |              |  | SRW_RT_F15.sup |             |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |         |                |  |  |              |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |
| SuplNit  |                |              |  | SRW_RT_F16.sup |             |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |         |                |  |  |              |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |
| SuplNit  |                |              |  | SRW_RT_F21.sup |             |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |         |                |  |  |              |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |
| SuplNit  |                |              |  | SRW_RT_F22.sup |             |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |         |                |  |  |              |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |
| SuplNit  |                |              |  | SRW_RT_F23.sup |             |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |         |                |  |  |              |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |
| SuplNit  |                |              |  | SRW_RT_F24.sup |             |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |         |                |  |  |              |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |
| SuplNit  |                |              |  | SRW_RT_F25.sup |             |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |         |                |  |  |              |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |
| SuplNit  |                |              |  | SRW_RT_F31.sup |             |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |         |                |  |  |              |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |
| SuplNit  |                |              |  | SRW_RT_F32.sup |             |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |         |                |  |  |              |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |
| SuplNit  |                |              |  | SRW_RT_F33.sup |             |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |         |                |  |  |              |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |
| SuplNit  |                |              |  | SRW_RT_F34.sup |             |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |         |                |  |  |              |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |
| SuplNit  |                |              |  | SRW_RT_F41.sup |             |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |         |                |  |  |              |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |
| SuplNit  |                |              |  | SRW_RT_F42.sup |             |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |         |                |  |  |              |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |
| SuplNit  |                |              |  | SRW_RT_F43.sup |             |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |         |                |  |  |              |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |
| SuplNit  |                |              |  | SRW_RT_F51.sup |             |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |         |                |  |  |              |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |
| SuplNit  |                |              |  | SRW_RT_F52.sup |             |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |         |                |  |  |              |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |
| SuplNit  |                |              |  | SRW_RT_F61.sup |             |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |         |                |  |  |              |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |
| LiveL  | 202            | 211          |  | SRW_RT_F11.sup | *           |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |         |                |  |  |              |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |
| LiveL  | 202            | 212          |  | SRW_RT_F12.sup | *           |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |         |                |  |  |              |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |
| LiveL  | 202            | 213          |  | SRW_RT_F13.sup | *           |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |         |                |  |  |              |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |
| LiveL  | 202            | 214          |  | SRW_RT_F14.sup | *           |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |         |                |  |  |              |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |
| LiveL  | 202            | 215          |  | SRW_RT_F15.sup | *           |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |         |                |  |  |              |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |
| LiveL  | 202            | 216          |  | SRW_RT_F16.sup | *           |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |         |                |  |  |              |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |
| LiveL  | 202            | 221          |  | SRW_RT_F21.sup | *           |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |         |                |  |  |              |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |
| LiveL  | 202            | 222          |  | SRW_RT_F22.sup | *           |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |         |                |  |  |              |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |
| LiveL  | 202            | 223          |  | SRW_RT_F23.sup | *           |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |         |                |  |  |              |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |
| LiveL  | 202            | 224          |  | SRW_RT_F24.sup | *           |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |         |                |  |  |              |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |
| LiveL  | 202            | 225          |  | SRW_RT_F25.sup | *           |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |         |                |  |  |              |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |
| LiveL  | 202            | 231          |  | SRW_RT_F31.sup | *           |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |         |                |  |  |              |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |
| LiveL  | 202            | 232          |  | SRW_RT_F32.sup | *           |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |         |                |  |  |              |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |
| LiveL  | 202            | 233          |  | SRW_RT_F33.sup | *           |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |         |                |  |  |              |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |
| LiveL  | 202            | 234          |  | SRW_RT_F34.sup | *           |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |         |                |  |  |              |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |
| LiveL  | 202            | 241          |  | SRW_RT_F41.sup | *           |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |         |                |  |  |              |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |
| LiveL  | 202            | 242          |  | SRW_RT_F42.sup | *           |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |         |                |  |  |              |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |
| LiveL  | 202            | 243          |  | SRW_RT_F43.sup | *           |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |         |                |  |  |              |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |
| LiveL  | 202            | 251          |  | SRW_RT_F51.sup | *           |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |         |                |  |  |              |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |
| LiveL  | 202            | 252          |  | SRW_RT_F52.sup | *           |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |         |                |  |  |              |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |
| LiveL  | 202            | 261          |  | SRW_RT_F61.sup | *           |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |         |                |  |  |              |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |
| SuplNit  | SRW_RT_F11.sup |              |  | SRW_RT_F.sup   |             |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |         |                |  |  |              |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |
| SupOrSup   | SRW_RT_F.sup   | SRW_RT_F12.s |  |                |             |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |         |                |  |  |              |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |
| SupOrSup   | SRW_RT_F.sup   | SRW_RT_F13.s |  |                |             |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |         |                |  |  |              |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |
| SupOrSup   | SRW_RT_F.sup   | SRW_RT_F14.s |  |                |             |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |         |                |  |  |              |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |
| SupOrSup   | SRW_RT_F.sup   | SRW_RT_F15.s |  |                |             |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |         |                |  |  |              |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |
| SupOrSup   | SRW_RT_F.sup   | SRW_RT_F16.s |  |                |             |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |         |                |  |  |              |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |
| SupOrSup   | SRW_RT_F.sup   | SRW_RT_F21.s |  |                |             |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |         |                |  |  |              |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |
| SupOrSup   | SRW_RT_F.sup   | SRW_RT_F22.s |  |                |             |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |         |                |  |  |              |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |
| SupOrSup   | SRW_RT_F.sup   | SRW_RT_F23.s |  |                |             |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |         |                |  |  |              |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |
| SupOrSup   | SRW_RT_F.sup   | SRW_RT_F24.s |  |                |             |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |         |                |  |  |              |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |
| SupOrSup   | SRW_RT_F.sup   | SRW_RT_F25.s |  |                |             |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |         |                |  |  |              |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |
| SupOrSup   | SRW_RT_F.sup   | SRW_RT_F31.s |  |                |             |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |         |                |  |  |              |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |
| SupOrSup   | SRW_RT_F.sup   | SRW_RT_F32.s |  |                |             |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |         |                |  |  |              |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |
| SupOrSup   | SRW_RT_F.sup   | SRW_RT_F33.s |  |                |             |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |         |                |  |  |              |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |
| SupOrSup   | SRW_RT_F.sup   | SRW_RT_F34.s |  |                |             |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |         |                |  |  |              |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |
| SupOrSup   | SRW_RT_F.sup   | SRW_RT_F41.s |  |                |             |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |         |                |  |  |              |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |
| SupOrSup   | SRW_RT_F.sup   | SRW_RT_F42.s |  |                |             |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |         |                |  |  |              |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |
| SupOrSup   | SRW_RT_F.sup   | SRW_RT_F43.s |  |                |             |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |         |                |  |  |              |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |
| SupOrSup   | SRW_RT_F.sup   | SRW_RT_F51.s |  |                |             |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |         |                |  |  |              |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |
| SupOrSup   | SRW_RT_F.sup   | SRW_RT_F52.s |  |                |             |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |         |                |  |  |              |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |
| SupOrSup   | SRW_RT_F.sup   | SRW_RT_F61.s |  |                |             |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |         |                |  |  |              |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |
| (GoDel)  | SRW_RT_F11.sup |              |  |                |             |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |         |                |  |  |              |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |
| (GoDel)  | SRW_RT_F12.sup |              |  |                |             |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |         |                |  |  |              |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |
| (GoDel)  | SRW_RT_F13.sup |              |  |                |             |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |         |                |  |  |              |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |
| Description: 6 Stage Actions (Calculation Actions)   |                |              |  |                | Project No. |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |         |                |  |  |              |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |
|  |                |              |  | Page :         | 128         |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |         |  |  |  |                |  |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |       |     |     |  |                |   |  |         |                |  |  |              |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |          |              |              |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |         |                |  |  |  |  |  |

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| Designer: VKS Infratech Management Pvt. Ltd.   |  |  |  |  |           |  |
| RM Bridge Professional Engineering Software  |  |  |  |  |           |  |
| project Arunachal Extradosed 63m+260m+63m  |  |  |  |  | 6/03/2022 |  |
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Designer: VKS Infratech Management Pvt. Ltd.



RM Bridge Professional Engineering Software

project Arunachal Extradosed 63m+260m+63m

6/03/2022

| Action    | Input-1       | Input-2       | Input-3 | Output-1      | Output-2 | dT |
|-----------|---------------|---------------|---------|---------------|----------|----|
| Calc      | Wind_P_T      |               |         | Wind_P_T.sup  | *        |    |
| SuplNit   |               |               |         |               |          |    |
| SupAndXLc | Wind_P_T.sup  | Wind_P_T      |         |               | *        |    |
| Calc      | Wind_P_L      |               |         | Wind_P_L.sup  | *        |    |
| SuplNit   |               |               |         |               |          |    |
| SupAndXLc | Wind_P_L.sup  | Wind_P_L      |         |               | *        |    |
| Calc      | Wind_SS_T     |               |         | Wind_SS_T.sup | *        |    |
| SuplNit   |               |               |         |               |          |    |
| SupAndXLc | Wind_SS_T.sup | Wind_SS_T     |         |               | *        |    |
| Calc      | Wind_SS_L     |               |         | Wind_SS_L.sup | *        |    |
| SuplNit   |               |               |         |               |          |    |
| SupAndXLc | Wind_SS_L.sup | Wind_SS_L     |         |               | *        |    |
| Calc      | Wind_SS_V     |               |         | Wind_SS_V.sup | *        |    |
| SuplNit   |               |               |         |               |          |    |
| SupAndXLc | Wind_SS_V.sup | Wind_SS_V     |         |               |          |    |
| SuplNit   | Wind_P_T.sup  |               |         | Wind.sup      |          |    |
| SupAddSup | Wind.sup      | Wind_P_L.sup  |         |               |          |    |
| SupAddSup | Wind.sup      | Wind_SS_T.sup |         |               |          |    |
| SupAddSup | Wind.sup      | Wind_SS_L.sup |         |               |          |    |
| SupAddSup | Wind.sup      | Wind_SS_V.sup |         |               |          |    |

| Stage    | OT<br>Over All Temperature |         |         |          | Start time<br>Duration | 36844<br>0 |
|----------|----------------------------|---------|---------|----------|------------------------|------------|
| Action   | Input-1                    | Input-2 | Input-3 | Output-1 | Output-2               | dT         |
| Calc     | OT+28                      |         |         |          | *                      |            |
| Calc     | OT-28                      |         |         |          | *                      |            |
| SuplNit  |                            |         |         | OT.sup   |                        |            |
| SupAddLc | OT.sup                     | OT+28   |         |          |                        |            |
| SupOrLc  | OT.sup                     | OT-28   |         |          |                        |            |

| Stage    | TEMP-GRAD  |         |         |            | Start time | 36844 |
|----------|------------|---------|---------|------------|------------|-------|
|          |            |         |         |            | Duration   | 0     |
| Action   | Input-1    | Input-2 | Input-3 | Output-1   | Output-2   | dT    |
| Calc     | TPR        |         |         |            | *          |       |
| Calc     | TPF        |         |         |            | *          |       |
| SuplNit  |            |         |         | T-GRAD.sup |            |       |
| SupAddLc | T-GRAD.sup | TPR     |         |            |            |       |
| SupOrLc  | T-GRAD.sup | TPF     |         |            |            |       |

| Stage    | DFST<br>Differential Settlements |         |         |             | Start time | 36844 |
|----------|----------------------------------|---------|---------|-------------|------------|-------|
|          |                                  |         |         |             | Duration   | 0     |
| Action   | Input-1                          | Input-2 | Input-3 | Output-1    | Output-2   | dT    |
| Calc     | DFST-1                           |         |         |             | *          |       |
| Calc     | DFST-2                           |         |         |             | *          |       |
| Calc     | DFST-3                           |         |         |             | *          |       |
| Calc     | DFST-4                           |         |         |             | *          |       |
| SuplNit  |                                  |         |         | DFST-12.sup |            |       |
| SupAddLc | DFST-12.sup                      | DFST-1  |         |             |            |       |
| SupAddLc | DFST-12.sup                      | DFST-2  |         |             |            |       |
| SuplNit  |                                  |         |         | DFST-13.sup |            |       |
| SupAddLc | DFST-13.sup                      | DFST-1  |         |             |            |       |
| SupAddLc | DFST-13.sup                      | DFST-3  |         |             |            |       |
| SuplNit  |                                  |         |         | DFST-14.sup |            |       |
| SupAddLc | DFST-14.sup                      | DFST-1  |         |             |            |       |
| SupAddLc | DFST-14.sup                      | DFST-4  |         |             |            |       |
| SuplNit  |                                  |         |         | DFST-23.sup |            |       |
| SupAddLc | DFST-23.sup                      | DFST-2  |         |             |            |       |
| SupAddLc | DFST-23.sup                      | DFST-3  |         |             |            |       |
| SuplNit  |                                  |         |         | DFST-24.sup |            |       |
| SupAddLc | DFST-24.sup                      | DFST-2  |         |             |            |       |

Description: 6 Stage Actions (Calculation Actions)

Project No.



|          |              |              |  |              |  |
|----------|--------------|--------------|--|--------------|--|
| SupAddLc | DFST-24.sup  | DFST-4       |  |              |  |
| SupInit  |              |              |  | DFST-34.sup  |  |
| SupAddLc | DFST-34.sup  | DFST-3       |  |              |  |
| SupAddLc | DFST-34.sup  | DFST-4       |  |              |  |
| SupInit  |              |              |  | DFST-123.sup |  |
| SupAddLc | DFST-123.sup | DFST-1       |  |              |  |
| SupAddLc | DFST-123.sup | DFST-2       |  |              |  |
| SupAddLc | DFST-123.sup | DFST-3       |  |              |  |
| SupInit  |              |              |  | DFST-124.sup |  |
| SupAddLc | DFST-124.sup | DFST-1       |  |              |  |
| SupAddLc | DFST-124.sup | DFST-2       |  |              |  |
| SupAddLc | DFST-124.sup | DFST-4       |  |              |  |
| SupInit  |              |              |  | DFST-134.sup |  |
| SupAddLc | DFST-134.sup | DFST-1       |  |              |  |
| SupAddLc | DFST-134.sup | DFST-3       |  |              |  |
| SupAddLc | DFST-134.sup | DFST-4       |  |              |  |
| SupInit  |              |              |  | DFST-234.sup |  |
| SupAddLc | DFST-234.sup | DFST-2       |  |              |  |
| SupAddLc | DFST-234.sup | DFST-3       |  |              |  |
| SupAddLc | DFST-234.sup | DFST-4       |  |              |  |
| SupInit  |              |              |  | DFST.sup     |  |
| SupAddLc | DFST.sup     | DFST-1       |  |              |  |
| SupOrLc  | DFST.sup     | DFST-2       |  |              |  |
| SupOrLc  | DFST.sup     | DFST-3       |  |              |  |
| SupOrLc  | DFST.sup     | DFST-4       |  |              |  |
| SupOrSup | DFST.sup     | DFST-12.sup  |  |              |  |
| SupOrSup | DFST.sup     | DFST-13.sup  |  |              |  |
| SupOrSup | DFST.sup     | DFST-14.sup  |  |              |  |
| SupOrSup | DFST.sup     | DFST-23.sup  |  |              |  |
| SupOrSup | DFST.sup     | DFST-24.sup  |  |              |  |
| SupOrSup | DFST.sup     | DFST-34.sup  |  |              |  |
| SupOrSup | DFST.sup     | DFST-123.sup |  |              |  |
| SupOrSup | DFST.sup     | DFST-124.sup |  |              |  |
| SupOrSup | DFST.sup     | DFST-134.sup |  |              |  |
| SupOrSup | DFST.sup     | DFST-234.sup |  |              |  |

| Stage     | SEISMIC           |          |         |                   | Start time     | 36844 |
|-----------|-------------------|----------|---------|-------------------|----------------|-------|
|           | Seismic analysis  |          |         |                   | Duration       | 0     |
| Action    | Input-1           | Input-2  | Input-3 | Output-1          | Output-2       | dT    |
| Calc      | Mass              |          |         |                   | *              |       |
| Eigen     | 100               | Mass     |         | Eigen_Mode.mod    | Natural_modes  |       |
| ListMod   | Eigen_Mode.mod    |          |         |                   | Eigen_Mode.lst |       |
| SupInit   |                   |          |         | EQ_X.sup          |                |       |
| SupInit   |                   |          |         | EQ_Y.sup          |                |       |
| SupInit   |                   |          |         | EQ_Z.sup          |                |       |
| RespS     | 1                 | ACTIVE   |         | EQ_X.sup          | EQ_X.lst       |       |
| RespS     | 2                 | ACTIVE   |         | EQ_Z.sup          | EQ_Z.lst       |       |
| RespS     | 3                 | ACTIVE   |         | EQ_Y.sup          | EQ_Y.lst       |       |
| SupInit   |                   |          |         | EQ_X_mm.sup       |                |       |
| SupInit   |                   |          |         | EQ_Z_mm.sup       |                |       |
| SupInit   |                   |          |         | EQ_Y_mm.sup       |                |       |
| SupAddSup | EQ_X_mm.sup       | EQ_X.sup | 1000    |                   |                |       |
| SupAddSup | EQ_Z_mm.sup       | EQ_Z.sup | 1000    |                   |                |       |
| SupAddSup | EQ_Y_mm.sup       | EQ_Y.sup | 1000    |                   |                |       |
| SupInit   |                   |          |         | 100Ex30Ez30Ey.sup |                |       |
| SupAddSup | 100Ex30Ez30Ey.sup | EQ_X.sup | 1.0,1.0 |                   |                |       |
| SupAddSup | 100Ex30Ez30Ey.sup | EQ_Z.sup | 0.3,0.3 |                   |                |       |
| SupAddSup | 100Ex30Ez30Ey.sup | EQ_Y.sup | 0.3,0.3 |                   |                |       |
| SupInit   |                   |          |         | 100Ez30Ex30Ey.sup |                |       |
| SupAddSup | 100Ez30Ex30Ey.sup | EQ_Z.sup | 1.0,1.0 |                   |                |       |
| SupAddSup | 100Ez30Ex30Ey.sup | EQ_X.sup | 0.3,0.3 |                   |                |       |
| SupAddSup | 100Ez30Ex30Ey.sup | EQ_Y.sup | 0.3,0.3 |                   |                |       |
| SupInit   |                   |          |         | 100Ey30Ex30Ez.sup |                |       |

Description: 6 Stage Actions (Calculation Actions)

Project No.

Designer: VKS Infratech Management Pvt. Ltd.



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project Arunachal Extradosed 63m+260m+63m

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|           |                   |              |         |                |  |  |
|-----------|-------------------|--------------|---------|----------------|--|--|
| SupAddSup | 100Ey30Ex30Ez.sup | EQ_Y.sup     | 1.0,1.0 |                |  |  |
| SupAddSup | 100Ey30Ex30Ez.sup | EQ_X.sup     | 0.3,0.3 |                |  |  |
| SupAddSup | 100Ey30Ex30Ez.sup | EQ_Z.sup     | 0.3,0.3 |                |  |  |
| SupInit   |                   |              |         | Earthquake.sup |  |  |
| SupAddSup | Earthquake.sup    | 100Ex30Ez30E | 1.0,1.0 |                |  |  |
| SupOrSup  | Earthquake.sup    | 100Ez30Ex30E |         |                |  |  |
| SupOrSup  | Earthquake.sup    | 100Ey30Ex30E |         |                |  |  |

| Stage   | SUPCOMB<br>Various Load Combinations as Per IRC |         |         |             | Start time 36844<br>Duration 0 |    |
|---------|---|---------|---------|-------------|--------------------------------|----|
| Action  | Input-1   | Input-2 | Input-3 | Output-1    | Output-2                       | dT |
| SupInit |   |         |         | CF.sup      |                                |    |
| SupComb | 1   |         |         | COMB_01.sup |                                |    |
| SupComb | 2   |         |         | COMB_02.sup |                                |    |
| SupComb | 3   |         |         | COMB_03.sup |                                |    |
| SupComb | 4   |         |         | COMB_04.sup |                                |    |
| SupComb | 5   |         |         | COMB_05.sup |                                |    |
| SupComb | 6   |         |         | COMB_06.sup |                                |    |
| SupComb | 7   |         |         | COMB_07.sup |                                |    |
| SupComb | 8   |         |         | COMB_08.sup |                                |    |
| SupComb | 9   |         |         | COMB_09.sup |                                |    |
| SupComb | 10  |         |         | COMB_10.sup |                                |    |
| SupComb | 11  |         |         | COMB_11.sup |                                |    |
| SupComb | 12  |         |         | COMB_12.sup |                                |    |
| SupComb | 13  |         |         | COMB_13.sup |                                |    |
| SupComb | 14  |         |         | COMB_14.sup |                                |    |
| SupComb | 15  |         |         | COMB_15.sup |                                |    |
| SupComb | 16  |         |         | COMB_16.sup |                                |    |
| SupComb | 17  |         |         | COMB_17.sup |                                |    |
| SupComb | 18  |         |         | COMB_18.sup |                                |    |
| SupComb | 19  |         |         | COMB_19.sup |                                |    |
| SupComb | 20  |         |         | COMB_20.sup |                                |    |
| SupComb | 21  |         |         | COMB_21.sup |                                |    |
| SupComb | 22  |         |         | COMB_22.sup |                                |    |
| SupComb | 23  |         |         | COMB_23.sup |                                |    |
| SupComb | 24  |         |         | COMB_24.sup |                                |    |
| SupComb | 25  |         |         | COMB_25.sup |                                |    |
| SupComb | 26  |         |         | COMB_26.sup |                                |    |
| SupComb | 27  |         |         | COMB_27.sup |                                |    |
| SupComb | 28  |         |         | COMB_28.sup |                                |    |
| SupComb | 29  |         |         | COMB_29.sup |                                |    |
| SupComb | 30  |         |         | COMB_30.sup |                                |    |
| SupComb | 31  |         |         | COMB_31.sup |                                |    |
| SupComb | 32  |         |         | COMB_32.sup |                                |    |
| SupComb | 33  |         |         | COMB_33.sup |                                |    |
| SupComb | 34  |         |         | COMB_34.sup |                                |    |
| SupComb | 35  |         |         | COMB_35.sup |                                |    |
| SupComb | 36  |         |         | COMB_36.sup |                                |    |
| SupComb | 37  |         |         | COMB_37.sup |                                |    |
| SupComb | 38  |         |         | COMB_38.sup |                                |    |
| SupComb | 39  |         |         | COMB_39.sup |                                |    |
| SupComb | 40  |         |         | COMB_40.sup |                                |    |
| SupComb | 41  |         |         | COMB_41.sup |                                |    |
| SupComb | 42  |         |         | COMB_42.sup |                                |    |
| SupComb | 43  |         |         | COMB_43.sup |                                |    |
| SupComb | 44  |         |         | COMB_44.sup |                                |    |

| Stage    | ULSCOMB<br>Combination For Ultimate Limit State Ch |             |         |            | Start time 36844<br>Duration 0 |    |
|----------|--|-------------|---------|------------|--------------------------------|----|
| Action   | Input-1  | Input-2     | Input-3 | Output-1   | Output-2                       | dT |
| SupInit  | COMB_01.sup  |             |         | ULS_BC.sup |                                |    |
| SupOrSup | ULS_BC.sup   | COMB_02.sup |         |            |                                |    |

Description: 6 Stage Actions (Calculation Actions)

Project No.



Designer: VKS Infratech Management Pvt. Ltd.



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|          |                |             |  |                |  |  |
|----------|----------------|-------------|--|----------------|--|--|
| SupOrSup | ULS_BC.sup     | COMB_03.sup |  |                |  |  |
| SupOrSup | ULS_BC.sup     | COMB_04.sup |  |                |  |  |
| SupOrSup | ULS_BC.sup     | COMB_05.sup |  |                |  |  |
| SupOrSup | ULS_BC.sup     | COMB_06.sup |  |                |  |  |
| SupInit  | ULS_BC.sup     |             |  | ULS_SUPSTR.sup |  |  |
| SupOrSup | ULS_SUPSTR.sup | COMB_07.sup |  |                |  |  |
| SupOrSup | ULS_SUPSTR.sup | COMB_08.sup |  |                |  |  |
| SupInit  | ULS_BC.sup     |             |  | ULS_SUBSTR.sup |  |  |
| SupOrSup | ULS_SUBSTR.sup | COMB_09.sup |  |                |  |  |
| SupOrSup | ULS_SUBSTR.sup | COMB_10.sup |  |                |  |  |

| Stage    | SLSCOMB<br>Combination For Servicivility Limit Sta |             |         |             | Start time | 36844 |
|----------|--|-------------|---------|-------------|------------|-------|
|          |  |             |         |             | Duration   | 0     |
| Action   | Input-1  | Input-2     | Input-3 | Output-1    | Output-2   | dT    |
| SupInit  | COMB_13.sup  |             |         | SLS_RC.sup  |            |       |
| SupOrSup | SLS_RC.sup   | COMB_14.sup |         |             |            |       |
| SupOrSup | SLS_RC.sup   | COMB_15.sup |         |             |            |       |
| SupOrSup | SLS_RC.sup   | COMB_16.sup |         |             |            |       |
| SupOrSup | SLS_RC.sup   | COMB_17.sup |         |             |            |       |
| SupOrSup | SLS_RC.sup   | COMB_18.sup |         |             |            |       |
| SupInit  | COMB_19.sup  |             |         | SLS_FC.sup  |            |       |
| SupOrSup | SLS_FC.sup   | COMB_20.sup |         |             |            |       |
| SupOrSup | SLS_FC.sup   | COMB_21.sup |         |             |            |       |
| SupOrSup | SLS_FC.sup   | COMB_22.sup |         |             |            |       |
| SupOrSup | SLS_FC.sup   | COMB_23.sup |         |             |            |       |
| SupOrSup | SLS_FC.sup   | COMB_24.sup |         |             |            |       |
| SupInit  | COMB_25.sup  |             |         | SLS_QPC.sup |            |       |
| SupOrSup | SLS_QPC.sup  | COMB_26.sup |         |             |            |       |
| DgmSet   | STR SLS RARE                                       |             |         | *           |            |       |

| Stage    | FND_BP_COMB<br>Combination For Foundation Base Pressur |             |         |                  | Start time | 36844 |
|----------|--|-------------|---------|------------------|------------|-------|
|          |  |             |         |                  | Duration   | 0     |
| Action   | Input-1  | Input-2     | Input-3 | Output-1         | Output-2   | dT    |
| SupInit  | COMB_27.sup  |             |         | FND_BP_COMB1N.su |            |       |
| SupOrSup | FND_BP_COMB1N.su                                       | COMB_28.sup |         |                  |            |       |
| SupInit  | COMB_29.sup  |             |         | FND_BP_COMB1TS.s |            |       |
| SupOrSup | FND_BP_COMB1TS.s                                       | COMB_30.sup |         |                  |            |       |
| SupInit  | COMB_31.sup  |             |         | FND_BP_COMB2W.s  |            |       |
| SupOrSup | FND_BP_COMB2W.s  | COMB_32.sup |         |                  |            |       |
| SupInit  | COMB_33.sup  |             |         | FND_BP_COMB2E.su |            |       |
| SupOrSup | FND_BP_COMB2E.su                                       | COMB_34.sup |         |                  |            |       |

| Stage    | FND_ULS_COMB<br>Combination For Ultimate Limit State of |              |         |                    | Start time | 36844 |
|----------|---|--------------|---------|--------------------|------------|-------|
|          |   |              |         |                    | Duration   | 0     |
| Action   | Input-1   | Input-2      | Input-3 | Output-1           | Output-2   | dT    |
| SupInit  | COMB_35.sup   |              |         | FND_ULS_Comb_I.su  |            |       |
| SupOrSup | FND_ULS_Comb_I.su                                       | COMB_36.sup  |         |                    |            |       |
| SupOrSup | FND_ULS_Comb_I.su                                       | COMB_37.sup  |         |                    |            |       |
| SupOrSup | FND_ULS_Comb_I.su                                       | COMB_38.sup  |         |                    |            |       |
| SupInit  | COMB_39.sup   |              |         | FND_ULS_Comb_II.su |            |       |
| SupOrSup | FND_ULS_Comb_II.su                                      | COMB_40.sup  |         |                    |            |       |
| SupOrSup | FND_ULS_Comb_II.su                                      | COMB_41.sup  |         |                    |            |       |
| SupOrSup | FND_ULS_Comb_II.su                                      | COMB_42.sup  |         |                    |            |       |
| SupInit  | COMB_43.sup   |              |         | FND_ULS_Comb_S.s   |            |       |
| SupOrSup | FND_ULS_Comb_S.s  | COMB_44.sup  |         |                    |            |       |
| SupInit  | FND_ULS_Comb_I.su                                       |              |         | FND_ULS.sup        |            |       |
| SupOrSup | FND_ULS.sup   | FND_ULS_Corr |         |                    |            |       |
| SupOrSup | FND_ULS.sup   | FND_ULS_Corr |         |                    |            |       |

|       |           |            |       |
|-------|-----------|------------|-------|
| Stage | ULS_CHECK | Start time | 36844 |
|-------|-----------|------------|-------|

Description: 6 Stage Actions (Calculation Actions)

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| Action   | Input-1        | Input-2 | Input-3 | Output-1    | Output-2 | dT |
|----------|----------------|---------|---------|-------------|----------|----|
| SuplNit  |                |         |         | Ult_ULS.sup |          |    |
| UltSup   | ULS_SUPSTR.sup | UltMz,* |         | Ult_ULS.sup | *        |    |
| DgmSet   | Uls_chk        |         |         | *           |          |    |
| ShearSup | ULS_SUPSTR.sup |         |         | *           |          |    |
| DgmSet   | Shear_Cap      |         |         | *           |          |    |

Description: 6 Stage Actions (Calculation Actions)

Project No.



## 7 DESIGN CODE VERIFICATION OF LIMIT STATES

### 7.1 ULTIMATE LIMIT STATE OF STRUCTURAL STRENGTH

RM V8i Calculates the Ultimate Moment Capacity of Section for Both Positive and Negative moment at all Longitudinal Girder element ends based on Concrete Parabolic Rectangular Stress Block presented in article 2.5.1.1 and Bilinear Stress Strain Relation of Prestressing Steel presented in article 2.5.1.2.

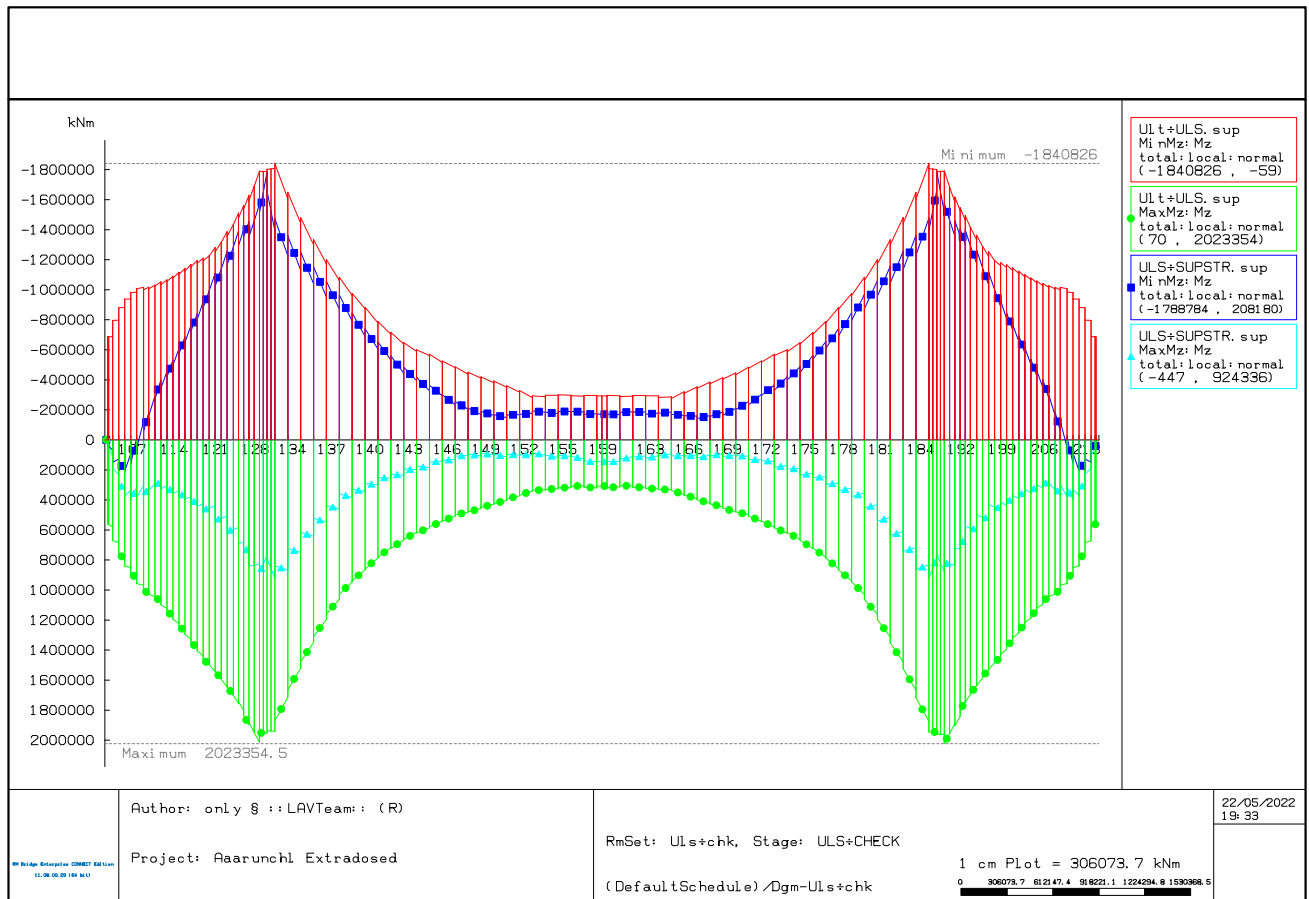
The Following figure presents Both Positive and Negative Moment Capacity as well as Applied ULS moment in Graphical Form.

The Red Line Indicates Minimum (-ve) ULS Moment Capacity of section.

The Green Line Indicates Maximum (+ve) ULS Moment Capacity of section.

The Cyan Line Indicates Minimum Applied ULS Moment of section.

The blue Line Indicates Maximum Applied ULS Moment of section



"Figure 3. Plot of Applied ULS Moment and ULS Moment Capacity of Section For Box Girder"

**It can be seen from the graph that at all points in structure the Minimum and Maximum Applied Longitudinal ULS Moment is well within the Upper and Lower Bound Of Capacity.**

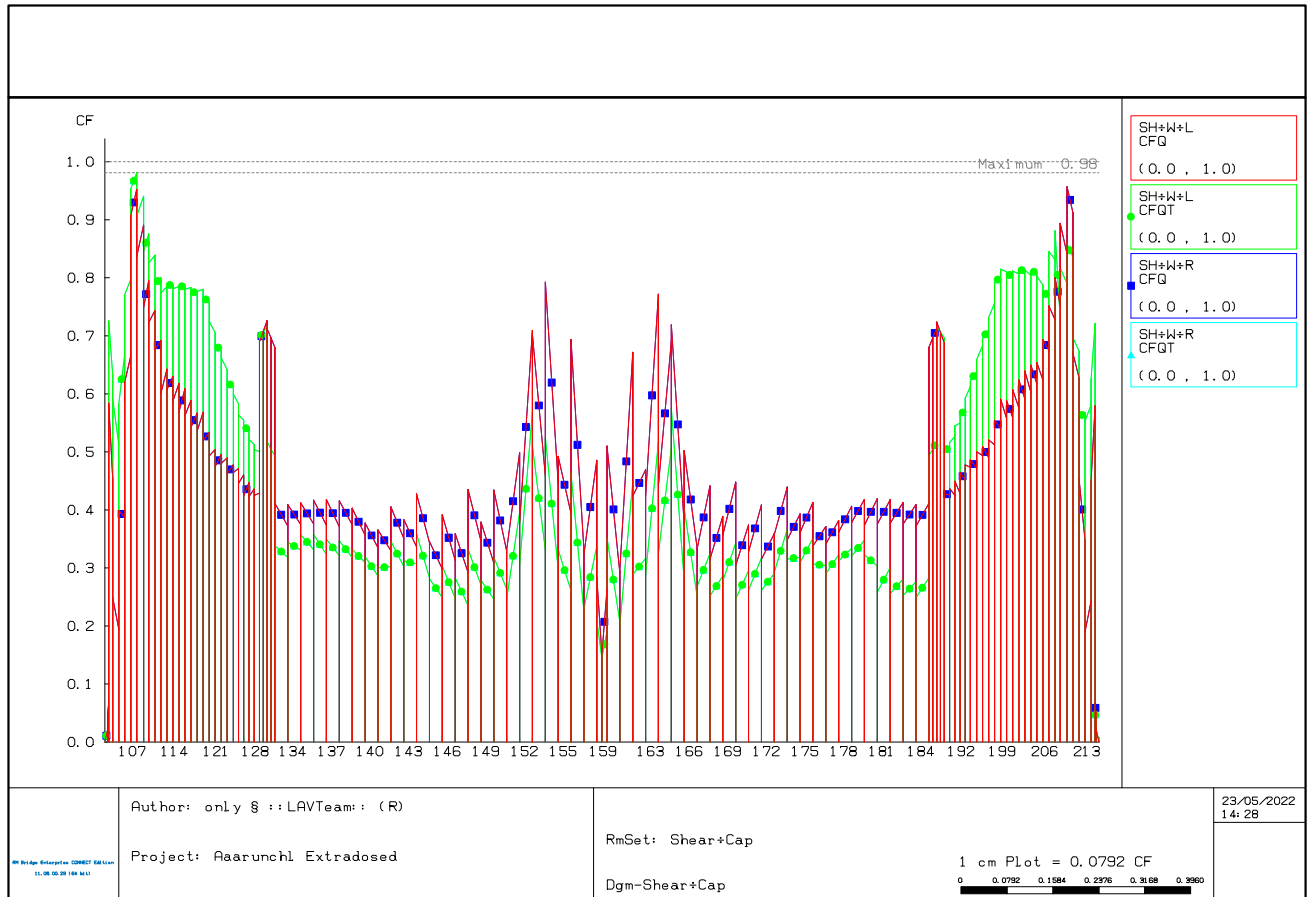
**Hence the Structure is Safe in Ultimate Limit state Of Structural Strength.**



## 7.2 ULTIMATE LIMIT STATE OF SHEAR AND TORSION

Calculated Capacity Factor for Shear, Torsion and combined shear and torsion are presented in figure Below.

The Capacity factor for Shear (CFQ) is shown by red line, Capacity factor for Torsion (CFT) is shown by green line and Capacity factor for combined shear and torsion (CFQT) is shown by blue line



"Figure 4. Plot of CFQ and CFQT of Section For Box Girder"

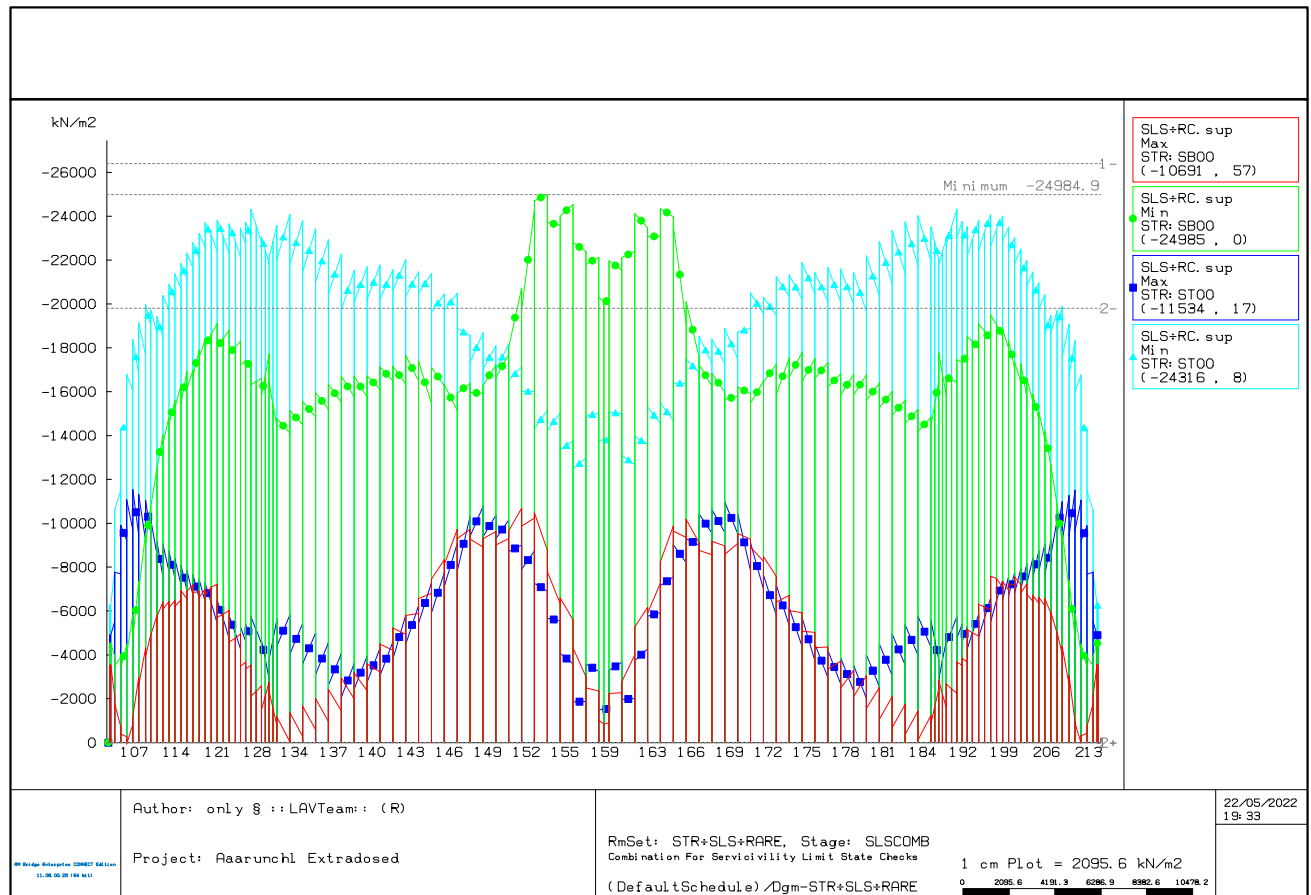
**From the figure it can be seen all three capacity factor CFQ (Shear) and CFQT (Combined Shear and Torsion) are less than 1.0 at all points in structure as required by article 2.5.2 of this document. Hence the sizing of members is safe.**



## 7.3 SERVICEABILITY LIMIT STATE OF INTERNAL STRESSES

### 7.3.1 Stress Limitation in Concrete

Following Figure present the stresses in top and bottom fibre of girder under RARE COMBINATION.



"Figure 5. Plot of Stress at Top and Bottom Fibre under Rare Combination at all Sections For Box Girder"

**1. It can be seen from above figure that no tensile stresses under RARE COMBINATION occur at top and bottom fiber of Box Girder and Girder. Hence No crack Occurs. Hence the stresses are to be calculated based on uncracked section.**

**2. It can also be seen that max compressive stress under RARE COMBINATION at top and bottom fibre are well within the limit of 26400 kN/m² as per article 2.5.3.1 (2) of this document**

## HYDRAULIC CALCULATION FOR HIGH LEVEL EXTRADOSED BRIDGE AT Km 2+908

### Calculation of discharge for extradosed bridge over Siang River at Chainage 2+908 Km Yingkiong, Upper Siang, Arunachal Pradesh

#### 1.0 Data

|                              |          |                    |
|------------------------------|----------|--------------------|
| Design Chainage              | 2+908    | km                 |
| HFL                          | 255.00   | m                  |
| Bed level                    | 201.3    | m                  |
| Energy slope (Fall of river) | 0.001    |                    |
| Catchment Area               | 298000   | Sq km (CWC Report) |
|                              | 29800000 | Hectare            |

#### 2.0 Discharge estimation by Dickens Formula

$$Q = CM^{3/4}$$

##### Where

|          |   |  |
|----------|---|--|
| <b>Q</b> | = | The peak run-off in M <sup>3</sup> /s  |
| <b>M</b> | = | Catchment area in sq. km   |
| <b>C</b> | = | 11-14 Where annual Rainfall is 60-120cm<br>14-19 Where annual Rainfall is more than 120cm<br>22 in Western Ghats |
| <b>M</b> | = | 298000 Sq km   |
| <b>C</b> | = | 19 Considered  |
| <b>Q</b> | = | 242335 m <sup>3</sup> /sec   |

#### 3.0 Discharge estimation by Ryves Formula

$$Q = CM^{2/3}$$

##### Where

|          |   |   |
|----------|---|---|
| <b>Q</b> | = | The peak run-off in M <sup>3</sup> /s   |
| <b>M</b> | = | Catchment area in sq. km  |
| <b>C</b> | = | 6.8 for areas within 25 km of the coast<br>8.5 for areas between 25 km and 160 km of the coast<br>10 for limited areas near the hills |
| <b>M</b> | = | 298000 Sq km  |
| <b>C</b> | = | 10 Considered   |
| <b>Q</b> | = | 44615 m <sup>3</sup> /sec   |

#### 4.0 Discharge estimation by Area velocity Method (Manning's Formula)

$$V = \frac{1}{n} \times R^{2/3} \times S^{1/2}$$

$V$  = Velocity of stream  
 $n$  = Rugosity Coefficient = 0.055  
 $S$  = Slope = 0.00100  
 $P$  = Wetted Perimeter = 265.00 m  
 $A$  = Flow Area = 8666.00 m<sup>2</sup>  
 $R$  =  $A/P$  (Hydraulic Radius) = 32.702  
 $V$  =  $\frac{1}{n} R^{2/3} S^{1/2}$  = 5.88 m/sec  
 Discharge  $Q$  =  $V \times A$  = 50945 m<sup>3</sup>/sec

#### 5.0 Fixing Design Discharge

Summary of Discharge from different methods

| S.No. | Method of calculation            | Discharge in cumecs |
|-------|----------------------------------|---------------------|
| 1     | Dickens Formula                  | 242335              |
| 2     | Ryves Formula                    | 44615               |
| 3     | Area Velocity Method (Manning's) | 50945               |

First Highest discharge of above = 242335 m<sup>3</sup>/sec  
 Second Highest discharge of above = 50945 m<sup>3</sup>/sec  
 1.5 times of second highest discharge = 76417 m<sup>3</sup>/sec  
 As per clause 6.2.1 of IRC:SP:13-2004  
 If 1.5\*2nd highest < 1st Highest than adopt 1.5\*2nd highest  
 If 1.5\*2nd highest > 1st Highest than adopt 1st highest

Adopted design discharge **76417 m<sup>3</sup>/sec**

#### 6.0 Scour Depth

Maximum scour depth is calculated for the foundations in flowing channel. In case of pier it is 2\*dsm and in case of abutments it is 1.27\*dsm which varies in the combination of seismic forces. Since there is no pier and abutment in the flowing channel restricting the flow of the channel, calculation of scour depth is not required.

## **Major Bridge at Km 2+590**

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# **Design of Superstructure**

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## Introduction

---

Super structure design presented in this booklet will be adopted for "**Major Bridge @ Ch.2+645**". Steel Plate Girder type super structure has been adopted at said location. The span and width of super structure has been kept to meet the geometrical requirement and also to accommodate the traffic requirement. Various spans and width of super structures has been proposed to cater the same. It has been proposed to use Simply supported module of super structure for better riding quality and to reduce number of bearing & expansion joints. Maintenance will also be easy for the structure as it has reduced number of bearing and expansion joints.

This design booklet presents the design of Simply Supported span of 51.5 m. Overall width of super structure has been kept to accommodate three lane carriageway for vehicular traffic and crash barrier at each end.

Structure has been Analyzed and Designed as per latest Indian Codal Provisions and Recommendations.

## Reference And Design Philosophy

---

For analysis and design of Steel Girder the codal references and design philosophy are discussed briefly in following sections.

### 2.1 Reference

Structure has been designed using "Indian Road Congress (IRC) and Indian Standard (IS)" guidelines and "Ministry of Shipping, Road Transport and Highways (MORTH)" specifications. As per requirement, reference from BS codes has also been taken. List of codes used in the designing of structure is as follows but is not limited to that.

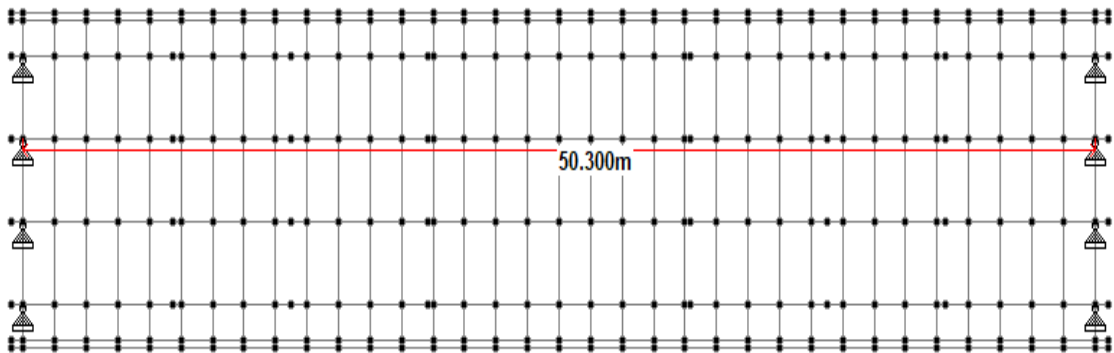
|                      |  |
|----------------------|--|
| IRC:5-2015           | Standard Specifications and Code of Practice for Road Bridges, Section I - General features of Design (Seventh Revision)                           |
| IRC:6-2017           | Standard Specifications and Code of Practice for Road Bridges, Section II - Loads and Stresses (Fifth Revision)                                    |
| IRC:22-2015          | Standard Specifications and Code of Practice for Road Bridges, Section VI - Composite Construction (Limit State Design) (Second Revision)          |
| IRC:24-2010          | Standard Specifications and Code of Practice for Road Bridges, Section V - Steel Road Bridges (Limit State Method) (Third Revision)                |
| IRC:112-2020         | Code of Practice for Concrete Road Bridges   |
| IRC:83-2015 Part I   | Standard Specifications and Code of Practice for Road Bridges, Section IX - Bearings, Part I: Metallic Bearings (First Revision)                   |
| IRC:83-2018 Part III | Standard Specifications and Code of Practice for Road Bridges, Section IX - Bearings, Part III: POT, POT-CUM-PTFE, Pin and Metallic Guide Bearings |
| IRC:SP:33-1989       | Guidelines on Supplemental Measures for Design, Detailing & Durability of Important Bridge Structures  |
| IS:456-2000          | Indian Standard - Plain and Reinforced concrete - Code of Practice (Fourth Revision)   |
| IS:800-2007          | Indian Standard - General Construction in Steel - Code of Practice (Third Revision)  |
| IS:1367(Part 3)-2002 | Indian Standard - Technical Supply Condition for Threaded Steel Fasteners (Fourth Revision)  |
| IS:2062-2011         | Indian Standard - Hot Rolled Low, Medium and High Tensile Structural Steel (Seventh Revision)  |
| IS:3757-1985         | Indian Standard - Specification for High Strength Structural Bolts (Second Revision)   |
| IS:4000-1992         | Indian Standard - High Strength Bolts in Steel Structures (First Revision)   |
| IS:9282-2002         | Wire Ropes and Strands for Suspension Bridges - Specification  |

### 2.2 Design Philosophy

Analysis of super structure has been done using STAAD.Pro software. Full model with

appropriate connection detail, support and sectional property as appropriate has been done to accurately analyze the structure.

Structure has been analyzed for different loading with different cross sectional property of members depending upon non composite and composite analysis. For longitudinal beam members, self weight of steel and concrete deck will be taken by non composite section and other loads such as SIDL, FPLL and Live Load etc will be taken by composite section.



Structure has been analyzed for different loading conditions which is stated in loading chapter and design forces has been found out with appropriate load factors as per codal provision for Limit State Method of design. All the members has been designed depending upon its type to withstand safely as per codal guidelines.

## 3.1 Units and Sign Convention

unless specified following units shall be applicable -

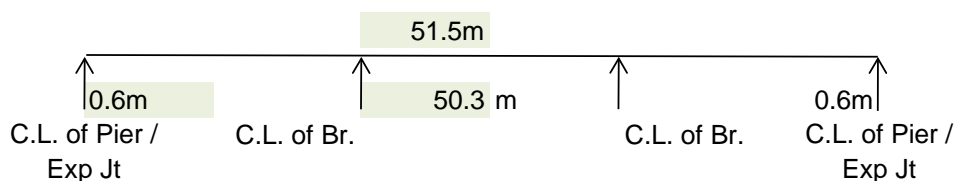
|                                |                   |
|--------------------------------|-------------------|
| measurement                    | m                 |
| forces                         | kN                |
| uniformly distributed load UDL | kN/m              |
| pressure load                  | kN/m <sup>2</sup> |
| moment                         | KNm               |
| stress                         | N/mm <sup>2</sup> |
| modulus of elasticity          | N/mm <sup>2</sup> |
| temperature                    | °C                |
| angular measurements           | radian            |

unless specified following sign convention shall be applicable -

|   |     |
|---|-----|
| tensile forces                                | -ve |
| compressive forces                            | +ve |
| hogging moment (tension at top of section)    | -ve |
| sagging moment (tension at bottom of section) | +ve |
| tensile stress                                | -ve |
| compressive stress                            | +ve |

## 3.2 Arrangement of Super Structure

|  |                 |
|--|-----------------|
| type of structure  | Steel Structure |
| total length of super structure (exp joint to exp joint) | 51.5            |



|  |   |       |
|--|---|-------|
| c/c distance of bearing                          |   | 50.3  |
| transverse distance between longitudinal girders | = | 3.000 |
| overall width of deck                            | = | 12.00 |
| carriage way width                               | = | 11.00 |
| footpath width on each side                      | = | 0.00  |
| width of crash barrier on each side              | = | 0.50  |
| thickness of wearing coat                        | = | 0.05  |

## 3.3 Material Specification

### 3.3.1 Structural Steel

|   |                |                          |
|---|----------------|--------------------------|
| rolled sections                                       | =              | E 250 (Fe 410) BO        |
|   | confirming to: | IS:2062-2006             |
| other than rolled sections (i.e. fabricated sections) | =              | E 350 (Fe 490) BO        |
|   | confirming to: | IS:2062-2006             |
| modulus of elasticity                                 | =              | 200000 N/mm <sup>2</sup> |

|              |   |   |                        |
|--------------|---|---|------------------------|
|              | poission ratio  | = | 0.3                    |
| <b>3.3.2</b> | <b>Reinforced Concrete</b>  |   |                        |
|              | <b>Concrete for Deck</b>  |   |                        |
|              | grade   | = | M 40                   |
|              | modulus of elasticity   | = | 32000                  |
|              | <b>Concrete for Crash Barrier</b>   |   |                        |
|              | grade   | = | M 35                   |
|              | modulus of elasticity   | = | 33000                  |
|              | <b>Untensioned Steel</b>  |   |                        |
|              | high yield strength deformed steel (HYSD)   | = | Fe 500                 |
|              | modulus of elasticity   | = | 200000                 |
|              | steel shall be as per IRC:112-2011 confirming IS:1786.  |   |                        |
| <b>3.3.3</b> | <b>Bearing</b>  |   |                        |
|              | type of bearing   | = | POT cum PTFE           |
| <b>3.3.4</b> | <b>Expansion Joint</b>  |   |                        |
|              | type of expansion joint   | = | Elastomeric Strip Seal |
| <b>3.3.5</b> | <b>Wearing Coat</b>   |   |                        |
|              | 65mm thick Wearing Coat shall be adopted in conformity with section 500 of MORTH specification.   |   |                        |
| <b>3.3.6</b> | <b>Bolts</b>  |   |                        |
|              | HSFG bolts shall be confirming as per IS:4000-1992 and IS:3757-1985.  |   |                        |
| <b>3.3.7</b> | <b>Welding Consumables</b>  |   |                        |
|              | the Welding Consumables to conform IS:814-1991 and of strength requirements appropriate for preheated HT Steel or un-heated mild steel. |   |                        |



### 4.1 Loads

Structure has been analyzed for loads as per latest IRC recommendations and the same is stated in next sections.

#### 4.1.1 Self Weight of Structural Steel

|                         |   |      |
|-------------------------|---|------|
| unit weight of material | = | 78.5 |
|-------------------------|---|------|

#### 4.1.2 Self Weight of Concrete Deck

|   |   |       |
|---|---|-------|
| unit weight of material                         | = | 25.0  |
| effective width for deck load on outer girder   | = | 3.00  |
| avr depth of slab for deck load on outer girder | = | 0.22  |
| so uniformly distributed load on outer girder   | = | 16.50 |
| effective width for deck load on inner girder   | = | 3.0   |
| avr depth of slab for deck load on inner girder | = | 0.220 |
| so uniformly distributed load on inner girder   | = | 16.50 |

#### 4.1.3 Super Imposed Dead Load

|  |   |      |
|--|---|------|
| UDL for each crash barrier (on 0.5m width) | = | 10.0 |
| UDL for each footpath                      | = | 0.0  |
| UDL for wearing coat                       | = | 4.3  |

#### 4.1.4 Footpath Live Load

|  |   |     |
|--|---|-----|
| uniform pressure                                 | = | 0.0 |
| design uniform pressure (deduction as per IRC:6) | = | 0.0 |
| UDL for FPLL                                     | = | 0.0 |

#### 4.1.5 Support Settlement

conservatively, 10mm support settlement load has been considered for analysis and designing of super structure

#### 4.1.6 Live Load

**live load considered for design -**

Special vehicle

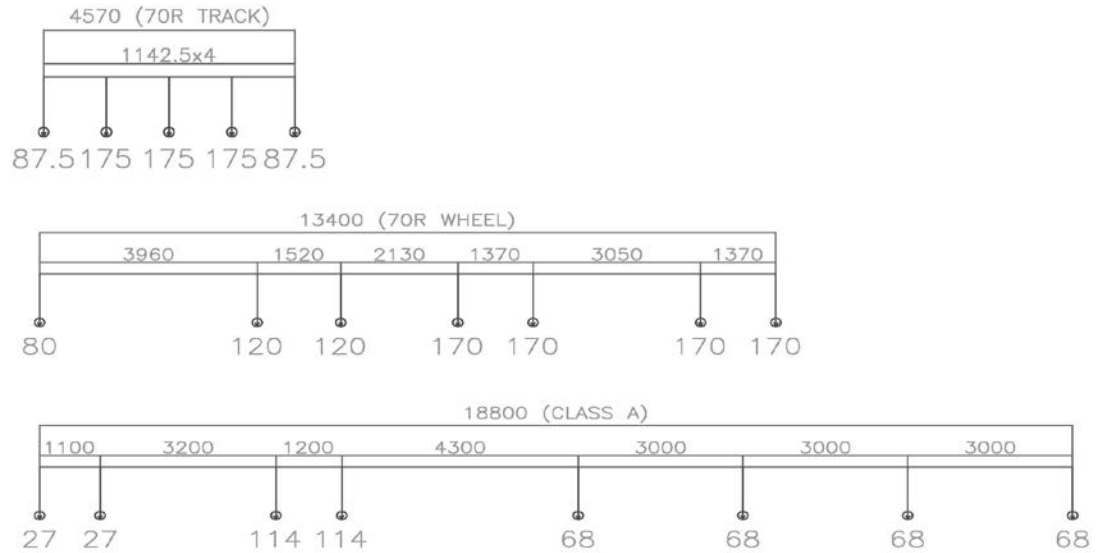
One lane of 70R Wheel and one lane of class A

Three lane of Class A

### impact factor -

|      |   |      |
|------|---|------|
| 70RT | = | 10 % |
| 70RW | = | 20 % |
| CA   | = | 20 % |

**single vehicles** - dimensions are in mm and loads are in kN



## 4.2 Load Combination

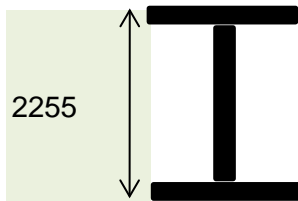
Effect of loads on structural members has been calculated using appropriate load factor given in IRC code for Limit State Method design.

## Cross Sectional Property

Dimensions used to calculate sectional property in this chapter are in mm.

### 5.1 Property - Non Composite Section

#### Longitudinal Girder - At Center

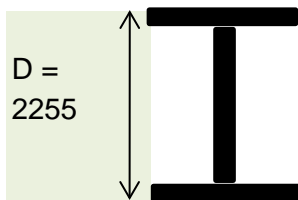


|                |     |      |
|----------------|-----|------|
| top plate =    | 500 | 32   |
| web plate =    | 20  | 2183 |
| bottom plate = | 800 | 40   |

|      |             |
|------|-------------|
| D =  | 2255        |
| Yt = | 1318        |
| Yb = | 937         |
| A =  | 91660       |
| Iy = | 2041455333  |
| Iz = | 73027445772 |

|      |          |
|------|----------|
| Zt = | 55398543 |
| Zb = | 77955780 |

#### Longitudinal Girder - At Support

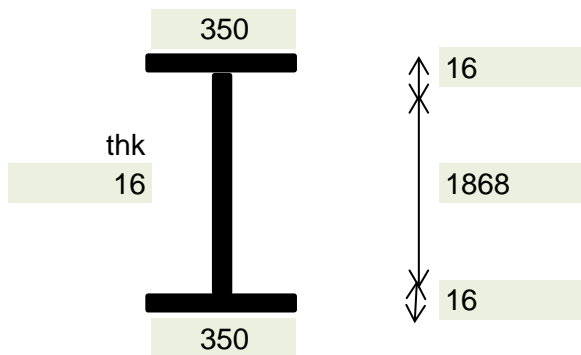


|                |     |      |
|----------------|-----|------|
| top plate =    | 500 | 32   |
| web plate =    | 20  | 2183 |
| bottom plate = | 800 | 40   |

|      |             |
|------|-------------|
| D =  | 2255        |
| Yt = | 1318        |
| Yb = | 937         |
| A =  | 91660       |
| Iy = | 2041455333  |
| Iz = | 73027445772 |

|      |          |
|------|----------|
| Zt = | 55398543 |
| Zb = | 77955780 |

#### End Cross Girder



|                |     |      |
|----------------|-----|------|
| top plate =    | 350 | 16   |
| web plate =    | 16  | 1868 |
| bottom plate = | 350 | 16   |

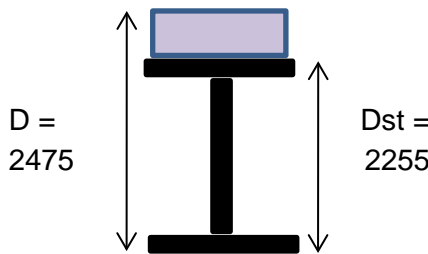
|      |             |
|------|-------------|
| D =  | 1900        |
| Yt = | 950         |
| Yb = | 950         |
| A =  | 41088       |
| Iy = | 114970944   |
| Iz = | 18629707776 |

|      |          |
|------|----------|
| Zt = | 19610219 |
| Zb = | 19610219 |

## 5.2

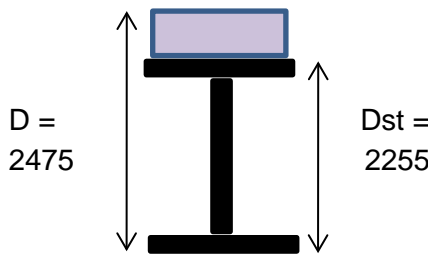
Composite Sections for Modular Ratio  $m = 15$  (For SIDL) $m = 15.0$ 

## Longitudinal Outer Girder - At Centre



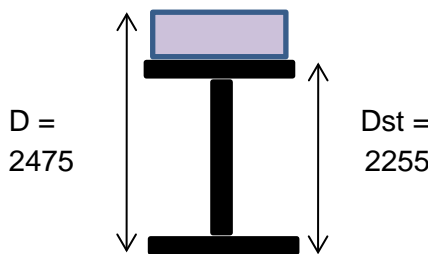
|                |      |      |  |            |              |
|----------------|------|------|--|------------|--------------|
| D =            | 2475 |      |  |            |              |
| Dst =          | 2255 |      |  |            |              |
|                |      |      |  | D =        | 2475         |
|                |      |      |  | Yt =       | 1075         |
|                |      |      |  | Yb =       | 1400         |
|                |      |      |  | A =        | 135660       |
|                |      |      |  | Iy =       | 2188122000   |
|                |      |      |  | Iz =       | 133846519768 |
|                |      |      |  |            |              |
| deck =         | 200  | 220  |  |            |              |
| top plate =    | 500  | 32   |  | Zt slab =  | 124509492    |
| web plate =    | 20   | 2183 |  | Zt steel = | 156547378    |
| bottom plate = | 800  | 40   |  | Zb =       | 95604008     |

## Longitudinal Outer Girder - At Support



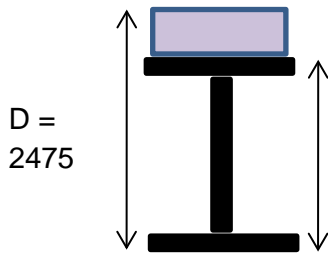
|                |      |      |                      |
|----------------|------|------|----------------------|
| D =            | 2475 |      |                      |
| Dst =          | 2255 |      |                      |
|                |      | D =  | 2475                 |
|                |      | Yt = | 1075                 |
|                |      | Yb = | 1400                 |
|                |      | A =  | 135660               |
|                |      | Iy = | 2188122000           |
|                |      | Iz = | 133846519768         |
| deck =         | 200  | 220  |                      |
| top plate =    | 500  | 32   | Zt slab = 124509492  |
| web plate =    | 20   | 2183 | Zt steel = 156547378 |
| bottom plate = | 800  | 40   | Zb = 95604008        |

## Longitudinal Inner Girder - At Centre



|                |      |      |  |            |              |
|----------------|------|------|--|------------|--------------|
| D =            | 2475 |      |  |            |              |
| Dst =          | 2255 |      |  |            |              |
|                |      |      |  | D =        | 2475         |
|                |      |      |  | Yt =       | 1075         |
|                |      |      |  | Yb =       | 1400         |
|                |      |      |  | A =        | 135660       |
|                |      |      |  | Iy =       | 2188122000   |
|                |      |      |  | Iz =       | 133846519768 |
|                |      |      |  |            |              |
| deck =         | 200  | 220  |  |            |              |
| top plate =    | 500  | 32   |  | Zt slab =  | 124509492    |
| web plate =    | 20   | 2183 |  | Zt steel = | 156547378    |
| bottom plate = | 800  | 40   |  | Zb =       | 95604008     |

### Longitudinal Inner Girder - At Support



|                |     |      |            |           |
|----------------|-----|------|------------|-----------|
| deck =         | 200 | 220  |            |           |
| top plate =    | 500 | 32   | Zt slab =  | 124509492 |
| web plate =    | 20  | 2183 | Zt steel = | 156547378 |
| bottom plate = | 800 | 40   | Zb =       | 95604008  |

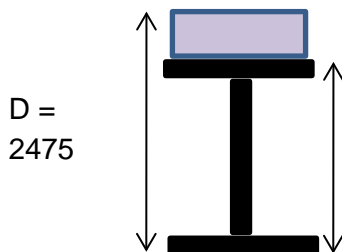
|      |              |
|------|--------------|
| D =  | 2475         |
| Yt = | 1075         |
| Yb = | 1400         |
| A =  | 135660       |
| Iy = | 2188122000   |
| Iz = | 133846519768 |

## 5.3

### Composite Sections for Modular Ratio $m = 7.5$ (For LL)

$m = 7.5$

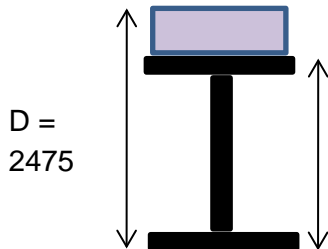
### Longitudinal Outer Girder - At Centre



|                |     |      |            |           |
|----------------|-----|------|------------|-----------|
| deck =         | 400 | 220  |            |           |
| top plate =    | 500 | 32   | Zt slab =  | 196698266 |
| web plate =    | 20  | 2183 | Zt steel = | 266645882 |
| bottom plate = | 800 | 40   | Zb =       | 100811708 |

|      |              |
|------|--------------|
| D =  | 2475         |
| Yt = | 839          |
| Yb = | 1636         |
| A =  | 179660       |
| Iy = | 3214788667   |
| Iz = | 164962479854 |

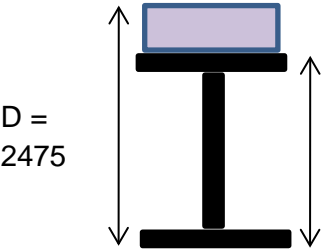
### Longitudinal Outer Girder - At Support



|                |     |      |            |           |
|----------------|-----|------|------------|-----------|
| deck =         | 400 | 220  |            |           |
| top plate =    | 500 | 32   | Zt slab =  | 196698266 |
| web plate =    | 20  | 2183 | Zt steel = | 266645882 |
| bottom plate = | 800 | 40   | Zb =       | 100811708 |

|      |              |
|------|--------------|
| D =  | 2475         |
| Yt = | 839          |
| Yb = | 1636         |
| A =  | 179660       |
| Iy = | 3214788667   |
| Iz = | 164962479854 |

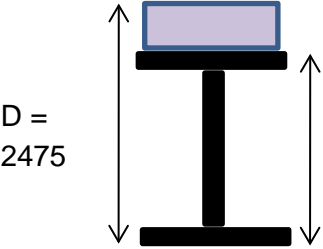
**Longitudinal Inner Girder - At Centre**



|                |     |      |
|----------------|-----|------|
| deck =         | 400 | 220  |
| top plate =    | 500 | 32   |
| web plate =    | 20  | 2183 |
| bottom plate = | 800 | 40   |

|            |              |
|------------|--------------|
| D =        | 2475         |
| Yt =       | 839          |
| Yb =       | 1636         |
| A =        | 179660       |
| Iy =       | 3214788667   |
| Iz =       | 164962479854 |
| Zt slab =  | 196698266    |
| Zt steel = | 266645882    |
| Zb =       | 100811708    |

**Longitudinal Inner Girder - At Support**



|                |     |      |
|----------------|-----|------|
| deck =         | 400 | 220  |
| top plate =    | 500 | 32   |
| web plate =    | 20  | 2183 |
| bottom plate = | 800 | 40   |

|            |              |
|------------|--------------|
| D =        | 2475         |
| Yt =       | 839          |
| Yb =       | 1636         |
| A =        | 179660       |
| Iy =       | 3214788667   |
| Iz =       | 164962479854 |
| Zt slab =  | 196698266    |
| Zt steel = | 266645882    |
| Zb =       | 100811708    |

## Design of Structural Steel Member

Design of various members are presented in following sections. Forces caused by different loads for designing of members has been presented using following legends:

|       |   |                                    |
|-------|---|------------------------------------|
| DL    | = | S/W of Steel and Deck Slab         |
| SIDL1 | = | Crash Barrier and Footpath Element |
| SIDL2 | = | Wearing Coat                       |
| FPLL  | = | Footpath Live Load                 |
| SUPP  | = | Support Settlement                 |
| LL    | = | Live Load with Impact              |

### 7.1 Moments and Forces

| Load                                     | Forces for Outer Girder |         |         | Forces for Inner Girder |         |         |
|--|-------------------------|---------|---------|-------------------------|---------|---------|
|  | Shear                   | Moment  |         | Shear                   | Moment  |         |
|  | Fy                      | Sagging | Hogging | Fy                      | Sagging | Hogging |
| DL                                       | 613                     | 7692    | 0       | 613                     | 7692    | 0       |
| SIDL1                                    | 0                       | 0       | 0       | 0                       | 0       | 0       |
| SIDL2                                    | 111                     | 1386    | 0       | 111                     | 1386    | 0       |
| SUPP                                     | 0                       | 0       | 0       | 0                       | 0       | 0       |
| FPLL                                     | 0                       | 0       | 0       | 0                       | 0       | 0       |
| LL                                       | 915                     | 9472    | 0       | 250                     | 3906    | 0       |
| Ultimate Limit State - Basic Combination |                         |         |         |                         |         |         |
|  | 2395                    | 27018   | 0       | 1397                    | 18668   | 0       |

Longitudinal girders has been designed as a composite section. The effect of composite section has been considered for SIDL, Support Settlement and Live Load effect.

factored applied forces - max force for critical design

|                |                          |   |       |
|----------------|--------------------------|---|-------|
| sagging moment | non composite section    | = | 10384 |
|                | composite section (SIDL) | = | 2426  |
|                | composite section (LL)   | = | 14208 |

|                |                          |   |   |
|----------------|--------------------------|---|---|
| hogging moment | non composite section    | = | 0 |
|                | composite section (SIDL) | = | 0 |
|                | composite section (LL)   | = | 0 |

design governing criteria -

combined shear force and bending moment

### 7.2 Data

material -

|                                   |               |                   |
|-----------------------------------|---------------|-------------------|
| grade of structural steel         | =             | E 350 (Fe 490) BO |
| ultimate tensile stress           | $f_u$         | = 490             |
| yield stress                      | $f_y$         | = 330             |
| partial safety factor             | $\gamma_{ml}$ | = 1.25            |
|                                   | $\gamma_{mo}$ | = 1.10            |
| grade of deck slab                | =             | 35 M              |
| For Basic and Seismic Combination | $\gamma_m$    | = 1.5             |
| For Accidental Combination        | =             | 1.2               |

### 7.3 Classification of cross section -

|   |   |              |
|---|---|--------------|
| $\epsilon = (250/f_y)^{0.5}$              | = | 0.87         |
| $(b/t_f)/\epsilon$ for compression flange | = | 8.6          |
| class of compression flange               | = | Compact      |
| $(d/t_w)/\epsilon$ for web                | = | 125.4        |
| class of web                              | = | Semi Compact |
| so, class of section                      | = | Semi Compact |

### 7.4 Member thickness check

Web

since  $(d/t_w)/\epsilon_w < 200$  & web connected to flange along both edge - trans stiffener not reqd

|  |                             |          |
|--|-----------------------------|----------|
| Transverse stiffener provided  | =                           | Yes      |
| Web connected to both edges of comp flange                                 | =                           | Yes      |
| Long stiffener provided  | =                           | No       |
| Long stiffener provided at NA  | =                           | No       |
| Depth of web, d  | =                           | 2183     |
| thickness of web $t_w$   | =                           | 20       |
| Spacing of trans stiffener, c  | =                           | 850      |
| for web connected to flange on both long edges & only trans stiff provided | $d/t_w/\epsilon_w \leq 270$ |          |
| $d/t_w/\epsilon_w$   | 125                         | < 270 OK |

Compression flange

Max perm width of comp flange for Semi Compact section, b 500

When transverse stiffeners provided and  $c < 1.5d$ ,  $d/tw/\epsilon_f \leq 345$   
 $d/tw/\epsilon_f$

125 < 345 OK

## 7.5 Section Design

Design governing criteria -  
 combined shear force and bending moment

### 7.5.1 Shear

shear strength -

plastic shear resistance

$$\begin{aligned} V_p &= A_v f_{yw} / \sqrt{3} \\ &= 8318 \\ &= > 67 \end{aligned}$$

( $d/tw$ )/ $\epsilon$  for web

shear buckling shear resistance

susceptible to shear buckling

shear buckling resistance -  
 simple post critical method

$$\begin{aligned} \text{spacing of transverse stiffener (mm) } c &= 850 \\ \text{depth of web (mm) } d &= 2183 \\ c/d &= 0.39 \\ K_v &= 4.81 \\ E &= 200000 \\ \text{poission ratio } \mu &= 0.30 \\ \tau_{cr,e} &= 73.0 \\ \lambda_w &= 1.62 \\ \text{shear stress } \tau_b &= 73 \\ \text{shear resistance } V_{cr} &= 3187 \end{aligned}$$

nominal shear strength (min of  $V_p$  and  $V_{cr}$ ) =  $V_n$

$$= 3187$$

so, shear strength

$$= 2897$$

Shear force is taken from support section of the  
 Girder where the shear force is maximum

applied shear force

$$V = 2395$$

60% of shear strength

$$= 1738$$

so, section is in high shear force

### 7.5.2 Bending

(i) Cons Stage1-Non-comp laterally unsupp grdr without lateral bracing-self wt of girder only

Centre-to-centre distance between flanges;  $h_f$

$$= 2.219 \text{ m}$$

Radius of gyration about minor (weaker axis-y),  $r_y = (I_y/A)^{1/2}$

$$= 0.149 \text{ m}$$

Modulus of rigidity,  $G = E/(2*(1+\mu))$

$$= 76923077 \text{ KN/m}^2$$

St venants tor con,  $I_t = \sum b^3 t^3 / 3$  for open,  $I_t = 4 * A_e^2 / (\sum b/t)$  for hollow

$$= 2.83493E-05 \text{ m}^4$$

For sagging (comp at top)

Unsupp Length of girder C/C support,  $L_u$

$$= 36 \text{ m}$$

Eff len for lateral torsional buckling  $L_{LT} = 1.2 * L_u + 2 * d$

$$= 47.71 \text{ m}$$

Self wt of one girder

$$= 7.20 \text{ KN/m}$$

Design sagging Moment due to self wt of girder

$$= 1282 \text{ KNm}$$

Design shear force

$$= 174.85 \text{ KN}$$

K for unrestrained rotation

$$= 1.000$$

Warping constant for unrestrained warping,  $K_w$

$$= 1.000$$

c1 for UDL

$$= 1.132$$

c2 for UDL

$$= 0.459$$

c3 for UDL

$$= 0.525$$

Moment of inertia of com flange about minor axis  $I_{fc}$

$$= 0.000333 \text{ m}^4$$

Moment of inertia of ten flange about minor axis  $I_{tc}$

$$= 0.001707 \text{ m}^4$$

$\beta_f = I_{tc} / (I_{fc} + I_{ti})$

$$= 0.1634$$

$I_w = (1 - \beta_f) * \beta_f^2 * I_y * h_f^2 / 2$  for mono symmetric, 0 for tee, hollow sect etc

$$= 0.0013741 \text{ m}^6$$

Distance of point of application of load from shear centre,  $y_g$

$$= 0.000 \text{ m}$$

For  $\beta_f \leq 0.5$ ,  $y_j = 1.0 * (2 * \beta_f - 1) * h_f / 2$

$$= -0.747$$

Critical elastic moment for symmetric section about minor axis,  $M_{cr}$

$$= 2090 \text{ KN-m}$$

$$M_{cr} = c_1 \frac{\pi^2 E I_y}{(L_{LT})^2} \left\{ \left[ \left( \frac{K}{K_w} \right)^2 \frac{I_w}{I_y} + \frac{G I_t (L_{LT})^2}{\pi^2 E I_y} + (c_2 y_g - c_3 y_j)^2 \right]^{0.5} - (c_2 y_g - c_3 y_j) \right\}$$

Critical elastic moment for doubly symmetric section,  $M_{cr}$

$$= 2443 \text{ KN-m}$$

$$M_{cr} = \sqrt{\left\{ \left[ \frac{\pi^2 E I_y}{(L_{LT})^2} \right] \left[ G I_t + \frac{\pi^2 E I_w}{(L_{LT})^2} \right] \right\}}$$

Since section is mono symmetric,  $M_{cr}$

$$= 2090 \text{ KN-m}$$

For semi compact section,  $\beta_b = Z_e / Z_p$

$$= 0.741$$

$(1.2 * Z_e * f_y / M_{cr})^{0.5}$

$$= 3.240$$

Slenderness ratio  $\lambda_{LT} = (\beta_b * Z_p * f_y / M_{cr})^{0.5} \leq (1.2 * Z_e * f_y / M_{cr})^{0.5}$

$$= 2.958$$

> 0.4

Since  $\lambda_{LT} > 0.4$  lateral torsional buckling has to be considered



|   |                     |
|---|---------------------|
| Imperfaction parameter, $\alpha_{LT}$   | 0.49 For Welded sec |
| $\phi_{LT} = 0.5(1 + \alpha_{LT}(\lambda_{LT} - 0.2) + \lambda_{LT}^2)$                                   | 5.55                |
| Bend stress reduction factor, $\chi_{LT} = 1/[\phi_{LT} + (\phi_{LT}^2 - \lambda_{LT}^2)^{0.5}] \leq 1.0$ | 0.10                |
| Design bending comp stress, $f_{bd} = \chi_{LT} * f_y / \gamma_{mo}$                                      | 29.28 mpa           |
| Desing strength, $M_d = \beta_b * Z_p * f_{bd}$   | 1622 >1,282 Safe    |
| Shear strength of section   | 2897 >175 Safe      |

**For Hogg (comp at bottom)**

|   |   |                          |
|---|---|--------------------------|
| Unsupp Length of girder C/C support, $L_u$  | = | 36.00 m                  |
| Eff len for lateral torsional buckling $L_{LT} = 1.2 * L_u + 2 * d$                         |   | 28.80 m                  |
| Self wt of one Girder   |   | 8.63 KN/m                |
| Design Hogging Moment due to self wt of girder  |   | 1678.52 KN-m             |
| Design shear force  |   | 279.75 KN                |
| K for restrained rotation   |   | 0.500                    |
| Warping constant for restrained warping, $K_w$  |   | 0.500                    |
| c1 for UDL  |   | 0.712                    |
| c2 for UDL  |   | 0.652                    |
| c3 for UDL  |   | 1.070                    |
| Moment of inertia of com flange about minor axis $I_{fc}$                                   |   | 0.000333 m <sup>4</sup>  |
| Moment of inertia of ten flange about minor axis $I_{tc}$                                   |   | 0.001707 m <sup>4</sup>  |
| $\beta_f = I_{tc} / (I_{fc} + I_{tc})$  |   | 0.1634                   |
| $I_w = (1 - \beta_f) * \beta_f * I_y * h_f^2$ for mono symmetric, 0 for tee, hollw sect etc |   | 0.0013741 m <sup>4</sup> |
| Distance of point of application of load from shear centre, $y_g$                           |   | 0.000 m                  |
| For $\beta_f \leq 0.5$ , $y_j = 1.0 * (2 * \beta_f - 1) * h_f / 2$                          |   | -0.747                   |

Critical elastic momen for symmetric section about minor axis , $M_{cr}$

1825 KN-m

$$M_{cr} = c_1 \frac{\pi^2 E I_y}{(L_{LT})^2} \left\{ \left[ \left( \frac{K}{K_w} \right)^2 \frac{I_w}{I_y} + \frac{G I_t (L_{LT})^2}{\pi^2 E I_y} + (c_2 y_g - c_3 y_j)^2 \right]^{0.5} - (c_2 y_g - c_3 y_j) \right\}$$

Critical elastic moment for doubly symmetric section ,  $M_{cr}$

5146 KN-m

$$M_{cr} = \sqrt{\left\{ \left( \frac{\pi^2 E I_y}{(L_{LT})^2} \right) \left[ G I_t + \frac{\pi^2 E I_w}{(L_{LT})^2} \right] \right\}}$$

Since section is doubly symeric,  $M_{cr}$

5146 KN-m

For semi compact section,  $\beta_b = Z_e / Z_p$

0.741

$(1.2 * Z_e * f_y / M_{cr})^{0.5}$

2.065

OK

Slenderness ratio  $\lambda_{LT} = (\beta_b * Z_p * f_y / M_{cr})^{0.5} \leq (1.2 * Z_e * f_y / M_{cr})^{0.5}$

0.000

< 0.4

Since  $\lambda_{LT} < 0.4$  it may be treated as laterally supported and Bend stress red factor =1

Imperfaction parameter,  $\alpha_{LT}$

0.49 For Welded sec

$\phi_{LT} = 0.5(1 + \alpha_{LT}(\lambda_{LT} - 0.2) + \lambda_{LT}^2)$

0.45

Bend stress reduction factor,  $\chi_{LT} = 1/[\phi_{LT} + (\phi_{LT}^2 - \lambda_{LT}^2)^{0.5}] \leq 1.0$

1.00

Design bending comp stress,  $f_{bd} = \chi_{LT} * f_y / \gamma_{mo}$

300.00 mpa

Desing strength,  $M_d = \beta_b * Z_p * f_{bd}$

16620 >1,679 Safe

Shear strength of section

2897 >280 Safe

**(ii) Cons Stage 2-Non-comp laterally supp grdr with lateral bracing-self wt+Green deck only**

|  |                            |
|--|----------------------------|
| Centre-to-centre distance between flanges; $h_f$   | 2.219 m                    |
| Radius of gyration about minor (weaker axis- $y$ ), $r_y = (I_y / A)^{0.5}$                        | 0.149 m                    |
| Modulus of rigidity, $G = E / (2 * (1 + \nu))$   | 76923077 KN/m <sup>2</sup> |
| St venants tor con, $I_t = \sum b * t^3 / 3$ for open, $I_t = 4 * A_e^2 / (\sum b / t)$ for hollow | 2.83493E-05 m <sup>4</sup> |

**For sagging (comp at top)**

|   |   |                          |
|---|---|--------------------------|
| Unsupp Length of girder C/C support, $L_u$  | = | 5.50 m                   |
| Eff len for lateral torsional buckling $L_{LT} = 1.2 * L_u + 2 * d$                         |   | 11.11 m                  |
| Self wt of one girder   |   | 7.20 KN/m                |
| Self wt of green concrete deck  |   | 17.16 KN/m               |
| Design sagging Moment due to self wt of girder  |   | 3946 KNm                 |
| Design shear force  |   | 26.71 KN                 |
| K for unrestrained rotation   |   | 1.000                    |
| Warping constant for unrestrained warping, $K_w$  |   | 1.000                    |
| c1 for UDL  |   | 1.132                    |
| c2 for UDL  |   | 0.459                    |
| c3 for UDL  |   | 0.525                    |
| Moment of inertia of com flange about minor axis $I_{fc}$                                   |   | 0.000333 m <sup>4</sup>  |
| Moment of inertia of ten flange about minor axis $I_{tc}$                                   |   | 0.001707 m <sup>4</sup>  |
| $\beta_f = I_{tc} / (I_{fc} + I_{tc})$  |   | 0.1634                   |
| $I_w = (1 - \beta_f) * \beta_f * I_y * h_f^2$ for mono symmetric, 0 for tee, hollw sect etc |   | 0.0013741 m <sup>4</sup> |
| Distance of point of application of load from shear centre, $y_g$                           |   | 0.000 m                  |
| For $\beta_f \leq 0.5$ , $y_j = 1.0 * (2 * \beta_f - 1) * h_f / 2$                          |   | -0.747                   |

Critical elastic moment for symmetric section about minor axis, $M_{cr}$

20444 KN-m

$$M_{cr} = c_1 \frac{\pi^2 E I_y}{(L_{LT})^2} \left\{ \left[ \left( \frac{K}{K_w} \right)^2 \frac{I_w}{I_y} + \frac{G I_t (L_{LT})^2}{\pi^2 E I_y} + (c_2 y_g - c_3 y_j)^2 \right]^{0.5} - (c_2 y_g - c_3 y_j) \right\}$$

Critical elastic moment for doubly symmetric section , M<sub>cr</sub>

$$M_{cr} = \sqrt{\left\{ \left[ \frac{\pi^2 EI_y}{(L_{LT})^2} \right] \left[ GI_t + \frac{\pi^2 EI_w}{(L_{LT})^2} \right] \right\}}$$

Since section is doubly symmetric, M<sub>cr</sub>

For semi compact section, β<sub>b</sub>=Z<sub>e</sub>/Z<sub>p</sub>

(1.2\*Z<sub>e</sub>\*f<sub>y</sub>/M<sub>cr</sub>)<sup>0.5</sup>

Slenderness ratio λ<sub>LT</sub> = (β<sub>b</sub>\*Z<sub>p</sub>\*f<sub>y</sub>/M<sub>cr</sub>)<sup>0.5</sup> <= (1.2\*Z<sub>e</sub>\*f<sub>y</sub>/M<sub>cr</sub>)<sup>0.5</sup>

Since λ<sub>LT</sub> > 0.4 lateral torsional buckling has to be considered

Imperfection parameter, α<sub>LT</sub>

φ<sub>LT</sub> = 0.5(1+α<sub>LT</sub>(λ<sub>LT</sub>-0.2)+λ<sub>LT</sub><sup>2</sup>)

Bend stress reduction factor, χ<sub>LT</sub> = 1/[φ<sub>LT</sub>+(φ<sub>LT</sub><sup>2</sup>-λ<sub>LT</sub><sup>2</sup>)<sup>0.5</sup>] <= 1.0

Design bending comp stress, f<sub>bd</sub> = χ<sub>LT</sub>\*f<sub>y</sub>/γ<sub>mo</sub>

Design strength, M<sub>d</sub> = β<sub>b</sub>\*Z<sub>p</sub>\*f<sub>bd</sub>

Shear strength of section

28082 KN-m

28082 KN-m

0.741

0.884

0.807 >0.4

0.49 For Welded sec

0.97

0.66

197.36 mpa

10933 >3,946 Safe

2897 >27 Safe

For Hogg (comp at bottom)

Unsupp Length of girder C/C support, L<sub>u</sub>

Eff len for lateral torsional buckling L<sub>LT</sub> = 1.2\*L<sub>u</sub>+2\*d

Self wt of one Girder

Self wt of green concrete deck

Design Hogging Moment due to self wt of girder

Design shear force

K for restrained rotation

Warping constant for restrained warping, K<sub>w</sub>

c<sub>1</sub> for UDL

c<sub>2</sub> for UDL

c<sub>3</sub> for UDL

Moment of inertia of com flange about minor axis I<sub>fc</sub>

Moment of inertia of ten flange about minor axis I<sub>tc</sub>

β<sub>f</sub> = I<sub>fc</sub>/(I<sub>fc</sub>+I<sub>ti</sub>)

I<sub>w</sub> = (1-β<sub>f</sub>)\*β<sub>f</sub>\*I<sub>y</sub>\*h<sub>f</sub><sup>2</sup> for mono symmetric, 0 for tee, hollw sect etc

Distance of point of application of load from shear centre, y<sub>g</sub>

For β<sub>f</sub> <= 0.5, y<sub>j</sub> = 1.0\*(2\*β<sub>f</sub>-1)\*h<sub>f</sub>/2

5.50 m

4.40 m

7.20 KN/m

17.16 KN/m

3712 KN-m

32.06 KN

0.500

0.500

0.712

0.652

1.070

0.000333 m<sup>4</sup>

0.001707 m<sup>4</sup>

0.1634

0.0013741 m<sup>4</sup>

0.000 m

-0.747

Critical elastic momen for symmetric section about minor axis ,M<sub>cr</sub>

$$M_{cr} = c_1 \frac{\pi^2 EI_y}{(L_{LT})^2} \left\{ \left[ \left( \frac{K}{K_w} \right)^2 \frac{I_w}{I_y} + \frac{GI_t (L_{LT})^2}{\pi^2 EI_y} + (c_2 y_g - c_3 y_j)^2 \right]^{0.5} - (c_2 y_g - c_3 y_j) \right\}$$

Critical elastic moment for doubly symmetric section , M<sub>cr</sub>

$$M_{cr} = \sqrt{\left\{ \left[ \frac{\pi^2 EI_y}{(L_{LT})^2} \right] \left[ GI_t + \frac{\pi^2 EI_w}{(L_{LT})^2} \right] \right\}}$$

Since section is doubly symmetric, M<sub>cr</sub>

For semi compact section, β<sub>b</sub>=Z<sub>e</sub>/Z<sub>p</sub>

(1.2\*Z<sub>e</sub>\*f<sub>y</sub>/M<sub>cr</sub>)<sup>0.5</sup>

Slenderness ratio λ<sub>LT</sub> = (β<sub>b</sub>\*Z<sub>p</sub>\*f<sub>y</sub>/M<sub>cr</sub>)<sup>0.5</sup> <= (1.2\*Z<sub>e</sub>\*f<sub>y</sub>/M<sub>cr</sub>)<sup>0.5</sup>

Since λ<sub>LT</sub> < 0.4 it may be treated as laterally supported and Bend stress red factor =1

Imperfection parameter, α<sub>LT</sub>

φ<sub>LT</sub> = 0.5(1+α<sub>LT</sub>(λ<sub>LT</sub>-0.2)+λ<sub>LT</sub><sup>2</sup>)

Bend stress reduction factor, χ<sub>LT</sub> = 1/[φ<sub>LT</sub>+(φ<sub>LT</sub><sup>2</sup>-λ<sub>LT</sub><sup>2</sup>)<sup>0.5</sup>] <= 1.0

Design bending comp stress, f<sub>bd</sub> = χ<sub>LT</sub>\*f<sub>y</sub>/γ<sub>mo</sub>

Design strength, M<sub>d</sub> = β<sub>b</sub>\*Z<sub>p</sub>\*f<sub>bd</sub>

Shear strength of section

51975 KN-m

172091 KN-m

172091 KN-m

0.741

0.357

0.326 < 0.4

0.49 For Welded sec

0.58

0.94

280.76 mpa

15554 >3,712 Safe

2897 >32 Safe

design strength in sagging moment -

|                                    |     |   | Moment of Resis. | Applied Moment | Status |
|------------------------------------|-----|---|------------------|----------------|--------|
| design strength - non composite    | Mdz | = | 16620            | 10384          | OK     |
| design strength - composite (SIDL) | Mdz | = | 52362            | 12810          | OK     |
| design strength - composite (LL)   | Mdz | = | 66477            | 27018          | OK     |

design strength in hogging moment -

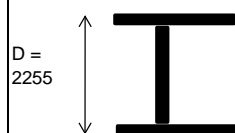
|                                 |     |   |        |   |    |
|---------------------------------|-----|---|--------|---|----|
| design strength - non composite | Mdz | = | -16620 | 0 | OK |
| design strength - composite     | Mdz | = | -20152 | 0 | OK |

the calculation of moment carrying capacity for composite sections are given above are presented below.

refer IRC 22 2008 - Annexure I for sagging moment capacity calculation

width of compression flange for compact section

$$= 500$$



top plate = 500 32  
web plate = 20 2183  
bottom plate = 800 40

D = 2255  
Yt = 1318  
Yb = 937  
A = 91660  
Iy = 2041455333  
Iz = 73027445772

Zte = 55398543  
Zbe = 77955780  
Zp = 74758246

#### sagging moment capacity for composite section - SIDL

effective width of concrete slab beff = 200  
overall depth of concrete slab ds = 220  
beff x ds = 44000  
 $\alpha = 19.2$   
cross section area of steel beam of a composite section As = 135660  
 $\alpha \times As = 2603283.582$   
area of top flange of steel beam of a composite section Af = 60000  
beff x ds + 2 x  $\alpha \times Af = 2346771.855$   
since beff x ds + 2 x  $\alpha \times Af < \alpha \times As$   
hence neutral axis in web  
avr thickness of top flange of steel section tf = 32  
avr thickness of web of steel section tw = 20  
distance btwn centroids of slab and steel beam in a composite beam dc = 1428  
depth of neutral axis at ULS of flexure from top of concrete xu = 586  
moment capacity of section = 52362

#### sagging moment capacity for composite section - LL

effective width of concrete slab beff = 400  
overall depth of concrete slab ds = 220  
beff x ds = 88000  
 $\alpha = 19.2$   
cross section area of steel beam of a composite section As = 179660  
 $\alpha \times As = 3447633.262$   
area of top flange of steel beam of a composite section Af = 104000  
beff x ds + 2 x  $\alpha \times Af = 4079471.215$   
since beff x ds + 2 x  $\alpha \times Af > \alpha \times As$   
hence check  
avr thickness of top flange of steel section tf = 32  
avr thickness of web of steel section tw = 20  
distance btwn centroids of slab and steel beam in a composite beam dc = 1428  
depth of neutral axis at ULS of flexure from top of concrete xu = -571  
moment capacity of section = 66477

refer IRC 22 2008 - Annexure I for hogging moment capacity calculation

#### hogging moment capacity for composite section

cross section area of steel beam of a composite section As = 91660  
R/F area within concrete flange Ast = 3393  
depth of steel section D = 2255  
depth of concrete deck ds = 220 mm  
As+Ast = 95053  
Ast x (D/2+ds) = 4571960  
xe = 48.1  
hogging moment in steel section alone Mes = 0  
Is = 73027445772  
Ic = 78968254442  
fs = 0.0  
hogging moment capacity Mel = -20152

**ULS Stress Check****Stress Check at Girder Top -**

|                                  |   | Design Stress Value | Permiss Stress Value | status |
|----------------------------------|---|---------------------|----------------------|--------|
| Design stress - non composite    | = | 187                 | 300                  | OK     |
| Design stress - composite (SIDL) | = | 82                  | 334                  | OK     |
| Design stress - composite (LL)   | = | 101                 | 249                  | OK     |

**Stress Check at Girder Bottom -**

|                                  |   | Design Stress Value | Permiss Stress Value | status |
|----------------------------------|---|---------------------|----------------------|--------|
| Design stress - non composite    | = | 133                 | 213                  | OK     |
| Design stress - composite (SIDL) | = | 134                 | 548                  | OK     |
| Design stress - composite (LL)   | = | 268                 | 659                  | OK     |

**Serviceability Check**

Yield Stress 330 Mpa

| Load        | Stress Value  |                  |                   |                  |
|-------------|---------------|------------------|-------------------|------------------|
|             | Stress at mid |                  | Stress at support |                  |
|             | Stress at top | Stress at bottom | Stress at top     | Stress at bottom |
| DL          | 138.85        | 98.67            | 0.00              | 0.00             |
| SIDL1       | 0.00          | 0.00             | 0.00              | 0.00             |
| SIDL2       | 8.85          | 14.50            | 0.00              | 0.00             |
| SUPP        | 0.00          | 0.00             | 0.00              | 0.00             |
| FPLL        | 0.00          | 0.00             | 0.00              | 0.00             |
| LL          | 35.52         | 93.96            | 0.00              | 0.00             |
| Temp        | 1.45          | 3.84             | 2.28              | 6.03             |
| Shrinkage   | 6.51          | 10.66            | 6.51              | 10.66            |
| Total       | 191.19        | 221.63           | 8.79              | 16.69            |
| Permissible | 297           | 297              | 297               | 297              |
| Status      | safe          | safe             | safe              | safe             |

**Design of Shear Connector -**

|  |   |       |
|--|---|-------|
| shear force for SIDL and LL                                    | = | 1567  |
| transformed concrete area above neutral axis (m <sup>2</sup> ) | = | 0.088 |
| CG distance of concrete from neutral axis (m)                  | = | 0.729 |
| longitudinal shear   | = | 609   |
| strength of one Shear Stud                                     | = | 216   |
| spacing of Shear stud required                                 | = | 0.10  |

## 7.6 Design of End Diaphragm

| Forces for End Diaphragm                 |  |       |  |         |         |
|--|--|-------|--|---------|---------|
| Load                                     |  | Shear |  | Moment  |         |
|  |  | Fy    |  | Sagging | Hogging |
| DL                                       |  | 12    |  | 32      | -42     |
| SIDL1                                    |  | 20    |  | 40      | -20     |
| SIDL2                                    |  | 10    |  | 10      | -5      |
| SUPP                                     |  | 0     |  | 0       | 0       |
| FPLL                                     |  | 0     |  | 0       | 0       |
| LL                                       |  | 942   |  | 244     | -270    |
| Ultimate Limit State - Basic Combination |  |       |  |         |         |
|  |  | 1473  |  | 480     | -497    |

force for jack lifting case at each jack location at center pier location -  
(refer *Annexure - 2* for STAAD Input file)

SF = 1379  
M = 1178

End Diaphragm has been designed as a non composite section for all the loads.

design governing criteria -  
combined shear force and bending moment

material -

grade of structural steel = E 350 (Fe 490) BO  
ultimate tensile stress  $f_u$  = 490  
yield stress  $f_y$  = 330  
partial safety factor  $\gamma_{ml}$  = 1.25  
 $\gamma_{mo}$  = 1.10

classification of cross section -

$\epsilon = (250/f_y)^{0.5}$  = 0.87  
(b/tf)/ $\epsilon$  for compression flange = 25.1  
(d/tw)/ $\epsilon$  for web = 67.1

for web connected to flange along both edge - transverse stiffener not required

shear strength -

plastic shear resistance  $V_p$  =  $A_v f_{yw} / \sqrt{3}$   
= 11389  
(d/tw)/ $\epsilon$  for web = > 67  
shear buckling shear resistance susceptible to shear buckling

so, shear strength = 10354

applied shear force V = 1473  
60% of shear strength = 6212

so, section is in absence of high shear force

design strength in sagging moment -

design strength Md<sub>z</sub> = 5883

for sagging moment - section of longitudinal girder is

>497 Safe

## Splice Design

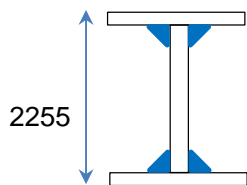
### 8.1 Splice Design

|  |                                  |   |  |
|--|----------------------------------|---|--|
| use plates:  | top and bottom flange location - |   | 1x450x16 +<br>2*175x16+2*300*28+<br>1*700*28 |
|  | web location -                   |   | 2*2050x16                                    |
| effective area of top flange splice plates (mm <sup>2</sup> )        | =                                |   | 20000 safe                                   |
| effective area of bottom flange splice plates (mm <sup>2</sup> )     | =                                |   | 36400 safe                                   |
| ultimate tensile stress of plates                                    | =                                |   | 490  |
| use bolts: HSFG bolts - M24 - 8.8 Grade                              |                                  |   |  |
| ultimate tensile stress $f_u$  | =                                |   | 800  |
| yield stress $f_y$   | =                                |   | 640  |
| nominal stress area (mm <sup>2</sup> ) $A_n$                         | =                                |   | 353  |
| proof load   | =                                |   | 198  |
| slip resistance of bolt per face $\mu \cdot N \cdot F / \gamma_{mf}$ | =                                |   | 79   |
| strength of one bolt in single shear                                 | $V_{nsb}$                        | = | 163  |
| shear capacity in single shear                                       | $V_{dsb}$                        | = | 130  |
| strength in bearing  | $V_{npb}$                        | = | 2.5 $k_b d t f_{1u}$                         |
|  | $k_b$                            | = | 0.59   |
|  | $d$ (mm)                         | = | 24   |
|  | $t$ (mm)                         | = | 16   |
|  | $f_{1u}$                         | = | 490  |
|  | $V_{npb}$                        | = | 277  |
|  | and $V_{dpb}$                    | = | 221  |
| bolt value in two interfaces, double shear & bearing                 | =                                |   | 158  |
| <b>bolt for top flange -</b>   |                                  |   |  |
| max bending stress in the flange                                     | =                                |   | 4100   |
| no. of bolt required   | =                                |   | 25.9   |
| <b>bolt for bottom flange -</b>                                      |                                  |   |  |
| max bending stress in the flange                                     | =                                |   | 9584   |
| no. of bolt required   | =                                |   | 60.6   |
| <b>bolt for web -</b>  |                                  |   |  |
| max shear force  | =                                |   | 2395   |
| bending moment shared by web   | =                                |   | 4273   |

| for 1 column of bolts |      |      |        |     |         |
|-----------------------|------|------|--------|-----|---------|
| x                     | x2   | y    | y2     | r   | r2      |
| 50                    | 2500 | 0    | 0      | 50  | 2500    |
| 50                    | 2500 | 75   | 5625   | 90  | 8125    |
| 50                    | 2500 | 150  | 22500  | 158 | 25000   |
| 50                    | 2500 | 225  | 50625  | 230 | 53125   |
| 50                    | 2500 | 300  | 90000  | 304 | 92500   |
| 50                    | 2500 | 375  | 140625 | 378 | 143125  |
| 50                    | 2500 | 450  | 202500 | 453 | 205000  |
| 50                    | 2500 | 525  | 275625 | 527 | 278125  |
| 50                    | 2500 | 600  | 360000 | 602 | 362500  |
| 50                    | 2500 | 675  | 455625 | 677 | 458125  |
| 50                    | 2500 | 750  | 562500 | 752 | 565000  |
| 50                    | 2500 | 825  | 680625 | 827 | 683125  |
| 50                    | 2500 | 900  | 810000 | 901 | 812500  |
| 50                    | 2500 | 975  | 950625 | 976 | 953125  |
| 50                    | 2500 | -75  | 5625   | 90  | 8125    |
| 50                    | 2500 | -150 | 22500  | 158 | 25000   |
| 50                    | 2500 | -225 | 50625  | 230 | 53125   |
| 50                    | 2500 | -300 | 90000  | 304 | 92500   |
| 50                    | 2500 | -375 | 140625 | 378 | 143125  |
| 50                    | 2500 | -450 | 202500 | 453 | 205000  |
| 50                    | 2500 | -525 | 275625 | 527 | 278125  |
| 50                    | 2500 | -600 | 360000 | 602 | 362500  |
| 50                    | 2500 | -675 | 455625 | 677 | 458125  |
| 50                    | 2500 | -750 | 562500 | 752 | 565000  |
| 50                    | 2500 | -825 | 680625 | 827 | 683125  |
| 50                    | 2500 | -900 | 810000 | 901 | 812500  |
| 50                    | 2500 | -975 | 950625 | 976 | 953125  |
| $\Sigma r^2 =$        |      |      |        |     | 9281250 |

|                                    |   |         |           |
|------------------------------------|---|---------|-----------|
| no of bolt in one column           | = | 27      |           |
| no of columns                      | = | 4       |           |
| max $r / \Sigma r^2$               | = | 0.00003 |           |
| force on each bolt for shear force | = | 22      |           |
| force on each bolt for bending     | = | 112     |           |
| total force on each bolt           | = | 115     | <158 Safe |

### 13.2 Weld check for connection of web and flange of long girder



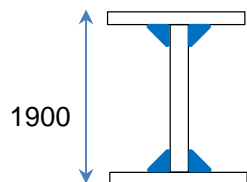
|      |             |
|------|-------------|
| D =  | 2255        |
| Yb = | 2255        |
| A =  | 91660       |
| Iy = | 2041455333  |
| Iz = | 73027445772 |

|              |     |      |
|--------------|-----|------|
| top plate    | 500 | 32   |
| web plate    | 20  | 2183 |
| bottom plate | 800 | 40   |

|                                    |                       |
|------------------------------------|-----------------------|
| Factored shear force, V            | 2395 KN               |
| Ultimate strength of weld material | 410 N/mm <sup>2</sup> |

|   |                          |
|---|--------------------------|
| Safety factor for shop weld $\gamma_{mw}$                           | 1.25                     |
| Design strength of weld material = $F_u / (3^{0.5} \gamma_{mw})$    | 189 N/mm <sup>2</sup>    |
| size of weld provided, s  | 10 mm                    |
| Thorat thickness = 0.7s   | 7 mm                     |
| $\Sigma t$  | 14 mm                    |
| $A_f \cdot Y_f$ (Comp flange)                                       | 17784000 mm <sup>3</sup> |
| Iz  | 7.E+10 mm <sup>4</sup>   |
| $\zeta_{vf\ cal} = V \cdot A_f \cdot Y_f / (I_{zz} \cdot \Sigma t)$ | 42 N/mm <sup>2</sup>     |

### 13.3 Weld check for connection of web and flange of End cross Girder



|              |     |      |
|--------------|-----|------|
| Top Plate    | 350 | 16   |
| web plate    | 16  | 1868 |
| bottom plate | 350 | 16   |

|                                    |                       |
|------------------------------------|-----------------------|
| Factored shear force, V            | 1473 KN               |
| Ultimate strength of weld material | 410 N/mm <sup>2</sup> |

|   |      |
|---|------|
| Safety factor for shop weld $\gamma_{mw}$ | 1.25 |
|---|------|



|  |                         |
|--|-------------------------|
| Design strength of weld material= $F_u/(3^{0.5} \gamma_{mw})$  | 189 N/mm <sup>2</sup>   |
| size of weld provided, s                                       | 10 mm                   |
| Thorat thickness=0.7s  | 7 mm                    |
| $\Sigma t$   | 14 mm                   |
| $A_f * Y_f$ (Comp flange)                                      | 2284800 mm <sup>3</sup> |
| $I_z$  | 2.E+10 mm <sup>4</sup>  |
| $\zeta_{vf \text{ cal}} = V * A_f * Y_f / (I_{zz} * \Sigma t)$ | 13 N/mm <sup>2</sup>    |

**Design for Fatigue Limit:***(Clause 605 of IRC 22-2015) Page 26*

|  |                |   |                                      |                   |
|--|----------------|---|--------------------------------------|-------------------|
| normal fatigue stress range                              | f              | = | 141                                  | N/mm <sup>2</sup> |
| shear stress range                                       | τ              | = | 7.64                                 | N/mm <sup>2</sup> |
| capacity reduction factor μ <sub>r</sub>                 |                | = | (25/t <sub>p</sub> ) <sup>0.25</sup> | ≤ 1               |
| t <sub>p</sub> is the thickness of thicker plate joined. |                |   |                                      |                   |
|  | t <sub>p</sub> | = | 32                                   | mm                |
|  | μ <sub>r</sub> | = | 0.940                                |                   |

**Values obtained from S-N curves shall be modified**

|  |   |       |
|--|---|-------|
| Assuming no of stress cycles N <sub>sc</sub> | = | 2E+05 |
|--|---|-------|

**Low Fatigue:**

**Fatigue assessment not required for a member, connection or detail, if normal and shear design stress ranges f, satisfy the following conditions:**

$$f \leq 27/\gamma_{mft}$$

OR

$$N_{sc} \leq 5 \times 10^6 \left( (27/\gamma_{mft}) / (\gamma_{fft} * f) \right)^3$$

$$\gamma_{mft} = 1.25$$

$$\gamma_{fft} = 1$$

|  |   |          |
|--|---|----------|
| 27/γ <sub>mft</sub>  | = | 21.6     |
| 5*10 <sup>6</sup> *((27/γ <sub>mft</sub> )/(γ <sub>fft</sub> *f)) <sup>3</sup> | = | 1.80E+04 |

**Fatigue assessment required****Fatigue assessment required****Fatigue Strength:**

for normal stress range:

|                |   |  |     |                 |   |                   |
|----------------|---|--|-----|-----------------|---|-------------------|
| f <sub>f</sub> | = | f <sub>fn</sub> * (5*10 <sup>6</sup> /N <sub>sc</sub> ) <sup>(1/3)</sup> | for | N <sub>sc</sub> | ≤ | 5*10 <sup>6</sup> |
| f <sub>f</sub> | = | f <sub>fn</sub> * (5*10 <sup>6</sup> /N <sub>sc</sub> ) <sup>(1/5)</sup> | for | N <sub>sc</sub> | ≥ | 5*10 <sup>6</sup> |

for shear stress range:

|                |   |  |
|----------------|---|--|
| τ <sub>f</sub> | = | τ <sub>fn</sub> * (5*10 <sup>6</sup> /N <sub>sc</sub> ) <sup>(1/5)</sup> |
|----------------|---|--|

f<sub>f</sub>, τ<sub>f</sub> = design normal and shear fatigue stress range for life cycle of N<sub>sc</sub>.f<sub>fn</sub>, τ<sub>fn</sub> = design normal and shear fatigue stress range for 5\*10<sup>6</sup> cycles.

|                                  |   |        |                   |
|----------------------------------|---|--------|-------------------|
| Detail Category, f <sub>fn</sub> | = | 92     | N/mm <sup>2</sup> |
| f <sub>f</sub>                   | = | 269    | N/mm <sup>2</sup> |
| Detail Category, τ <sub>fn</sub> | = | 92     | N/mm <sup>2</sup> |
| τ <sub>f</sub>                   | = | 175.14 | N/mm <sup>2</sup> |

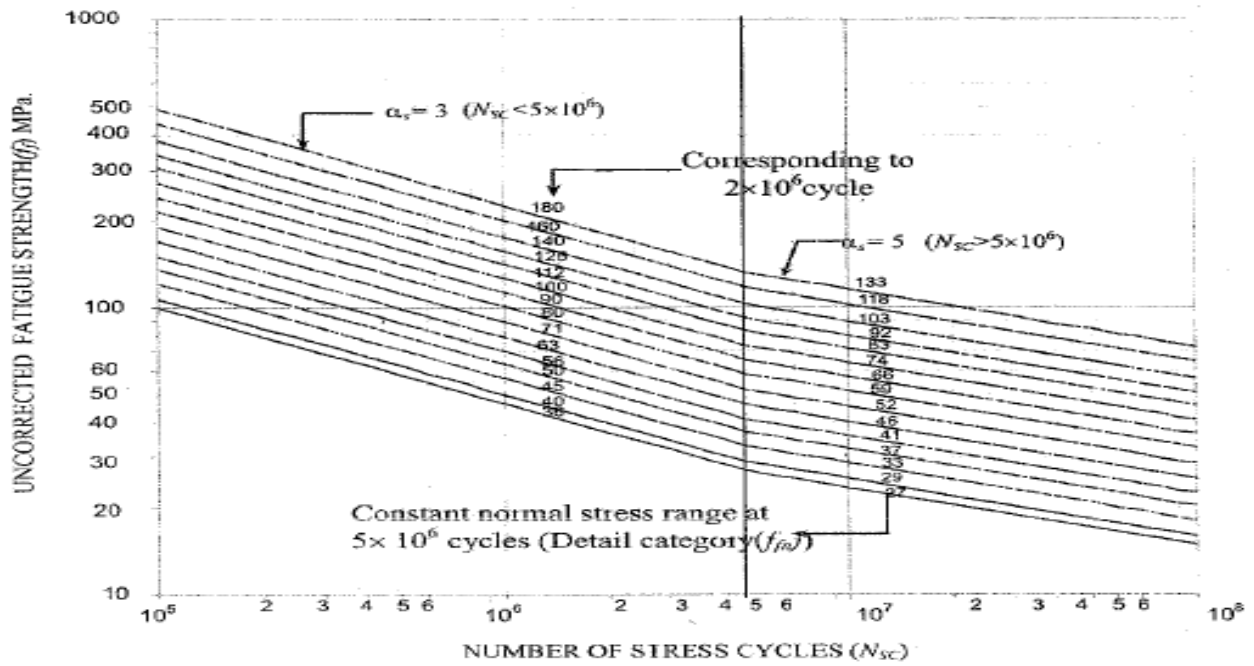


Fig. 6a. S-N Curve for Normal Stress

#### Fatigue Assessment:

The design fatigue strength for  $N_{sc}$  life cycles is given as:

$$\begin{aligned} f_{fd} &= \mu_r^* f_f / \gamma_{mft} \\ \tau_{fd} &= \mu_r^* \tau_f / \gamma_{mft} \end{aligned}$$

$$\begin{aligned} f_{fd} &= 202.328 \text{ N/mm}^2 \\ \tau_{fd} &= 131.724 \text{ N/mm}^2 \end{aligned}$$

#### Constant Stress range:

$$\begin{aligned} f &\leq f_{fd} && \text{Equation satisfied} \\ \tau &\leq \tau_{fd} && \text{Equation satisfied} \end{aligned}$$

## Differential temperature

Differential temperature occurs between the prefabricated steel girder and in-situ concrete deck slab, and this results in the development of internal stresses.

Force developed due to restraint of deck  $F = AE\alpha \Delta_t$

Coefficient of thermal movement  $\alpha = 1.20E-05 \text{ } ^\circ\text{C}$

Young's Modulus of Elasticity of Concrete = M40 32000

### a] Positive Temperature differential

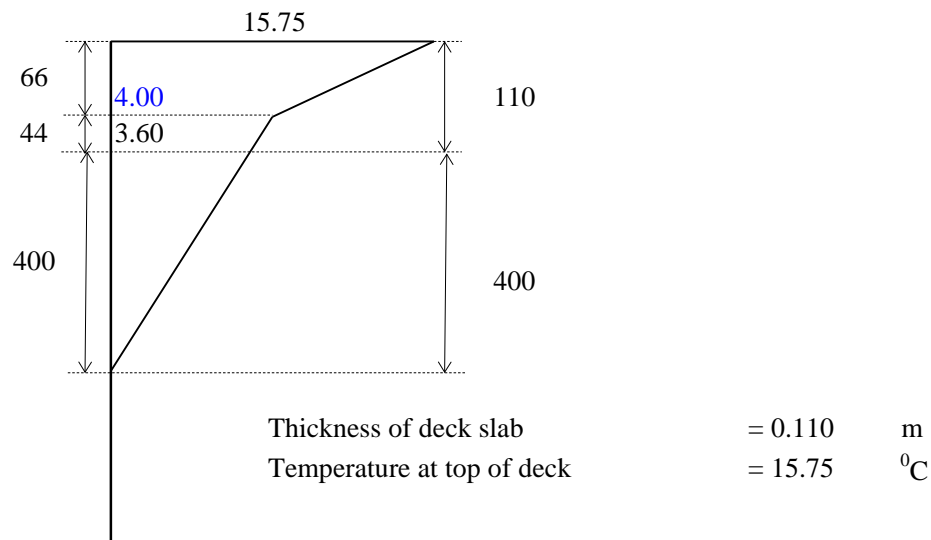


Fig (10b) : +ve temp difference

For temperature the modular ratio  $m = 7.5$

Table : Calculation of temperature force & moment

Distance of short term neutral axis from top of deck = 0.839 m

| Element no.1                                      | Width (mm) | Thickness (mm) | E (N/mm <sup>2</sup> ) | Av. Temp. $\Delta_t$ (°C) | F (kN) | y from NA (m) | M (kNm) |
|---|------------|----------------|------------------------|---------------------------|--------|---------------|---------|
| 1   | 3000       | 66             | 32000                  | 9.88                      | 750.82 | 0.81          | 609.81  |
| 2   | 3000       | 44             | 32000                  | 3.80                      | 192.71 | 0.75          | 144.73  |
| 3   | 20         | 400            | 200000                 | 1.80                      | 34.59  | 0.60          | 20.59   |
| Total Force & moment at CG of Girder (Short term) |            |                |                        |                           | 978.12 |               | 775.14  |

Primary stresses due to differential temperature  $\sigma = -P/A - My/I + E\alpha \Delta_t$

Stress at top of Deck

$$= -3.86 \text{ N/mm}^2$$

Stress at top of girder

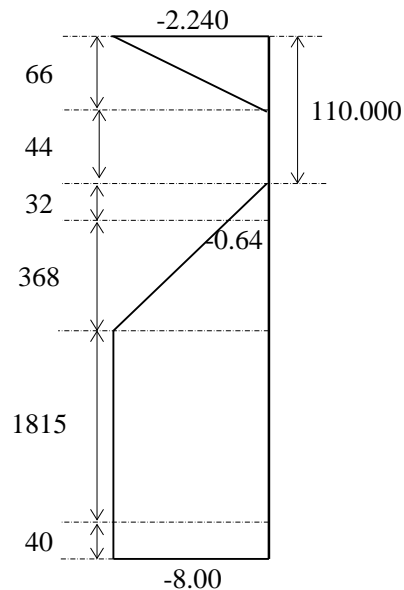
$$= 0.30 \text{ N/mm}^2$$

Stress at bottom of girder

$$= -13.13 \text{ N/mm}^2$$

|                  |             |
|------------------|-------------|
| Primary Moment   | 775.14 KNm  |
| Secondary Moment | 1162.71 KNm |
| Net Moment       | 387.57 KNm  |

#### b] Negative Temperature differential



Thickness of deck slab + haunch = 0.110  
Temperature at top of deck = 2.240

Fig (10b) : -ive temp difference

Table : Calculation of temperature force & moment

Distance of short term neutral axis from top of deck = 0.839 m

| Element no.1                                      | Width (mm) | Thickness (mm) | E (N/mm <sup>2</sup> ) | Av. Temp. $\Delta_t$ (°C) | F (kN)   | y from NA (m) | M (kNm) |
|---|------------|----------------|------------------------|---------------------------|----------|---------------|---------|
| 1   | 3000       | 66             | 32000                  | -1.12                     | -85.16   | 0.82          | -69.54  |
| 2   | 500        | 32             | 200000                 | -0.32                     | -12.29   | 0.71          | -8.69   |
| 4   | 20         | 368            | 200000                 | -4.32                     | -76.31   | 0.46          | -35.13  |
| 5   | 20         | 1815           | 200000                 | -8.00                     | -696.96  | -0.58         | 403.43  |
| 7   | 800        | 40             | 200000                 | -8.00                     | -614.40  | -1.51         | 925.50  |
| Total Force & moment at CG of Girder (Short term) |            |                |                        |                           | -1485.11 |               | 1215.56 |

Primary stresses due to differential temperature  $\sigma = -P/A - My/I + E\alpha \Delta_t$

Stress at top of deck

$$= -5.19 \quad \text{N/mm}^2$$

Stress at top of girder

$$= 3.71 \quad \text{N/mm}^2$$

Stress at bottom of girder

$$= -22.99 \quad \text{N/mm}^2$$

(-ve tension +ve comp.)

|                  |             |
|------------------|-------------|
| Primary Moment   | 1215.56 KNm |
| Secondary Moment | 1823.34 KNm |
| Net Moment       | 607.78 KNm  |

**CALCULATION FOR DIFFERENTIAL SHRINKAGE****50.3 m**

Shrinkage strain of R.C. slab                      **0.0002**  
 Shrinkage strain of Steel                              **0.00**  
 Differential shrinkage strain                              **0.0002**  
 Grade of concrete                      M      **35**

**As SHRINKAGE is long term effect so the moular ratio m = 15**

Area of slab (inner beam)      0.220      x      3.00                                      =      0.660 m<sup>2</sup>

Elasticity of M40 concrete                      =                      **32000**                      MPa  
 Elasticity of Steel                                      =                      **200000**                      MPa

Shrinkage is modified by creep reduction factor  $f_c =$                       **0.5**

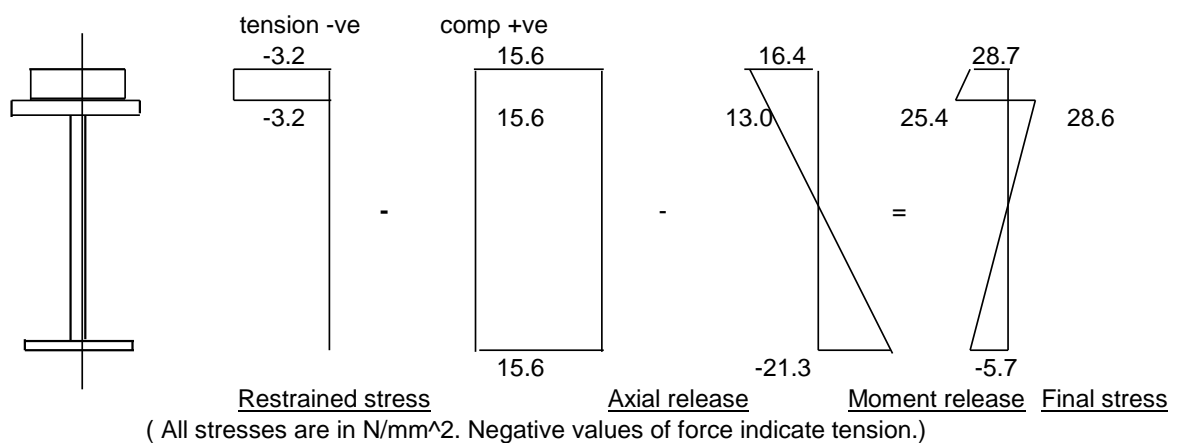
Restraining force =  $e_{dc} \times E_s / m \times A_{slab} \times f_c =$                       2.11E+06                      N

Restraining moment =(Ycst - ts/2)xRestraining force =                      **2.0E+06**                      Nm

|                  |                    |
|------------------|--------------------|
| Primary Moment   | <b>2038.06 KNm</b> |
| Secondary Momnet | <b>3057.09 KNm</b> |
| Net Moment       | <b>1019.03 KNm</b> |

**Properties of composite girder**

Area of composite section                      m<sup>2</sup>                      **0.136**  
 Section modulus at top of slab                      m<sup>3</sup>                      **0.125**  
 Section modulus at top of beam                      m<sup>3</sup>                      **0.157**  
 Section modulus at bottom of beam                      m<sup>3</sup>                      **0.096**



⇒ Design of Connection between Deck Slab & Girder:

⇒ Design of Shear Connectors

(IRC 22:2015-Table-7.8)

**Properties of Shear Connector**

|   |          |            |
|---|----------|------------|
| Grade of Concrete used for Deck Slab      | =        | 35 MPa     |
| Diameter of Stud                          | =        | 20 mm      |
| Overall height of Stud                    | =        | 100 mm     |
| Partial safety factor for shear Connector | =        | 1.25       |
| Characteristic yield strength of Stud     | =        | 385 MPa    |
| Characteristic Tensile Strength of Stud   | =        | 495 MPa    |
| Ultimate Static Strength of one Stud      | =        | 95 kN      |
| Number of Studs in one row                | =        | 3          |
| No's of fatigue cycle                     | $N_{sc}$ | = 2.00E+06 |
| Nominal Fatigue Strength                  | $Q_r$    | = 25 kN    |

⇒ Ultimate Limit State (Strength Criteria)

(As per IRC: 22-2015 Clause 606.4.1)

| Type           | Description              | Impact Factor | Partial Safety Factor | Outer Girder           |                                 |                                 | Inner Girder           |                                 |                                 |
|----------------|--------------------------|---------------|-----------------------|------------------------|---------------------------------|---------------------------------|------------------------|---------------------------------|---------------------------------|
|                |                          |               |                       | Shear Force at Support | Shear Force at 1st & 4th splice | Shear Force at 2nd & 3rd splice | Shear Force at Support | Shear Force at 1st & 4th splice | Shear Force at 2nd & 3rd splice |
|                |                          |               |                       | kN                     | kN                              | kN                              | kN                     | kN                              | kN                              |
| Long Term Load | Steel girder             | 100%          | 1.35                  | 189                    | 166                             | 67                              | 189                    | 155                             | 67                              |
|                | Slab                     | 100%          | 1.35                  | 424                    | 324                             | 150                             | 424                    | 324                             | 150                             |
|                | SIDL without surfacing   | 100%          | 1.35                  | 200                    | 126                             | 34                              | 55                     | 63                              | 34                              |
|                | Surfacing (Wearing Coat) | 100%          | 1.75                  | 111                    | 85                              | 33                              | 111                    | 85                              | 33                              |
|                | Differential Shrinkage   | 100%          | 1.00                  | 0                      | 0                               | 0                               | 0                      | 0                               | 0                               |
|                | Temperature              | 100%          | 1.00                  | 0                      | 0                               | 0                               | 0                      | 0                               | 0                               |
| Short Term     | Veicular Live Load       | 118%          | 1.50                  | 742                    | 646                             | 400                             | 220                    | 196                             | 98                              |
|                | Footpath Live Load       | 0%            | 1.50                  | 0                      | 0                               | 0                               | 0                      | 0                               | 0                               |

(IRC:22-2015 Clause 606.4.1, Pg 40)

The longitudinal shear per unit length is given by

$$V_L =$$

Where,

|          |   |   |
|----------|---|---|
| $V_L$    | = | Longitudinal shear per unit length  |
| $V$      | = | Vertical Shear forces due to dead load and live load (with impact)  |
| $A_{ec}$ | = | The transformed compressive area of concrete above neutral axis of composite cross section considering appropriate modular ratio with respect to nature of load |
| $Y$      | = | C.G distance of transformed concrete area from neutral axis   |
| $I$      | = | Moment of inertia of whole concrete section using appropriate modular ratio   |

Spacing of shear connectors for above case is given by,  $S_{L1} =$

Where,

|       |   |  |
|-------|---|--|
| $Q_u$ | = | Ultimate Static strength of shear connector (Taken as sum of static strengths of all studs in given section) |
|-------|---|--|

**-For Outer Girder :-**

| Type           | Description            | Shear Force at Support | Shear Force at 1st & 4th splice | Shear Force at 2nd & 3rd splice | $A_{ec}$       | $Y$  | $I$            | $V_L$ at Support | $V_L$ at 1st splice | $V_L$ at 2nd splice |
|----------------|------------------------|------------------------|---------------------------------|---------------------------------|----------------|------|----------------|------------------|---------------------|---------------------|
|                |                        | kN                     | kN                              | kN                              | m <sup>2</sup> | m    | m <sup>4</sup> | kN/m             |                     |                     |
| Long Term Load | Steel (Selfweight)     | 255                    | 225                             | 90                              | 0.1357         | 0.96 | 0.1338         | 249              | 220                 | 88                  |
|                | Slab                   | 572                    | 437                             | 203                             | 0.1357         | 0.96 | 0.1338         | 560              | 428                 | 198                 |
|                | SIDL without Surfacing | 270                    | 170                             | 46                              | 0.1357         | 0.96 | 0.1338         | 264              | 166                 | 45                  |
|                | Surface (Wearing coat) | 194                    | 115                             | 45                              | 0.1357         | 0.96 | 0.1338         | 190              | 112                 | 44                  |
|                | Differential Shrinkage | 0                      | 0                               | 0                               | 0.1357         | 0.96 | 0.1338         | 0                | 0                   | 0                   |
|                | Temperature            | 0                      | 0                               | 0                               | 0.1357         | 0.96 | 0.1338         | 0                | 0                   | 0                   |
| Short Term     | Veicular Live Load     | 1,309                  | 872                             | 540                             | 0.1797         | 0.73 | 0.1650         | 1,039            | 692                 | 429                 |
|                | Footpath Live Load     | 0                      | 0                               | 0                               | 0.1797         | 0.73 | 0.1650         | 0                | 0                   | 0                   |
|                |                        | Sum                    |                                 |                                 |                |      |                | 2,302            | 1,618               | 803                 |

**-For Inner Girder :-**

| Type           | Description               | Shear Force at Support | Shear Force at 1st & 4th splice | Shear Force at 2nd & 3rd splice | $A_{ec}$       | $Y$  | $I$            | $V_L$ at Support | $V_L$ at 1st splice | $V_L$ at 2nd splice |
|----------------|---------------------------|------------------------|---------------------------------|---------------------------------|----------------|------|----------------|------------------|---------------------|---------------------|
|                |                           | kN                     | kN                              | kN                              | m <sup>2</sup> | m    | m <sup>4</sup> | kN/m             |                     |                     |
| Long Term Load | Steel (Selfweight)        | 255                    | 210                             | 90                              | 0.14           | 0.96 | 0.13           | 249              | 205                 | 88                  |
|                | Slab                      | 572                    | 437                             | 203                             | 0.14           | 0.96 | 0.13           | 560              | 428                 | 198                 |
|                | SIDL without Surfacing    | 74                     | 85                              | 46                              | 0.14           | 0.96 | 0.13           | 73               | 83                  | 45                  |
|                | Surface (Wearing coating) | 194                    | 149                             | 58                              | 0.14           | 0.96 | 0.13           | 190              | 145                 | 56                  |
|                | Differential Shrinkage    | 0                      | 0                               | 0                               | 0.14           | 0.96 | 0.13           | 0                | 0                   | 0                   |
|                | Temperature               | 0                      | 0                               | 0                               | 0.14           | 0.96 | 0.13           | 0                | 0                   | 0                   |
| Short Term     | Veicular Live Load        | 388                    | 346                             | 173                             | 0.18           | 0.73 | 0.16           | 308              | 274                 | 137                 |
|                | Footpath Live Load        | 0                      | 0                               | 0                               | 0.18           | 0.73 | 0.16           | 0                | 0                   | 0                   |
|                |                           | Sum                    |                                 |                                 |                |      |                | 1,379            | 1,136               | 525                 |

Therefore spacing of shear connectors  $S_{L1}$  is given as,

|                                |   |        |
|--------------------------------|---|--------|
| Spacing Required at Support    | = | 207 mm |
| Spacing Required 1st splice    | = | 251 mm |
| Spacing required at 2nd splice | = | 543 mm |

⇒ Full Shear Connection

Maximum horizontal force in the slab (H):

(IRC:22-2015 Clause 606.4.1.1, Page 40)

Minimum of  $H_1$  &  $H_2$

$$H_1 = A_{sl} f_y 10^{-3} g_m$$

$$H_2 = 0.36 f_{ck} A_{ec} 10^{-3}$$

Where,

|          |   |  |
|----------|---|--|
| $A_{sl}$ | = | Area of tensile steel in longitudinal direction (mm <sup>2</sup> )                     |
| $A_{ec}$ | = | Effective area of concrete 60.00   |
|          | = | $b_{eff} \cdot X_u$ for NA within Slab and $b_{eff} \cdot d_s$ for NA in steel section |

Spacing of Shear Connector (m)

$$S_{L2} = (\Sigma Q_u / H) \cdot L$$

| Sr. No. | Member       | A <sub>sl</sub> | A <sub>sc</sub> | V <sub>m</sub> | H <sub>1</sub> | H <sub>2</sub> | L    | S <sub>L2</sub> |
|---------|--------------|-----------------|-----------------|----------------|----------------|----------------|------|-----------------|
|         |              | mm <sup>2</sup> | mm <sup>2</sup> |                | kN             | kN             | m    | mm              |
| 1       | Outer Girder | 135660          | 660000          | 1.25           | 35814          | 8316           | 25.2 | 862             |
| 2       | Inner Girder | 135660          | 660000          | 1.25           | 35814          | 8316           | 25.2 | 862             |

\* L = Length between max BM and Support

### 5.6.3 Serviceability Limit State (Limit State of Fatigue)

(IRC:22-2015 Clause 606.4.2, Page 41)

Calculate shear V<sub>r</sub> at interface due to live load and iMPact

$$V_r =$$

Where,

$$V_R$$

=

Vertical shear difference due to maximum and minimum shear envelop due to live load and impact

| Type         | Description        | Shear Force at Support | Shear Force at 1st & 4th splice | Shear Force at 2nd & 3rd splice | A <sub>sc</sub> | Y    | I              | V <sub>r</sub> at Support | V <sub>r</sub> at 1st splice | V <sub>r</sub> at 2nd splice |
|--------------|--------------------|------------------------|---------------------------------|---------------------------------|-----------------|------|----------------|---------------------------|------------------------------|------------------------------|
|              | Short Term Load    | kN                     | kN                              | kN                              | m <sup>2</sup>  | m    | m <sup>4</sup> | kN/m                      | kN/m                         | kN/m                         |
| Outer Girder | Vehicle Live Load  | 872                    | 760                             | 470                             | 1.04E-01        | 0.73 | 0.16           | 401                       | 349                          | 216                          |
|              | Footpath Live Load | 0                      | 0                               | 0                               | 1.04E-01        | 0.73 | 0.16           | 0                         | 0                            | 0                            |
| Inner Girder | Vehicle Live Load  | 259                    | 230                             | 115                             | 1.04E-01        | 0.73 | 0.16           | 119                       | 106                          | 53                           |
|              | Footpath Live Load | 0                      | 0                               | 0                               | 1.04E-01        | 0.73 | 0.16           | 0                         | 0                            | 0                            |
| Max.Sum      |                    |                        |                                 |                                 |                 |      |                | 401                       | 349                          | 216                          |

Spacing Required at Support

=

187 mm

Spacing Required 1st splice

=

215 mm

Spacing required at 2nd splice

=

347 mm

### Check for Transverse Shear

(IRC:22-2015 Clause 606.6, Page 42)

Longitudinal Shear transferred from the steel girder to slab is further distributed in the transverse direction through the transverse strength of the slab as well as the transverse reinforcement provided at the section.

The transverse strength and amount of transverse steel needs to be checked as per formulas given below.

(IRC:22-2015 Clause 606.10, Page 44)

The shear force transferred per metre length should satisfy both the following conditions:

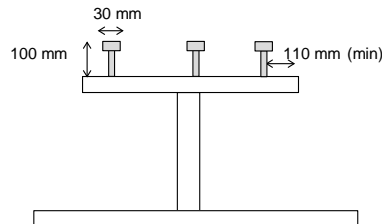
- 1) 1,160 < 1,645 OK
- 2) 1,160 < 5,519 OK

Where,

|                 |   |  |   |   |
|-----------------|---|--|---|---|
| V <sub>L</sub>  | = | Longitudinal shear force per unit length calculated for Ultimate Limit State in kN/m | = | 1,160 kN/m  |
| f <sub>ck</sub> | = | Characteristic strength of concrete in MPa   | = | 35 MPa  |
| f <sub>st</sub> | = | Yield strength of transverse reinforcement in MPa                                    | = | 435 MPa   |
| L               | = | Length of possible shear plane envelope (as per Fig.11, Pg 45, IRC 22-2015) in mm    | = | 440 mm  |
| n               | = | No. of times each lower transverse reinforcing bar is intersected by a shear surface | = | 2.00  |
| A <sub>st</sub> | = | Sectional area of transverse reinforcement in cm <sup>2</sup> per metre run of beam  | = | 2.5V <sub>L</sub> / f <sub>st</sub> cm <sup>2</sup> /m        |
|                 | = | 56.50 cm <sup>2</sup> /m   | = | 2.5V <sub>L</sub> / f <sub>st</sub> = 6.67 cm <sup>2</sup> /m |

OK

### Detailing of Shear Connector



(IRC:22-2015 Clause 606.6, Fig. 8a)

|                                     |   |           |                                     |    |
|-------------------------------------|---|-----------|-------------------------------------|----|
| Diameter of Stud                    | = | 20.00     | > 2 times plate thickness           | OK |
| Height of Stud                      | = | 100.00    | > 4 times diameter of stud OR 100mm | OK |
| Diameter of Head                    | = | 30.00 mm  |                                     |    |
| Number Stud Provided in Section     | = | 3.00 NO's |                                     |    |
| Minimum Edge Distance of Shear Stud | = | 110 mm    |                                     |    |

### Spacing of Shear Connector

(IRC:22-2015 Clause 606.9)

Spacing of Shear Connector shall not exceed :

- 1 Three times the thickness of the deck slab = 660 mm
- 2 4 times the height of the stud connector = 400 mm
- 3 600mm = 600 mm

Required Spacing @

From Support to 10m = 187 mm

Provided Spacing @

From Support to 10m = 100 mm C/C

mm  
mm

OK

Shear Connector Shall be extended 40mm(min) above transverse reinforcement and 40 mm into compression zone of

(IRC:22-2015 Clause 606.6.1)



## <> Design of Stiffeners for Main Girder:

### (i) Design of Intermediate Stiffeners:

[As per Clause 509.7 of IRC:24 - 2010]

When transverse stiffener are not required as per cl. no. 509.6.1.1 a) of IRC: 24-2010

Thickness of web plate without any stiffener plates  $d/t_w \leq 200e_w$   $d = 2183 \text{ mm}$   
 $e_w = (250/f_y)^{1/2} = 0.87$   $t_w \geq 12.54 \text{ mm}$   
 As per cl. no. 509.6.1.1 b)(i) of IRC: 24-2010 when  $3d \geq c \geq d$   $d/t_w \leq 200e_w$   
 As per cl. no. 509.6.1.1 b)(ii) of IRC: 24-2010 when  $d > c \geq 0.74d$   $c/t_w \leq 200e_w$   
 As per cl. no. 509.6.1.1 b)(i) of IRC: 24-2010 when  $c \leq 0.74d$   $d/t_w \leq 270e_w$   
 $c = \text{clear panel} = 1850 \text{ mm} < 1.5d = 3274.5 \text{ mm}$  As per cl. No. G4.11.2.2 of IRC:24 - 2010  
 $> 0.33d = 720.39 \text{ mm}$   
 $t_w = 10.63 \text{ mm} < 20 \text{ mm}$  **OK**

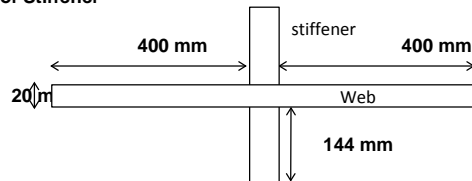
A gap of **40 mm** is to be provided between bottom flange and stiffener not greater than  $4t_w$  **OK**

As per cl. No. 509.7 of IRC:24 - 2010, shear buckling resistance shall be checked.

$c/d \geq \sqrt{2}$   $I_s \geq 0.75dt_w^3$   $c/d < \sqrt{2}$  Moment of Inertia  $I_s \geq 0.15d^3t_w^3/c^2$   
 $c/d = 0.84746 < \sqrt{2} = 1.414$   $I_{\min} = 1.5 \times d^3 \times t_w^3 / c^2$   
 $= 1.5 \times 2183^3 \times 10.63^3 / 1850^2 = 5.47E+06 \text{ mm}^4$   
 Thickness of intermediate stiffener provided  $t = 12 \text{ mm}$   
 Effective outstand of stiffener as per G4.11.2.6 of IRC:24 - 2010  $12t = 144 \text{ mm}$   
 As per cl. no. 509.7.1.2 of IRC: 24-2010, maximum outstand not greater than  $20t_e$  and  $14t_e$  to be considered for design for width in between  $20t_e$  and  $14t_e$ .

Min. flange width available  $= 500 \text{ mm}$   
 Available width for stiffener on each side of web  $= (500-20)/2 = 240 \text{ mm}$   
 Considering effective width of outstand  $= \text{Min of } (144, 240) = 144 \text{ mm}$

### Buckling Resistance of Stiffener



MOI of intermediate stiffener  $= 12 \times ((144+144+20)^3/12 - 12 \times 20^3/12) = 2.92E+07 > 5.47E+06$  **OK**

Core Area  $A_e = 19696 \text{ mm}^2$   
 Considering 20 times web thickness ( $20t_w$ ) of web on both side of stiffener  $= 400 \text{ mm}$   
 Moment of Inertia of core area,  $I = 3E+07 \text{ mm}^4$   
 Radius of Gyration,  $r = 39 \text{ mm}$   
 Flange is restrained against rotation and lateral deflection, **Cl. 509.7.1.5 of IRC 24:2010**  
 Effective Length of Transverse stiffener  $= 0.7 \times L$   
 $KL/r = 39.7$

For any solid section, As per Table 4 of IRC 24-2010, page 49 Section lies in buckling Class C

| KL/r | Yield Stress $f_y$ , (MPa) | $f_y = 390$ | For |
|------|----------------------------|-------------|-----|
|      | 380                        | 400         | 390 |
| 10   | 345                        | 364         | 355 |
| 20   | 332                        | 348         | 340 |

(IRC 24:2010 Table 6c)

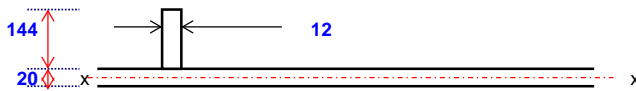
Design compressive stress  $f_{cd} = 369 \text{ MPa}$   
 As per cl. No. 507.1.2  $P_d = A_e f_{cd}$   $g_{mo} = 1.1$   $f_{cd} = \text{Design compressive stress}$   
 $f_{cd} = \frac{f_y/g_{mo}}{\{1 + \{f_y^2 - f_{cc}^2\}^{0.5}\}}$   $f = 0.5[1 + a(I - 0.2) + I^2]$   $f_y = 490 \text{ Mpa}$   
 $I = \text{SQRT}(f_y/f_{cc})$   $E = 2.00E+05 \text{ Mpa}$   
 $f_{cc} = p^2 E / (KL/r)^2 = 1254 \text{ Mpa}$   $I = 0.625$   
 As per Table 3 & 4 of IRC :24-2010,  $a = 0.49$   
**Buckling Class is c**  $f = 0.80$   
 $f_{cd} = 369.0 \text{ MPa}$   
 Buckling resistance of the stiffener  $F_{qd} = f_{cd} A = 7267.8 \text{ kN}$

### Shear Buckling check

$F_q = (V - V_{cr})/g_{mo} \leq F_{qd}$   
 $V = \text{factored shear force, maximum value near support} = 1889 \text{ kN}$   
 $V_{cr} = \text{shear buckling resistance of the web panel} = 3187 \text{ kN}$   
 $(V - V_{cr})/g_{rr} = -1008 < 7268 \text{ kN}$  **OK**  
 Hence provide **144 mm x 12 mm** stiffeners on both side of web

(ii) Design of Connection between transverse stiffener and web at cross girder location

[As per Clause 509.7.2.6 of IRC:24 - 2010]



|   |                           |   |        |                   |
|---|---------------------------|---|--------|-------------------|
| Design Shear force for transverse stiffener =     | $t_w^2/(5b_s)$            | = | 555.6  | KN/m              |
| Depth of stiffener =                              | $d_t$                     | = | 2.18   | m                 |
| Total Shear force                                 |                           | = | 1212.8 | KN                |
| Number of weld surface available                  |                           | = | 2      |                   |
| Minimum weld size required [IS: 9595 - 1980]      |                           | = | 4      | mm                |
| Weld size provided                                |                           | = | 6      | mm                |
| Effect length of weld                             |                           | = | 4.366  | m                 |
| Permissible shear capacity of fillet weld in shop |                           | = | 190.53 | N/mm <sup>2</sup> |
| Shear capacity of continuous weld                 | $= 6 * 190.525588832577/$ | = | 808.3  | KN/m              |

<> (iii) Design of End Load Bearing Stiffeners

[As per Clause 509.7 of IRC:24 - 2010]

|                                   |        |   |       |    |
|-----------------------------------|--------|---|-------|----|
| Depth of web, d                   | d      | = | 2,183 | mm |
| Spacing of Transverse stiffeners  | c      | = | 850   | mm |
| Thickness of Stiffener            |        | = | 16    | mm |
| Outstand of Web stiffener         |        | = | 230   | mm |
| Permissible outstand of stiffener | $12t$  | = | 192   | mm |
|                                   | $14te$ | = | 195   | mm |

As per cl. no. 509.7.1.2 of IRC: 24-2010, maximum outstand not greater than 20te and 14te to be considered for design for width in between 20te and 14te.

|   |                  |     |       |
|---|------------------|-----|-------|
| Available width for stiffener on each side of web = | $(500-20)/2$     | 240 | mm    |
| Considering effective width of outstand =           | Min of (144,240) | 192 | < 195 |

Hence, stiffener shall be designed using 195 mm Outstand

|   |                |          |                 |
|---|----------------|----------|-----------------|
| Therefore core area of stiffener on each side                       | =              | 195 mm   | x 16mm          |
| Moment of Inertia of Stiffer @ CG of web                            | =              | 9.18E+07 | mm <sup>4</sup> |
| Effective Length of Transverse stiffener                            | $0.7 \times L$ | =        | 1528 mm         |
| Considering 20 times web thickness of web on both side of stiffener | =              | 400      | mm              |
| Core area   | =              | 22559    | mm <sup>2</sup> |
| Moment of Inertia of core area                                      | =              | 9.24E+07 | mm <sup>4</sup> |
| Radius of Guration  | =              | 246      | mm              |
|   | $KL/r$         | =        | 6.2             |

For any solid section, As per Table 4 of IRC 24-2010, page 49 Section lies in buckling Class C

| KL/r | Yiel Stress $f_y$ , (MPa) | $f_y = 390$ | For    |
|------|---------------------------|-------------|--------|
|      | 380                       | 400         | 390.00 |
| 10   | 345                       | 364         | 345    |
| 20   | 332                       | 348         | 332    |

|                           |          |   |     |     |
|---------------------------|----------|---|-----|-----|
| Design compressive stress | $f_{cd}$ | = | 350 | MPa |
|---------------------------|----------|---|-----|-----|

|  |                                 |   |      |    |
|--|---------------------------------|---|------|----|
| Buckling Resistance of Member ( $F_{qd}$ ) | $= 349.921 \times 22559 / 1000$ | = | 7894 | KN |
|--|---------------------------------|---|------|----|

Shear Buckling Force

(IRC:24-2010 Clause 509.7.2.5 and Clause 509.4.2.2)

|          |   |  |        |            |
|----------|---|--|--------|------------|
| $F_q$    | = | $(V - V_{cr}) / g_{mo}$                        | $\leq$ | $F_{qd}$   |
|          |   | Factored Shear Force from End Cross Girder     | V      | = 1,379 kN |
|          |   | Factored Shear Force adjacent to the stiffener | V      | = 3,268 kN |
| $V_{cr}$ | = | Shear force corresponding to web buckling      |        |            |
|          | = | 3187 kN  |        |            |
| $F_q$    | = | 371  | <      | OK         |

Load bearing stiffeners must satisfy the following interaction expression,

(IRC:24 :2010, Clause 509.7.2.5 Page 105)

$$\left[ \frac{F_q - F_x}{F_{qd}} + \frac{F_x}{F_{xd}} + \frac{M_q}{M_{yq}} \right] < 1$$

|          |   |  |
|----------|---|--|
| $F_q$    | = | Stiffener Force  |
|          | = | 371  |
| $F_{qd}$ | = | Design resistance of an intermediate web stiffener corresponding to buckling @ an axis parallel to the web |
|          | = | 7,894  |
| $F_x$    | = | External load or reaction at the stiffener   |

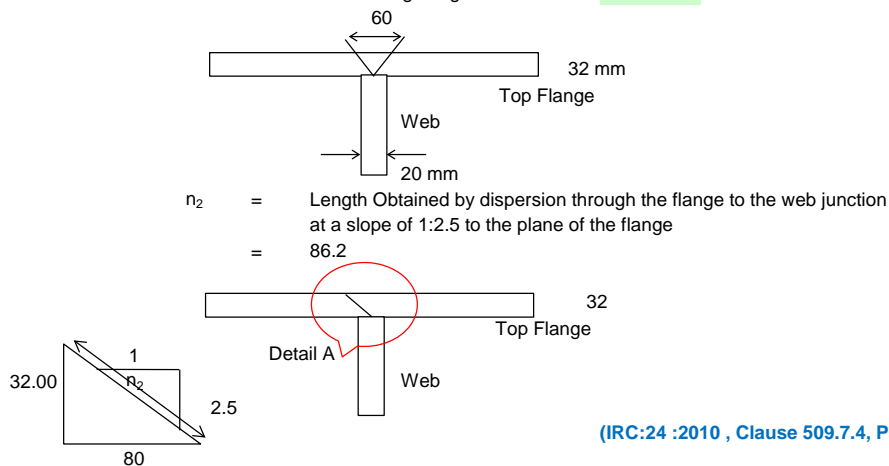
$$\begin{aligned}
 &= 3,268 \\
 \text{If } F_q < F_x \text{ then } &F_q - F_x = 0.00 \\
 M_q &= 1.2 Z_e f_y / \gamma_{mo} \\
 &= 1.2 \times 2,183 / 2 \times 330 / 1.10 / 1000 \\
 &= 392.9 \text{ kNm} \\
 M_q &= \text{Moment on the stiffener due to eccentrically applied load and transverse load} \\
 &= 0 \text{ No External Moment acting on stiffener as stiffener is connected to flange} \\
 M_{yq} &= \text{Yield Moment Capacity of the stiffener based on its elastic modulus about its centroidal axis parallel to the web} \\
 &= 392.94 \\
 &= 0.41 < 1 \quad \text{OK}
 \end{aligned}$$

#### Check stiffener for load bearing

Bearing stiffeners should be provided for webs where force applied through a flange by loads or reaction exceed the local capacity of the web and its connection to the flange

#### Local Capacity of Web

$$\begin{aligned}
 F_w &= (b_1 + n_2) t_w f_{yw} / \gamma_{mo} \\
 b_1 &= \text{Stiff Bearing Length} = 60 \text{ mm}
 \end{aligned}$$



(IRC:24 :2010 , Clause 509.7.4, Page 106)

$$\begin{aligned}
 t_w &= \text{Thickness of the web} \\
 f_{yw} &= \text{Yield stress of the web}
 \end{aligned}$$

Force transferred through Flanges

Local Capacity of web

$$\begin{aligned}
 F_w &= 3,268 \text{ kN} \\
 &= 877 \text{ kN}
 \end{aligned}$$

**Bearing stiffener Required**

Bearing stiffener is designed for =

$$\begin{aligned}
 V - F_w &= 3,268 - 877 \\
 &= 2391 \text{ kN}
 \end{aligned}$$

Bearing Capacity of stiffener alone,  $F_{psd}$  =

$$\begin{aligned}
 &= 7360.00 \times 330 / (1000 \times 0.8 \times 1.1) \\
 &= 5520 > 2391
 \end{aligned}$$

**OK**

Bearing capacity of stiffener is greater than load coming on stiffener

,hence the stiffener is safe as a load bearing stiffener

Hence provide stiffener of size,

$$230 \times 16 \text{ as end bearing stiffener}$$

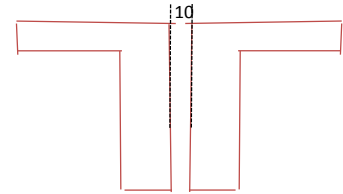
#### Check for Torsional Restraint:

As per cl. No. 509.7 of IRC:24 - 2010, torsional stiffness of bearing stiffener.

$$\begin{aligned}
 I_s &\geq 0.34 a_s D^3 T_{ef} \\
 a_s &= 0.006 \text{ for } L/r_y \leq 50 \\
 &= 0.3 / (L/r_y) \text{ for } 50 < L/r_y \leq 100 \\
 &= 30 / (L/r_y)^2 \text{ for } L/r_y \geq 101 \\
 a_s &= 0.006 \\
 D &= \text{Overall depth of beam at support} \\
 &= 2183 \text{ mm} \\
 T_{ef} &= \text{maximum thickness of compression flange in span under consideration} \\
 &= 32 \text{ mm} \\
 KL &= \text{Laterally unsupported effective length of the compression flange in the beam} \\
 r_y &= \text{radius of gyration of the beam about minor axis} \\
 0.34 a_s D^3 T_{ef} &= 6.79 \text{E}+08 \\
 I_s &= 9.06 \text{E}+08 \\
 \text{Hence, } 9.06 \text{E}+08 &> 6.79 \text{E}+08 \quad \text{OK}
 \end{aligned}$$

## Design of Bracing Members

|                 |                    |   |        |            |                    |
|-----------------|--------------------|---|--------|------------|--------------------|
|                 | $F_y$              | = | 330    | $N/mm^2$   |                    |
|                 | $F_u$              | = | 490    | $N/mm^2$   |                    |
|                 | $E$                | = | 200000 | $N/mm^2$   |                    |
|                 | $\mu$              | = | 0.3    |            |                    |
|                 |                    |   |        |            | Bolts used         |
|                 |                    |   |        |            | No. 4              |
|                 |                    |   |        |            | Dia 20             |
|                 |                    |   |        |            | Area 1256.637      |
| W/m             | (kg/m)             | = | 29.8   | 0.298      | (kN/m)             |
| A               | (cm <sup>2</sup> ) | = | 38.06  | 3806       | (mm <sup>2</sup> ) |
| h               | (mm)               | = | 100    | 100        | (mm)               |
| b               | (mm)               | = | 100    | 100        | (mm)               |
| $t_f$           | (mm)               | = | 10     | 10         | (mm)               |
| $t_w$           | (mm)               | = | 10     | 10         | (mm)               |
| $I_{xx}$        | (cm <sup>4</sup> ) | = | 354    | 0.00000354 | (m <sup>4</sup> )  |
| C <sub>xx</sub> | (cm)               | = | 2.84   | 28.4       | (mm)               |
| $r_{xx}$        | (cm)               | = | 3.05   | 30.5       | (mm)               |
| $r_{yy}$        | (cm)               | = | 4.38   | 43.8       | (mm)               |
| $Z_{xx}$        | (cm <sup>3</sup> ) | = | 49.4   | 0.0000494  | (m <sup>3</sup> )  |



ISA 100 X 100 X 10

### Design as a Tension member

|   |  |   |   |                 |
|---|--|---|---|-----------------|
| 1 | $T_{Dg}$ (Design Strength governed by yielding of gross section)   |   |   |                 |
|   | $T_{Dg}$   | = | $A_g f_y / \gamma_{m0}$   |                 |
|   |  | = | 1141800   | N               |
|   |  | = | 1141.8  | KN              |
| 2 | $T_{dn}$ (Design Strength governed by rupture of critical section) |   |   |                 |
|   | $T_{dn}$   | = | $0.9 A_{nv} f_u / \gamma_{m1} + \beta A_{go} f_y / \gamma_{m0}$           |                 |
|   |  | = | 899415.2447   | N               |
|   |  | = | 899.4152447   | KN              |
|   | $\beta$  | = | $\left\{ \begin{array}{l} 0.939346939 \\ 1.306666667 \end{array} \right.$ | Min             |
|   |  | = | 0.7   | Max             |
|   | $\beta$  | = | 0.939346939   |                 |
|   | $A_{nc}$   | = | 743.3629386   | mm <sup>2</sup> |
|   | $A_{go}$   | = | 2000  | mm <sup>2</sup> |
|   | $T_{dn}$   | = | 825866.608  | N               |
|   |  | = | 825.866608  | KN              |
| 3 | $T_{dh}$ (Design Strength governed by Block Shear)                 |   |   |                 |
|   | $T_{dh}$   | = | $(A_{vg} f_y / (3^{1/2} \gamma_{m0}) + 0.9 A_{tn} f_u / \gamma_{m1})$     |                 |
|   | $A_{vg}$   | = | 3680  | mm <sup>2</sup> |
|   | $A_{tn}$   | = | 2080  | mm <sup>2</sup> |
|   | $T_{dh}$   | = | 1371218.697   | N               |
|   |  | = | 1371.218697   | KN              |
|   | Design Tensile Strength  | = | 826   | KN              |
|   | Tensile Force  | = | 600   | KN              |
|   |  |   |   | Safe            |

### Design as a compression Member

|  |                              |   |   |  |
|--|------------------------------|---|---|--|
|  | $P_d$                        | = | $A_e f_{cd}$  |  |
|  | $f_{cd}$                     | = | $\frac{f_y / \gamma_{m0}}{\phi + [\phi^2 - \lambda^2]}$ | = $X f_y / \gamma_{m0} \leq f_y / \gamma_{m0}$ |
|  | Imperfection Factor $\alpha$ | = | 0.49  | From Table 3 & 4                               |
|  | KL/r                         | = | 60.84474886   |  |
|  | $\lambda$                    | = | 0.786710963   |  |
|  | $\phi$                       | = | $0.5 \sqrt{1 + \alpha (\lambda - 0.2) + \lambda^2}$     |  |
|  | $\phi$                       | = | 0.953201256   |  |
|  | $f_{cd}$                     | = | 241.3749198   |  |
|  | b/ $t_f$                     | = | 10  |  |
|  | $\epsilon$                   | = | 0.87038828  |  |
|  | Section is Semi Compact      |   |   |  |

|       |   |      |                 |      |
|-------|---|------|-----------------|------|
| $A_e$ | = | 3806 | mm <sup>2</sup> |      |
| $P_d$ | = | 919  | KN              |      |
| $P$   | = | 600  | KN              | Safe |

#### Check for Shear

|                                      |   |                              |                 |
|--------------------------------------|---|------------------------------|-----------------|
| $V_n$                                | = | $V_p$                        |                 |
| $V_p$                                | = | $\frac{A_v f_{yw}}{3^{1/2}}$ |                 |
|                                      | = | 381.0511777                  | KN              |
| $A_v$                                | = | 2000                         | mm <sup>2</sup> |
| $c$                                  | = | 1                            | mm              |
| $d$                                  | = | 100                          | mm              |
| $c/d$                                | = | 0.01                         |                 |
| $K_v$                                | = | 5.35                         |                 |
| $t_{cr,e}$                           | = | 9670.766217                  |                 |
| $\lambda_w$                          | = | 0.140360923                  |                 |
| $t_b$                                | = | 190.5255888                  |                 |
| $V_{cr}$                             | = | 381.0511777                  | KN              |
| (min of $V_p$ and $V_{cr}$ ) = $V_n$ | = | 381.0511777                  | KN              |
| $V$                                  | = | 0                            | KN              |
| $V/V_d$                              | = | 0                            |                 |

#### Check for Bending

|                                       |   |                            |                 |
|---------------------------------------|---|----------------------------|-----------------|
| $M_d$                                 | = | $\beta_b Z_p f_y / Y_{m0}$ |                 |
| $\beta_b$                             | = | 0.318794885                |                 |
| $Z_p$                                 | = | 154958.5714                | mm <sup>3</sup> |
| $Z_e$                                 | = | 49400                      | mm <sup>3</sup> |
| $Z_e/Z_p$                             | = | 0.318794885                |                 |
| $M_d$                                 | = | 14.82                      | KNm             |
| <u>For Combined Shear and Bending</u> |   |                            |                 |
| $Z_e/Z_p$                             | = | 0.274444444                |                 |
| $\beta_b$                             | = | 0.274444444                |                 |
| $M_{fd}$                              | = | 14.82                      | KNm             |
| $\beta$                               | = | $(2V/V_d - 1)^2$           |                 |
| $\beta$                               | = | 1                          |                 |
| $M_{dv}$                              | = | 14.82                      | KNm             |
| $M_{dv}$                              | = | 14.82                      | KNm             |
| For Semi Compact Sections             |   |                            |                 |
| $M_{dv}$                              | = | 14.82                      | KNm             |
| Final bending Strength                |   |                            |                 |
| $M_d$                                 | = | 14.82                      | KNm             |
| $M$                                   | = | 0                          | KNm             |

#### Design for combined axial force and bending moment

|                                  |   |                      |   |                      |    |             |
|----------------------------------|---|----------------------|---|----------------------|----|-------------|
| $\frac{N}{N_d}$                  | + | $\frac{M_y}{M_{dy}}$ | + | $\frac{M_z}{M_{dz}}$ | <= | 1.0         |
| For Tension :<br>0.726509577     | + | 0                    | + | 0                    | <= | 1.0<br>Okay |
| For Compression :<br>0.653116001 | + | 0                    | + | 0                    | <= | 1.0<br>Okay |

#### Check for Holes in Tension Zone

|   |   |             |                 |
|---|---|-------------|-----------------|
| $(A_{nf}/A_{gf}) \geq (f_y/f_u)(Y_{m1}/Y_{m0})/0.9$ |   |             |                 |
| $A_{nf}$  | = | 1000        | mm <sup>2</sup> |
| $A_{gf}$  | = | 1000        | mm <sup>2</sup> |
| $A_{nf}/A_{gf}$                                     | = | 1           |                 |
| $f_y/f_u$   | = | 0.673469388 |                 |
| $Y_{m1}/Y_{m0}$                                     | = | 1.136363636 |                 |
|   |   | Okay        |                 |

## Design of Bolted Connection

### Design of Bolts

|   |   |  |            |                   |
|---|---|--|------------|-------------------|
| Diameter of bolt  | d   | =  | 24         | mm                |
| Grade of bolt   |   | =  | 8.8        |                   |
| Yield stress of bolt                                    | $F_Y$   | =  | 640        | N/mm <sup>2</sup> |
| ultimate tensile stress                                 | $F_{ub}$  | =  | 800        | N/mm <sup>2</sup> |
| Grade of steel  | $F_u$   | =  | 490        | N/mm <sup>2</sup> |
| Elongation percentage                                   |   | =  | 9          | min               |
| Cross sectional area of bolt                            | $A_{sb}$  | =  | 452.389342 | mm <sup>2</sup>   |
| Net tensile stress area of bolt                         | $A_{nb} = 0.78 * A_{sb}$                          | =  | 352.863687 | mm <sup>2</sup>   |
| Partial safety factor for the material of bolt          | $\gamma_{mb}$                                     | =  | 1.25       |                   |
| Pitch   | p   | =  | 60         |                   |
| End distance  | e   | =  | 40.8       |                   |
| Diameter of hole  | $d_0$   | =  | 25.5       | mm                |
| $k_b$ should be least of                                |   | =  | 0.533      |                   |
| $e/3d_0$  |   | =  | 0.533      |                   |
| $p/3d_0$  |   | =  | 0.784      |                   |
| $F_{ub}/F_u$  |   | =  | 1.63       |                   |
| thickness to be considered for bearing will be least of | t   | =  | 10         |                   |
| Aggregate thickness of cover plates                     |   | =  | 10         |                   |
| Minimum thickness of the main plates joined             |   | =  | 10         |                   |
| <b>Strength of bolt in single shear</b>                 |   |  |            |                   |
| $V_{sb}$  | $= (A_{nb} * F_{ub}) / ((3)^{0.5} \gamma_{mb})$   | =  | 130.384605 | Kn                |
| <b>Strength of bolt in bearing</b>                      |   |  |            |                   |
| $V_{pb}$  | $= (2.5 * k_b * d * t * F_u) / (\gamma_{mb})$     | Note :- $F_u$ will be lesser of $F_u$ & $F_{ub}$ | =          | 125.44 Kn         |
| $F_u$ for strength of bolt in bearing                   |   |  | =          | 490               |
| <b>Strength of bolt in double shear</b>                 |   |  |            |                   |
| $V_{sb}$  | $= 2 * A_{nb} * F_{ub} / (3^{0.5} * \gamma_{mb})$ |  | =          | 407.451889 Kn     |
| <b>Strength of bolt</b>                                 | (Axial Connection)                                |  | =          | 125.44 Kn         |
| Force in inclined member                                |   |  | =          | 385 Kn            |
| <b>No. of bolts</b>                                     |   |  | =          | 3.069             |
| <b>No. of bolts provided</b>                            |   |  | =          | 4.000             |

## Design of Bolted Connection

### Design of Bolts

|   |                          |   |            |                   |
|---|--------------------------|---|------------|-------------------|
| Diameter of bolt  | d                        | = | 24         | mm                |
| Grade of bolt   |                          | = | 8.8        |                   |
| Yield stress of bolt                                    | $F_Y$                    | = | 640        | N/mm <sup>2</sup> |
| ultimate tensile stress                                 | $F_{ub}$                 | = | 800        | N/mm <sup>2</sup> |
| Grade of steel  | $F_u$                    | = | 490        | N/mm <sup>2</sup> |
| Elongation percentage                                   |                          | = | 9          | min               |
| Cross sectional area of bolt                            | $A_{sb}$                 | = | 452.389342 | mm <sup>2</sup>   |
| Net tensile stress area of bolt                         | $A_{nb} = 0.78 * A_{sb}$ | = | 352.863687 | mm <sup>2</sup>   |
| Partial safety factor for the material of bolt          | $\gamma_{mb}$            | = | 1.25       |                   |
| Pitch   | p                        | = | 60         |                   |
| End distance  | e                        | = | 40.8       |                   |
| Diameter of hole  | $d_0$                    | = | 25.5       | mm                |
| $k_b$ should be least of                                |                          | = | 0.533      |                   |
| $e/3d_0$  |                          | = | 0.533      |                   |
| $p/3d_0$  |                          | = | 0.784      |                   |
| $F_{ub}/F_u$  |                          | = | 1.63       |                   |
| thickness to be considered for bearing will be least of | t                        | = | 10         |                   |
| Aggregate thickness of cover plates                     |                          | = | 10         |                   |
| Minimum thickness of the main plates joined             |                          | = | 10         |                   |

### Strength of bolt in single shear

$$V_{sb} = \frac{(A_{nb} * F_{ub}) / ((3)^{0.5} \gamma_{mb})}{1} = 130.384605 \text{ Kn}$$

### Strength of bolt in bearing

$$V_{pb} = \frac{(2.5 * k_b * d * t * F_u) / (\gamma_{mb})}{1} \quad \text{Note :- } F_u \text{ will be lesser of } F_u \text{ \& } F_{ub} = 125.44 \text{ Kn}$$

$$F_u \text{ for strength of bolt in bearing} = 490$$

### Strength of bolt in double shear

$$V_{sb} = \frac{2 * A_{nb} * F_{ub} / (3^{0.5} * \gamma_{mb})}{1} = 407.451889 \text{ Kn}$$

$$\text{Strength of bolt (Axial Connection)} = 125.44 \text{ Kn}$$

$$\text{Force in inclined member} = 570 \text{ Kn}$$

$$\text{No. of bolts} = 4.544$$

$$\text{No. of bolts provided} = 5.000$$

$$\text{Strength of bolt (Axial Connection)} = 125.44 \text{ Kn}$$

$$\text{Force in Horizontal member} = 580 \text{ Kn}$$

$$\text{No. of bolts} = 4.624$$

$$\text{No. of bolts provided} = 5.000$$

## Design of Weld Connection for Gusset Plate

### For Web

### Weld Strength

$$f_u = 490 \text{ N/mm}^2$$

$$S = 10 \text{ mm}$$

$$K = 0.7$$

$$L_w = 700 \text{ mm}$$

$$\text{Type of Weld} = \text{Site Weld}$$

$$Y_{mw} = 1.5$$

$$P_{dw} = 924145.3 \text{ N}$$

$$= 924.1453 \text{ KN}$$

$$P = 580 \text{ KN}$$

Safe



## Camber Check

### Deflection

- a) For calculating deflection the modular ratio of short term and long term shall be 7.5 and 15 respectively.
- b) In any case under the worst combination of dead load, super-impose dead load, live load and impact effect, the total deflection of the girder shall not exceed 1/600 of span i.e., = 84 mm
- c) If camber is provided for dead load and super-impose dead load, then the permissible deflection of live load with impact shall not exceed 1/800 of span i.e., = 63 mm

| Type of girder      | Outer Girder                                   |   |                            |                                  |                |
|---------------------|--|---|----------------------------|----------------------------------|----------------|
| Load Case 1         | Dead Load and SIDL                             |   |                            |                                  |                |
| Distance            | Deflection of DL<br>calculated as per<br>staad | Deflection of SIDL &<br>WC calculated as per<br>staad | Deflection of DL<br>+ SIDL | Permissible<br>Deflection(in mm) | Remark         |
| 0.00                | 16.647   | 4.362   | 21.009                     | 84                               | OK             |
| 1st & 4th<br>Splice | 58.328   | 15.222  | 73.550                     | 84                               | OK             |
| 2nd & 3rd<br>Splice | 112.402  | 29.099  | 141.501                    | 84                               | Provide Camber |
| Mid                 | 118.259  | 30.585  | 148.844                    | 84                               | Provide Camber |
| Type of girder      | Outer Girder                                   |   |                            |                                  |                |
| Load Case 2         | Live load with Impact                          |   |                            |                                  |                |
| Distance            |  |   | Deflection of LL           | Permissible                      | Remark         |
| 0                   |  |   | 4.440                      | 63                               | OK             |
| 1st & 4th<br>Splice |  |   | 20.949                     | 63                               | OK             |
| 2nd & 3rd<br>Splice |  |   | 48.328                     | 63                               | OK             |
| Mid                 |  |   | 51.769                     | 63                               | OK             |
| Type of girder      | Outer Girder                                   |   |                            |                                  |                |
| Load Case 3         | DL + SIDL + Live load with Impact              |   |                            |                                  |                |
| Distance            | DL + SIDL                                      | Deflection of<br>governing LL                         | DL + SIDL + LL             | Permissible<br>Deflection(in mm) | Remark         |
| 0                   | 21.009   | 4.440   | 25.449                     | 84                               | OK             |
| 1st & 4th<br>Splice | 73.550   | 20.949  | 94.499                     | 84                               | Provide Camber |
| 2nd & 3rd<br>Splice | 141.501  | 48.328  | 189.829                    | 84                               | Provide Camber |
| Mid                 | 148.844  | 51.769  | 200.613                    | 84                               | Provide Camber |
| Type of girder      | Inner Girder                                   |   |                            |                                  |                |
| Load Case 1         | Dead Load and SIDL                             |   |                            |                                  |                |
| Distance            | Deflection of DL                               | Deflection of SIDL                                    | Deflection of DL +         | Permissible                      | Remark         |
| 0                   | 16.647   | 3.130   | 19.777                     | 84                               | OK             |
| 1st & 4th<br>Splice | 58.328   | 11.026  | 69.354                     | 84                               | OK             |
| 2nd & 3rd<br>Splice | 112.402  | 21.483  | 133.885                    | 84                               | Provide Camber |
| Mid                 | 118.259  | 22.633  | 140.892                    | 84                               | Provide Camber |

|                  |                                   |               |                  |             |                |
|------------------|-----------------------------------|---------------|------------------|-------------|----------------|
| Type of girder   | Inner Girder                      |               |                  |             |                |
| Load Case 2      | Live load with Impact             |               |                  |             |                |
| Distance         |                                   |               | Deflection of LL | Permissible | Remark         |
| 0                |                                   |               | 3.232            | 63          | OK             |
| 1st & 4th Splice |                                   |               | 11.363           | 63          | OK             |
| 2nd & 3rd Splice |                                   |               | 22.690           | 63          | OK             |
| Mid              |                                   |               | 24.075           | 63          | OK             |
| Type of girder   | Inner Girder                      |               |                  |             |                |
| Load Case 3      | DL + SIDL + Live load with Impact |               |                  |             |                |
| Distance         | DL + SIDL                         | Deflection of | DL + SIDL + LL   | Permissible | Remark         |
| 0                | 19.777                            | 3.232         | 23.009           | 84          | OK             |
| 1st & 4th Splice | 69.354                            | 11.363        | 80.717           | 84          | OK             |
| 2nd & 3rd Splice | 133.885                           | 22.690        | 156.575          | 84          | Provide Camber |
| Mid              | 140.892                           | 24.075        | 164.967          | 84          | Provide Camber |

# A1

## *Design of Abutment of Major Bridge*

| Sr.No. | Chainage |
|--------|----------|
| 1      | 2+645    |

## BASIC DESIGN DATA

### 1 Basic Design Data

#### 1.1 Span and Cross section Data

|                                      |   |          |
|--------------------------------------|---|----------|
| C/C of bearing                       | = | 50.300 m |
| C/C of expansion gap                 | = | 51.450 m |
| Distance of bearing to expansion gap | = | 0.600 m  |
| Exp. Gap                             | = | 50 mm    |
| Carriageway width                    | = | 7.50 m   |
| Total width                          | = | 12.00 m  |
| Footpath Width (Left side)           | = | 1.50 m   |
| Footpath Width (Right side)          | = | 1.50 m   |
| Crash Barrier Width (Left side)      | = | 0.50 m   |
| Crash Barrier Width (Right side)     | = | 0.50 m   |
| Handrail Width (Left side)           | = | 0.00 m   |
| Handrail Width (Right side)          | = | 0.00 m   |
| Skew Angle                           | = | 0.0 °    |

#### 1.2 Superstructure Details

|  |                            |          |
|--|----------------------------|----------|
| Depth of superstructure                      | =                          | 2.403 m  |
| Depth of Girder                              | =                          | 2.183 m  |
| Thickness of Deck Slab                       | =                          | 0.220 m  |
| Thickness of wearing coat                    | =                          | 0.065 m  |
| No. of Girders                               | =                          | 4        |
| No. of Corss Girders                         | =                          | 0        |
| Distance of FRL from bearing of least height | =                          | 2.47 m   |
| Spacing between girders                      | =                          | 3.0 m    |
| Cross-slope                                  | =                          | 2.50%    |
| Thickness of bearing (assumed)               | =                          | 0.150 m  |
| Type of Bearing                              | assumed for design purpose | Pot ptfe |
| Thickness of pedestal (minimum)              | =                          | 0.350 m  |
| Thickness of nearest bearing+pedestal        | =                          | 0.500 m  |

#### 1.3 Material Data

|  |                        |   |                       |
|--|------------------------|---|-----------------------|
| Grade of concrete                            | $f_{ck}$               | = | M45                   |
| Grade of steel                               | $f_{yk}$               | = | Fe500                 |
| Density of Steel                             |                        | = | 7.85 t/m <sup>3</sup> |
| Density of wearing course                    |                        | = | 2.2 t/m <sup>3</sup>  |
| Coefficient of Thermal Expansion of concrete | (Cl.215.4, IRC 6 2014) | = | 1.20E-05 /°C          |
| Shrinkage strain                             | (Cl.217.3, IRC 6 2014) | = | 2.0E-04               |
| Modulus of Elasticity of steel               | $E_s$                  | = | 2.0E+05 MPa           |
| Modulus of Elasticity of concrete            | $E_c$                  | = | 3.2E+04 MPa           |
| Mean axial tensile strength of concrete      | $f_{ctm}$              | = | 2.8 MPa               |
| Relative humidity                            |                        | = | 70                    |
| Exposure condition                           |                        | = | Moderate              |

#### 1.4 Typical Levels

|                                       |                         |   |          |
|---------------------------------------|-------------------------|---|----------|
| Formation Level "FRL"                 | For design purpose only | = | 303.50 m |
| Dirt wall level                       |                         | = | 303.50 m |
| Max. Abutment cap level "CTL"         |                         | = | 300.88 m |
| Front Ground level "GL" / Scour Level |                         | = | 280.00 m |
| Lower water Level                     |                         | = | 280.50 m |
| Highest flood level "HFL"             |                         | = | 280.00 m |
| Foundation Level                      |                         | = | 279.81 m |

#### 1.5 Soil Parameters

|   |                      |   |                      |
|---|----------------------|---|----------------------|
| Angle of internal friction,                 | $\phi$               | = | 30 °                 |
| Angle of friction between soil and concrete | $\delta$             | = | 20 °                 |
| 1/2 d <sub>dry</sub>                        | $\delta_{submerged}$ | = | 10 °                 |
| Surcharge angle                             | $\iota$              | = | 0 °                  |
| Dry density of earth                        | $\gamma_{dry}$       | = | 2.0 t/m <sup>3</sup> |
| Saturated density of earth                  | $\gamma_{sat}$       | = | 2.0 t/m <sup>3</sup> |
| water density                               | $\gamma_{water}$     | = | 1.0 t/m <sup>3</sup> |
| Submerged density of earth                  | $\gamma_{sub}$       | = | 1.0 t/m <sup>3</sup> |
| coeff. Of friction b/w footing base & earth | $\mu$                | = | 0.80                 |

|   |   |      |
|---|---|------|
| Live load surcharge   | = | 1.20 |
| Type of soil  | = | Rock |
| Coefficient of friction between<br>(Soil/Rock and concrete) | = | 0.80 |

### 1.6 Abutment Dimensions

|  |   |        |
|--|---|--------|
| Length of abutment cap in L-L direction at top | = | 1.43 m |
| Length of footing                              | = | 8.20 m |
| Length of heel                                 | = | 3.40 m |
| Thickness of base slab                         | = | 0.90 m |
| Heel thickness at root                         | = | 2.00 m |
| Toe thickness at root                          | = | 2.00 m |
| Length of heel                                 | = | 3.20 m |
| Stem top thickness                             | = | 1.20 m |
| Stem bottom thickness                          | = | 1.60 m |
| Dirtwall thickness                             | = | 0.35 m |
| Depth of abutment cap (Constant portion)       | = | 0.75 m |
| Depth of abutment cap (Varying portion)        | = | 0.75 m |
| Thickness of return wall (Avg.)                | = | 0.65 m |
| No. of return wall                             | = | 2      |
| Provision of weep holes in abutment wall       | = | Yes    |

### 1.7 Partial Safety Factors

(As per Annex B of IRC:6-2017)

**Also refer latest amendment, notification no 78, dated october 2014**

Partial safety factor for relevant loads are presented here

**For Loads**

**Ultimate Limit State (For Verification of Equilibrium)**

(Table 3.1, Annex B, IRC:6-2017)

| Load  | Basic Comb             |           | Seismic Comb           |           |
|---|------------------------|-----------|------------------------|-----------|
|   | Overturning or Sliding | Resisting | Overturning or Sliding | Resisting |
| Dead Load                                     | 1                      | 1         | 1.00                   | 1.00      |
| SIDL (except surfacing)                       | 1                      | 1         | 1.00                   | 1.00      |
| SIDL (surfacing)                              | 1                      | 1         | 1.00                   | 1.0       |
| Live load and associated loads (Leading)      | 1                      | 0         | -                      | -         |
| Live load and associated loads (Accompanying) | 1                      | 0         | 0.2                    | 0         |
| Water Current                                 | 1.0                    | 0         | 1.0                    | -         |
| Buoyancy                                      | 1.0                    | -         | 1.0                    | -         |
| Earth Pressure                                | 1                      | -         | 1.0                    | -         |
| Live Load Surcharge                           | 1                      | 0         | -                      | -         |
| Thermal Load (Leading)                        | 1                      | 0         | -                      | -         |
| Thermal Load (Accompanying)                   | 1                      | 0         | 0.5                    | -         |
| Seismic Effect (During service)               | -                      | -         | 1.0                    | -         |
| Seismic Effect (During construction)          | -                      | -         | 0.5                    | -         |

**Ultimate Limit State (For Verification of Structural Strength)**

| Load  | Basic Comb | Seismic Comb |
|---|------------|--------------|
| Dead Load                                     | 1.35       | 1.35         |
| SIDL (except surfacing)                       | 1.35       | 1.35         |
| SIDL (surfacing)                              | 1.75       | 1.75         |
| Live load and associated loads (Leading)      | 1.5        | 0            |
| Live load and associated loads (Accompanying) | 1.15       | 0.2          |
| Water Current                                 | 1          | 1            |
| Buoyancy                                      | 0.15       | 1            |
| Earth Pressure                                | 1.5        | 1.5          |
| Live Load Surcharge                           | 1.2        | 0.2          |
| Seismic Effect (During service)               | -          | 1.5          |
| Seismic Effect (During construction)          | -          | 0.75         |

(Table 3.2, Annex B, IRC:6-2017)

**Serviceability Limit State**

| Load  | Rare Comb | Quasi-permanent Comb |
|---|-----------|----------------------|
| Dead Load                                     | 1         | 1                    |
| SIDL (except surfacing)                       | 1         | 1                    |
| SIDL (surfacing)                              | 1.2       | 1.2                  |
| Live load and associated loads (Leading)      | 1         | 0                    |
| Live load and associated loads (Accompanying) | 0.75      | 0                    |
| Earth Pressure                                | 1.0       | 1.0                  |
| Live Load Surcharge                           | 0.8       | 0                    |
| Water Current                                 | 1         | -                    |
| Buoyancy                                      | 0.15      | 0.15                 |
| Thermal Load (Leading)                        | 1.0       | -                    |
| Thermal Load (Accompanying)                   | 0.6       | 0.5                  |

(Table 3.4, Annex B, IRC:6-2017)

**Combination for Base Pressure and Design of Foundation**

| Load  | Comb 1 | Comb 2 | Seismic Comb |
|---|--------|--------|--------------|
| Dead Load                                     | 1.35   | 1      | 1.35         |
| SIDL (except surfacing)                       | 1.35   | 1      | 1.35         |
| SIDL (surfacing)                              | 1.75   | 1      | 1.75         |
| Live load and associated loads (Leading)      | 1.5    | 1.3    | 0            |
| Live load and associated loads (Accompanying) | 1.15   | 1      | 0.2          |
| Water Current                                 | 1      | 1      | 1            |
| Buoyancy (Base Pressure)                      | 1      | 1      | 1            |
| Buoyancy (Structural Design)                  | 0.15   | 0.15   | 0.15         |
| Earth Pressure                                | 1.5    | 1.3    | 0            |
| Live Load Surcharge                           | 1.2    | 1      | 0.2          |
| Thermal load                                  | 0.9    | 0.8    | 0.5          |
| Seismic Effect (During service)               | -      | -      | 1.5          |
| Seismic Effect (During construction)          | -      | -      | 0.75         |

**For Materials**

| Material          | Basic Comb | Seismic Comb |
|-------------------|------------|--------------|
| Concrete          | 1.5        | 1.5          |
| Reinforcing steel | 1.15       | 1.15         |

**1.80 Clear Cover**

|               |   |       |
|---------------|---|-------|
| Dirt Wall     | = | 50 mm |
| Abutment Cap  | = | 50 mm |
| Abutment Stem | = | 50 mm |
| Footing       | = | 75 mm |

**1.9**

|  |   |        |
|--|---|--------|
| Seismic Zone                           | = | V      |
| Type of soil                           | = | medium |
| Zone factor                            | = | 0.36   |
| Importance factor                      | = | 1.2    |
| Response Reduction Factor, $R_{long}$  | = | 3      |
| Response Reduction Factor, $R_{trans}$ | = | 1      |
| Response Reduction Factor, $R_{vert}$  | = | 3      |



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## SALIENT FEATURES OF THE BRIDGE :

|                                       |   |         |
|---------------------------------------|---|---------|
| Span c/c of brg.                      | = | 50.3 m  |
| c/L of brg. c/L of exp. J             | = | 0.6 m   |
| Exp. Gap                              | = | 50 mm   |
| Overall span                          | = | 51.45 m |
| Depth of super-structure              | = | 2.403 m |
| Wearing Coat thickness                | = | 65 mm   |
| Depth of Bearing + Pedestal (minimum) | = | 0.5 mm  |
| Overall Deck width                    | = | 12.00 m |
| Clear carriageway width               | = | 7.50 m  |
| Cross Camber                          | = | 2.50%   |

## MATERIAL USED & THERE PROPERTIES :

### CONCRETE

|   |      |   |            |
|---|------|---|------------|
| Grade of Concrete                           | fck  | = | M 45 Mpa   |
| Mean value of concrete compressive strength | fcm  | = | M 55 Mpa   |
| Design Concrete compressive strength        | fcd  | = | 0.447 *fck |
|   |      | = | 20.100 MPa |
| Secant Modulus of Elasticity                | Ecm  | = | 34313 MPa  |
| Mean axial tensile strength                 | fctm | = | 3.28 Mpa   |

### REINFORCING STEEL

|  |     |   |            |
|--|-----|---|------------|
| Grade of Reinforcement                 | fyk | = | Fe 500 Mpa |
| Design yield strength of reinforcement | fyd | = | 0.870 *fyk |
|  |     | = | 435 Mpa    |
| Modulus of Elasticity                  | Es  | = | 200000 Mpa |

|                  |   |                       |
|------------------|---|-----------------------|
| Steel Density    | = | 7.85 t/m <sup>3</sup> |
| Concrete Density | = | 2.5 t/m <sup>4</sup>  |

## ANALYSES ASSUMPTION

### Enviromental parameters

|                    |   |          |
|--------------------|---|----------|
| Relative humidity  | = | 70 %     |
| Exposure condition | = | Moderate |

|                                    |            |   |                  |
|------------------------------------|------------|---|------------------|
| Modulus of Elasticity for Concrete |            |   |                  |
| For short Term loading             | <b>Ecm</b> | = | <b>34313 Mpa</b> |
| For long Term loading              | Ecm'       | = | Ecm/ (1+φ)       |
| φ = Creep coefficient              |            |   |                  |

|                                  |             |   |                                |
|----------------------------------|-------------|---|--------------------------------|
| Creep coefficient for Foundation | φ           | = | 1                              |
|                                  |             |   | ( As ho = ∞ , For foundations) |
|                                  | <b>Ecm'</b> | = | <b>17156.5 Mpa</b>             |

**Creep for abutment shaft**

|   |       |   |                         |
|---|-------|---|-------------------------|
| Cross-sectional Area  | Ac    | = | 19.20 m <sup>2</sup>    |
| Perimeter in contact with atmosphere u                              |       | = | 12.00 m                 |
| Notational size ho  | 2Ac/u | = | 3200 mm                 |
| Age of concrete at the time of loading to t <sub>∞</sub> considered |       | = | 90 days                 |
|   |       | = | 36500 days              |
| φ (∞,90)  |       | = | 1.10 (Refer Appendix B) |
| *(Increased by 10% on the conservative side)                        |       | ≅ | 1.21                    |
|   | Ecm'  | = | 15549 N/mm <sup>2</sup> |

**SERVICEABILITY LIMIT STATE :**

|  |                    |          |            |
|--|--------------------|----------|------------|
| Max permissible Stress in Concrete     |                    |          |            |
| Rare Combination                       | =                  | 0.48*fck | = 21.6 Mpa |
| Quasi permanent Combination            | =                  | 0.36*fck | = 16.2 Mpa |
| Max permissible Stress in Steel (QLS)  | =                  | 0.8*fyk  | = 400 Mpa  |
| Max permissible Stress in Steel (Rare) | =                  | 0.6*fyk  | = 300 Mpa  |
| Permissible crack width                | w <sub>k,max</sub> | =        | 0.3 mm     |

**Backfill Soil Parameter**

|                        |   |   |   |                    |
|------------------------|---|---|---|--------------------|
| φ                      | = | Angle of internal friction,                 | = | 30 °               |
| δ                      | = | Angle of friction between soil and concrete | = | 20 °               |
| δ <sub>submerged</sub> | = | 1/2 d <sub>dry</sub>                        | = | 10 °               |
| ι                      | = | Surcharge angle                             | = | 0 °                |
| γ <sub>dry</sub>       | = | Dry density of earth                        | = | 2 t/m <sup>3</sup> |
| γ <sub>sat</sub>       | = | Saturated density of earth                  | = | 2 t/m <sup>3</sup> |
| γ <sub>water</sub>     | = | water density                               | = | 1 t/m <sup>3</sup> |
| γ <sub>sub</sub>       | = | Submerged density of earth                  | = | 1 t/m <sup>3</sup> |
| μ                      | = | coeff. Of friction b/w footing base & earth | = | 0.8                |

**Live Load Surcharge :**

|                                 |                   |                      |
|---------------------------------|-------------------|----------------------|
| Equivalent to                   | 1.20 m Earth Fill |                      |
| Live Load surcharge intensity q | =                 | 2.4 t/m <sup>2</sup> |

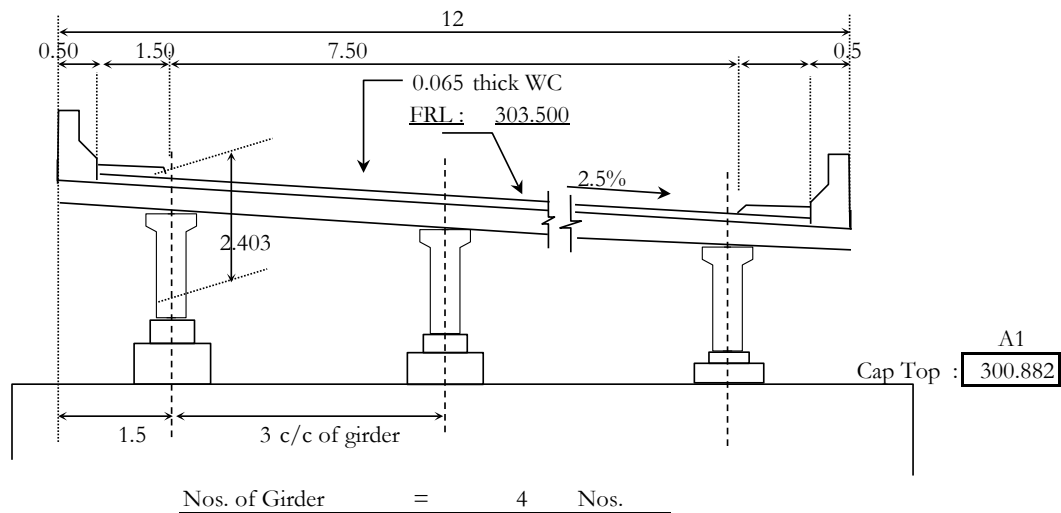
**SEISMIC PARAMETER**

|  |   |   |        |
|--|---|---|--------|
| Seismic Zone                                   |   | = | V      |
| Type of soil                                   |   | = | medium |
| Zone factor                                    | Z | = | 0.36   |
| Importance factor                              | I | = | 1.2    |
| Response Reduction Factor, R <sub>long.</sub>  |   | = | 3      |
| Response Reduction Factor, R <sub>trans.</sub> |   | = | 1      |
| Response Reduction Factor, R <sub>vert.</sub>  |   | = | 3      |

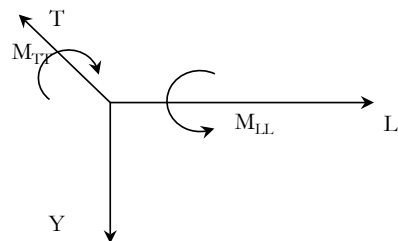
#### LEVEL DETAILS :

|                    |   |           |
|--------------------|---|-----------|
| Formation level    | = | 303.500 m |
| Lowest water level | = | 280.500 m |
| HFL                | = | 280.000   |
| Ground Level / MSL | = | 280.000 m |
| MSL                | = | 280.500 m |
| Founding Level     | = | 279.812 m |

|                  |   |                         |                                      |
|------------------|---|-------------------------|--------------------------------------|
| Bearing capacity | = | 90.00 t/m <sup>2</sup>  | */( Working State, Non-Seismic case) |
|                  | = | 112.50 t/m <sup>2</sup> | */( Working State, Seismic Case)     |



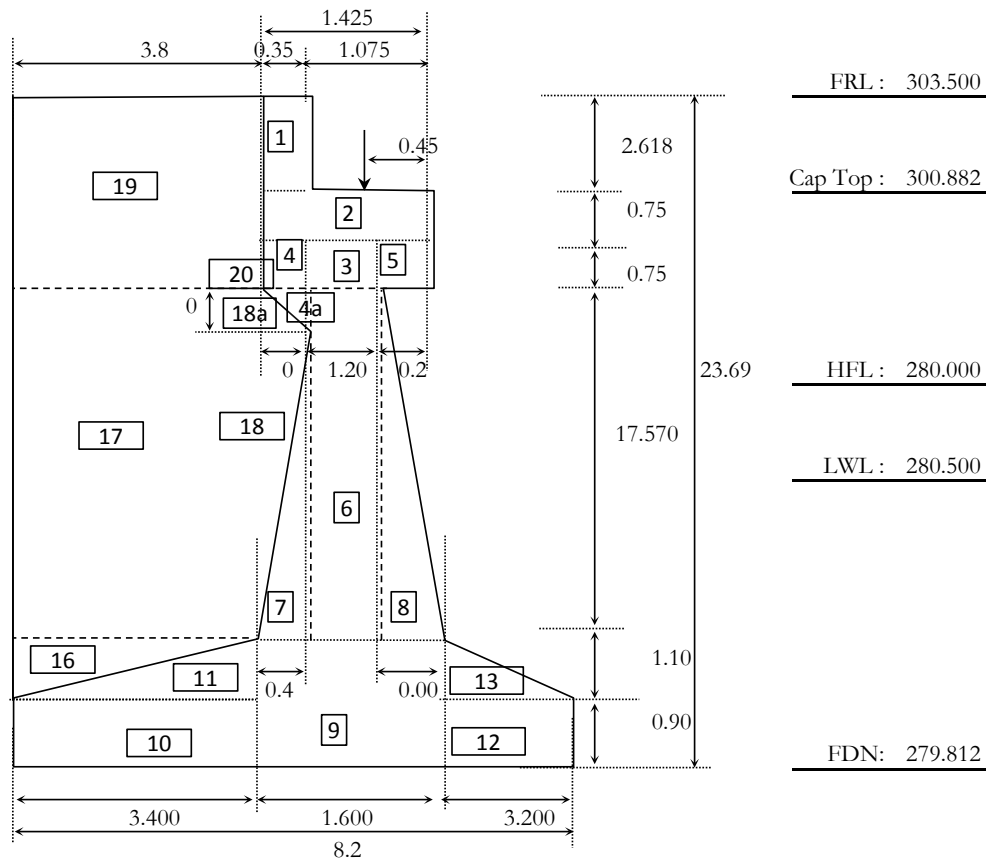
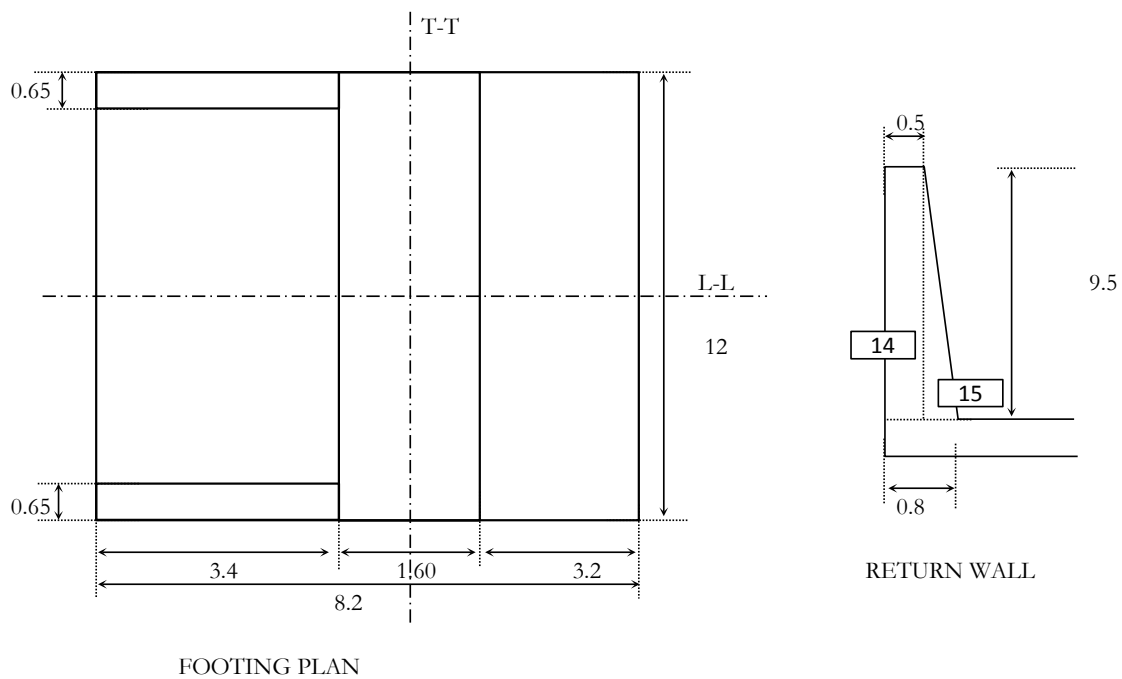
#### Sign Convention :



Showing +ve Force & Moment Direction

Length of Abutment = 12.00 m

Length of Abutment = 12.00 m


$$\alpha = \text{Angle of wall face with horizontal} = 88.70^\circ$$


### FORCES DUE TO SELFWEIGHT OF SUB STRUCTURE & FOUNDATION :

Forces @ Footing Base

$e_L$  = Cg. w.r.t. Toe Edge (along L-L axis)  
 $e_T$  = Cg. Form c/L of base ( along T-T axis)  
 $e_Y$  = Cg. From Footing base

| <b>Calculating Selfweight of Sub-structure :</b>        |             |  |       |    |                |               |              |              |              |
|---|-------------|--|-------|----|----------------|---------------|--------------|--------------|--------------|
| Element   | Area Factor | B  | H     | L  | V              | W             | $e_Y$        | $e_L$        | $e_T$        |
|   |             | m  | m     | m  | m <sup>3</sup> | Tonne         | m            | m            | m            |
| <b>Dirt Wall &amp; Abutment Cap</b>                     |             |  |       |    |                |               |              |              |              |
| 1   | 1           | 0.35   | 2.618 | 12 | 11.00          | 27.49         | 22.38        | -4.225       | 0            |
| 2   | 1           | 1.425  | 0.75  | 12 | 12.825         | 32.06         | 20.69        | -3.69        | 0            |
| 3   | 1           | 1.425  | 0.75  | 12 | 12.825         | 32.0625       | 19.94        | -3.6875      | 0            |
| 4   | 0           | 0  | 0.75  | 12 | 0.00           | 0.00          | 20.07        | -4.4         | 0            |
| 4(a)  | 0           | 0  | 0     | 12 | 0.00           | 0.00          | 19.57        | -4.4         | 0            |
| 5   | 0           | 0.225  | 0.75  | 12 | 0.00           | 0.00          | 20.07        | -3.125       | 0            |
| <b>Total</b>  |             |  |       |    | <b>36.65</b>   | <b>91.62</b>  | <b>20.94</b> | <b>-3.85</b> | <b>0.00</b>  |
| */ Increase Abutment cap weight by                      |             | 0% on account of bearing, bearing pedestal, stopper etc. |       |    |                |               |              |              |              |
| <i>Abutment Cap weight Considered</i>                   |             |  |       |    | <i>36.65</i>   | <i>91.62</i>  | <i>20.94</i> | <i>-3.85</i> | <i>0.00</i>  |
| <b>Abutment Shaft</b>                                   |             |  |       |    |                |               |              |              |              |
| 6   | 1           | 1.2  | 17.57 | 12 | 253.00         | 632.5         | 10.78        | -3.8         | 0            |
| 7   | 0.5         | 0.4  | 17.57 | 12 | 42.17          | 105.4         | 7.86         | -4.53333     | 0            |
| 8   | 0.5         | 0  | 17.57 | 12 | 0.00           | 0.0           | 7.86         | -3.200       | 0            |
| <i>Abutment shaft weight considered.</i>                |             |  |       |    | <i>295.17</i>  | <i>737.92</i> | <i>10.37</i> | <i>-3.90</i> | <i>0.00</i>  |
| <b>Total Sub-structure self weight at base of shaft</b> |             |  |       |    | <b>331.82</b>  | <b>829.54</b> | <b>11.53</b> | <b>-3.90</b> | <b>0.000</b> |

### Calculating Selfweight Foundation:

| Element                              | Area Fact | No.s | B   | H   | L             | V              | W             | $e_Y$        | $e_L$        | $e_T$       |
|--------------------------------------|-----------|------|-----|-----|---------------|----------------|---------------|--------------|--------------|-------------|
|                                      |           |      | m   | m   | m             | m <sup>3</sup> | Tonne         | m            | m            | m           |
| <b>Footing</b>                       |           |      |     |     |               |                |               |              |              |             |
| 9                                    | 1         | 1    | 1.6 | 2   | 12            | 38.40          | 96.00         | 1.00         | -4           | 0           |
| 10                                   | 1         | 1    | 3.4 | 0.9 | 12            | 36.72          | 91.80         | 0.45         | -6.5         | 0           |
| 11                                   | 0.5       | 1    | 3.4 | 1.1 | 12            | 22.44          | 56.10         | 1.27         | -5.93        | 0           |
| 12                                   | 1         | 1    | 3.2 | 0.9 | 12            | 34.56          | 86.40         | 0.45         | -1.6         | 0           |
| 13                                   | 0.5       | 1    | 3.2 | 1.1 | 12            | 21.12          | 52.80         | 1.27         | -2.133       | 0           |
| <i>Total Footing weight</i>          |           |      |     |     |               | <i>153.24</i>  | <i>383.10</i> | <i>0.82</i>  | <i>-4.08</i> | <i>0.00</i> |
| <b>Return wall</b>                   |           |      |     |     |               |                |               |              |              |             |
| 14                                   | 1         | 2    | 0.5 | 9.5 | 3.4           | 32.30          | 80.75         | 4.75         | -6.5         | 0           |
| 15                                   | 0.5       | 2    | 0.3 | 9.5 | 3.4           | 9.69           | 24.23         | 3.17         | -6.5         | 0           |
| <i>Total Footing weight</i>          |           |      |     |     |               | <i>41.99</i>   | <i>104.98</i> | <i>4.38</i>  | <i>-6.50</i> | <i>0.00</i> |
| <b>Total Sub-structure + Footing</b> |           |      |     |     | <b>527.05</b> | <b>1317.61</b> | <b>7.85</b>   | <b>-4.16</b> | <b>0.00</b>  |             |

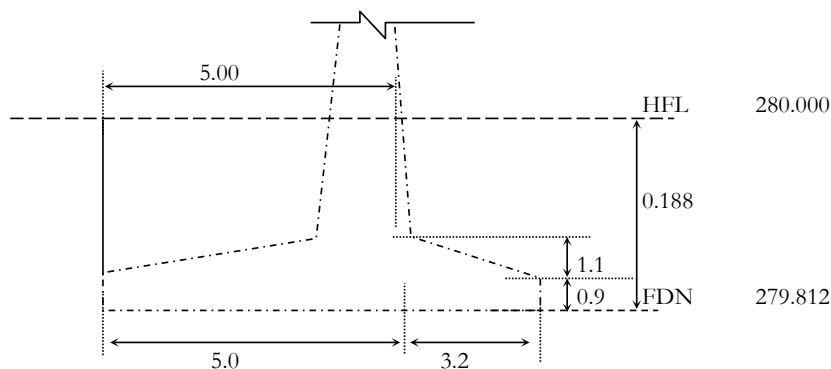
|  |   |            |
|--|---|------------|
| Total Weight of sub-structure & foundation | = | 1317.61 T  |
| Lever arm about toe (along L-L axis)       | = | -4.16 m    |
| Moment $M_{TT}$                            | = | -5480.8 Tm |
| Lever arm about c/L base (along T-T axis)  | = | 0 m        |
| Moment $M_{LL}$                            | = | 0 Tm       |

#### Calculating Weight of Backfill Dry Condition

| Element           | Area Fact | No.s | B   | H      | L    | V              | W       | $e_Y$ | $e_L$    | $e_T$ |
|-------------------|-----------|------|-----|--------|------|----------------|---------|-------|----------|-------|
|                   |           |      | m   | m      | m    | m <sup>3</sup> | Tonne   | m     | m        | m     |
| Earth Fill Weight |           |      |     |        |      |                |         |       |          |       |
| 16                | 0.5       | 1    | 3.4 | 1.1    | 10.7 | 20.01          | 40.02   | 1.63  | -7.06667 | 0     |
| 17                | 1         | 1    | 3.4 | 11.688 | 10.7 | 425.21         | 850.42  | 6.84  | -6.5     | 0     |
| 18                | 0.5       | 1    | 0.4 | 17.570 | 10.7 | 37.60          | 75.20   | 13.71 | -4.53333 | 0     |
| 18a               | 0.5       | 1    | 0   | 0.000  | 10.7 | 0.00           | 0.00    | 19.57 | -4.533   | 0     |
| 19                | 1         | 1    | 1.4 | 10.000 | 10.7 | 149.80         | 299.60  | 18.69 | -7.5     | 0     |
| 20                | 0         | 1    | 0   | 0.75   | 10.7 | 0.00           | 0.00    | 19.82 | -4.400   | 0     |
| Total Earth Fill  |           |      |     |        |      | 632.62         | 1265.23 | 9.89  | -6.64    | 0.00  |

|   |   |             |
|---|---|-------------|
| Total Weight of backfill                  | = | 1265.23 T   |
| Lever arm about toe (along L-L axis)      | = | -6.64 m     |
| Moment $M_{TT}$                           | = | -8398.41 Tm |
| Lever arm about c/L base (along T-T axis) | = | 0 m         |
| Moment $M_{LL}$                           | = | 0 Tm        |

#### Calculation of Buoyancy



| Element           | Area Fact | No.s | B    | H     | L  | V              | W      | e <sub>Y</sub> | e <sub>L</sub> | e <sub>T</sub> |
|-------------------|-----------|------|------|-------|----|----------------|--------|----------------|----------------|----------------|
|                   |           |      | m    | m     | m  | m <sup>3</sup> | Tonne  | m              | m              | m              |
| Earth Fill Weight |           |      |      |       |    |                |        |                |                |                |
| 1                 | 1         | -1   | 5.00 | 0.188 | 12 | -11.28         | -11.28 | 0.09           | -5.70          | 0              |
| 2                 | 0.5       | -1   | 0.00 | 0.188 | 12 | 0.00           | 0.00   | 0.13           | -3.20          | 0              |
| 3                 | 1         | -1   | 3.2  | 0.9   | 12 | -34.56         | -34.56 | 0.45           | -1.6           | 0              |
| 4                 | 0.5       | -1   | 3.2  | 1.1   | 12 | -21.12         | -21.12 | 1.27           | 2.13           | 0              |
| Total Earth Fill  |           |      |      |       |    | -66.96         | -66.96 | 0.65           | -1.11          | 0.00           |

|   |   |           |
|---|---|-----------|
| Total buoyant weight                      | = | -66.96 T  |
| Lever arm about toe (along L-L axis)      | = | -1.11 m   |
| Moment M <sub>TT</sub>                    | = | 74.536 Tm |
| Lever arm about c/L base (along T-T axis) | = | 0.00 m    |
| Moment M <sub>LL</sub>                    | = | 0 Tm      |



### Finding Creep Coefficient

$$f_{ck} = 45 \text{ Mpa} \quad (\text{Considering Precast Beam material})$$

$$f_{cm} = 55 \text{ Mpa}$$

$$t = 36500 \text{ days}$$

$$t_o = 90 \text{ days}$$

$$\phi(t, t_o) = \phi_o \beta_c(t, t_o)$$

$$\phi_o = \phi_{RH} \beta(f_{cm}) \beta(t_o)$$

$$\phi_{RH} = \begin{cases} 1 + \frac{1 - RH/100}{0.1 (h_o)^{1/3}} & \text{for } f_{cm} \leq 45 \text{ Mpa} \\ \left[ 1 + \frac{1 - RH/100}{0.1 (h_o)^{1/3}} \alpha_1 \right] * \alpha_2 & \text{for } f_{cm} > 45 \text{ Mpa} \end{cases}$$

$$RH = \text{Relative humidity}$$

$$= 70 \%$$

$$h_o = 3200 \text{ mm}$$

$$\alpha_1 = [43.75 / f_{cm}]^{0.7} = 0.85198$$

$$\alpha_2 = [43.75 / f_{cm}]^{0.2} = 0.95526$$

$$\phi_{RH} = 1.12095$$

$$\beta(f_{cm}) = 18.78 / \sqrt{f_{cm}}$$

$$= 2.53229$$

$$\beta(t_o) = 1 / (0.1 + t_o^{0.2})$$

$$= 0.3907$$

$$\phi_o = 1.10903$$

$$\beta_c(t, t_o) = [(t - t_o) / (\beta_H + t - t_o)]^{0.3}$$

$$\beta_H = \begin{cases} \text{Min} \begin{cases} 1.5 [1 + (0.012 RH)^{18}] h_o + 250 \\ 1500 \end{cases} & \text{for } f_{cm} \leq 35 \text{ Mpa} \\ \text{Min} \begin{cases} 1.5 [1 + (0.012 RH)^{18}] h_o + 250 \alpha_3 \\ 1500 * \alpha_3 \end{cases} & \text{for } f_{cm} > 35 \text{ Mpa} \end{cases}$$

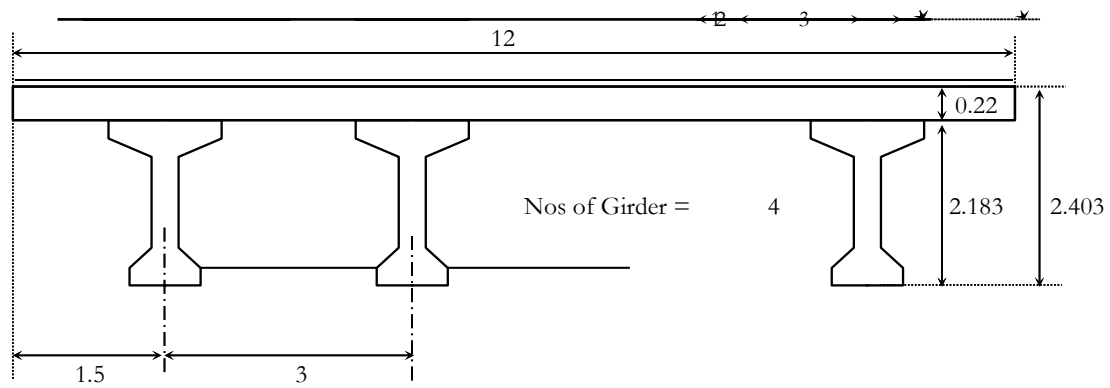
$$\alpha_2 = [43.75 / f_{cm}]^{0.5} = 0.892$$

$$\beta_H = 1337.82$$

|                     |       |
|---------------------|-------|
| $\beta_c(t, t_o) =$ | 0.989 |
| $\phi(t, t_o) =$    | 1.10  |

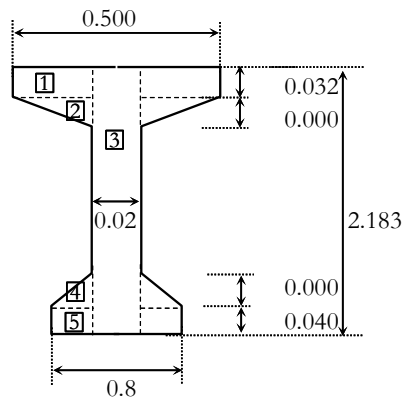
### DEAD LOAD CALCULATION OF SUPER-STRUCTURE :

|                                |   |          |
|--------------------------------|---|----------|
| Overall Span                   | = | 51.45 m  |
| C/c of Bearing                 | = | 50.3 m   |
| Total Deck Width               | = | 12 m     |
| Thickness of Deck width        | = | 0.22 m   |
| Total depth of super-structure | = | 2.403 m  |
| Nos. of Girder                 | = | 4 Nos.   |
| Depth of girder                | = | 2.183 m  |
| c/c of Girders                 | = | 3 m      |
| Nos. of Cross Girder           | = | 0        |
| Density of Steel               | = | 7.85 T/m |

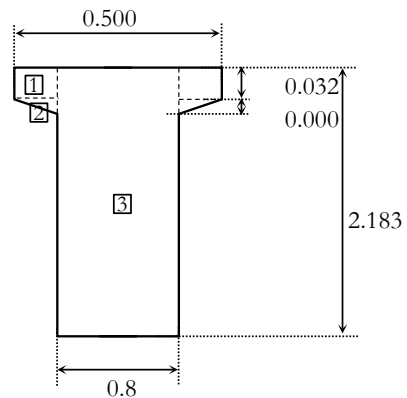


Super-Structure Cross-section

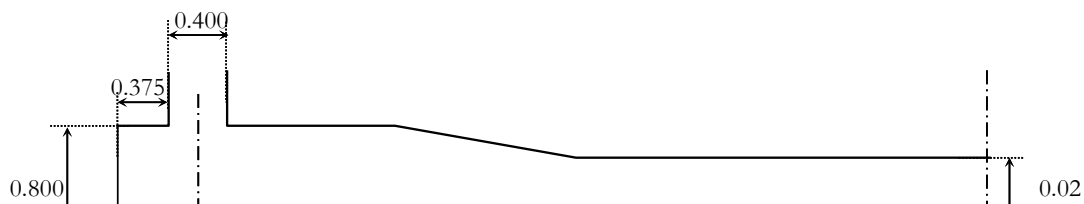
### Girder Cross-Section :

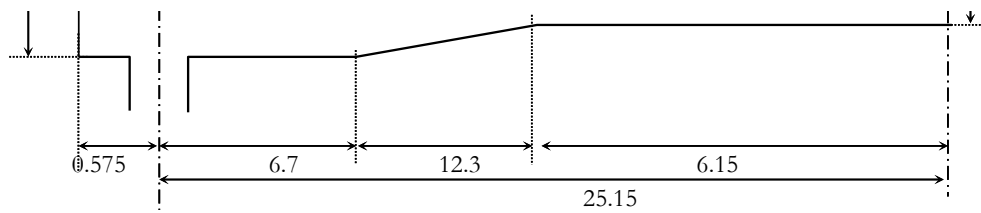


Section at Mid Span



Section at Support

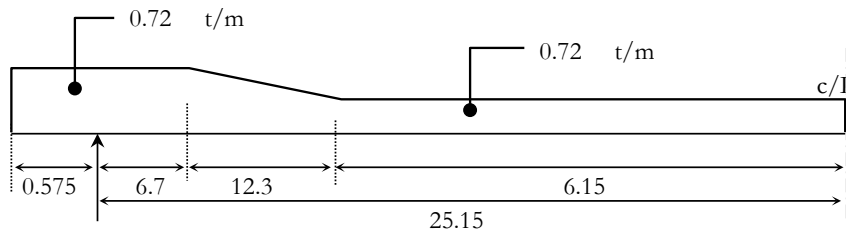




| Section Property of Girder At Mid Span |        |       |       |      |                |                  |
|--|--------|-------|-------|------|----------------|------------------|
| Element No.                            | Factor | B     | D     | Nos. | A              | cg <sub>y'</sub> |
|  |        | m     | m     |      | m <sup>2</sup> | m                |
| 1                                      | 1      | 0.500 | 0.032 | 1    | 0.016          | 0.016            |
| 2                                      | 0.5    | 0.500 | 0     | 2    | 0.0000         | 0.032            |
| 3                                      | 1      | 0.02  | 2.183 | 1    | 0.044          | 1.0915           |
| 4                                      | 0.5    | 0.8   | 0     | 2    | 0.000          | 2.14             |
| 5                                      | 1      | 0.8   | 0.04  | 1    | 0.032          | 2.16             |
|  |        |       |       |      |                |                  |
| <b>Total</b>                           |        |       |       |      | <b>0.09166</b> | <b>1.278</b>     |

| Section Property of Girder At Support Section |        |       |       |      |                |                  |
|---|--------|-------|-------|------|----------------|------------------|
| Element No.                                   | Factor | B     | D     | Nos. | A              | cg <sub>y'</sub> |
|   |        | m     | m     |      | m <sup>2</sup> | m                |
| 1   | 1      | 0.500 | 0.032 | 1    | 0.016          | 0.016            |
| 2   | 1      | 0.02  | 2.183 | 1    | 0.044          | 1.0915           |
| 3   | 1      | 0.8   | 0.040 | 1    | 0.032          | 0.02             |
|   |        |       |       |      |                |                  |
| <b>Total</b>                                  |        |       |       |      | <b>0.09166</b> | <b>0.530</b>     |

Self weight of Precast Beam



| Reaction due to self weight of each girder |             |              |              |  |                   |
|--|-------------|--------------|--------------|--|-------------------|
| Description                                | wt/m<br>T/m | Length<br>m  | weight<br>T  |  | cg. From top<br>m |
| Weight of Support Section                  | 0.72        | 7.275        | 5.23         |  | 0.530             |
| Weight of Transition section               | 0.72        | 12.30        | 8.85         |  | 0.904             |
| Weight of mid span                         | 0.72        | 6.15         | 4.43         |  | 1.278             |
| <b>Total Reaction</b>                      |             |              | <b>18.51</b> |  | <b>0.887</b>      |
|  |             |              |              |  |                   |
| Total weight of one Girder                 | =           | 37.02 Tonne  |              |  |                   |
| Total Nos. of girder                       | =           | 4 Nos.       |              |  |                   |
| Total weight of all girders                | =           | 148.08 Tonne |              |  |                   |



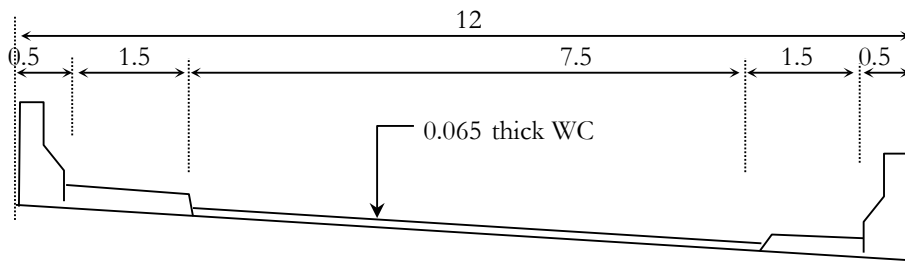
| <u>Calculating weight of superstructure</u> |   | Weight          | Cg. From Deck Top |
|---|---|-----------------|-------------------|
| Weight of all Girder                        | = | 148.08 T        | 1.11 m            |
| Weigth of Concrete Deck                     | = | 339.57 T        | 0.11 m            |
| Weigth of 12 m solid slab                   | = | 264.00 T        |                   |
| End cross girder Diaphragm                  | = | 46.25 T         | 1.29 m            |
| <b>Total Weight</b>                         | = | <b>797.90 T</b> |                   |
| Increase Concrete weight by 0%              | = | 797.90 T        | 0.327 m           |
| Reaction Over Each End                      | = | 398.95 Tonne    |                   |

|                                       |   |                    |
|---------------------------------------|---|--------------------|
| <b>Total Reaction at Each support</b> | = | <b>398.9 Tonne</b> |
| <b>Cg. From Deck Top</b>              | = | <b>0.327 m</b>     |

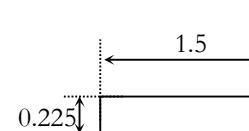
*Forces due to Super-Structure DL about base slab toe :*

|   |   |              |
|---|---|--------------|
| Vertical Load (Sup DL Reaction)           | = | 398.95 Tonne |
| Lever arm about toe (along L-L axis)      | = | -3.4 m       |
| Moment $M_{TT}$                           | = | -1366.4 Tm   |
| Lever arm about c/L base (along T-T axis) | = | 0 m          |
| Moment $M_{LL}$                           | = | 0 Tm         |
| Cg. From base slab bottom                 | = | 23.30 m      |

## Calculation of SIDL



|                               |   |                      |
|-------------------------------|---|----------------------|
| Overall span                  | = | 63.45 m              |
| Crash barrier weight          | = | 1 t/m                |
| Cg. From crash barrier bottom | = | 0.476 m              |
| Footpath weight               | = | 0.84375 t/m          |
| Cg. Of Footpath above deck    | = | 0.1125 m             |
| Wearing coat                  | = | 2.2 t/m <sup>2</sup> |



## Forces & Moments @ Foundation base

| Element                     | Description         | wt/m<br>t/m | L<br>m | W<br>Tonne | e <sub>y</sub><br>m | e <sub>T</sub><br>m |
|-----------------------------|---------------------|-------------|--------|------------|---------------------|---------------------|
| SIDL (excluding surfacing)  |                     |             |        |            |                     |                     |
| 1                           | Crash barrier Left  | 1           | 63.45  | 63.45      | 0.476               | -5.75               |
| 2                           | Crash barrier Right | 1           | 63.45  | 63.45      | 0.476               | 5.75                |
| 3                           | Footpath Left       | 0.84375     | 63.45  | 53.54      | 0.1125              | -4.75               |
| 4                           | Footpath Right      | 0.84375     | 63.45  | 53.54      | 0.1125              | 4.75                |
| <i>Total Load</i>           |                     |             |        | 233.97     | 0.31                | 0.00                |
|                             |                     |             |        |            |                     |                     |
| <i>Reaction per support</i> |                     |             |        | 116.99     | 0.31                | 0.00                |

## Forces due to Super-Structure SIDL about base slab toe :

|   |   |              |
|---|---|--------------|
| Vertical Load (Sup SIDL Reaction)         | = | 116.99 Tonne |
| Lever arm about toe (along L-L axis)      | = | -3.425 m     |
| Moment $M_{TT}$                           | = | -400.677 Tm  |
|   |   |              |
| Lever arm about c/L base (along T-T axis) | = | 0.00 m       |
| Moment $M_{LL}$                           | = | 0.00 Tm      |
|   |   |              |
| Cg. From base Slab bottom                 | = | 23.93 m      |

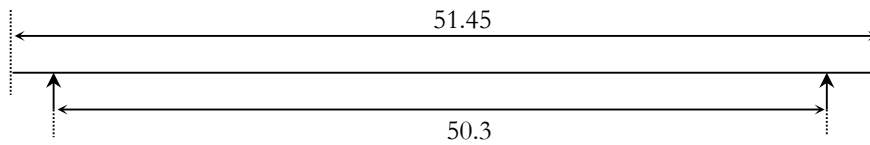
**Selfweight of surfacing**

| Element                     | Description  | wt/m <sup>2</sup> | B   | L     | W     | e <sub>Y</sub> | e <sub>T</sub> |
|-----------------------------|--------------|-------------------|-----|-------|-------|----------------|----------------|
|                             |              | t/m <sup>2</sup>  | m   | m     | Tonne | m              | m              |
| Surfacing<br>1              | Wearing coat | 2.2               | 7.5 | 63.45 | 68.05 | 0.033          | -0.25          |
| <i>Total Load</i>           |              |                   |     |       | 68.05 | 0.033          | -0.25          |
|                             |              |                   |     |       |       |                |                |
| <i>Reaction per support</i> |              |                   |     |       | 34.03 | 0.033          | -0.25          |

***Forces due to Super-Structure Surfacing about base slab toe :***

|   |   |             |
|---|---|-------------|
| Vertical Load (Sup Surfacing Reaction)    | = | 34.03 Tonne |
| Lever arm about toe (along L-L axis)      | = | -3.425 m    |
| Moment $M_{TT}$                           | = | -116.536 Tm |
|   |   |             |
| Lever arm about c/L base (along T-T axis) | = | -0.25 m     |
| Moment $M_{LL}$                           | = | -8.50627 Tm |
|   |   |             |
| Cg. From base Slab bottom                 | = | 23.66 m     |

### FINDING LIVE LOAD REACTIONS OVER ABUTMENT



SPAN\_1                      0.575              50.3              0.575

| CLASS A |   |     |     |     |     |      |      |     |     |
|---------|---|-----|-----|-----|-----|------|------|-----|-----|
| TYPE    | 1 | 6.8 | 6.8 | 6.8 | 6.8 | 11.4 | 11.4 | 2.7 | 2.7 |
| DIST    |   | 3   | 3   | 3   | 4.3 | 1.2  | 3.2  | 1.1 |     |

| CLASS 70R Wheeled |   |      |      |      |      |      |      |    |  |
|-------------------|---|------|------|------|------|------|------|----|--|
| TYPE              | 2 | 8    | 12   | 12   | 17   | 17   | 17   | 17 |  |
| DIST              |   | 3.96 | 1.52 | 2.13 | 1.37 | 3.05 | 1.37 |    |  |

| CLASS 70R Tracked |   |      |      |      |      |      |   |  |  |
|-------------------|---|------|------|------|------|------|---|--|--|
| TYPE              | 3 | 7    | 14   | 14   | 14   | 14   | 7 |  |  |
| DIST              |   | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 |   |  |  |

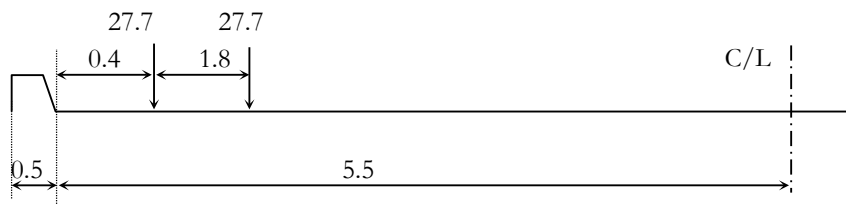
| Reactions                      | R11<br>Tonne | R12<br>Tonne | Transverse Ecc |
|--------------------------------|--------------|--------------|----------------|
| <b>Maximum Reaction Case :</b> |              |              |                |
| Class A                        | 45.8         | 9.6          | 4.2            |
| Class 70R wheeled              | 90.8         | 9.2          | 2.91           |
| Class 70R tracked              | 67.1         | 2.9          | 3.28           |
| Class A 2Lane                  | 91.6         | 19.2         | 2.45           |
| Class A 3Lane                  | 137.4        | 28.8         | 0.70           |
| Class 1A+70RW                  | 136.6        | 18.8         | 3.20           |
| <b>Governing Case</b>          | <b>137.4</b> | <b>28.8</b>  | <b>2.9</b>     |
|                                |              |              |                |

| <b>Forces due to LL about base slab toe :</b> |   |  |  | <b>Max Reaction</b> | <b>Min Reaction</b> |  |
|---|---|--|--|---------------------|---------------------|--|
| Vertical Load (CW LL Reaction)                | = |  |  | 137.40 Tonne        | 28.80 Tonne         |  |
| Lever arm about toe (along L-L axis)          | = |  |  | -3.425 m            | -3.425 m            |  |
| Moment $M_{TT}$                               | = |  |  | -470.596 Tm         | -98.639 Tm          |  |
| Lever arm about c/L base (along T-T axis)     | = |  |  | 2.91 m              | 2.91 m              |  |
| Moment $M_{LL}$                               | = |  |  | 399.83 Tm           | 83.81 Tm            |  |

Maximum Possible Eccentricity in transverse direction

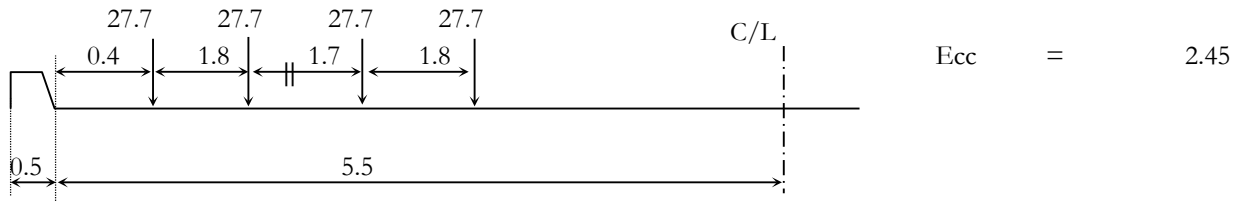


**Class A**

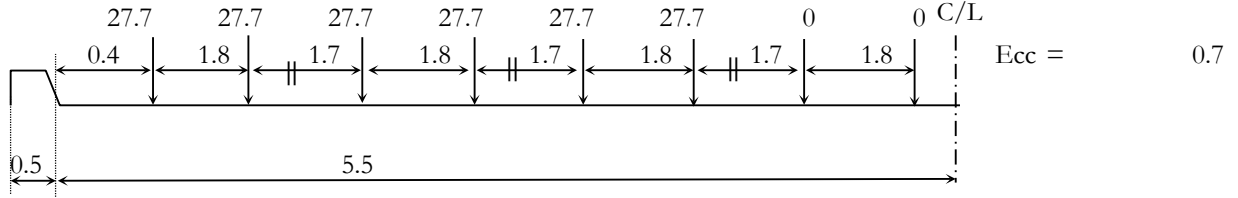


$$Ecc = 4.2$$

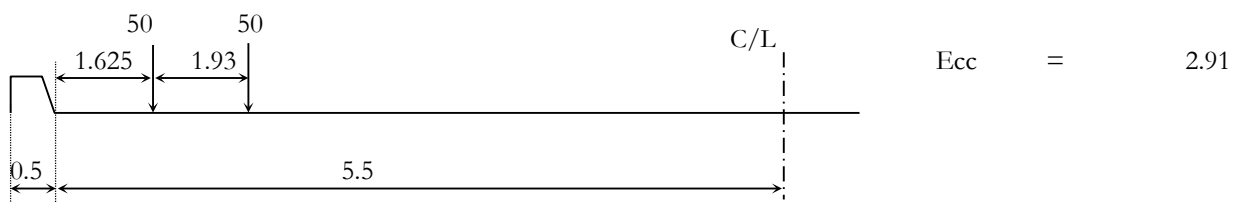
### Class A 2 Lane



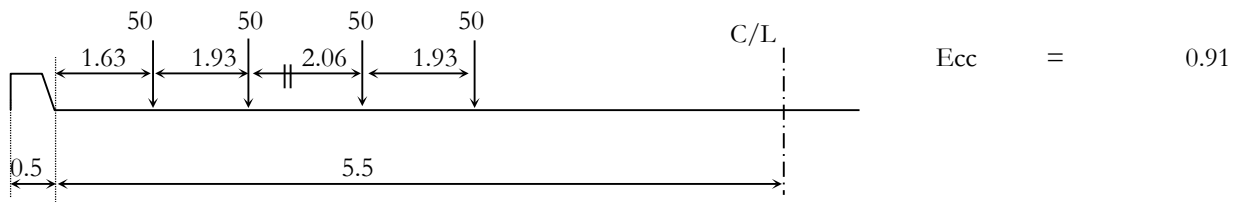
### Class A 3 Lane



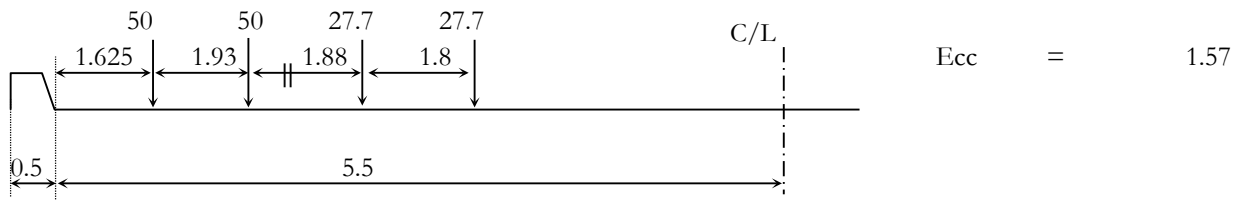
### Class 70R Wheeled



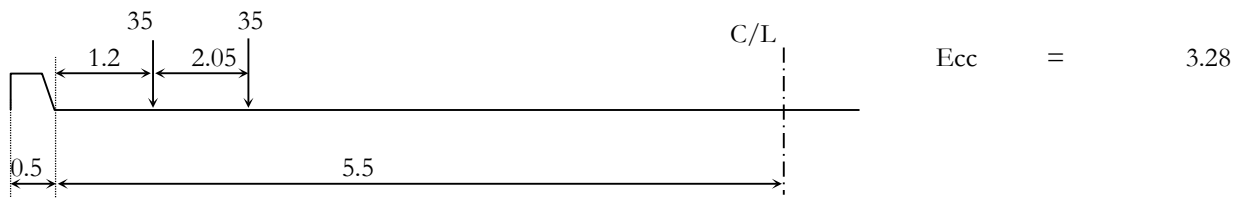
### Class 70R Wheeled 2 Lane



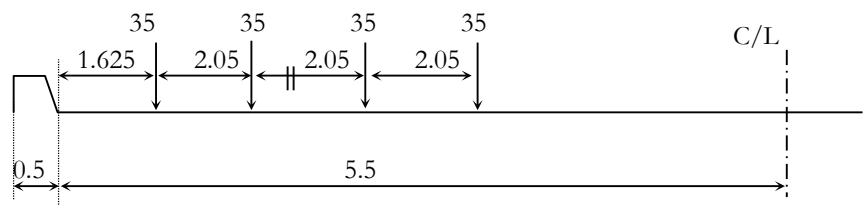
### Class A 1 Lane + Class 70R Wheeled II



### Class 70R Tracked

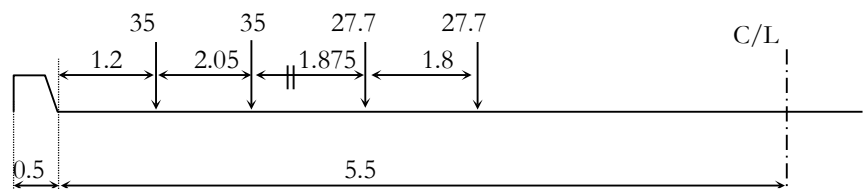


**Class 70R Tracked 2 lanes**



Ecc = 0.80

**Class A 1 Lane + Class 70R Tracked II**



Ecc = 1.60

## Calculation of Longitudinal Forces

### Maximum LL over span :

|            |   |              |
|------------|---|--------------|
| Class A    | = | 137.40 tonne |
| Class 70 R | = | 90.76 tonne  |

$$\begin{aligned} \text{Breaking Force } F_h &= 137.400 \times 0.2 + 0.00 \times 0.05 \\ &= 27.48 \text{ tonne} \end{aligned}$$

$$\text{Coefficient of thermal expansion} = 0.0000117 / ^\circ\text{C}$$

$$\text{Maximum temperature} = 45.2 ^\circ\text{C}$$

$$\text{Minimum temperature} = -2.9 ^\circ\text{C}$$

$$\text{Bridge Temperature} = 31.15 ^\circ\text{C}$$

$$\text{Longitudinal strain} = 0.00036$$

$$\text{Shrinkage coefficient} = 0.0002$$

$$\text{Total strain for longitudinal movement} = 0.00056$$

$$\begin{aligned}
 \text{Horizontal movement} &= \frac{0.00056 \times 50.00 \times 1000}{2} \\
 &= 14.111 \text{ mm} \\
 \text{Size of bearing} &= 500 \times 500 \times 142 \text{ mm} \\
 \text{Strain in bearing} &= \frac{14.111}{142} = 0.09938 \\
 \text{Shear modulus} &= 1 \text{ Mpa} \\
 \text{Shear force per Bearing} &= 0.0994 \times 1.0 \times 500 \times 500 \\
 &= 24844 \text{ N} = 2.533 \text{ t} \\
 \text{Total shear force for 4 bearings ( with 5 \% increase )} &= 2.533 \times 4 \times 1.05 \\
 &= 10.637 \text{ t} \\
 \text{Refer IRC : 6 clause 214.5.1.5;} \\
 &10 \% \text{ increase for variation in movement of span} \\
 \text{Total shear force} &= 1.1 \times 10.637 \\
 &= 11.700 \text{ t}
 \end{aligned}$$

As per clause 214.2 of IRC:6, horizontal braking force  $F_h$ , for each span is:

$$\begin{aligned}
 \text{For Class A Single lane} \quad F_h &= 0.2 \times 55.40 = 11.08 \text{ t} \\
 \text{Class A 2 lane} \quad F_h &= 0.2 \times 110.80 = 22.16 \text{ t} \\
 \text{For class 70R wheeled} \quad F_h &= 0.2 \times 100.0 = 20 \text{ t}
 \end{aligned}$$

Longitudinal force per support

$$\begin{aligned}
 \text{For Class A 2 lane} &= \frac{22.160}{2} + 11.700 = 22.78 \text{ t} \\
 \text{For 70 R} &= \frac{20}{2} + 11.700 = 21.70 \text{ t}
 \end{aligned}$$

Horizontal force at Brg. Level

$$\begin{aligned}
 F_{\text{Longitudinal}} &= \text{Max. of } \begin{cases} \text{i)} &= 22.8 \text{ tonne} \\ \text{ii)} &= 21.7 \text{ tonne} \end{cases} \\
 &= \text{MAX}(22.78, 21.7) \\
 &= 22.78 \text{ tonne} \\
 F_{\text{Longitudinal}} &= \underline{\underline{27.48 \text{ tonne}}}
 \end{aligned}$$

| Forces due to LL Longitudinal Forces, about base slab toe : |   |            |
|---|---|------------|
| Longitudinal Force  | = | 27.5 Tonne |
| Lever arm from footing base                                 | = | 21.22 m    |
| Moment in about transverse axis $M_{TT}$                    | = | 583.1 tm   |

### Calculation of Longitudinal Forces

Horizontal force at bearing level in the longitudinal direction at **fixed bearing** (other than elastomeric bearing)

$$= \text{Maximum of } \begin{cases} \text{i) } F_h - \mu (R_g + R_q) \\ \text{ii) } F_h / 2 + \mu (R_g + R_q) \end{cases} \quad \text{Refer Clause 211.5 IRC: 6-2017}$$

Where

$$\begin{aligned} F_h &= \text{Applied Horizontal force} \\ R_g &= \text{Reaction at free end due to dead load and SIDL} \\ R_q &= \text{Reaction at free end due to live load load} \\ \mu &= \text{Coefficient of Friction at movable bearing} = 0.03 \quad \text{or} \quad 0.05 \quad \text{which ever govern} \end{aligned}$$

\*  $F_h$  (braking force) is considered 20 % of the first train load + 10 % of the load of the succeeding trains or part thereof.

Reaction due to dead load and SIDL

$$\begin{aligned} R_g &= \text{DL} \quad \text{SIDL} \quad \text{Surfacing} \\ &= 398.95 + 116.99 + 34.03 \\ &= 549.96 \text{ tonne} \end{aligned}$$

$$R_q \text{ max} = 137.40 \text{ tonne}$$

$$\begin{aligned} \text{Corresponding Live load over Span} &= 100 \text{ tonne of Class 70 R} \\ \text{Braking Force } F_h &= 100 \times 0.2 + 55.4 \times 0.05 \\ &= 22.77 \text{ tonne} \end{aligned}$$

$$\begin{aligned} F_{\text{Longitudinal}} &= \text{Max of } \begin{cases} F_h - \mu (R_g + R_q) = 22.77 - 0.03 \times (137.4 + 549.961) \\ F_h / 2 + \mu (R_g + R_q) = 11.385 + 0.05 \times (137.4 + 549.961) \end{cases} \\ &= \text{Max of } (2.149, 45.753) \\ &= \underline{\underline{45.8 \text{ tonne}}} \end{aligned}$$

| Forces due to LL Longitudinal Forces, about base slab toe : |   |                   |
|---|---|-------------------|
| Longitudinal Force  | = | <b>45.8 Tonne</b> |
| Lever arm from footing base                                 | = | 21.22 m           |
| Moment in about transverse axis $M_{TT}$                    | = | <b>970.9 tm</b>   |

**CALCULATION OF LONGITUDINAL HORIZONTAL FORCES (NORMAL and SEISMIC LONGITUDINAL CASE):**

Maximum LL over span :

Class A = 137.40 tonne  
Class 70 R = 90.76 tonne

Minimum LL over span :

Class A = 9.60 tonne  
Class 70 R = 2.85 tonne

Breaking Force  $F_h$  =  $147.000 \times 0.2 + 0.00 \times 0.05$   
= 29.40 tonne

$\mu R$  =  $0.05 \times \left( \frac{DL}{398.95} + \frac{SIDL}{151.01} \right)$

=  $0.05 \times 549.96$  = 27.50 tonne

$F_h/2$  =  $29.40 / 2.00$  = 14.70 tonne

$F_h/2$  or  $\mu R$  = (whichever is maximum) = 27.50 tonne

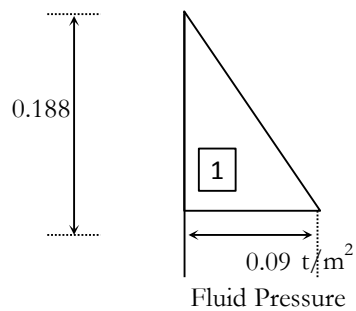
| <b>Forces due to LL Longitudinal Forces, about base slab toe :</b> |   |                   |
|--|---|-------------------|
| Longitudinal Force   | = | <b>45.8 Tonne</b> |
| Lever arm from footing base  | = | 21.22 m           |
| Moment in about transverse axis $M_{TT}$                           | = | <b>970.9 tm</b>   |

### **FLUID PRESSURE CALCULATION UP TO FOUNDING LEVEL :**

Fluid density = 0.48 t/m<sup>3</sup>  
 Abutment Length L = 12 m  
 Footing Base width B = 8.2 m

GL 280.000

Found.L 279.812



Total Fluid Pressure

| Component | Factor | p                | h     | L  | F     | ey    |
|-----------|--------|------------------|-------|----|-------|-------|
|           |        | T/m <sup>2</sup> | m     | m  | Tonne | m     |
| 1         | 0.5    | 0.090            | 0.188 | 12 | 0.10  | 0.063 |
| Total     |        |                  |       |    | 0.10  | 0.063 |

**Total fluid Pressure** = **0.10 Tonne**  
**Lever arm** = **0.06**  
**Moment M<sub>TT</sub>** = **0.01 Tm**  
  
**Net Moment M<sub>TT</sub>** = **0.01 Tm**

### **SUMMARY FLUID PRESSURE :**

| Description      | Fluid Pressure               |                        |
|------------------|------------------------------|------------------------|
|                  | Horizontal (H <sub>L</sub> ) | M <sub>TT</sub> (Dest) |
|                  | Tonne                        | Tm                     |
| 1) LWL Condition | 0.10                         | 0.01                   |



# **CALCULATION OF SEISMIC ACCELERATION SA/G (As per Appendix A1 of IRC SP 114-2018)**

(Notifications of IRC SP 114-2018, Pg 50)

|                           |       |           |        |
|---------------------------|-------|-----------|--------|
| Seismic Zone              |       | Zone      | V      |
| Type of soil              |       | Soil Type | medium |
| Zone factor               |       | Z         | 0.36   |
| Importance Factor         |       | I         | 1.2    |
| Response Reduction Factor | Long  | R.L       | 3.00   |
|                           | Trans | R.T       | 1.00   |

| PARAMETERS   | unit            | Longitudinal | Transverse |
|--|-----------------|--------------|------------|
| Area of Bearing  | mm <sup>2</sup> | 250000       | 250000     |
| Total no. of Bearing   | Nos             | 4            | 4          |
| Total thickness of elastomer   | mm              | 142          | 142        |
| Hardness, IRHD   |                 | 60           | 60         |
| Shear modulus of Elastomer   | Mpa             | 0.9          | 0.9        |
| Stiffness of Elastomer =NAG/t  | N/mm            | 8239         | 8239       |
| Distance of cg of super structure from top of bearing (assuming CG is at centre of superstructure) | m               | 21.436       | 21.436     |
| Force required for 1mm deflection in bearing   | KN              | 8.23943662   | 8.23943662 |
| Corresponding deflection in pier due to force KN for longitudinal direction                        | mm              | 0.640        |            |
| Moment due to force KN in transverse direction   | KN-m            |              | 176.62     |
| Corresponding deflection in pier due to KN and moment KN-m for transverse direction                | mm              |              | 0.06314    |
| Total deflection in( pier and bearing )  | mm              | 1.640        | 1.063      |
| Equivalent stiffness of system   | N/mm            | 5023.89      | 8043.06    |
| Force required for total deflection of 1mm (pier and bearing )(F)                                  | KN              | 5.024        | 8.043      |
| Appropriate Lumped Mass (Total mass)   | KN              | 5774         | 5774       |
| Time Period<br>$\frac{2}{\sqrt{\frac{D}{1000F}}}$  | sec             | 2.144        | 1.695      |
| Avg. response Acc. coeff. for Hard soil sites (Sa/g)   |                 | 0.466        | 0.590      |

Deflection calculations for abutment

For Elastomeric Bearings R =1

1. For Longitudinal direction ,force is acting at top of bearing hence.

$$\text{Deflection} = \frac{PL^3}{3EI}$$

2. For transeverse direction,force is acting at c.g of superstructure hence

$$\text{Deflection} = \frac{PL^3}{3EI} + \frac{ML^2}{2EI}$$

$$\text{Stiffness of Abutment, K2 L} = \frac{3.E.I}{L^3} = 12873 \text{ N/mm}$$

$$\text{Stiffness of Abutment, K2 T} = \frac{3.E.I}{L^3} = 337460 \text{ N/mm}$$

$$\text{Cross Camber} = 749.98\%$$

$$\text{Wearing Coat} = 65 \text{ mm}$$

**Bearing Stiffness has been increased by 30% as per annexure D IRC:83-2018 (part -II)**

$$\text{Depth of superstructure} = 2.403 \text{ m}$$

$$E = 34313 \text{ N/mm}^2 \quad B = 6.40 \text{ m}$$

$$I_L = 1.04167E+12 \text{ mm}^4 \quad D = 1.25 \text{ m}$$

$$I_T = 2.73067E+13 \text{ mm}^4$$

$$I_H = 20271 \text{ mm}$$

$$I_T = 20271 \text{ mm}$$

$$\frac{S_a}{g} = \begin{cases} \text{For rocky or hard soil site} : \begin{cases} 2.5 & 0 < T < 0.40 \text{ s} \\ 1/T & 0.40 \text{ s} < T < 4.00 \text{ s} \\ 0.25 & T > 4.00 \text{ s} \end{cases} \\ \text{For medium stiff soil sites} : \begin{cases} 2.5 & 0 < T < 0.55 \text{ s} \\ 1.36/T & 0.55 \text{ s} < T \leq 4.00 \text{ s} \\ 0.34 & T > 4.00 \text{ s} \end{cases} \\ \text{For soft soil sites} : \begin{cases} 2.5 & 0 \leq T \leq 0.67 \text{ s} \\ 1.67/T & 0.67 \text{ s} \leq T \leq 4.00 \text{ s} \\ 0.42 & T > 4.00 \text{ s} \end{cases} \end{cases}$$

## **ACTIVE EARTH PRESSURE CALCULATION FOR OVER-TURNING & SLIDING:**

### **A) Non-Seismic Case :**

Coefficient of Active Earth Pressure

$$\text{Active earth pressure} \quad Ka = \frac{\sin^2(\alpha + \phi)}{\sin^2 \alpha \cdot \sin(\alpha - \delta) \cdot \left[ 1 + \sqrt{\frac{\sin(\phi + \delta) \cdot \sin(\phi - i)}{\sin(\alpha - \delta) \cdot \sin(\alpha + i)}} \right]^2}$$

Backfill Soil Parameter

|                             |   |                    |   |               |
|-----------------------------|---|--------------------|---|---------------|
| $\phi$                      | = | 30 °               | = | 0.524 Radians |
| $\delta$                    | = | 20 °               | = | 0.349 Radians |
| $\delta_{\text{submerged}}$ | = | 10 °               | = | 0.175 Radians |
| $i$                         | = | 0 °                | = | 0 Radians     |
| $\alpha$                    | = | 88.70 °            | = | 1.548 Radians |
| $\gamma_{\text{dry}}$       | = | 2 t/m <sup>3</sup> |   |               |
| $\gamma_{\text{sat}}$       | = | 2 t/m <sup>3</sup> |   |               |
| $\gamma_{\text{sub}}$       | = | 1 t/m <sup>3</sup> |   |               |

|                        |   |   |                      |
|------------------------|---|---|----------------------|
| LL surcharge intensity | q | = | 2.4 t/m <sup>2</sup> |
|------------------------|---|---|----------------------|

|                 |   |   |      |
|-----------------|---|---|------|
| Abutment Length | L | = | 12 m |
|-----------------|---|---|------|

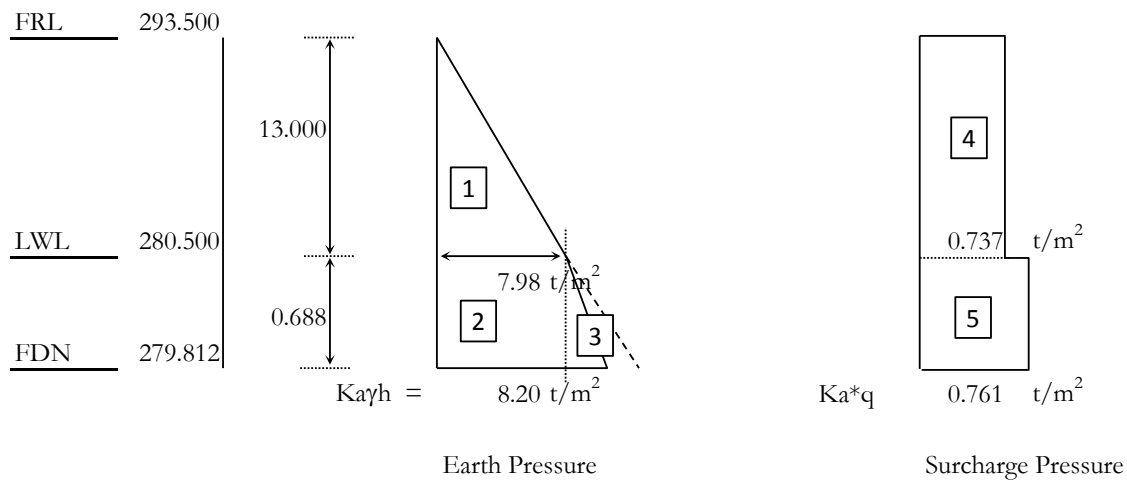
|                    |   |   |       |
|--------------------|---|---|-------|
| Footing Base width | B | = | 8.2 m |
|--------------------|---|---|-------|

|                   |   |       |
|-------------------|---|-------|
| $Ka_{\text{Dry}}$ | = | 0.307 |
|-------------------|---|-------|

|                          |   |       |
|--------------------------|---|-------|
| $Ka'_{\text{Submerged}}$ | = | 0.317 |
|--------------------------|---|-------|

### **1) LWL CONDITION**

|                             |   |                      |
|-----------------------------|---|----------------------|
| $Ka$                        | = | 0.307                |
| $Ka'$                       | = | 0.317                |
| $\gamma_{\text{dry}}$       | = | 2 t/m <sup>3</sup>   |
| $\gamma_{\text{sub}}$       | = | 1 t/m <sup>3</sup>   |
| $\delta$                    | = | 20 °                 |
| $\delta_{\text{submerged}}$ | = | 10 °                 |
| q                           | = | 2.4 t/m <sup>2</sup> |
| L                           | = | 12 m                 |
| B                           | = | 8.2 m                |



#### Total Active Earth Presure

| Component | Factor | p                | h     | L  | F          | $\delta$ | F*Cos $\delta$ | ey    | F*Sin $\delta$ | ex   |
|-----------|--------|------------------|-------|----|------------|----------|----------------|-------|----------------|------|
|           |        | T/m <sup>2</sup> | m     | m  | Tonne      | deg      | Tonne          | m     | Tonne          | m    |
| 1         | 0.5    | 7.982            | 13    | 12 | 622.60     | 20       | 585.05         | 6.148 | 212.94         | -8.2 |
| 2         | 1      | 7.982            | 0.688 | 12 | 65.90      | 10       | 64.90          | 0.344 | 11.44          | -8.2 |
| 3         | 0.5    | 0.2181           | 0.688 | 12 | 0.90       | 10       | 0.89           | 0.229 | 0.16           | -8.2 |
| Total     |        |                  |       |    | 689.395692 |          | 650.834        | 5.561 | 224.54         | -8.2 |

|                                    |   |                     |
|------------------------------------|---|---------------------|
| <b>Total Active Earth Pressure</b> | = | <b>689.40 Tonne</b> |
| <b>Horizontal Component</b>        | = | <b>650.83</b>       |
| <b>Lever arm</b>                   | = | <b>5.56</b>         |
| <b>Moment M<sub>TT</sub></b>       | = | <b>3619.41 Tm</b>   |
| <b>Vertical Component</b>          | = | <b>224.54</b>       |
| <b>Lever arm</b>                   | = | <b>-8.20 m</b>      |
| <b>Moment M<sub>TT</sub></b>       | = | <b>-1841.23 Tm</b>  |
| <b>Net Moment M<sub>TT</sub></b>   | = | <b>1778.18 Tm</b>   |

#### Total Surcharge pressure

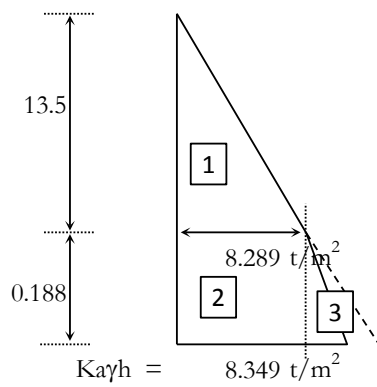
| Component | Factor | p                | h     | L  | F       | ey      |
|-----------|--------|------------------|-------|----|---------|---------|
|           |        | T/m <sup>2</sup> | m     | m  | Tonne   | m       |
| 4         | 1      | 0.7368           | 13    | 12 | 114.941 | 7.188   |
| 5         | 1      | 0.7608           | 0.688 | 12 | 6.28116 | 0.344   |
| Total     |        |                  |       |    | 121.222 | 6.83338 |

|                          |   |              |
|--------------------------|---|--------------|
| Total Surcharge Pressure | = | 121.22 Tonne |
| Lever arm above base     | = | 6.83 m       |
| Moment $M_{TT}$          | = | 828.36 Tm    |

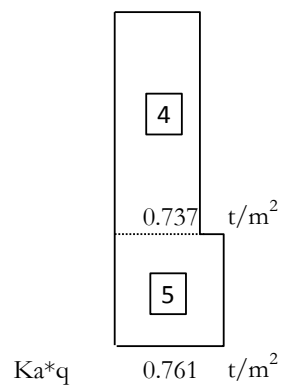
## 2) HFL CONDITION

|                      |   |                      |
|----------------------|---|----------------------|
| $K_a$                | = | 0.307                |
| $K_a'$               | = | 0.317                |
| $\gamma_{dry}$       | = | 2 t/m <sup>3</sup>   |
| $\gamma_{sub}$       | = | 1 t/m <sup>3</sup>   |
| $\delta$             | = | 20 °                 |
| $\delta_{submerged}$ | = | 10 °                 |
| q                    | = | 2.4 t/m <sup>2</sup> |
| L                    | = | 12 m                 |
| B                    | = | 8.2 m                |

|     |         |
|-----|---------|
| FRL | 293.500 |
| HFL | 280.000 |
| FDN | 279.812 |



Earth Pressure



Surcharge Pressure

Total Active Earth Pressure

| Component | Factor | p                | h     | L  | F          | $\delta$ | F*Cos $\delta$ | ey    | F*Sin $\delta$ | ex   |
|-----------|--------|------------------|-------|----|------------|----------|----------------|-------|----------------|------|
|           |        | T/m <sup>2</sup> | m     | m  | Tonne      | deg      | Tonne          | m     | Tonne          | m    |
| 1         | 0.5    | 8.289            | 13.5  | 12 | 671.41     | 20       | 630.92         | 5.858 | 229.64         | -8.2 |
| 2         | 1      | 8.289            | 0.188 | 12 | 18.70      | 10       | 18.42          | 0.094 | 3.25           | -8.2 |
| 3         | 0.5    | 0.0596           | 0.188 | 12 | 0.07       | 10       | 0.07           | 0.063 | 0.01           | -8.2 |
| Total     |        |                  |       |    | 690.176208 |          | 649.4          | 5.694 | 232.8943       | -8.2 |

|                                    |   |                     |
|------------------------------------|---|---------------------|
| <b>Total Active Earth Pressure</b> | = | <b>690.18 Tonne</b> |
| <b>Horizontal Component</b>        | = | <b>649.40</b>       |
| <b>Lever arm</b>                   | = | <b>5.69</b>         |
| <b>Moment M<sub>TT</sub></b>       | = | <b>3697.65 Tm</b>   |
| <b>Vertical Component</b>          | = | <b>232.89</b>       |
| <b>Lever arm</b>                   | = | <b>-8.20 m</b>      |
| <b>Moment M<sub>TT</sub></b>       | = | <b>-1909.73 Tm</b>  |
| <b>Net Moment M<sub>TT</sub></b>   | = | <b>1787.92 Tm</b>   |

Total Surcharge pressure

| Component | Factor | p                | h     | L  | F       | ey      |
|-----------|--------|------------------|-------|----|---------|---------|
|           |        | T/m <sup>2</sup> | m     | m  | Tonne   | m       |
| 4         | 1      | 0.7368           | 13.5  | 12 | 119.362 | 6.938   |
| 5         | 1      | 0.7608           | 0.188 | 12 | 1.71636 | 0.094   |
| Total     |        |                  |       |    | 121.078 | 6.84098 |

|                                 |   |                     |
|---------------------------------|---|---------------------|
| <b>Total Surcharge Pressure</b> | = | <b>121.08 Tonne</b> |
| <b>Lever arm above base</b>     | = | <b>6.84 m</b>       |
| <b>Moment M<sub>TT</sub></b>    | = | <b>828.29 Tm</b>    |

**SUMMARY OF FORCES FOR OVERTURNING AND SLIDING****SUMMARY ACTIVE EARTH PRESSURE :**

| Description      | Earth Pressure       |                 |                |                 |
|------------------|----------------------|-----------------|----------------|-----------------|
|                  | Horizontal ( $H_L$ ) | $M_{TT}$ (Dest) | Vertical ( V ) | $M_{TT}$ (Steb) |
|                  | Tonne                | Tm              | Tonne          | Tm              |
| 1) LWL Condition | 650.83               | 3619.41         | 224.54         | -1841.2         |
| 1) HFL Condition | 649.40               | 3697.65         | 232.89         | -1909.7         |

**SUMMARY SURCHARGE PRESSURE :**

| Description      | Surcharge Pressure   |                 |
|------------------|----------------------|-----------------|
|                  | Horizontal ( $H_L$ ) | $M_{TT}$ (Dest) |
|                  | Tonne                | Tm              |
| 1) LWL Condition | 121.22               | 828.36          |
| 2) HFL Condition | 121.08               | 828.29          |

**SUMMARY OF FORCES FOR BASE PRESSURE**

*Total base width* = 8.2 m  
*Distance from toe to shaft back* = 4.8 m

**SUMMARY ACTIVE EARTH PRESSURE :**

| Description      | Earth Pressure       |                 |                |                 |
|------------------|----------------------|-----------------|----------------|-----------------|
|                  | Horizontal ( $H_L$ ) | $M_{TT}$ (Dest) | Vertical ( V ) | $M_{TT}$ (Steb) |
|                  | Tonne                | Tm              | Tonne          | Tm              |
| 1) LWL Condition | 650.83               | 3619.41         | 224.54         | -1077.79        |
| 1) HFL Condition | 649.40               | 3697.65         | 232.89         | -1117.89        |

**SUMMARY SURCHARGE PRESSURE :**

| Description      | Surcharge Pressure   |                 |
|------------------|----------------------|-----------------|
|                  | Horizontal ( $H_L$ ) | $M_{TT}$ (Dest) |
|                  | Tonne                | Tm              |
| 1) LWL Condition | 121.22               | 828.36          |
| 2) HFL Condition | 121.08               | 828.29          |

### SEISMIC FORCE CALCULATION :

$$\text{Time Period Calculation} \quad T = 2 \sqrt{\frac{D}{1000 F}}$$

$$\begin{aligned} D &= \text{Approximate DL of super-structure \& LL in Tonne (DL+20\% LL)} \\ &= 549.96 + 27 \text{ t} \\ &= 577.441 \text{ Tonne} \end{aligned}$$

$$F = \text{Horizontal force in Tonne required to be applied at center of mass of super-structure for 1 mm deflection at the top of pier / abutment along the considered direction of horizontal force.}$$

$$F = \frac{6 E I}{x^2(3L-x)} \quad \text{for 1 mm deflection at } x$$

$$E = 34313 \text{ N/mm}^2$$

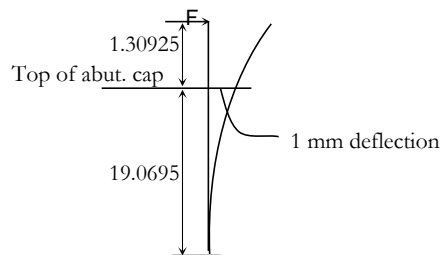
Column Cross-Section

$$B = 12 \text{ m}$$

$$D = 1.4 \text{ m (Average)}$$

$$I_L = 2.744\text{E}+12 \text{ m}^4$$

$$I_T = 2.016\text{E}+14 \text{ m}^4$$



$$\text{Force required in Long. Dir. } F_L = 3.7 \text{ tonne}$$

$$\text{Force required in Long. Dir. } F_T = 271.3 \text{ tonne}$$

$$\text{Time Period -Longitudinal Seismic Case} = 0.791$$

$$\text{Time Period -Transverse Seismic Case} = 0.09$$

$$\begin{aligned} \text{Sa/g -Longitudinal Seismic Case} &= 0.47 \\ \text{Sa/g -Transverse Seismic Case} &= 0.59 \\ \text{Sa/g -Vertical Seismic Case} &= 0.59 \end{aligned} \quad \begin{aligned} &(\text{Amendment no. 1/} \\ &\text{August 2013/} \\ &\text{IRC:6-2010 clause} \\ &\text{219.5}) \end{aligned}$$

$$\text{Seismic Zone} = V$$

$$\text{Type of soil} = \text{medium}$$

$$\text{Zone factor } Z = 0.36$$

$$\text{Importance factor } I = 1.2$$

$$\text{Horizontal seismic coeff. -Long., } A_{hL} = (Z/2)*(I)*(Sa/g)_{(Long.)} = 0.10$$

$$\text{Horizontal seismic coeff. -Trans., } A_{hT} = (Z/2)*(I)*(Sa/g)_{(Trans.)} = 0.13$$

$$\text{Vertical seismic coeff. } A_v = 2/3 A_h = 0.08$$

$$\text{Response Reduction Factor, } R_{long.} = 3$$

$$\text{Response Reduction Factor, } R_{trans.} = 1$$

$$\text{Response Reduction Factor, } R_{vert.} = 3$$

$$\text{Design Horizontal Longitudinal seismic coeff., } A_{hL} = A_h'/R_{(Long.)} = 0.03358$$

$$\text{Design Horizontal Transverse seismic coeff., } A_{hT} = A_h'/R_{(Trans.)} = 0.12746$$

$$\text{Design Vertical Seismic Coefficient - } A_v = A_v'/R_{(vert.)} = 0.02832$$

## **DYNAMIC EARTH PRESSURE CALCULATION FOR OVER-TURNING & SLIDING :**

### **A) Non-Seismic Case :**

Coefficient of Active Earth Pressure

$$K_a \text{ Dry} = 0.307$$

$$K_a' \text{ Submerged} = 0.317$$

Backfill Soil Parameter

|                             |   |                   |   |               |
|-----------------------------|---|-------------------|---|---------------|
| $\phi$                      | = | $30^\circ$        | = | 0.524 Radians |
| $\delta$                    | = | $20^\circ$        | = | 0.349 Radians |
| $\delta_{\text{submerged}}$ | = | $10^\circ$        | = | 0.175 Radians |
| $i$                         | = | $0^\circ$         | = | 0.000 Radians |
| $\alpha$                    | = | $90^\circ$        | = | 1.571 Radians |
| $\gamma_{\text{dry}}$       | = | $2 \text{ t/m}^3$ |   |               |
| $\gamma_{\text{sat}}$       | = | $2 \text{ t/m}^3$ |   |               |
| $\gamma_{\text{sub}}$       | = | $1 \text{ t/m}^3$ |   |               |

LL surcharge intensity  $q = 2.4 \text{ t/m}^2$

Abutment Length  $L = 12 \text{ m}$

Footing Base width  $B = 8.2 \text{ m}$

$$C_a = \frac{(1 \pm \alpha_v) * \sin^2(\alpha + \phi - \lambda)}{\cos \lambda * \sin^2 \alpha \cdot \sin(\alpha - \delta - \lambda) \cdot \left[ 1 + \sqrt{\frac{\sin(\phi + \delta) \cdot \sin(\phi - i - \lambda)}{\sin(\alpha - \delta - \lambda) \cdot \sin(\alpha + i)}} \right]^2}$$

$\alpha_h = 0.03358$

$\alpha_v = 0.02832$

| $\lambda$                    | Formula used  | For | $+\alpha_v$ | $-\alpha_v$ |     |
|------------------------------|---|-----|-------------|-------------|-----|
| $\lambda_{\text{dry}}$       | $= \tan^{-1} \frac{\alpha_h}{1 \pm \alpha_v}$   |     | 1.87        | 1.98        | deg |
| $\lambda_{\text{submerged}}$ | $= \tan^{-1} \frac{\gamma_{\text{sat}} * \alpha_h}{(\gamma_{\text{sat}} - 1) (1 \pm \alpha_v)}$ |     | 3.74        | 3.95        | deg |

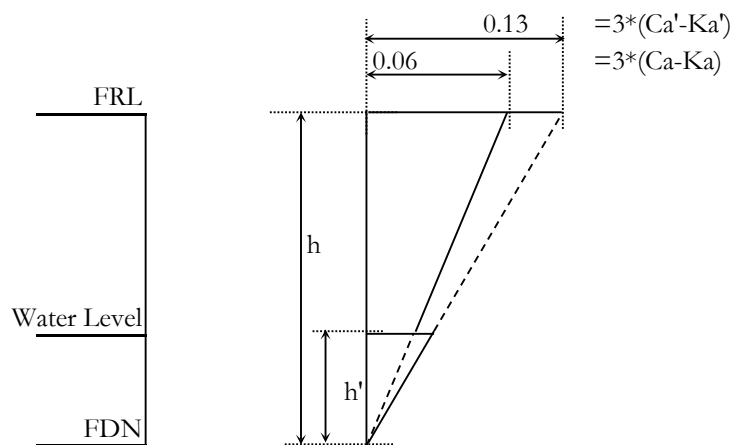
| $+\alpha_v$ | $-\alpha_v$ |         |
|-------------|-------------|---------|
| 0.03        | 0.03        | Radians |
| 0.07        | 0.07        | Radians |

| Seismic case (Coefficient of Earth Pressure) |         |       |
|--|---------|-------|
| For Seismic downward dry condition           | $C_a$   | 0.327 |
| For Seismic downward submerged condition     | $C_a'$  | 0.359 |
| For Seismic upward dry condition             | $C_a-$  | 0.310 |
| For Seismic upward submerged condition       | $C_a-'$ | 0.342 |

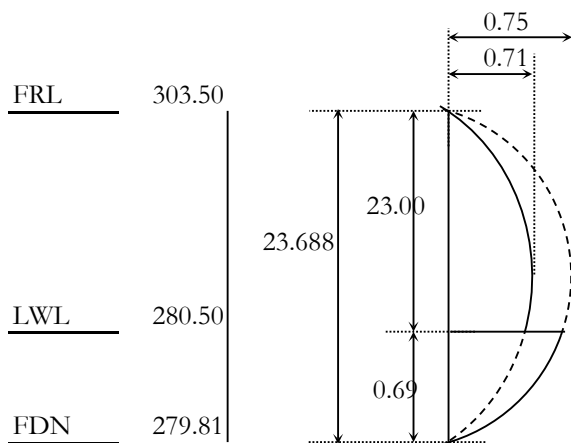


### 1) LWL Seismic Downward

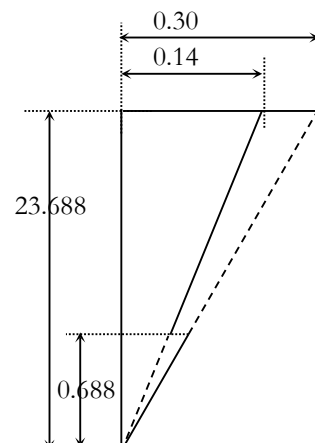
|                             |   |                      |
|-----------------------------|---|----------------------|
| $K_a$                       | = | 0.307                |
| $K_a'$                      | = | 0.317                |
| $C_a$                       | = | 0.327                |
| $C_a'$                      | = | 0.359                |
| $\gamma_{\text{dry}}$       | = | 2 t/m <sup>3</sup>   |
| $\gamma_{\text{sat}}$       | = | 2 t/m <sup>3</sup>   |
| $\gamma_{\text{sub}}$       | = | 1 t/m <sup>3</sup>   |
| $\delta$                    | = | 20 deg               |
| $\delta_{\text{submerged}}$ | = | 10 deg               |
| $q$                         | = | 2.4 t/m <sup>2</sup> |
| $L$                         | = | 12 m                 |
| $B$                         | = | 8.2 m                |



Dynamic Earth Pressure Coeff. Variation



Dynamic Earth Pressure



Dynamic Surcharge Pressure

#### Dyanmic Earth Pressure Calculation

Parabola above Water Level

|                         |   |                       |
|-------------------------|---|-----------------------|
| p <sub>mid_height</sub> | = | 0.71 t/m <sup>2</sup> |
| h                       | = | 23.688 m              |
| y                       | = | 11.156 m              |
| L                       | = | 12 m                  |

Parabola below Water Level

|                         |   |                       |
|-------------------------|---|-----------------------|
| p <sub>mid_height</sub> | = | 0.75 t/m <sup>2</sup> |
| h                       | = | 23.688 m              |
| y                       | = | -11.156 m             |
| L                       | = | 12 m                  |

| Dyanmic Earth Pressure              | Pa           | δ    | Pa*Cosδ      | ey          | Pa*Sinδ     | ex          |
|-------------------------------------|--------------|------|--------------|-------------|-------------|-------------|
|                                     | T            | deg. | T            | m           | T           | m           |
| Parabola above Water Level          | 134.3        | 20   | 126.2        | 11.9        | 45.9        | -8.2        |
| Parabola below Water Level          | 0.4          | 10   | 0.3          | 0.5         | 0.1         | -8.2        |
| <b>Total Dynamic Earth Pressure</b> | <b>134.6</b> |      | <b>126.5</b> | <b>11.8</b> | <b>46.0</b> | <b>-8.2</b> |

|                                     |   |                     |
|-------------------------------------|---|---------------------|
| <b>Total Dynamic Earth Pressure</b> | = | <b>134.62 Tonne</b> |
| <b>Horizontal Component</b>         | = | <b>126.52</b>       |
| <b>Lever arm</b>                    | = | <b>11.84</b>        |
| <b>Moment M<sub>TT</sub></b>        | = | <b>1498.13 Tm</b>   |
| <b>Vertical Component</b>           | = | <b>45.98</b>        |
| <b>Lever arm</b>                    | = | <b>-8.20 m</b>      |
| <b>Moment M<sub>TT</sub></b>        | = | <b>-377.075 Tm</b>  |
| <b>Net Moment M<sub>TT</sub></b>    | = | <b>1121.06 Tm</b>   |

#### Dyanmic Surcharge Pressure Calculation

Pressure Distribution above water level

|                          |   |                       |
|--------------------------|---|-----------------------|
| Intensity at top         | = | 0.14 t/m <sup>2</sup> |
| Intensity at water Level | = | 0.00 t/m <sup>2</sup> |
| h-h'                     | = | 23.00 m               |
| L                        | = | 12 m                  |

Pressure Distribution below water level

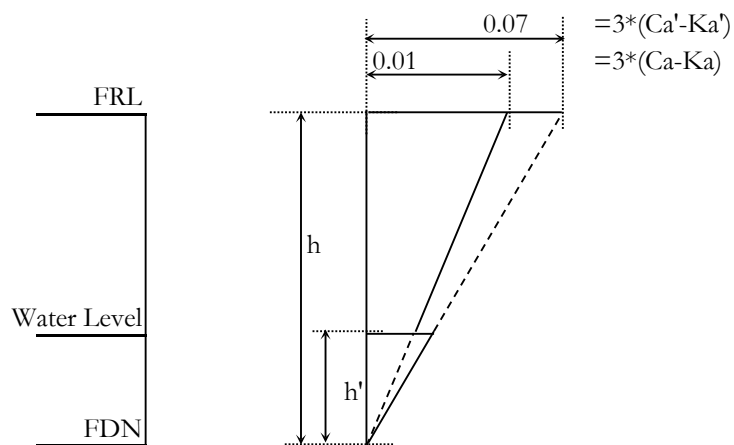
|                          |   |                       |
|--------------------------|---|-----------------------|
| Intensity at water Level | = | 0.01 t/m <sup>2</sup> |
| Intensity at base        | = | 0 t/m <sup>2</sup>    |
| h                        | = | 0.688 m               |
| L                        | = | 12 m                  |

| Dyanmic Surcharge Pressure              | Pa           | Lever arm above Base |
|---|--------------|----------------------|
|   | T/m          | m                    |
| Trapezodial Portion above water Level   | 20.44        | 15.80                |
| Traingular Portion below water Level    | 0.04         | 0.46                 |
| <b>Total Dynamic Surcharge Pressure</b> | <b>20.48</b> | <b>15.78</b>         |

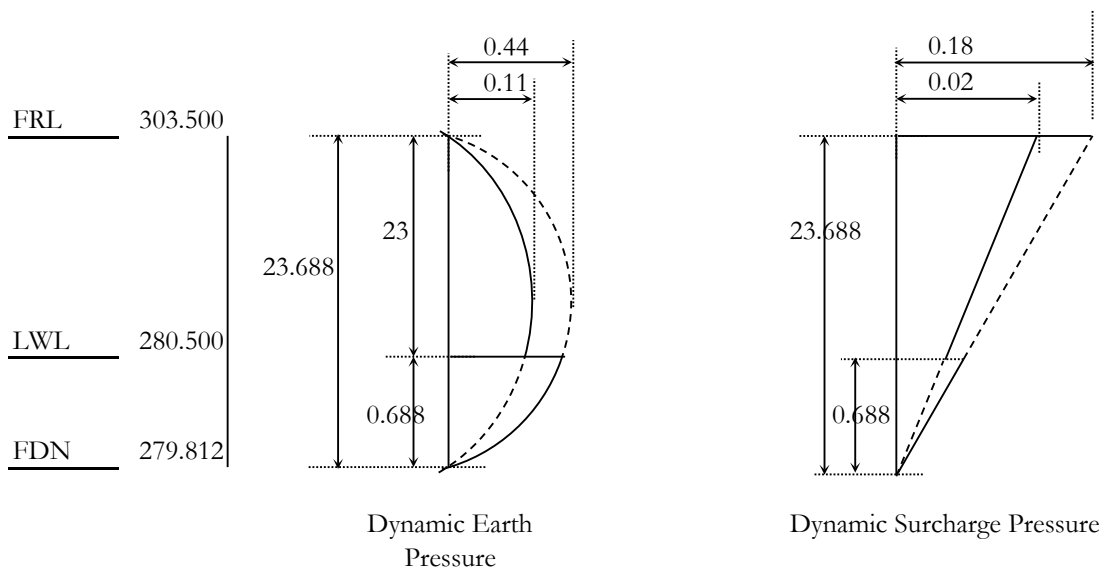
|                                 |   |                    |
|---------------------------------|---|--------------------|
| <b>Total Surcharge Pressure</b> | = | <b>20.48 Tonne</b> |
| <b>Levera arm above base</b>    | = | <b>15.78 m</b>     |
| <b>Moment M<sub>TT</sub></b>    | = | <b>323.06 Tm</b>   |

## 2) LWL Seismic Upward

|                      |   |                      |
|----------------------|---|----------------------|
| $K_a$                | = | 0.307                |
| $K_a'$               | = | 0.317                |
| $C_a$                | = | 0.310                |
| $C_a'$               | = | 0.342                |
| $\gamma_{dry}$       | = | 2 t/m <sup>3</sup>   |
| $\gamma_{sat}$       | = | 2 t/m <sup>3</sup>   |
| $\gamma_{sub}$       | = | 1 t/m <sup>3</sup>   |
| $\delta$             | = | 20 deg               |
| $\delta_{submerged}$ | = | 10 deg               |
| $q$                  | = | 2.4 t/m <sup>2</sup> |
| $L$                  | = | 12 m                 |
| $B$                  | = | 8.2 m                |



Dynamic Earth Pressure Coeff. Variation



Dynamic Earth Pressure

Dynamic Surcharge Pressure

### Dyanmic Earth Pressure Calculation

#### Parabola above Water Level

|                         |   |                       |
|-------------------------|---|-----------------------|
| p <sub>mid_height</sub> | = | 0.11 t/m <sup>2</sup> |
| h                       | = | 23.688 m              |
| y                       | = | 11.156 m              |
| L                       | = | 12 m                  |

#### Parabola below Water Level

|                         |   |                       |
|-------------------------|---|-----------------------|
| p <sub>mid_height</sub> | = | 0.44 t/m <sup>2</sup> |
| h                       | = | 23.688 m              |
| y                       | = | -11.156 m             |
| L                       | = | 12 m                  |

| Dyanmic Earth Pressure              | Pa          | δ    | Pa*Cosδ     | ey          | Pa*Sinδ    | ex          |
|-------------------------------------|-------------|------|-------------|-------------|------------|-------------|
|                                     | T           | deg. | T           | m           | T          | m           |
| Parabola above Water Level          | 21.5        | 20   | 20.2        | 11.9        | 7.3        | -8.2        |
| Parabola below Water Level          | 0.2         | 10   | 0.2         | 0.5         | 0.0        | -8.2        |
| <b>Total Dynamic Earth Pressure</b> | <b>21.7</b> |      | <b>20.4</b> | <b>11.8</b> | <b>7.4</b> | <b>-8.2</b> |

|                                     |   |                    |
|-------------------------------------|---|--------------------|
| <b>Total Dynamic Earth Pressure</b> | = | <b>21.66 Tonne</b> |
| <b>Horizontal Component</b>         | = | <b>20.37</b>       |
| <b>Lever arm</b>                    | = | <b>11.76</b>       |
| <b>Moment M<sub>TT</sub></b>        | = | <b>239.47 Tm</b>   |
| <b>Vertical Component</b>           | = | <b>7.37</b>        |
| <b>Lever arm</b>                    | = | <b>-8.20 m</b>     |
| <b>Moment M<sub>TT</sub></b>        | = | <b>-60.4718 Tm</b> |
| <b>Net Moment M<sub>TT</sub></b>    | = | <b>179.00 Tm</b>   |

### Dyanmic Surcharge Pressure Calculation

#### Pressure Distribution above water level

|                          |   |                        |
|--------------------------|---|------------------------|
| Intensity at top         | = | 0.02 t/m <sup>2</sup>  |
| Intensity at water Level | = | 0.001 t/m <sup>2</sup> |
| h-h'                     | = | 23 m                   |
| L                        | = | 12 m                   |

#### Pressure Distribution below water level

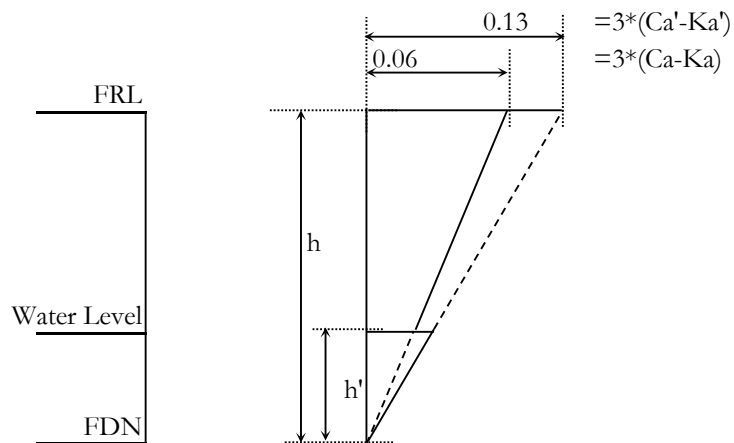
|                          |   |                       |
|--------------------------|---|-----------------------|
| Intensity at water Level | = | 0.01 t/m <sup>2</sup> |
| Intensity at base        | = | 0 t/m <sup>2</sup>    |
| h                        | = | 0.688 m               |
| L                        | = | 12 m                  |

| Dyanmic Surcharge Pressure              | Pa          | Lever arm above Base |
|---|-------------|----------------------|
|   | T/m         | m                    |
| Trapezoidal Portion above water Level   | 3.27        | 15.80                |
| Triangular Portion below water Level    | 0.02        | 0.46                 |
| <b>Total Dynamic Surcharge Pressure</b> | <b>3.29</b> | <b>15.70</b>         |

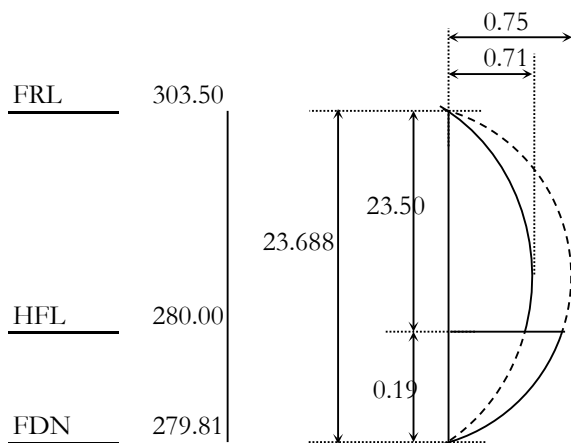
|                                 |   |                   |
|---------------------------------|---|-------------------|
| <b>Total Surcharge Pressure</b> | = | <b>3.29 Tonne</b> |
| <b>Lever arm above base</b>     | = | <b>15.70 m</b>    |
| <b>Moment M<sub>TT</sub></b>    | = | <b>51.63 Tm</b>   |

### 3) HFL Seismic Downward

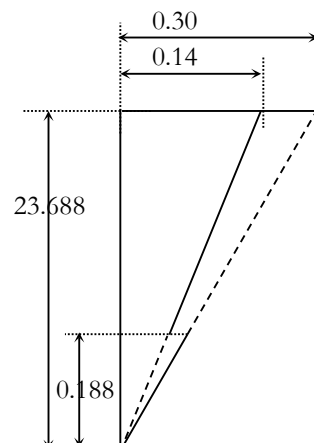
|                             |   |                      |
|-----------------------------|---|----------------------|
| $K_a$                       | = | 0.307                |
| $K_a'$                      | = | 0.317                |
| $C_a$                       | = | 0.327                |
| $C_a'$                      | = | 0.359                |
| $\gamma_{\text{dry}}$       | = | 2 t/m <sup>3</sup>   |
| $\gamma_{\text{sat}}$       | = | 2 t/m <sup>3</sup>   |
| $\gamma_{\text{sub}}$       | = | 1 t/m <sup>3</sup>   |
| $\delta$                    | = | 20 deg               |
| $\delta_{\text{submerged}}$ | = | 10 deg               |
| $q$                         | = | 2.4 t/m <sup>2</sup> |
| $L$                         | = | 12 m                 |
| $B$                         | = | 8.2 m                |



Dynamic Earth Pressure Coeff. Variation



Dynamic Earth Pressure



Dynamic Surcharge Pressure

#### Dyanmic Earth Pressure Calculation

##### Parabola above Water Level

|                         |   |                       |
|-------------------------|---|-----------------------|
| p <sub>mid_height</sub> | = | 0.71 t/m <sup>2</sup> |
| h                       | = | 23.688 m              |
| y                       | = | 11.656 m              |
| L                       | = | 12 m                  |

##### Parabola below Water Level

|                         |   |                       |
|-------------------------|---|-----------------------|
| p <sub>mid_height</sub> | = | 0.75 t/m <sup>2</sup> |
| h                       | = | 23.688 m              |
| y                       | = | -11.656 m             |
| L                       | = | 12 m                  |

| Dyanmic Earth Pressure              | Pa           | δ    | Pa*Cosδ      | ey          | Pa*Sinδ     | ex          |
|-------------------------------------|--------------|------|--------------|-------------|-------------|-------------|
|                                     | T            | deg. | T            | m           | T           | m           |
| Parabola above Water Level          | 134.6        | 20   | 126.5        | 11.8        | 46.0        | -8.2        |
| Parabola below Water Level          | 0.0          | 10   | 0.0          | 0.1         | 0.0         | -8.2        |
| <b>Total Dynamic Earth Pressure</b> | <b>134.6</b> |      | <b>126.5</b> | <b>11.8</b> | <b>46.0</b> | <b>-8.2</b> |

|                                     |   |                     |
|-------------------------------------|---|---------------------|
| <b>Total Dynamic Earth Pressure</b> | = | <b>134.61 Tonne</b> |
| <b>Horizontal Component</b>         | = | <b>126.49</b>       |
| <b>Lever arm</b>                    | = | <b>11.84</b>        |
| <b>Moment M<sub>TT</sub></b>        | = | <b>1498.12 Tm</b>   |
| <b>Vertical Component</b>           | = | <b>46.03</b>        |
| <b>Lever arm</b>                    | = | <b>-8.20 m</b>      |
| <b>Moment M<sub>TT</sub></b>        | = | <b>-377.476 Tm</b>  |
| <b>Net Moment M<sub>TT</sub></b>    | = | <b>1120.64 Tm</b>   |

#### Dyanmic Surcharge Pressure Calculation

##### Pressure Distribution above water level

|                          |   |                        |
|--------------------------|---|------------------------|
| Intensity at top         | = | 0.14 t/m <sup>2</sup>  |
| Intensity at water Level | = | 0.001 t/m <sup>2</sup> |
| h-h'                     | = | 23.5 m                 |
| L                        | = | 12 m                   |

##### Pressure Distribution below water level

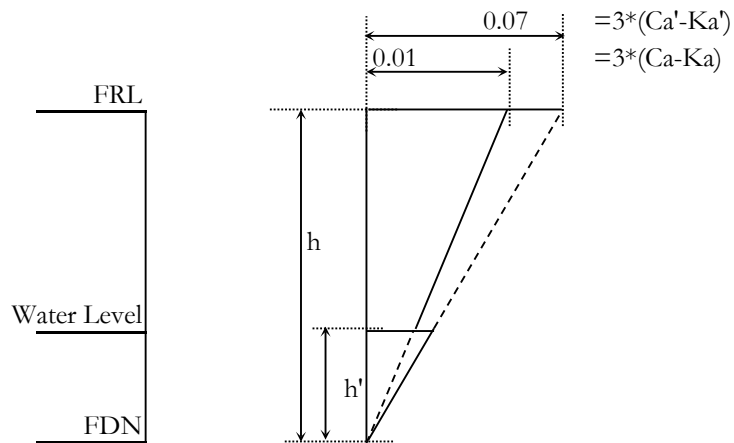
|                          |   |                       |
|--------------------------|---|-----------------------|
| Intensity at water Level | = | 0.00 t/m <sup>2</sup> |
| Intensity at base        | = | 0 t/m <sup>2</sup>    |
| h                        | = | 0.188 m               |
| L                        | = | 12 m                  |

| Dyanmic Surcharge Pressure              | Pa           | Lever arm above Base |
|---|--------------|----------------------|
|   | T/m          | m                    |
| Trapezoidal Portion above water Level   | 20.46        | 15.79                |
| Triangular Portion below water Level    | 0.00         | 0.13                 |
| <b>Total Dynamic Surcharge Pressure</b> | <b>20.46</b> | <b>15.79</b>         |

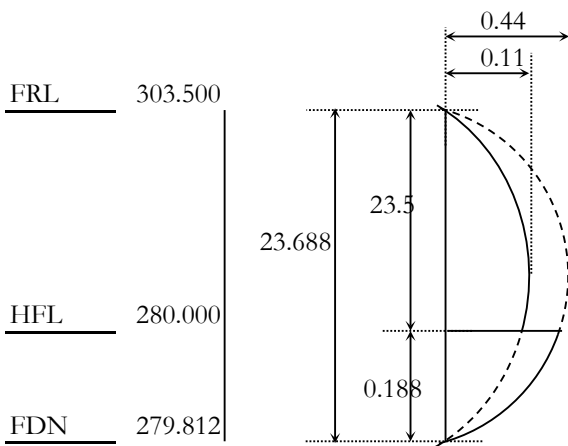
|                                 |   |                    |
|---------------------------------|---|--------------------|
| <b>Total Surcharge Pressure</b> | = | <b>20.46 Tonne</b> |
| <b>Lever arm above base</b>     | = | <b>15.79 m</b>     |
| <b>Moment M<sub>TT</sub></b>    | = | <b>323.05 Tm</b>   |

#### 4) HFL Seismic Upward

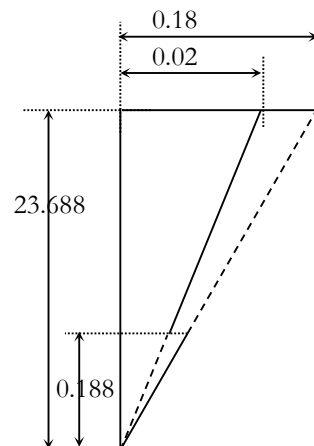
|                      |   |                      |
|----------------------|---|----------------------|
| $K_a$                | = | 0.307                |
| $K_a'$               | = | 0.317                |
| $C_a$                | = | 0.310                |
| $C_a'$               | = | 0.342                |
| $\gamma_{dry}$       | = | 2 t/m <sup>3</sup>   |
| $\gamma_{sat}$       | = | 2 t/m <sup>3</sup>   |
| $\gamma_{sub}$       | = | 1 t/m <sup>3</sup>   |
| $\delta$             | = | 20 deg               |
| $\delta_{submerged}$ | = | 10 deg               |
| $q$                  | = | 2.4 t/m <sup>2</sup> |
| $L$                  | = | 12 m                 |
| $B$                  | = | 8.2 m                |



Dynamic Earth Pressure Coeff. Variation



Dynamic Earth Pressure



Dynamic Surcharge Pressure

### Dyanmic Earth Pressure Calculation

Parabola above Water Level

|                         |   |                       |
|-------------------------|---|-----------------------|
| p <sub>mid_height</sub> | = | 0.11 t/m <sup>2</sup> |
| h                       | = | 23.688 m              |
| y                       | = | 11.656 m              |
| L                       | = | 12 m                  |

Parabola below Water Level

|                         |   |                       |
|-------------------------|---|-----------------------|
| p <sub>mid_height</sub> | = | 0.44 t/m <sup>2</sup> |
| h                       | = | 23.688 m              |
| y                       | = | -11.656 m             |
| L                       | = | 12 m                  |

| Dyanmic Earth Pressure              | Pa          | δ    | Pa*cosδ     | ey          | Pa*sinδ    | ex          |
|-------------------------------------|-------------|------|-------------|-------------|------------|-------------|
|                                     | T           | deg. | T           | m           | T          | m           |
| Parabola above Water Level          | 21.5        | 20   | 20.2        | 11.8        | 7.4        | -8.2        |
| Parabola below Water Level          | 0.0         | 10   | 0.0         | 0.1         | 0.0        | -8.2        |
| <b>Total Dynamic Earth Pressure</b> | <b>21.5</b> |      | <b>20.2</b> | <b>11.8</b> | <b>7.4</b> | <b>-8.2</b> |

|                                     |   |                    |
|-------------------------------------|---|--------------------|
| <b>Total Dynamic Earth Pressure</b> | = | <b>21.52 Tonne</b> |
| <b>Horizontal Component</b>         | = | <b>20.22</b>       |
| <b>Lever arm</b>                    | = | <b>11.84</b>       |
| <b>Moment M<sub>TT</sub></b>        | = | <b>239.40 Tm</b>   |
| <b>Vertical Component</b>           | = | <b>7.36</b>        |
| <b>Lever arm</b>                    | = | <b>-8.20 m</b>     |
| <b>Moment M<sub>TT</sub></b>        | = | <b>-60.3363 Tm</b> |
| <b>Net Moment M<sub>TT</sub></b>    | = | <b>179.06 Tm</b>   |

### Dyanmic Surcharge Pressure Calculation

Pressure Distribution above water level

|                          |   |                        |
|--------------------------|---|------------------------|
| Intensity at top         | = | 0.02 t/m <sup>2</sup>  |
| Intensity at water Level | = | 0.000 t/m <sup>2</sup> |
| h-h'                     | = | 23.5 m                 |
| L                        | = | 12 m                   |

Pressure Distribution below water level

|                          |   |                       |
|--------------------------|---|-----------------------|
| Intensity at water Level | = | 0.00 t/m <sup>2</sup> |
| Intensity at base        | = | 0 t/m <sup>2</sup>    |
| h                        | = | 0.188 m               |
| L                        | = | 12 m                  |

| Dyanmic Surcharge Pressure              | Pa          | Lever arm above Base |
|---|-------------|----------------------|
|   | T/m         | m                    |
| Trapezoidal Portion above water Level   | 3.27        | 15.79                |
| Triangular Portion below water Level    | 0.00        | 0.13                 |
| <b>Total Dynamic Surcharge Pressure</b> | <b>3.27</b> | <b>15.79</b>         |

|                                 |   |                   |
|---------------------------------|---|-------------------|
| <b>Total Surcharge Pressure</b> | = | <b>3.27 Tonne</b> |
| <b>Lever arm above base</b>     | = | <b>15.79 m</b>    |
| <b>Moment M<sub>TT</sub></b>    | = | <b>51.62 Tm</b>   |



**1) SUMMARY DYNAMIC PRESSURE FOR OVERTURNING & SLIDING:**

**a) EARTH PRESSURE FOR OVERTURNING & SLIDING:**

| Description   | Dynamic Earth Pressure       |                        |              |                        |
|---|------------------------------|------------------------|--------------|------------------------|
|   | Horizontal (H <sub>L</sub> ) | M <sub>TT</sub> (Dest) | Vertical (V) | M <sub>TT</sub> (Steb) |
|   | Tonne                        | Tm                     | Tonne        | Tm                     |
| 1) LWL Seismic Downward<br>Horizontal Component<br>Vertical Component | 126.52                       | 1498.13                | 45.98        | -377.07                |
| 2) LWL Seismic Upward<br>Horizontal Component<br>Vertical Component   | 20.37                        | 239.47                 | 7.37         | -60.47                 |
| 3) HFL Seismic Downward<br>Horizontal Component<br>Vertical Component | 126.49                       | 1498.12                | 46.03        | -377.48                |
| 4) HFL Seismic Upward<br>Horizontal Component<br>Vertical Component   | 20.22                        | 239.40                 | 7.36         | -60.34                 |

**b) SURCHARGE PRESSURE FOR OVERTURNING & SLIDING:**

| Description             | Dynamic Surcharge Pressure   |                        |
|-------------------------|------------------------------|------------------------|
|                         | Horizontal (H <sub>L</sub> ) | M <sub>TT</sub> (Dest) |
|                         | Tonne                        | Tm                     |
| 1) LWL Seismic Downward | 20.48                        | 323.06                 |
| 2) LWL Seismic Upward   | 3.29                         | 51.63                  |
| 3) HFL Seismic Downward | 20.46                        | 323.05                 |
| 4) HFL Seismic Upward   | 3.27                         | 51.62                  |

**2) SUMMARY DYNAMIC PRESSURE FOR BASE PRESSURE:**

Total base width = 8.2 m  
Distance from toe to shaft back = 4.8 m

| <b><i>a) EARTH PRESSURE FOR BASE PRESSURE:</i></b>                    |                              |                        |               |                        |
|---|------------------------------|------------------------|---------------|------------------------|
| Description   | Dynamic Earth Pressure       |                        |               |                        |
|   | Horizontal (H <sub>L</sub> ) | M <sub>TT (Dest)</sub> | Vertical (V ) | M <sub>TT (Steb)</sub> |
|   | Tonne                        | Tm                     | Tonne         | Tm                     |
| 1) LWL Seismic Downward<br>Horizontal Component<br>Vertical Component | 126.52                       | 1498.13                | 45.98         | -220.73                |
| 2) LWL Seismic Upward<br>Horizontal Component<br>Vertical Component   | 20.37                        | 239.47                 | 7.37          | -35.40                 |
| 3) HFL Seismic Downward<br>Horizontal Component<br>Vertical Component | 126.49                       | 1498.12                | 46.03         | -220.96                |
| 4) HFL Seismic Upward<br>Horizontal Component<br>Vertical Component   | 20.22                        | 239.40                 | 7.36          | -35.32                 |

***b) SURCHARGE PRESSURE FOR BASE PRESSURE:***

| Description             | Dynamic Surcharge Pressure   |                        |
|-------------------------|------------------------------|------------------------|
|                         | Horizontal (H <sub>L</sub> ) | M <sub>TT (Dest)</sub> |
|                         | Tonne                        | Tm                     |
| 1) LWL Seismic Downward | 20.48                        | 323.06                 |
| 2) LWL Seismic Upward   | 3.29                         | 51.63                  |
| 3) HFL Seismic Downward | 20.46                        | 323.05                 |
| 4) HFL Seismic Upward   | 3.27                         | 51.62                  |

**SEISMIC COMPONENT OF SUPER-STRUCTURE DL & SIDL :**

|   |          |   |         |
|---|----------|---|---------|
| Longitudinal Horizontal seismic coefficient | $A_{hL}$ | = | 0.03358 |
| Transverse Horizontal seismic coefficient   | $A_{hT}$ | = | 0.12746 |
| Vertical seismic coefficient                | $A_V$    | = | 0.02832 |

Loads & Their Lever arm from base slab bottom

| Description                |   | W      | ey    |
|----------------------------|---|--------|-------|
|                            |   | Tonne  | m     |
| Total Super-Structure DL   | = | 797.9  | 23.30 |
| Total Super-Structure SIDL | = | 234.0  | 23.93 |
| Total Surfacing weight     | = | 68.1   | 23.66 |
| Total                      |   | 1099.9 | 23.5  |

W = Weight of super-structure

ey = Cg. above base slab in vertical direction

Distance From base slab bottom to bearing top = 21.22 m

Distance from toe tip to c/L of brg = -3.425 m

**SEISMIC LONGITUDINAL :**

|  |          |   |              |
|--|----------|---|--------------|
| Longitudinal seismic coefficient         | $A_{hL}$ | = | 0.03358      |
| Total weight of sup DL, SIDL & surfacing |          | = | 1099.9 Tonne |

***Forces at fixed end***

|                                |   |            |
|--------------------------------|---|------------|
| Seismic Component              | = | 36.9 Tonne |
| Lever arm above base slab      | = | 21.2 m     |
| Moment about T-T axis $M_{TT}$ | = | 783.7 Tm   |

***Forces at free end***

|                                |   |           |
|--------------------------------|---|-----------|
| Seismic Component              | = | 0.0 Tonne |
| Lever arm above base slab      | = | 0.0 m     |
| Moment about T-T axis $M_{TT}$ | = | 0.0 Tm    |

**SEISMIC TRANSVERSE :**

|  |          |   |              |
|--|----------|---|--------------|
| Horizontal seismic coefficient           | $A_{hT}$ | = | 0.12746      |
| Total weight of sup DL, SIDL & surfacing |          | = | 1099.9 Tonne |

***Forces at fixed end***

|                               |  |   |            |
|-------------------------------|--|---|------------|
| Seismic Component             |  | = | 70.1 Tonne |
| Lever arm above base slab     |  | = | 23.5 m     |
| Moment about LL axis $M_{LL}$ |  | = | 1644.1 Tm  |

***Forces at free end***

|                               |  |   |            |
|-------------------------------|--|---|------------|
| Seismic Component             |  | = | 70.1 Tonne |
| Lever arm above base slab     |  | = | 23.5 m     |
| Moment about LL axis $M_{LL}$ |  | = | 1644.1 Tm  |

**SEISMIC VERTICAL :**

|  |       |   |              |
|--|-------|---|--------------|
| Horizontal seismic coefficient           | $A_v$ | = | 0.02832      |
| Total weight of sup DL, SIDL & surfacing |       | = | 1099.9 Tonne |

***Forces at fixed end***

|                                |  |   |            |
|--------------------------------|--|---|------------|
| Seismic Component              |  | = | 15.6 Tonne |
| Lever arm from toe             |  | = | -3.4 m     |
| Moment about T-T axis $M_{TT}$ |  | = | -53.4 Tm   |

***Forces at free end***

|                                |  |   |            |
|--------------------------------|--|---|------------|
| Seismic Component              |  | = | 15.6 Tonne |
| Lever arm from toe             |  | = | -3.4 m     |
| Moment about T-T axis $M_{TT}$ |  | = | -53.4 Tm   |

**Summary of Permanent Load (DL+SIDL+SURFACING) seismic Component :**

| At Fixed End, Force about toe | V<br>T | $H_L$<br>T | $H_T$<br>T | ey<br>m | $e_L$<br>m | $M_{LL}$<br>Tm | $M_{TT}$<br>Tm |
|-------------------------------|--------|------------|------------|---------|------------|----------------|----------------|
| Seismic Longitudinal          |        | 36.9       |            | 21.2    |            |                | 783.7          |
| Seismic Transverse            |        |            | 70.1       | 23.5    |            | 1644.1         |                |
| Seismic Vertical              | 15.6   |            |            |         | -3.4       |                | -53.4          |

**SEISMIC COMPONENT OF LIVE LOAD :**

|   |          |   |         |
|---|----------|---|---------|
| Longitudinal Horizontal seismic coefficient | $A_{hL}$ | = | 0.03358 |
| Transverse Horizontal seismic coefficient   | $A_{hT}$ | = | 0.12746 |
| Vertical seismic coefficient                | $A_v$    | = | 0.02832 |

Loads & Their Lever arm from base slab bottom

| Description         | W     | ey   |
|---------------------|-------|------|
|                     | Tonne | m    |
| Maximum Live Load = | 137.4 | 24.9 |
| Minimum Live Load   | 28.8  | 24.9 |

W = Live Load Reaction

ey = Cg. above base slab in vertical direction

Distance From base slab bottom to bearing top = 21.285 m

Distance from toe tip to c/L of brg. = -3.425 m

**SEISMIC LONGITUDINAL :**

No Live Load seismic component is considered in longitudinal direction

**SEISMIC TRANSVERSE :**

Horizontal seismic coefficient  $A_{hT}$  = 0.12746

**Max Live Load Reaction Case :**

|                               |   |              |
|-------------------------------|---|--------------|
| Maximum Live Load reaction    | = | 137.40 Tonne |
| Seismic Component             | = | 17.51 Tonne  |
| Lever arm above base slab     | = | 24.89 m      |
| Moment about LL axis $M_{LL}$ | = | 435.87 Tm    |

**Min Live Load Reaction Case :**

|                               |   |             |
|-------------------------------|---|-------------|
| Minimum Live Load reaction    | = | 28.80 Tonne |
| Seismic Component             | = | 3.67 Tonne  |
| Lever arm above base slab     | = | 24.89 m     |
| Moment about LL axis $M_{LL}$ | = | 91.36 Tm    |

**SEISMIC VERTICAL :**

Vertical seismic coefficient  $A_{hT}$  = 0.02832

**Max Live Load Reaction Case :**

Maximum Live Load reaction = 137.40 Tonne  
 Seismic Component = 3.89 Tonne  
 Lever arm from toe = -3.43 m  
 Moment about LL axis  $M_{LL}$  = -13.33 Tm

**Min Live Load Reaction Case :**

Minimum Live Load reaction = 28.80 Tonne  
 Seismic Component = 0.82 Tonne  
 Lever arm from toe = -3.43 m  
 Moment about LL axis  $M_{LL}$  = -2.79 Tm

**Summary of LL seismic component transferred from super-structure :****Max Live Load Reaction Case :**

| At Fixed/ Free End   | V<br>T | $H_L$<br>T | $H_T$<br>T | ey<br>m | $e_L$<br>m | $M_{LL}$<br>Tm | $M_{TT}$<br>Tm |
|----------------------|--------|------------|------------|---------|------------|----------------|----------------|
| Seismic Longitudinal |        | 0.0        |            | 0.0     |            |                | 0.0            |
| Seismic Transverse   |        |            | 17.5       | 24.89   |            | 435.9          |                |
| Seismic Vertical     | 3.9    |            |            | -3.43   |            |                | -13.3          |

**Min Live Load Reaction Case :**

| At Fixed/ Free End   | V<br>T | $H_L$<br>T | $H_T$<br>T | ey<br>m | $e_L$<br>m | $M_{LL}$<br>Tm | $M_{TT}$<br>Tm |
|----------------------|--------|------------|------------|---------|------------|----------------|----------------|
| Seismic Longitudinal |        | 0.0        |            | 0.0     |            |                | 0.0            |
| Seismic Transverse   |        |            | 3.7        | 24.89   |            | 91.4           |                |
| Seismic Vertical     | 0.8    |            |            | -3.43   |            |                | -2.8           |

**SEISMIC COMPONENT OF SUB-STRUCTURE & BACKFILL :**

|   |          |   |         |
|---|----------|---|---------|
| Longitudinal Horizontal seismic coefficient | $A_{hL}$ | = | 0.03358 |
| Transverse Horizontal seismic coefficient   | $A_{hT}$ | = | 0.12746 |
| Vertical seismic coefficient                | $A_v$    | = | 0.02832 |

**Sub-structure Vertical load**

| Description     | W     | ey   | ex   |
|-----------------|-------|------|------|
|                 | Tonne | m    | m    |
| Sub-structure = | 829.5 | 11.5 | -3.9 |
| Return wall =   | 105.0 | 4.4  | -6.5 |
| Total           | 934.5 | 10.7 | -4.2 |

W = Weight of super-structure

ey = Cg. above base slab in vertical direction

**Backfill Vertical load**

| Description       | W      | ey  | ex   |
|-------------------|--------|-----|------|
|                   | Tonne  | m   | m    |
| Backfill Weight = | 1265.2 | 9.9 | -6.6 |
| Total             | 1265.2 | 9.9 | -6.6 |

**SEISMIC LONGITUDINAL :**

|                                  |          |   |               |
|----------------------------------|----------|---|---------------|
|                                  |          |   | Sub-Structure |
| Longitudinal seismic coefficient | $A_{hL}$ | = | 0.03358       |
| Total weight of Sub-structure    |          | = | 934.5 Tonne   |
| Seismic Component                |          | = | 31.4 Tonne    |
| Lever arm above base slab        |          | = | 10.7 m        |
| Moment about T-T axis $M_{TT}$   |          | = | 336.7 Tm      |

**SEISMIC TRANSVERSE :**

|                                |          |   |             |
|--------------------------------|----------|---|-------------|
| Horizontal seismic coefficient | $A_{hT}$ | = | 0.12746     |
| Total weight of Sub-structure  |          | = | 934.5 Tonne |
| Seismic Component              |          | = | 119.1 Tonne |
| Lever arm above base slab      |          | = | 10.7 m      |
| Moment about LL axis $M_{LL}$  |          | = | 1278.2 Tm   |

**SEISMIC VERTICAL :**

|                                |       |   |             |
|--------------------------------|-------|---|-------------|
| Horizontal seismic coefficient | $A_v$ | = | 0.02832     |
| Total weight of Sub-structure  |       | = | 934.5 Tonne |
| Seismic Component              |       | = | 26.5 Tonne  |
| Lever arm from toe             |       | = | -4.2 m      |
| Moment about T-T axis $M_{TT}$ |       | = | -110.9 Tm   |

**Summary of Sub-structure seismic component :**

| At Fixed End         | V<br>T | $H_L$<br>T | $H_T$<br>T | $M_{LL}$<br>Tm | $M_{TT}$<br>Tm |
|----------------------|--------|------------|------------|----------------|----------------|
| Seismic Longitudinal |        | 31.4       |            |                | 336.7          |
| Seismic Transverse   |        |            | 119.1      | 1278.2         |                |
| Seismic Vertical     | 26.5   |            |            |                | -110.9         |

**SEISMIC COMPONENT OF BACK FILL :****SEISMIC LONGITUDINAL :**

|                                  |          |   |              |
|----------------------------------|----------|---|--------------|
|                                  |          |   | Earth Fill   |
| Longitudinal seismic coefficient | $A_{hL}$ | = | 0.03358      |
| Total weight of Sub-structure    |          | = | 1265.2 Tonne |
| Seismic Component                |          | = | 42.5 Tonne   |
| Lever arm above base slab        |          | = | 9.9 m        |
| Moment about T-T axis $M_{TT}$   |          | = | 420.3 Tm     |

**SEISMIC TRANSVERSE :**

|                                |          |   |              |
|--------------------------------|----------|---|--------------|
| Horizontal seismic coefficient | $A_{hT}$ | = | 0.12746      |
| Total weight of Sub-structure  |          | = | 1265.2 Tonne |
| Seismic Component              |          | = | 161.3 Tonne  |
| Lever arm above base slab      |          | = | 9.9 m        |
| Moment about LL axis $M_{LL}$  |          | = | 1595.3 Tm    |

**SEISMIC VERTICAL :**

|                                |       |   |              |
|--------------------------------|-------|---|--------------|
| Horizontal seismic coefficient | $A_v$ | = | 0.02832      |
| Total weight of Sub-structure  |       | = | 1265.2 Tonne |
| Seismic Component              |       | = | 35.8 Tonne   |
| Lever arm from toe             |       | = | -6.6 m       |
| Moment about T-T axis $M_{TT}$ |       | = | -237.9 Tm    |



***Summery of Earthfill seismic component :***

| At Fixed End         | V    | H <sub>L</sub> | H <sub>T</sub> | M <sub>LL</sub> | M <sub>TT</sub> |
|----------------------|------|----------------|----------------|-----------------|-----------------|
|                      | T    | T              | T              | Tm              | Tm              |
| Seismic Longitudinal |      | 42.5           |                |                 | 420.3           |
| Seismic Transverse   |      |                | 161.3          | 1595.3          |                 |
| Seismic Vertical     | 35.8 |                |                |                 | -237.9          |

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LOAD COMBINATION  
FOR BASE PRESSURE CHECK

| LC-1  | NS, LWL, Span dislodge, FP  | Forces about toe |                |                |                 |                 |  | LC-1 |
|-------|-----------------------------|------------------|----------------|----------------|-----------------|-----------------|--|------|
| S.N.  | Description                 | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |  |      |
|       |                             | Tonne            | Tonne          | Tonne          | Tm              | Tm              |  |      |
| 1)    | Sub-structure & Foundation  | 1317.6           |                |                | -5480.8         | 0.0             |  | 0.95 |
| 2)    | Backfill                    | 1265.2           |                |                | -8398.4         | 0.0             |  | 0.95 |
| 9)    | Fluid Pressure              |                  | 0.10           |                | 0.01            |                 |  | 1.5  |
| 10.1) | Surcharge Pressure LWL(O/S) |                  | 121.2          |                | 828.4           |                 |  | 1.2  |

| S.N. | Description                | Forces about toe |                |                |                       |                       |                       |                       |
|------|----------------------------|------------------|----------------|----------------|-----------------------|-----------------------|-----------------------|-----------------------|
|      |                            | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT(Dest)</sub> | M <sub>TT(Steb)</sub> | M <sub>LL(Dest)</sub> | M <sub>LL(Steb)</sub> |
|      |                            | Tonne            | Tonne          | Tonne          | Tm                    | Tm                    | Tm                    | Tm                    |
| LC-1 | NS, LWL, Span dislodge, FP | 2453.71          | 145.619        | 0              | 994.036               | -13185.3              | 0                     | 0                     |

| LC-2  | NS, LWL, Span dislodge, EP  | Forces about toe |                |                |                 |                 |  | LC-2 |
|-------|-----------------------------|------------------|----------------|----------------|-----------------|-----------------|--|------|
| S.N.  | Description                 | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |  |      |
|       |                             | Tonne            | Tonne          | Tonne          | Tm              | Tm              |  |      |
| 1)    | Sub-structure & Foundation  | 1317.6           |                |                | -5480.8         | 0.0             |  | 0.95 |
| 2)    | Backfill                    | 1265.2           |                |                | -8398.4         | 0.0             |  | 0.95 |
| 9.1)  | Earth Pressure LWL (O/S)    |                  |                |                |                 |                 |  | 1.5  |
|       | Horizontal Component        |                  | 650.8          |                | 3619.4          |                 |  | 1.5  |
|       | Vertical Component          | 224.5            |                |                | -1841.2         |                 |  | 1.5  |
| 10.1) | Surcharge Pressure LWL(O/S) |                  | 121.2          |                | 828.4           |                 |  | 1.2  |

| S.N. | Description                | Forces about toe |                |                |                       |                       |                       |                       |
|------|----------------------------|------------------|----------------|----------------|-----------------------|-----------------------|-----------------------|-----------------------|
|      |                            | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT(Dest)</sub> | M <sub>TT(Steb)</sub> | M <sub>LL(Dest)</sub> | M <sub>LL(Steb)</sub> |
|      |                            | Tonne            | Tonne          | Tonne          | Tm                    | Tm                    | Tm                    | Tm                    |
| LC-2 | NS, LWL, Span dislodge, EP | 2790.52          | 1121.72        | 0              | 6423.14               | -15947.1              | 0                     | 0                     |

| LC-3 | NS, LWL, Min LL Lead, FP             | Forces about toe |                |                |                 |                 |  | LC-3 |
|------|--------------------------------------|------------------|----------------|----------------|-----------------|-----------------|--|------|
| S.N. | Description                          | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |  |      |
|      |                                      | Tonne            | Tonne          | Tonne          | Tm              | Tm              |  |      |
| 1)   | Sub-structure & Foundation           | 1317.6           |                |                | -5480.8         | 0.0             |  | 0.95 |
| 2)   | Backfill                             | 1265.2           |                |                | -8398.4         | 0.0             |  | 0.95 |
| 3)   | Super-structure DL                   | 398.9            |                |                | -1366.4         | 0.0             |  | 0.95 |
| 4)   | SIDL (excluding surfacing)           | 117.0            |                |                | -400.7          | 0.0             |  | 0.95 |
| 5)   | Surfacing                            | 34.0             |                |                | -116.5          | -8.5            |  | 1    |
| 6.2) | Live Load Vertical Load Min Reaction | 28.8             |                |                | -98.6           | 83.8            |  | 1.5  |
| 7)   | Live Load Horizontal Forces          |                  | 45.8           |                | 970.9           |                 |  | 1.5  |
| 9)   | Fluid Pressure                       |                  | 0.10           |                | 0.01            |                 |  | 1.5  |

|       |                             |  |       |  |       |  |  |     |
|-------|-----------------------------|--|-------|--|-------|--|--|-----|
| 10.1) | Surcharge Pressure LWL(O/S) |  | 121.2 |  | 828.4 |  |  | 1.2 |
|-------|-----------------------------|--|-------|--|-------|--|--|-----|

| S.N. | Description              | Forces about toe |                |                |                       |                       |                       |                       |
|------|--------------------------|------------------|----------------|----------------|-----------------------|-----------------------|-----------------------|-----------------------|
|      |                          | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT(Dest)</sub> | M <sub>TT(Steb)</sub> | M <sub>LL(Dest)</sub> | M <sub>LL(Steb)</sub> |
|      |                          | Tonne            | Tonne          | Tonne          | Tm                    | Tm                    | Tm                    | Tm                    |
| LC-3 | NS, LWL, Min LL Lead, FP | 3021.07          | 214.249        | 0              | 2450.36               | -15128.5              | 125.711               | -8.50627              |

| S.N.  | Description                          | Forces about toe |                |                |                 |                 | LC-4 |
|-------|--------------------------------------|------------------|----------------|----------------|-----------------|-----------------|------|
|       |                                      | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |      |
|       |                                      | Tonne            | Tonne          | Tonne          | Tm              | Tm              |      |
| 1)    | Sub-structure & Foundation           | 1317.6           |                |                | -5480.8         | 0.0             | 0.95 |
| 2)    | Backfill                             | 1265.2           |                |                | -8398.4         | 0.0             | 0.95 |
| 3)    | Super-structure DL                   | 398.9            |                |                | -1366.4         | 0.0             | 0.95 |
| 4)    | SIDL (excluding surfacing)           | 117.0            |                |                | -400.7          | 0.0             | 0.95 |
| 5)    | Surfacing                            | 34.0             |                |                | -116.5          | -8.5            | 1    |
| 6.2)  | Live Load Vertical Load Min Reaction | 28.8             |                |                | -98.6           | 83.8            | 1.5  |
| 7)    | Live Load Horizontal Forces          |                  | 45.8           |                | 970.9           |                 | 1.5  |
| 9.1)  | Earth Pressure LWL (O/S)             |                  |                |                |                 |                 | 1.5  |
|       | Horizontal Component                 |                  | 650.8          |                | 3619.4          |                 | 1.5  |
|       | Vertical Component                   | 224.5            |                |                | -1841.2         |                 | 1.5  |
| 10.1) | Surcharge Pressure LWL(O/S)          |                  | 121.2          |                | 828.4           |                 | 1.2  |

| S.N. | Description              | Forces about toe |                |                |                       |                       |                       |                       |
|------|--------------------------|------------------|----------------|----------------|-----------------------|-----------------------|-----------------------|-----------------------|
|      |                          | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT(Dest)</sub> | M <sub>TT(Steb)</sub> | M <sub>LL(Dest)</sub> | M <sub>LL(Steb)</sub> |
|      |                          | Tonne            | Tonne          | Tonne          | Tm                    | Tm                    | Tm                    | Tm                    |
| LC-4 | NS, LWL, Min LL Lead, EP | 3357.88          | 1190.35        | 0              | 7879.46               | -17890.3              | 125.711               | -8.50627              |

| S.N.                        | Description                                     | Forces about toe |                |                |                 |                 | LC-5  |
|-----------------------------|---|------------------|----------------|----------------|-----------------|-----------------|-------|
|                             |   | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |       |
|                             |   | Tonne            | Tonne          | Tonne          | Tm              | Tm              |       |
| 1)                          | Sub-structure & Foundation                      | 1317.6           |                |                | -5480.8         | 0.0             | 0.95  |
| 2)                          | Backfill  | 1265.2           |                |                | -8398.4         | 0.0             | 0.95  |
| 9.1)                        | Earth Pressure LWL (O/S)                        |                  |                |                |                 |                 | 1     |
|                             | Horizontal Component                            |                  | 650.8          |                | 3619.4          |                 | 1     |
|                             | Vertical Component                              | 224.5            |                |                | -1841.2         |                 | 1     |
| <b>Seismic Longitudinal</b> |   |                  |                |                |                 |                 | 0.75  |
| 11)                         | Sub-structure Component                         |                  | 31.4           |                | 336.7           |                 | 0.75  |
| 12)                         | Earth fill component                            |                  | 42.5           |                | 420.3           |                 | 0.75  |
| 12)                         | Super-Structure DL, SIDL, & Surfacing Component |                  | 36.9           |                | 783.7           |                 | 0.75  |
| 13)                         | Dynamic Earth Pressure LWL                      |                  |                |                |                 |                 | 0.75  |
| 13.1)                       | LWL Seismic Downward_O/S                        |                  |                |                |                 |                 | 0.75  |
|                             | Horizontal Component                            |                  | 126.5          |                | 1498.1          |                 | 0.75  |
|                             | Vertical Component                              | 46.0             |                |                | -377.1          |                 | 0.75  |
| <b>Seismic Transverses</b>  |   |                  |                |                |                 |                 | 0.225 |
| 15)                         | Sub-structure Component                         |                  |                | 119.1          |                 | 1278.2          | 0.225 |
| 17)                         | Super-Structure DL, SIDL, & Surfacing Component |                  |                | 70.1           |                 | 1644.1          | 0.225 |

|                                  |                                       |         |  |     |          |      |  |       |
|----------------------------------|---------------------------------------|---------|--|-----|----------|------|--|-------|
| 18.2)                            | Live Load Component (Min. Reaction)   |         |  | 3.7 |          | 91.4 |  | 0.045 |
| <b>Seismic Vertical Downward</b> |                                       |         |  |     |          |      |  | 0.225 |
| 19)                              | Sub-structure Component               | 26.47   |  |     | -110.931 |      |  | 0.225 |
| 20)                              | Earthfill component                   | 35.8    |  |     | -237.9   |      |  | 0.225 |
| 21)                              | Super-Structure DL, SIDL, & Surfacing | 15.5776 |  |     | -53.3532 |      |  | 0.225 |
| 22.2)                            | Live Load Component (Min. Reaction)   | 0.81575 |  |     | -2.79394 |      |  | 0.045 |

| S.N. | Description                            | Forces about toe |                |                |                       |                       |                       |                       |
|------|--|------------------|----------------|----------------|-----------------------|-----------------------|-----------------------|-----------------------|
|      |  | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT(Dest)</sub> | M <sub>TT(Steb)</sub> | M <sub>LL(Dest)</sub> | M <sub>LL(Steb)</sub> |
|      |  | Tonne            | Tonne          | Tonne          | Tm                    | Tm                    | Tm                    | Tm                    |
| LC-5 | SIS,LWL, Span dislodge ,Seismic Sx=1,S | 2730.3           | 828.824        | 42.7384        | 5898.57               | -15399.9              | 661.624               | 0                     |

| LC-6                             | SIS, LWL,Span dislodge ,Seismic Sx=1,S          | Forces about toe |                |                |                 |                 |  | LC-6   |
|----------------------------------|---|------------------|----------------|----------------|-----------------|-----------------|--|--------|
| S.N.                             | Description                                     | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |  |        |
|                                  |   | Tonne            | Tonne          | Tonne          | Tm              | Tm              |  |        |
| 1)                               | Sub-structure & Foundation                      | 1317.6           |                |                | -5480.8         | 0.0             |  | 0.95   |
| 2)                               | Backfill  | 1265.2           |                |                | -8398.4         | 0.0             |  | 0.95   |
| 9.1)                             | Earth Pressure LWL (O/S)                        |                  |                |                |                 |                 |  | 1      |
|                                  | Horizontal Component                            |                  | 650.8          |                | 3619.4          |                 |  | 1      |
|                                  | Vertical Component                              | 224.5            |                |                | -1841.2         |                 |  | 1      |
| <b>Seismic Longitudinal</b>      |   |                  |                |                |                 |                 |  | 0.75   |
| 11)                              | Sub-structure Component                         |                  | 31.4           |                | 336.7           |                 |  | 0.75   |
| 12)                              | Earth fill component                            |                  | 42.5           |                | 420.3           |                 |  | 0.75   |
| 12)                              | Super-Structure DL, SIDL, & Surfacing Component |                  | 36.9           |                | 783.7           |                 |  | 0.75   |
| 13)                              | Dynamic Earth Pressure LWL                      |                  |                |                |                 |                 |  | 0.75   |
| 13.2)                            | LWL Seismic Upward_O/S                          |                  |                |                |                 |                 |  | 0.75   |
|                                  | Horizontal Component                            |                  | 20.4           |                | 239.5           |                 |  | 0.75   |
|                                  | Vertical Component                              | 7.4              |                |                | -60.5           |                 |  | 0.75   |
| <b>Seismic Transveres</b>        |   |                  |                |                |                 |                 |  | 0.225  |
| 15)                              | Sub-structure Component                         |                  |                | 119.1          |                 | 1278.2          |  | 0.225  |
| 17)                              | Super-Structure DL, SIDL, & Surfacing Component |                  |                | 70.1           |                 | 1644.1          |  | 0.225  |
| 18.2)                            | Live Load Component (Min. Reaction)             |                  |                | 3.7            |                 | 91.4            |  | 0.045  |
| <b>Seismic Vertical Downward</b> |   |                  |                |                |                 |                 |  | 0.225  |
| 19)                              | Sub-structure Component                         | 26.47            |                |                | -110.931        |                 |  | -0.225 |
| 21)                              | Super-Structure DL, SIDL, & Surfacing           | 15.5776          |                |                | -53.3532        |                 |  | -0.225 |
| 22.2)                            | Live Load Component (Min. Reaction)             | 0.81575          |                |                | -2.79394        |                 |  | -0.045 |

| S.N. | Description                            | Forces about toe |                |                |                       |                       |                       |                       |
|------|--|------------------|----------------|----------------|-----------------------|-----------------------|-----------------------|-----------------------|
|      |  | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT(Dest)</sub> | M <sub>TT(Steb)</sub> | M <sub>LL(Dest)</sub> | M <sub>LL(Steb)</sub> |
|      |  | Tonne            | Tonne          | Tonne          | Tm                    | Tm                    | Tm                    | Tm                    |
| LC-6 | SIS, LWL,Span dislodge ,Seismic Sx=1,S | 2674.28          | 749.209        | 42.7384        | 4991.66               | -15071.8              | 661.624               | 0                     |

| LC-7 | SIS,LWL,Min LL Acc,Seismic Sx=1,Sz= | Forces about toe |                |                |                 |                 |  | LC-7 |
|------|-------------------------------------|------------------|----------------|----------------|-----------------|-----------------|--|------|
| S.N. | Description                         | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |  |      |
|      |                                     | Tonne            | Tonne          | Tonne          | Tm              | Tm              |  |      |
| 1)   | Sub-structure & Foundation          | 1317.6           |                |                | -5480.8         | 0.0             |  | 0.95 |

|                                  |   |         |       |       |          |        |      |
|----------------------------------|---|---------|-------|-------|----------|--------|------|
| 2)                               | Backfill  | 1265.2  |       |       | -8398.4  | 0.0    | 0.95 |
| 3)                               | Super-structure DL                              | 398.9   |       |       | -1366.4  | 0.0    | 0.95 |
| 4)                               | SIDL (excluding surfacing)                      | 117.0   |       |       | -400.7   | 0.0    | 0.95 |
| 5)                               | Surfacing                                       | 34.0    |       |       | -116.5   | -8.5   | 1    |
| 6.2)                             | Live Load Vertical Load Min Reaction            | 28.8    |       |       | -98.6    | 83.8   | 0.2  |
| 7)                               | Live Load Horizontal Forces                     |         | 45.8  |       | 970.9    |        | 0.2  |
| 9.1)                             | Earth Pressure LWL (O/S)                        |         |       |       |          |        | 1    |
|                                  | Horizontal Component                            |         | 650.8 |       | 3619.4   |        | 1    |
|                                  | Vertical Component                              | 224.5   |       |       | -1841.2  |        | 1    |
| <b>Seismic Longitudinal</b>      |   |         |       |       |          |        | 1.5  |
| 11)                              | Sub-structure Component                         |         | 31.4  |       | 336.7    |        | 1.5  |
| 12)                              | Earth fill component                            |         | 42.5  |       | 420.3    |        | 1.5  |
| 12)                              | Super-Structure DL, SIDL, & Surfacing Component |         | 36.9  |       | 783.7    |        | 1.5  |
| 13)                              | Dynamic Earth Pressure LWL                      |         |       |       |          |        | 1.5  |
| 13.1)                            | LWL Seismic Downward_O/S                        |         |       |       |          |        | 1.5  |
|                                  | Horizontal Component                            |         | 126.5 |       | 1498.1   |        | 1.5  |
|                                  | Vertical Component                              | 46.0    |       |       | -377.1   |        | 1.5  |
| <b>Seismic Transverses</b>       |   |         |       |       |          |        | 0.45 |
| 15)                              | Sub-structure Component                         |         |       | 119.1 |          | 1278.2 | 0.45 |
| 17)                              | Super-Structure DL, SIDL, & Surfacing Component |         |       | 70.1  |          | 1644.1 | 0.45 |
| 18.2)                            | Live Load Component (Min. Reaction)             |         |       | 3.7   |          | 91.4   | 0.09 |
| <b>Seismic Vertical Downward</b> |   |         |       |       |          |        | 0.45 |
| 19)                              | Sub-structure Component                         | 26.47   |       |       | -110.931 |        | 0.45 |
| 20)                              | Earthfill component                             | 35.8    |       |       | -237.9   |        | 0.45 |
| 21)                              | Super-Structure DL, SIDL, & Surfacing           | 15.5776 |       |       | -53.3532 |        | 0.45 |
| 22.2)                            | Live Load Component (Min. Reaction)             | 0.81575 |       |       | -2.79394 |        | 0.09 |

| S.N. | Description                         | Forces about toe |                |                |                        |                        |                        |                        |
|------|-------------------------------------|------------------|----------------|----------------|------------------------|------------------------|------------------------|------------------------|
|      |                                     | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> (Dest) | M <sub>TT</sub> (Steb) | M <sub>LL</sub> (Dest) | M <sub>LL</sub> (Steb) |
|      |                                     | Tonne            | Tonne          | Tonne          | Tm                     | Tm                     | Tm                     | Tm                     |
| LC-7 | SIS,LWL,Min LL Acc,Seismic Sx=1,Sz= | 3312.27          | 1015.97        | 85.4767        | 8371.91                | -17588.3               | 1340.01                | -8.50627               |

| S.N.                        | Description                                     | Forces about toe |                |                |                 |                 | LC-8 |
|-----------------------------|---|------------------|----------------|----------------|-----------------|-----------------|------|
|                             |   | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |      |
|                             |   | Tonne            | Tonne          | Tonne          | Tm              | Tm              |      |
| 1)                          | Sub-structure & Foundation                      | 1317.6           |                |                | -5480.8         | 0.0             | 0.95 |
| 2)                          | Backfill  | 1265.2           |                |                | -8398.4         | 0.0             | 0.95 |
| 3)                          | Super-structure DL                              | 398.9            |                |                | -1366.4         | 0.0             | 0.95 |
| 4)                          | SIDL (excluding surfacing)                      | 117.0            |                |                | -400.7          | 0.0             | 0.95 |
| 5)                          | Surfacing                                       | 34.0             |                |                | -116.5          | -8.5            | 1    |
| 6.2)                        | Live Load Vertical Load Min Reaction            | 28.8             |                |                | -98.6           | 83.8            | 0.2  |
| 7)                          | Live Load Horizontal Forces                     |                  | 45.8           |                | 970.9           |                 | 0.2  |
| 9.1)                        | Earth Pressure LWL (O/S)                        |                  |                |                |                 |                 | 1    |
|                             | Horizontal Component                            |                  | 650.8          |                | 3619.4          |                 | 1    |
|                             | Vertical Component                              | 224.5            |                |                | -1841.2         |                 | 1    |
| <b>Seismic Longitudinal</b> |   |                  |                |                |                 |                 | 1.5  |
| 11)                         | Sub-structure Component                         |                  | 31.4           |                | 336.7           |                 | 1.5  |
| 12)                         | Earth fill component                            |                  | 42.5           |                | 420.3           |                 | 1.5  |
| 12)                         | Super-Structure DL, SIDL, & Surfacing Component |                  | 36.9           |                | 783.7           |                 | 1.5  |
| 13)                         | Dynamic Earth Pressure LWL                      |                  |                |                |                 |                 | 1.5  |

|   |         |      |       |          |        |  |       |
|---|---------|------|-------|----------|--------|--|-------|
| 13.2) LWL Seismic Upward_O/S                        |         |      |       |          |        |  | 1.5   |
| Horizontal Component                                |         | 20.4 |       | 239.5    |        |  | 1.5   |
| Vertical Component                                  | 7.4     |      |       | -60.5    |        |  | 1.5   |
| <b>Seismic Transverses</b>                          |         |      |       |          |        |  |       |
| 15) Sub-structure Component                         |         |      | 119.1 |          | 1278.2 |  | 0.45  |
| 17) Super-Structure DL, SIDL, & Surfacing Component |         |      | 70.1  |          | 1644.1 |  | 0.45  |
| 18.2) Live Load Component (Min. Reaction)           |         |      | 3.7   |          | 91.4   |  | 0.09  |
| <b>Seismic Vertical Downward</b>                    |         |      |       |          |        |  |       |
| 19) Sub-structure Component                         | 26.47   |      |       | -110.931 |        |  | -0.45 |
| 21) Super-Structure DL, SIDL, & Surfacing           | 15.5776 |      |       | -53.3532 |        |  | -0.45 |
| 22.2) Live Load Component (Min. Reaction)           | 0.81575 |      |       | -2.79394 |        |  | -0.09 |

| S.N. | Description                             | Forces about toe |                |                |                        |                        |                        |                        |
|------|---|------------------|----------------|----------------|------------------------|------------------------|------------------------|------------------------|
|      |   | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> (Dest) | M <sub>TT</sub> (Steb) | M <sub>LL</sub> (Dest) | M <sub>LL</sub> (Steb) |
|      |   | Tonne            | Tonne          | Tonne          | Tm                     | Tm                     | Tm                     | Tm                     |
| LC-8 | SIS, LWL, Min LL Acc, Seismic Sx=1, Sz= | 3200.24          | 856.735        | 85.4767        | 6558.09                | -16932.2               | 1340.01                | -8.50627               |

| S.N.  | Description                 | Forces about toe |                |                |                 |                 | LC-9 |
|-------|-----------------------------|------------------|----------------|----------------|-----------------|-----------------|------|
|       |                             | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |      |
|       |                             | Tonne            | Tonne          | Tonne          | Tm              | Tm              |      |
| 1)    | Sub-structure & Foundation  | 1317.6           |                |                | -5480.8         | 0.0             | 0.95 |
| 2)    | Backfill                    | 1265.2           |                |                | -8398.4         | 0.0             | 0.95 |
| 8)    | Buoyancy                    | -67.0            |                |                | 74.5            | 0.0             | 1    |
| 9.1)  | Earth Pressure HFL (O/S)    |                  |                |                |                 |                 | 1.5  |
|       | Horizontal Component        |                  | 649.4          |                | 3697.7          |                 | 1.5  |
|       | Vertical Component          | 232.9            |                |                | -1909.7         |                 | 1.5  |
| 10.1) | Surcharge Pressure HFL(O/S) |                  | 121.1          |                | 828.3           |                 | 1.2  |

| S.N. | Description                | Forces about toe |                |                |                        |                        |                        |                        |
|------|----------------------------|------------------|----------------|----------------|------------------------|------------------------|------------------------|------------------------|
|      |                            | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> (Dest) | M <sub>TT</sub> (Steb) | M <sub>LL</sub> (Dest) | M <sub>LL</sub> (Steb) |
|      |                            | Tonne            | Tonne          | Tonne          | Tm                     | Tm                     | Tm                     | Tm                     |
| LC-9 | NS, HFL, Span dislodge, EP | 2736.09          | 1119.39        | 0              | 6614.97                | -16049.9               | 0                      | 0                      |

| S.N. | Description                          | Forces about toe |                |                |                 |                 | LC-10 |
|------|--------------------------------------|------------------|----------------|----------------|-----------------|-----------------|-------|
|      |                                      | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |       |
|      |                                      | Tonne            | Tonne          | Tonne          | Tm              | Tm              |       |
| 1)   | Sub-structure & Foundation           | 1317.6           |                |                | -5480.8         | 0.0             | 0.95  |
| 2)   | Backfill                             | 1265.2           |                |                | -8398.4         | 0.0             | 0.95  |
| 3)   | Super-structure DL                   | 398.9            |                |                | -1366.4         | 0.0             | 0.95  |
| 4)   | SIDL (excluding surfacing)           | 117.0            |                |                | -400.7          | 0.0             | 0.95  |
| 5)   | Surfacing                            | 34.0             |                |                | -116.5          | -8.5            | 1     |
| 6.2) | Live Load Vertical Load Min Reaction | 28.8             |                |                | -98.6           | 83.8            | 1.5   |
| 7)   | Live Load Horizontal Forces          |                  | 45.8           |                | 970.9           |                 | 1.5   |
| 8)   | Buoyancy                             | -67.0            |                |                | 74.5            | 0.0             | 1     |
| 9.1) | Earth Pressure HFL (O/S)             |                  |                |                |                 |                 | 1.5   |
|      | Horizontal Component                 |                  | 649.4          |                | 3697.7          |                 | 1.5   |

|       |                             |       |       |  |         |  |  |     |
|-------|-----------------------------|-------|-------|--|---------|--|--|-----|
| 10.1) | Vertical Component          | 232.9 |       |  | -1909.7 |  |  | 1.5 |
|       | Surcharge Pressure HFL(O/S) |       | 121.1 |  | 828.3   |  |  | 1.2 |

| S.N.  | Description              | Forces about toe |                |                |                       |                       |                       |                       |
|-------|--------------------------|------------------|----------------|----------------|-----------------------|-----------------------|-----------------------|-----------------------|
|       |                          | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT(Dest)</sub> | M <sub>TT(Steb)</sub> | M <sub>LL(Dest)</sub> | M <sub>LL(Steb)</sub> |
|       |                          | Tonne            | Tonne          | Tonne          | Tm                    | Tm                    | Tm                    | Tm                    |
| LC-10 | NS, HFL, Min LL Lead, EP | 3303.45          | 1188.02        | 0              | 8071.29               | -17993.1              | 125.711               | -8.50627              |

| S.N.                             | Description                                     | Forces about toe |                |                |                 |                 | LC-11 |
|----------------------------------|---|------------------|----------------|----------------|-----------------|-----------------|-------|
|                                  |   | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |       |
|                                  |   | Tonne            | Tonne          | Tonne          | Tm              | Tm              |       |
| 1)                               | Sub-structure & Foundation                      | 1317.6           |                |                | -5480.8         | 0.0             | 0.95  |
| 2)                               | Backfill  | 1265.2           |                |                | -8398.4         | 0.0             | 0.95  |
| 8)                               | Buoyancy  | -67.0            |                |                | 74.5            | 0.0             | 1     |
| 9.1)                             | Earth Pressure HFL (O/S)                        |                  |                |                |                 |                 | 1     |
|                                  | Horizontal Component                            |                  | 649.4          |                | 3697.7          |                 | 1     |
|                                  | Vertical Component                              | 232.9            |                |                | -1909.7         |                 | 1     |
| <b>Seismic Longitudinal</b>      |   |                  |                |                |                 |                 | 0.75  |
| 11)                              | Sub-structure Component                         |                  | 31.4           |                | 336.7           |                 | 0.75  |
| 12)                              | Earth fill component                            |                  | 42.5           |                | 420.3           |                 | 0.75  |
| 12)                              | Super-Structure DL, SIDL, & Surfacing Component |                  | 36.9           |                | 783.7           |                 | 0.75  |
| 13)                              | Dynamic Earth Pressure HFL                      |                  |                |                |                 |                 | 0.75  |
| 13.1)                            | HFL Seismic Downward_O/S                        |                  |                |                |                 |                 | 0.75  |
|                                  | Horizontal Component                            |                  | 126.5          |                | 1498.1          |                 | 0.75  |
|                                  | Vertical Component                              | 46.0             |                |                | -377.5          |                 | 0.75  |
| <b>Seismic Transverses</b>       |   |                  |                |                |                 |                 | 0.225 |
| 15)                              | Sub-structure Component                         |                  |                | 119.1          |                 | 1278.2          | 0.225 |
| 17)                              | Super-Structure DL, SIDL, & Surfacing Component |                  |                | 70.1           |                 | 1644.1          | 0.225 |
| 18.2)                            | Live Load Component (Min. Reaction)             |                  |                | 3.7            |                 | 91.4            | 0.045 |
| <b>Seismic Vertical Downward</b> |   |                  |                |                |                 |                 | 0.225 |
| 19)                              | Sub-structure Component                         | 26.47            |                |                | -110.931        |                 | 0.225 |
| 20)                              | Earthfill component                             | 35.8             |                |                | -237.9          |                 | 0.225 |
| 21)                              | Super-Structure DL, SIDL, & Surfacing           | 15.5776          |                |                | -53.3532        |                 | 0.225 |
| 22.2)                            | Live Load Component (Min. Reaction)             | 0.81575          |                |                | -2.79394        |                 | 0.045 |

| S.N.  | Description                            | Forces about toe |                |                |                       |                       |                       |                       |
|-------|--|------------------|----------------|----------------|-----------------------|-----------------------|-----------------------|-----------------------|
|       |  | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT(Dest)</sub> | M <sub>TT(Steb)</sub> | M <sub>LL(Dest)</sub> | M <sub>LL(Steb)</sub> |
|       |  | Tonne            | Tonne          | Tonne          | Tm                    | Tm                    | Tm                    | Tm                    |
| LC-11 | SIS,HFL, Span dislodge ,Seismic Sx=1,S | 2671.73          | 827.368        | 42.7384        | 6051.34               | -15468.7              | 661.624               | 0                     |

| S.N. | Description                | Forces about toe |                |                |                 |                 | LC-12 |
|------|----------------------------|------------------|----------------|----------------|-----------------|-----------------|-------|
|      |                            | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |       |
|      |                            | Tonne            | Tonne          | Tonne          | Tm              | Tm              |       |
| 1)   | Sub-structure & Foundation | 1317.6           |                |                | -5480.8         | 0.0             | 0.95  |
| 2)   | Backfill                   | 1265.2           |                |                | -8398.4         | 0.0             | 0.95  |
| 8)   | Buoyancy                   | -67.0            |                |                | 74.5            | 0.0             | 1     |

|                                  |   |         |       |       |          |        |        |
|----------------------------------|---|---------|-------|-------|----------|--------|--------|
| 9.1)                             | Earth Pressure HFL (O/S)                        |         |       |       |          |        | 1      |
|                                  | Horizontal Component                            |         | 649.4 |       | 3697.7   |        | 1      |
|                                  | Vertical Component                              | 232.9   |       |       | -1909.7  |        | 1      |
| <b>Seismic Longitudinal</b>      |   |         |       |       |          |        | 0.75   |
| 11)                              | Sub-structure Component                         |         | 31.4  |       | 336.7    |        | 0.75   |
| 12)                              | Earth fill component                            |         | 42.5  |       | 420.3    |        | 0.75   |
| 12)                              | Super-Structure DL, SIDL, & Surfacing Component |         | 36.9  |       | 783.7    |        | 0.75   |
| 13)                              | Dynamic Earth Pressure HFL                      |         |       |       |          |        | 0.75   |
| 13.2)                            | HFL Seismic Upward_O/S                          |         |       |       |          |        | 0.75   |
|                                  | Horizontal Component                            |         | 20.2  |       | 239.4    |        | 0.75   |
|                                  | Vertical Component                              | 7.4     |       |       | -60.3    |        | 0.75   |
| <b>Seismic Transverses</b>       |   |         |       |       |          |        | 0.225  |
| 15)                              | Sub-structure Component                         |         |       | 119.1 |          | 1278.2 | 0.225  |
| 17)                              | Super-Structure DL, SIDL, & Surfacing Component |         |       | 70.1  |          | 1644.1 | 0.225  |
| 18.2)                            | Live Load Component (Min. Reaction)             |         |       | 3.7   |          | 91.4   | 0.045  |
| <b>Seismic Vertical Downward</b> |   |         |       |       |          |        | 0.225  |
| 19)                              | Sub-structure Component                         | 26.47   |       |       | -110.931 |        | -0.225 |
| 21)                              | Super-Structure DL, SIDL, & Surfacing           | 15.5776 |       |       | -53.3532 |        | -0.225 |
| 22.2)                            | Live Load Component (Min. Reaction)             | 0.81575 |       |       | -2.79394 |        | -0.045 |

| S.N.  | Description                               | Forces about toe |                         |                         |                             |                             |                             |                             |
|-------|---|------------------|-------------------------|-------------------------|-----------------------------|-----------------------------|-----------------------------|-----------------------------|
|       |   | V<br>Tonne       | H <sub>L</sub><br>Tonne | H <sub>T</sub><br>Tonne | M <sub>TT(Dest)</sub><br>Tm | M <sub>TT(Steb)</sub><br>Tm | M <sub>LL(Dest)</sub><br>Tm | M <sub>LL(Steb)</sub><br>Tm |
| LC-12 | SIS, HFL, Span dislodge ,Seismic Sx=1,Sz= | 2615.66          | 747.668                 | 42.7384                 | 5144.39                     | -15140.2                    | 661.624                     | 0                           |

| S.N.                        | Description                                     | Forces about toe |                         |                         |                       |                       | LC-13 |
|-----------------------------|---|------------------|-------------------------|-------------------------|-----------------------|-----------------------|-------|
|                             |   | V<br>Tonne       | H <sub>L</sub><br>Tonne | H <sub>T</sub><br>Tonne | M <sub>TT</sub><br>Tm | M <sub>LL</sub><br>Tm |       |
| 1)                          | Sub-structure & Foundation                      | 1317.6           |                         |                         | -5480.8               | 0.0                   | 0.95  |
| 2)                          | Backfill  | 1265.2           |                         |                         | -8398.4               | 0.0                   | 0.95  |
| 3)                          | Super-structure DL                              | 398.9            |                         |                         | -1366.4               | 0.0                   | 0.95  |
| 4)                          | SIDL (excluding surfacing)                      | 117.0            |                         |                         | -400.7                | 0.0                   | 0.95  |
| 5)                          | Surfacing                                       | 34.0             |                         |                         | -116.5                | -8.5                  | 1     |
| 6.2)                        | Live Load Vertical Load Min Reaction            | 28.8             |                         |                         | -98.6                 | 83.8                  | 0.2   |
| 7)                          | Live Load Horizontal Forces                     |                  | 45.8                    |                         | 970.9                 |                       | 0.2   |
| 8)                          | Buoyancy  | -67.0            |                         |                         | 74.5                  | 0.0                   | 1     |
| 9.1)                        | Earth Pressure HFL (O/S)                        |                  |                         |                         |                       |                       | 1     |
|                             | Horizontal Component                            |                  | 649.4                   |                         | 3697.7                |                       | 1     |
|                             | Vertical Component                              | 232.9            |                         |                         | -1909.7               |                       | 1     |
| <b>Seismic Longitudinal</b> |   |                  |                         |                         |                       |                       | 1.5   |
| 11)                         | Sub-structure Component                         |                  | 31.4                    |                         | 336.7                 |                       | 1.5   |
| 12)                         | Earth fill component                            |                  | 42.5                    |                         | 420.3                 |                       | 1.5   |
| 12)                         | Super-Structure DL, SIDL, & Surfacing Component |                  | 36.9                    |                         | 783.7                 |                       | 1.5   |
| 13)                         | Dynamic Earth Pressure HFL                      |                  |                         |                         |                       |                       | 1.5   |
| 13.1)                       | HFL Seismic Downward_O/S                        |                  |                         |                         |                       |                       | 1.5   |
|                             | Horizontal Component                            |                  | 126.5                   |                         | 1498.1                |                       | 1.5   |
|                             | Vertical Component                              | 46.0             |                         |                         | -377.5                |                       | 1.5   |
| <b>Seismic Transverses</b>  |   |                  |                         |                         |                       |                       | 0.45  |
| 15)                         | Sub-structure Component                         |                  |                         | 119.1                   |                       | 1278.2                | 0.45  |
| 17)                         | Super-Structure DL, SIDL, & Surfacing Component |                  |                         | 70.1                    |                       | 1644.1                | 0.45  |



|                                  |                                       |         |  |     |          |      |  |      |
|----------------------------------|---------------------------------------|---------|--|-----|----------|------|--|------|
| 18.2)                            | Live Load Component (Min. Reaction)   |         |  | 3.7 |          | 91.4 |  | 0.09 |
| <b>Seismic Vertical Downward</b> |                                       |         |  |     |          |      |  | 0.45 |
| 19)                              | Sub-structure Component               | 26.47   |  |     | -110.931 |      |  | 0.45 |
| 20)                              | Earthfill component                   | 35.8    |  |     | -237.9   |      |  | 0.45 |
| 21)                              | Super-Structure DL, SIDL, & Surfacing | 15.5776 |  |     | -53.3532 |      |  | 0.45 |
| 22.2)                            | Live Load Component (Min. Reaction)   | 0.81575 |  |     | -2.79394 |      |  | 0.09 |

| S.N.  | Description                         | Forces about toe |                |                |                       |                       |                       |                       |
|-------|-------------------------------------|------------------|----------------|----------------|-----------------------|-----------------------|-----------------------|-----------------------|
|       |                                     | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>IT(Dest)</sub> | M <sub>IT(Steb)</sub> | M <sub>LL(Dest)</sub> | M <sub>LL(Steb)</sub> |
|       |                                     | Tonne            | Tonne          | Tonne          | Tm                    | Tm                    | Tm                    | Tm                    |
| LC-13 | SIS,HFL,Min LL Acc,Seismic Sx=1,Sz= | 3253.74          | 1014.49        | 85.4767        | 8524.67               | -17657.4              | 1340.01               | -8.50627              |

| S.N.                             | Description                                     | Forces about toe |                |                |                 |                 |  | LC-14 |
|----------------------------------|---|------------------|----------------|----------------|-----------------|-----------------|--|-------|
|                                  |   | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>IT</sub> | M <sub>LL</sub> |  |       |
|                                  |   | Tonne            | Tonne          | Tonne          | Tm              | Tm              |  |       |
| 1)                               | Sub-structure & Foundation                      | 1317.6           |                |                | -5480.8         | 0.0             |  | 0.95  |
| 2)                               | Backfill  | 1265.2           |                |                | -8398.4         | 0.0             |  | 0.95  |
| 3)                               | Super-structure DL                              | 398.9            |                |                | -1366.4         | 0.0             |  | 0.95  |
| 4)                               | SIDL (excluding surfacing)                      | 117.0            |                |                | -400.7          | 0.0             |  | 0.95  |
| 5)                               | Surfacing                                       | 34.0             |                |                | -116.5          | -8.5            |  | 1     |
| 6.2)                             | Live Load Vertical Load Min Reaction            | 28.8             |                |                | -98.6           | 83.8            |  | 0.2   |
| 7)                               | Live Load Horizontal Forces                     |                  | 45.8           |                | 970.9           |                 |  | 0.2   |
| 8)                               | Buoyancy  | -67.0            |                |                | 74.5            | 0.0             |  | 1     |
| 9.1)                             | Earth Pressure HFL (O/S)                        |                  |                |                |                 |                 |  | 1     |
|                                  | Horizontal Component                            |                  | 649.4          |                | 3697.7          |                 |  | 1     |
|                                  | Vertical Component                              | 232.9            |                |                | -1909.7         |                 |  | 1     |
| <b>Seismic Longitudinal</b>      |   |                  |                |                |                 |                 |  | 1.5   |
| 11)                              | Sub-structure Component                         |                  | 31.4           |                | 336.7           |                 |  | 1.5   |
| 12)                              | Earth fill component                            |                  | 42.5           |                | 420.3           |                 |  | 1.5   |
| 12)                              | Super-Structure DL, SIDL, & Surfacing Component |                  | 36.9           |                | 783.7           |                 |  | 1.5   |
| 13)                              | Dynamic Earth Pressure HFL                      |                  |                |                |                 |                 |  | 1.5   |
| 13.2)                            | HFL Seismic Upward_O/S                          |                  |                |                |                 |                 |  | 1.5   |
|                                  | Horizontal Component                            |                  | 20.2           |                | 239.4           |                 |  | 1.5   |
|                                  | Vertical Component                              | 7.4              |                |                | -60.3           |                 |  | 1.5   |
| <b>Seismic Transverses</b>       |   |                  |                |                |                 |                 |  | 0.45  |
| 15)                              | Sub-structure Component                         |                  |                | 119.1          |                 | 1278.2          |  | 0.45  |
| 17)                              | Super-Structure DL, SIDL, & Surfacing Component |                  |                | 70.1           |                 | 1644.1          |  | 0.45  |
| 18.2)                            | Live Load Component (Min. Reaction)             |                  |                | 3.7            |                 | 91.4            |  | 0.09  |
| <b>Seismic Vertical Downward</b> |   |                  |                |                |                 |                 |  | 0.45  |
| 19)                              | Sub-structure Component                         | 26.47            |                |                | -110.931        |                 |  | -0.45 |
| 21)                              | Super-Structure DL, SIDL, & Surfacing           | 15.5776          |                |                | -53.3532        |                 |  | -0.45 |
| 22.2)                            | Live Load Component (Min. Reaction)             | 0.81575          |                |                | -2.79394        |                 |  | -0.09 |

| S.N.  | Description                          | Forces about toe |                |                |                       |                       |                       |                       |
|-------|--------------------------------------|------------------|----------------|----------------|-----------------------|-----------------------|-----------------------|-----------------------|
|       |                                      | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>IT(Dest)</sub> | M <sub>IT(Steb)</sub> | M <sub>LL(Dest)</sub> | M <sub>LL(Steb)</sub> |
|       |                                      | Tonne            | Tonne          | Tonne          | Tm                    | Tm                    | Tm                    | Tm                    |
| LC-14 | SIS, HFL,Min LL Acc,Seismic Sx=1,Sz= | 3141.61          | 855.087        | 85.4767        | 6710.77               | -17000.5              | 1340.01               | -8.50627              |

**VERIFICATION of EQUILIBRIUM (OVERTURNING & SLIDING):**

$$FOS|_{\text{sliding}} = \frac{(\mu \cdot \Sigma V + \Sigma H_{\text{restoring}})}{\Sigma H_{\text{sliding}}} \geq 1$$

$$\mu = 0.80$$

$$FOS|_{\text{overturning}} = \frac{\Sigma M_{\text{restoring}}}{\Sigma M_{\text{overturning}}} \geq 1$$

**SUMMARY OF FORCES:**

| S.N.  | Description                            | Forces about toe |                         |                         |                             |                             |                             |                             |
|-------|--|------------------|-------------------------|-------------------------|-----------------------------|-----------------------------|-----------------------------|-----------------------------|
|       |  | V<br>Tonne       | H <sub>L</sub><br>Tonne | H <sub>T</sub><br>Tonne | M <sub>TT(Dest)</sub><br>Tm | M <sub>TT(Steb)</sub><br>Tm | M <sub>LL(Dest)</sub><br>Tm | M <sub>LL(Steb)</sub><br>Tm |
| LC-1  | NS, LWL, Span dislodge, FP             | 2453.71          | 145.619                 | 0                       | 994.036                     | -13185.3                    | 0                           | 0                           |
| LC-2  | NS, LWL, Span dislodge, EP             | 2790.52          | 1121.72                 | 0                       | 6423.14                     | -15947.1                    | 0                           | 0                           |
| LC-3  | NS, LWL, Min LL Lead, FP               | 3021.07          | 214.249                 | 0                       | 2450.36                     | -15128.5                    | 125.711                     | -8.50627                    |
| LC-4  | NS, LWL, Min LL Lead, EP               | 3357.88          | 1190.35                 | 0                       | 7879.46                     | -17890.3                    | 125.711                     | -8.50627                    |
|       |  |                  |                         |                         |                             |                             |                             |                             |
| LC-5  | SIS,LWL, Span dislodge ,Seismic Sx=1,S | 2730.3           | 828.824                 | 42.7384                 | 5898.57                     | -15399.9                    | 661.624                     | 0                           |
| LC-6  | SIS, LWL,Span dislodge ,Seismic Sx=1,S | 2674.28          | 749.209                 | 42.7384                 | 4991.66                     | -15071.8                    | 661.624                     | 0                           |
| LC-7  | SIS,LWL,Min LL Acc,Seismic Sx=1,Sz=    | 3312.27          | 1015.97                 | 85.4767                 | 8371.91                     | -17588.3                    | 1340.01                     | -8.50627                    |
| LC-8  | SIS, LWL,Min LL Acc,Seismic Sx=1,Sz=   | 3200.24          | 856.735                 | 85.4767                 | 6558.09                     | -16932.2                    | 1340.01                     | -8.50627                    |
|       |  |                  |                         |                         |                             |                             |                             |                             |
| LC-9  | NS, HFL, Span dislodge, EP             | 2736.09          | 1119.39                 | 0                       | 6614.97                     | -16049.9                    | 0                           | 0                           |
| LC-10 | NS, HFL, Min LL Lead, EP               | 3303.45          | 1188.02                 | 0                       | 8071.29                     | -17993.1                    | 125.711                     | -8.50627                    |
|       |  |                  |                         |                         |                             |                             |                             |                             |
| LC-11 | SIS,HFL, Span dislodge ,Seismic Sx=1,S | 2671.73          | 827.368                 | 42.7384                 | 6051.34                     | -15468.7                    | 661.624                     | 0                           |
| LC-12 | SIS, HFL,Span dislodge ,Seismic Sx=1,S | 2615.66          | 747.668                 | 42.7384                 | 5144.39                     | -15140.2                    | 661.624                     | 0                           |
| LC-13 | SIS,HFL,Min LL Acc,Seismic Sx=1,Sz=    | 3253.74          | 1014.49                 | 85.4767                 | 8524.67                     | -17657.4                    | 1340.01                     | -8.50627                    |
| LC-14 | SIS, HFL,Min LL Acc,Seismic Sx=1,Sz=   | 3141.61          | 855.087                 | 85.4767                 | 6710.77                     | -17000.5                    | 1340.01                     | -8.50627                    |
|       |  |                  |                         |                         |                             |                             |                             |                             |

| Along Long. Dir <sup>n</sup> |       |
|------------------------------|-------|
| FOS<br> <br>sliding          | Check |
| 13.48                        | OK    |
| 1.99                         | OK    |
| 11.28                        | OK    |
| 2.26                         | OK    |
|                              |       |
| 2.64                         | OK    |
| 2.86                         | OK    |
| 2.61                         | OK    |
| 2.99                         | OK    |
|                              |       |
| 1.96                         | OK    |
| 2.22                         | OK    |
|                              |       |
| 2.58                         | OK    |
| 2.80                         | OK    |
| 2.57                         | OK    |
| 2.94                         | OK    |

LOAD COMBINATION  
FOR FOOTING DESIGN

| LC-1  | NS, LWL, Span dislodge, FP     | Forces about toe |                |                |                 |                 |  | LC-1 |
|-------|--------------------------------|------------------|----------------|----------------|-----------------|-----------------|--|------|
| S.N.  | Description                    | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |  |      |
|       |                                | Tonne            | Tonne          | Tonne          | Tm              | Tm              |  |      |
| 1)    | Sub-structure & Foundation     | 1317.6           |                |                | -5480.8         | 0.0             |  | 1    |
| 2)    | Backfill                       | 1265.2           |                |                | -8398.4         | 0.0             |  | 1    |
| 9)    | Fluid Pressure                 |                  | 0.10           |                | 0.01            |                 |  | 1    |
| 10.3) | Surcharge Pressure LWL(BP, SD) |                  | 121.2          |                | 828.4           |                 |  | 1    |

| S.N. | Description                | Forces about toe |                |                |                 |                 |
|------|----------------------------|------------------|----------------|----------------|-----------------|-----------------|
|      |                            | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|      |                            | Tonne            | Tonne          | Tonne          | Tm              | Tm              |
| LC-1 | NS, LWL, Span dislodge, FP | 2582.85          | 121.32         | 0              | -13050.9        | 0               |

| LC-2  | NS, LWL, Span dislodge, EP     | Forces about toe |                |                |                 |                 |  | LC-2 |
|-------|--------------------------------|------------------|----------------|----------------|-----------------|-----------------|--|------|
| S.N.  | Description                    | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |  |      |
|       |                                | Tonne            | Tonne          | Tonne          | Tm              | Tm              |  |      |
| 1)    | Sub-structure & Foundation     | 1317.6           |                |                | -5480.8         | 0.0             |  | 1    |
| 2)    | Backfill                       | 1265.2           |                |                | -8398.4         | 0.0             |  | 1    |
| 9.3)  | Earth Pressure LWL (BP, SD)    |                  |                |                |                 |                 |  | 1    |
|       | Horizontal Component           |                  | 650.8          |                | 3619.4          |                 |  | 1    |
|       | Vertical Component             | 224.5            |                |                | -1077.8         |                 |  | 1    |
| 10.3) | Surcharge Pressure LWL(BP, SD) |                  | 121.2          |                | 828.4           |                 |  | 1    |

| S.N. | Description                | Forces about toe |                |                |                 |                 |
|------|----------------------------|------------------|----------------|----------------|-----------------|-----------------|
|      |                            | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|      |                            | Tonne            | Tonne          | Tonne          | Tm              | Tm              |
| LC-2 | NS, LWL, Span dislodge, EP | 2807.39          | 772.06         | 0              | -10509.2        | 0               |

| LC-3 | NS, LWL, Max LL, FP                  | Forces about toe |                |                |                 |                 |  | LC-3 |
|------|--------------------------------------|------------------|----------------|----------------|-----------------|-----------------|--|------|
| S.N. | Description                          | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |  |      |
|      |                                      | Tonne            | Tonne          | Tonne          | Tm              | Tm              |  |      |
| 1)   | Sub-structure & Foundation           | 1317.6           |                |                | -5480.8         | 0.0             |  | 1    |
| 2)   | Backfill                             | 1265.2           |                |                | -8398.4         | 0.0             |  | 1    |
| 3)   | Super-structure DL                   | 398.9            |                |                | -1366.4         | 0.0             |  | 1    |
| 4)   | SIDL (excluding surfacing)           | 117.0            |                |                | -400.7          | 0.0             |  | 1    |
| 5)   | Surfacing                            | 34.0             |                |                | -116.5          | -8.5            |  | 1    |
| 6.1) | Live Load Vertical Load Max Reaction | 137.4            |                |                | -470.6          | 399.8           |  | 1    |

|       |                                |  |       |  |       |  |  |   |
|-------|--------------------------------|--|-------|--|-------|--|--|---|
| 7)    | Live Load Horizontal Forces    |  | 45.8  |  | 970.9 |  |  | 1 |
| 9)    | Fluid Pressure                 |  | 0.10  |  | 0.01  |  |  | 1 |
| 10.3) | Surcharge Pressure LWL(BP, SD) |  | 121.2 |  | 828.4 |  |  | 1 |

| S.N. | Description         | Forces about toe |                |                |                 |                 |
|------|---------------------|------------------|----------------|----------------|-----------------|-----------------|
|      |                     | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|      |                     | Tonne            | Tonne          | Tonne          | Tm              | Tm              |
| LC-3 | NS, LWL, Max LL, FP | 3270.21          | 167.08         | 0              | -14434.2        | 391.329         |

| LC-4  | NS, LWL, Max LL, EP                  | Forces about toe |                |                |                 |                 |  | LC-4 |
|-------|--------------------------------------|------------------|----------------|----------------|-----------------|-----------------|--|------|
| S.N.  | Description                          | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |  |      |
|       |                                      | Tonne            | Tonne          | Tonne          | Tm              | Tm              |  |      |
| 1)    | Sub-structure & Foundation           | 1317.6           |                |                | -5480.8         | 0.0             |  | 1    |
| 2)    | Backfill                             | 1265.2           |                |                | -8398.4         | 0.0             |  | 1    |
| 3)    | Super-structure DL                   | 398.9            |                |                | -1366.4         | 0.0             |  | 1    |
| 4)    | SIDL (excluding surfacing)           | 117.0            |                |                | -400.7          | 0.0             |  | 1    |
| 5)    | Surfacing                            | 34.0             |                |                | -116.5          | -8.5            |  | 1    |
| 6.1)  | Live Load Vertical Load Max Reaction | 137.4            |                |                | -470.6          | 399.8           |  | 1    |
| 7)    | Live Load Horizontal Forces          |                  | 45.8           |                | 970.9           |                 |  | 1    |
| 9.3)  | Earth Pressure LWL (BP, SD)          |                  |                |                |                 |                 |  | 1    |
|       | Horizontal Component                 |                  | 650.8          |                | 3619.4          |                 |  | 1    |
|       | Vertical Component                   | 224.5            |                |                | -1077.8         |                 |  | 1    |
| 10.3) | Surcharge Pressure LWL(BP, SD)       |                  | 121.2          |                | 828.4           |                 |  | 1    |

| S.N. | Description         | Forces about toe |                |                |                 |                 |
|------|---------------------|------------------|----------------|----------------|-----------------|-----------------|
|      |                     | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|      |                     | Tonne            | Tonne          | Tonne          | Tm              | Tm              |
| LC-4 | NS, LWL, Max LL, EP | 3494.75          | 817.81         | 0              | -11892.6        | 391.329         |

| LC-5                        | SIS,LWL, Span dislodge ,Seismic Sx=1.5          | Forces about toe |                |                |                 |                 |  | LC-5 |
|-----------------------------|---|------------------|----------------|----------------|-----------------|-----------------|--|------|
| S.N.                        | Description                                     | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |  |      |
|                             |   | Tonne            | Tonne          | Tonne          | Tm              | Tm              |  |      |
| 1)                          | Sub-structure & Foundation                      | 1317.6           |                |                | -5480.8         | 0.0             |  | 1    |
| 2)                          | Backfill  | 1265.2           |                |                | -8398.4         | 0.0             |  | 1    |
| 9.3)                        | Earth Pressure LWL (BP, SD)                     |                  |                |                |                 |                 |  | 1    |
|                             | Horizontal Component                            |                  | 650.8          |                | 3619.4          |                 |  | 1    |
|                             | Vertical Component                              | 224.5            |                |                | -1077.8         |                 |  | 1    |
| 10.3)                       | Surcharge Pressure LWL(BP, SD)                  |                  | 121.2          |                | 828.4           |                 |  | 0.2  |
| <b>Seismic Longitudinal</b> |   |                  |                |                |                 |                 |  | 0.5  |
| 11)                         | Sub-structure Component                         |                  | 31.4           |                | 336.7           |                 |  | 0.5  |
| 12)                         | Earth fill component                            |                  | 42.5           |                | 420.3           |                 |  | 0.5  |
| 12)                         | Super-Structure DL, SIDL, & Surfacing Component |                  | 36.9           |                | 783.7           |                 |  | 0.5  |
| 13)                         | Dynamic Earth Pressure LWL                      |                  |                |                |                 |                 |  | 0.5  |

|                                  |   |         |       |       |          |        |      |
|----------------------------------|---|---------|-------|-------|----------|--------|------|
| 13)                              | 13.5)LWL Seismic Downward_BP/SD                 |         |       |       |          |        | 0.5  |
|                                  | Horizontal Component                            |         | 126.5 |       | 1498.1   |        | 0.5  |
|                                  | Vertical Component                              | 46.0    |       |       | -220.7   |        | 0.5  |
| 14)                              | 14.2) Dynamic Surcharge Pressure BP/SD          |         |       |       |          |        | 0.2  |
|                                  | LWL Seismic Downward                            |         | 20.5  |       | 323.1    |        | 0.2  |
| <b>Seismic Transverses</b>       |   |         |       |       |          |        | 0.15 |
| 15)                              | Sub-structure Component                         |         |       | 119.1 |          | 1278.2 | 0.15 |
| 17)                              | Super-Structure DL, SIDL, & Surfacing Component |         |       | 70.1  |          | 1644.1 | 0.15 |
| <b>Seismic Vertical Downward</b> |   |         |       |       |          |        | 0.15 |
| 19)                              | Sub-structure Component                         | 26.47   |       |       | -110.931 |        | 0.15 |
| 20)                              | Earth fill                                      | 35.8    |       |       | -237.9   |        | 0.15 |
| 21)                              | Super-Structure DL, SIDL, & Surfacing           | 15.5776 |       |       | -53.3532 |        | 0.15 |

| S.N. | Description                            | Forces about toe |                |                |                 |                 |
|------|--|------------------|----------------|----------------|-----------------|-----------------|
|      |  | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|      |  | Tonne            | Tonne          | Tonne          | Tm              | Tm              |
| LC-5 | SIS,LWL, Span dislodge ,Seismic Sx=1,S | 2842.06          | 797.83         | 28.3821        | -9758.56        | 438.342         |

| LC-6                             | SIS, LWL,Span dislodge ,Seismic Sx=1,S          | Forces about toe |                |                |                 |                 | LC-6  |
|----------------------------------|---|------------------|----------------|----------------|-----------------|-----------------|-------|
| S.N.                             | Description                                     | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |       |
|                                  |   | Tonne            | Tonne          | Tonne          | Tm              | Tm              |       |
| 1)                               | Sub-structure & Foundation                      | 1317.6           |                |                | -5480.8         | 0.0             | 1     |
| 2)                               | Backfill  | 1265.2           |                |                | -8398.4         | 0.0             | 1     |
| 9.3)                             | Earth Pressure LWL (BP, SD)                     |                  |                |                |                 |                 | 1     |
|                                  | Horizontal Component                            |                  | 650.8          |                | 3619.4          |                 | 1     |
|                                  | Vertical Component                              | 224.5            |                |                | -1077.8         |                 | 1     |
| 10.3)                            | Surcharge Pressure LWL(BP, SD)                  |                  | 121.2          |                | 828.4           |                 | 0.2   |
| <b>Seismic Longitudinal</b>      |   |                  |                |                |                 |                 | 0.5   |
| 11)                              | Sub-structure Component                         |                  | 31.4           |                | 336.7           |                 | 0.5   |
| 12)                              | Earth fill component                            |                  | 42.5           |                | 420.3           |                 | 0.5   |
| 12)                              | Super-Structure DL, SIDL, & Surfacing Compone   |                  | 36.9           |                | 783.7           |                 | 0.5   |
| 13)                              | Dynamic Earth Pressure LWL                      |                  |                |                |                 |                 | 0.5   |
|                                  | 13.6) LWL Seismic Upward_BP/SD                  |                  |                |                |                 |                 | 0.5   |
|                                  | Horizontal Component                            |                  | 20.4           |                | 239.5           |                 | 0.5   |
|                                  | Vertical Component                              | 7.4              |                |                | -35.4           |                 | 0.5   |
| 14)                              | 14.2) Dynamic Surcharge Pressure BP/SD          |                  |                |                |                 |                 | 0.2   |
|                                  | LWL Seismic Upward                              |                  | 3.3            |                | 51.6            |                 | 0.2   |
| <b>Seismic Transverses</b>       |   |                  |                |                |                 |                 | 0.15  |
| 15)                              | Sub-structure Component                         |                  |                | 119.1          |                 | 1278.2          | 0.15  |
| 17)                              | Super-Structure DL, SIDL, & Surfacing Component |                  |                | 70.1           |                 | 1644.1          | 0.15  |
| <b>Seismic Vertical Downward</b> |   |                  |                |                |                 |                 | 0.15  |
| 19)                              | Sub-structure Component                         | 26.47            |                |                | -110.931        |                 | -0.15 |
| 21)                              | Super-Structure DL, SIDL, & Surfacing           | 15.5776          |                |                | -53.3532        |                 | -0.15 |

| S.N. | Description | Forces about toe |                |                |                 |                 |
|------|-------------|------------------|----------------|----------------|-----------------|-----------------|
|      |             | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |

|      |   | Tonne   | Tonne  | Tonne   | Tm       | Tm      |
|------|---|---------|--------|---------|----------|---------|
| LC-6 | SIS, LWL, Span dislodge ,Seismic Sx=1,Sz=0.3, | 2804.77 | 741.32 | 28.3821 | -10264.5 | 438.342 |

| LC-7                             | SIS,LWL,Max LL,Seismic Sx=1,Sz=0.3,             | Forces about toe |                |                |                 |                 | LC-7 |
|----------------------------------|---|------------------|----------------|----------------|-----------------|-----------------|------|
| S.N.                             | Description                                     | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |      |
|                                  |   | Tonne            | Tonne          | Tonne          | Tm              | Tm              |      |
| 1)                               | Sub-structure & Foundation                      | 1317.6           |                |                | -5480.8         | 0.0             | 1    |
| 2)                               | Backfill  | 1265.2           |                |                | -8398.4         | 0.0             | 1    |
| 3)                               | Super-structure DL                              | 398.9            |                |                | -1366.4         | 0.0             | 1    |
| 4)                               | SIDL (excluding surfacing)                      | 117.0            |                |                | -400.7          | 0.0             | 1    |
| 5)                               | Surfacing                                       | 34.0             |                |                | -116.5          | -8.5            | 1    |
| 6.1)                             | Live Load Vertical Load Max Reaction            | 137.4            |                |                | -470.6          | 399.8           | 0.2  |
| 7)                               | Live Load Horizontal Forces                     |                  | 45.8           |                | 970.9           |                 | 0.2  |
| <b>9.3)</b>                      | Earth Pressure LWL (BP, SD)                     |                  |                |                |                 |                 | 1    |
|                                  | Horizontal Component                            |                  | 650.8          |                | 3619.4          |                 | 1    |
|                                  | Vertical Component                              | 224.5            |                |                | -1077.8         |                 | 1    |
| 10.3)                            | Surcharge Pressure LWL(BP, SD)                  |                  | 121.2          |                | 828.4           |                 | 0.2  |
| <b>Seismic Longitudinal</b>      |   |                  |                |                |                 |                 | 1    |
| 11)                              | Sub-structure Component                         |                  | 31.4           |                | 336.7           |                 | 1    |
| <b>12)</b>                       | Earth fill component                            |                  | 42.5           |                | 420.3           |                 | 1    |
| 12)                              | Super-Structure DL, SIDL, & Surfacing Component |                  | 36.9           |                | 783.7           |                 | 1    |
| <b>13)</b>                       | Dynamic Earth Pressure LWL                      |                  |                |                |                 |                 | 1    |
| <b>13)</b>                       | 13.5)LWL Seismic Downward_BP/SD                 |                  |                |                |                 |                 | 1    |
|                                  | Horizontal Component                            |                  | 126.5          |                | 1498.1          |                 | 1    |
|                                  | Vertical Component                              | 46.0             |                |                | -220.7          |                 | 1    |
| <b>14)</b>                       | 14.2) Dynamic Surcharge Pressure BP/SD          |                  |                |                |                 |                 | 0.2  |
|                                  | LWL Seismic Downward                            |                  | 20.5           |                | 323.1           |                 | 0.2  |
| <b>Seismic Transverses</b>       |   |                  |                |                |                 |                 | 0.3  |
| 15)                              | Sub-structure Component                         |                  |                | 119.1          |                 | 1278.2          | 0.3  |
| 17)                              | Super-Structure DL, SIDL, & Surfacing Component |                  |                | 70.1           |                 | 1644.1          | 0.3  |
| 18.1)                            | Live Load Component (Max. Reaction)             |                  |                | 17.513         |                 | 435.871         | 0.06 |
| <b>Seismic Vertical Downward</b> |   |                  |                |                |                 |                 | 0.3  |
| 19)                              | Sub-structure Component                         | 26.47            |                |                | -110.931        |                 | 0.3  |
| 20)                              | Earth fill                                      | 35.8             |                |                | -237.9          |                 | 0.3  |
| 21)                              | Super-Structure DL, SIDL, & Surfacing           | 15.5776          |                |                | -53.3532        |                 | 0.3  |
| 22.1)                            | Live Load Component (Max. Reaction)             | 3.9              |                |                | -13.3           |                 | 0.06 |

| S.N. | Description                         | Forces about toe |                |                |                 |                 |
|------|-------------------------------------|------------------|----------------|----------------|-----------------|-----------------|
|      |                                     | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|      |                                     | Tonne            | Tonne          | Tonne          | Tm              | Tm              |
| LC-7 | SIS,LWL,Max LL,Seismic Sx=1,Sz=0.3, | 3454.41          | 925.64         | 57.815         | -10194.2        | 974.297         |

| LC-8 | SIS, LWL,Max LL,Seismic Sx=1,Sz=0.3, | Forces about toe |                |                |                 |                 | LC-8 |
|------|--------------------------------------|------------------|----------------|----------------|-----------------|-----------------|------|
| S.N. | Description                          | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |      |

|                                  |   | Tonne   | Tonne   | Tonne  | Tm       | Tm      |  |       |
|----------------------------------|---|---------|---------|--------|----------|---------|--|-------|
| 1)                               | Sub-structure & Foundation                      | 1317.6  |         |        | -5480.8  | 0.0     |  | 1     |
| 2)                               | Backfill  | 1265.2  |         |        | -8398.4  | 0.0     |  | 1     |
| 3)                               | Super-structure DL                              | 398.9   |         |        | -1366.4  | 0.0     |  | 1     |
| 4)                               | SIDL (excluding surfacing)                      | 117.0   |         |        | -400.7   | 0.0     |  | 1     |
| 5)                               | Surfacing                                       | 34.0    |         |        | -116.5   | -8.5    |  | 1     |
| 6.1)                             | Live Load Vertical Load Max Reaction            | 137.4   |         |        | -470.6   | 399.8   |  | 0.2   |
| 7)                               | Live Load Horizontal Forces                     |         | 45.8    |        | 970.9    |         |  | 0.2   |
| 10.1)                            | Surcharge Pressure LWL(O/S)                     |         | 121.222 |        | 828.355  |         |  | 0.2   |
| 9.3)                             | Earth Pressure LWL (BP, SD)                     |         |         |        |          |         |  | 1     |
|                                  | Horizontal Component                            |         | 650.8   |        | 3619.4   |         |  | 1     |
|                                  | Vertical Component                              | 224.5   |         |        | -1077.8  |         |  | 1     |
| 10.3)                            | Surcharge Pressure LWL(BP, SD)                  |         | 121.2   |        | 828.4    |         |  | 0.2   |
| <b>Seismic Longitudinal</b>      |   |         |         |        |          |         |  | 1     |
| 11)                              | Sub-structure Component                         |         | 31.4    |        | 336.7    |         |  | 1     |
| 12)                              | Earth fill component                            |         | 42.5    |        | 420.3    |         |  | 1     |
| 12)                              | Super-Structure DL, SIDL, & Surfacing Component |         | 36.9    |        | 783.7    |         |  | 1     |
| 13)                              | Dynamic Earth Pressure LWL                      |         |         |        |          |         |  | 1     |
|                                  | 13.6) LWL Seismic Upward_BP/SD                  |         |         |        |          |         |  | 1     |
|                                  | Horizontal Component                            |         | 20.4    |        | 239.5    |         |  | 1     |
|                                  | Vertical Component                              | 7.4     |         |        | -35.4    |         |  | 1     |
| 14)                              | 14.2) Dynamic Surcharge Pressure BP/SD          |         |         |        |          |         |  | 0.2   |
|                                  | LWL Seismic Upward                              |         | 3.3     |        | 51.6     |         |  | 0.2   |
| <b>Seismic Transverses</b>       |   |         |         |        |          |         |  | 0.3   |
| 15)                              | Sub-structure Component                         |         |         | 119.1  |          | 1278.2  |  | 0.3   |
| 17)                              | Super-Structure DL, SIDL, & Surfacing Component |         |         | 70.1   |          | 1644.1  |  | 0.3   |
| 18.1)                            | Live Load Component (Max. Reaction)             |         |         | 17.513 |          | 435.871 |  | 0.06  |
| <b>Seismic Vertical Downward</b> |   |         |         |        |          |         |  | 0.3   |
| 19)                              | Sub-structure Component                         | 26.47   |         |        | -110.931 |         |  | -0.3  |
| 21)                              | Super-Structure DL, SIDL, & Surfacing           | 15.5776 |         |        | -53.3532 |         |  | -0.3  |
| 22.1)                            | Live Load Component (Max. Reaction)             | 3.9     |         |        | -13.3    |         |  | -0.06 |

| S.N. | Description                         | Forces about toe |                |                |                 |                 |
|------|-------------------------------------|------------------|----------------|----------------|-----------------|-----------------|
|      |                                     | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|      |                                     | Tonne            | Tonne          | Tonne          | Tm              | Tm              |
| LC-8 | SIS, LWL,Max LL,Seismic Sx=1,Sz=0.3 | 3379.36          | 840.30         | 57.815         | -10984.6        | 974.297         |

| S.N.  | Description                    | Forces about toe |                |                |                 |                 | LC-9 |
|-------|--------------------------------|------------------|----------------|----------------|-----------------|-----------------|------|
|       |                                | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |      |
|       |                                | Tonne            | Tonne          | Tonne          | Tm              | Tm              |      |
| 1)    | Sub-structure & Foundation     | 1317.6           |                |                | -5480.8         | 0.0             | 1    |
| 2)    | Backfill                       | 1265.2           |                |                | -8398.4         | 0.0             | 1    |
| 8)    | Buoyancy                       | -67.0            |                |                | 74.5            | 0.0             | 1    |
| 9.3)  | Earth Pressure HFL (BP, SD)    |                  |                |                |                 |                 | 1    |
|       | Horizontal Component           |                  | 649.4          |                | 3697.7          |                 | 1    |
|       | Vertical Component             | 232.9            |                |                | -1117.9         |                 | 1    |
| 10.3) | Surcharge Pressure HFL(BP, SD) |                  | 121.1          |                | 828.3           |                 | 1    |

| S.N. | Description                | Forces about toe |                |                |                 |                 |
|------|----------------------------|------------------|----------------|----------------|-----------------|-----------------|
|      |                            | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|      |                            | Tonne            | Tonne          | Tonne          | Tm              | Tm              |
| LC-9 | NS, HFL, Span dislodge, EP | 2748.78          | 770.48         | 0              | -10396.6        | 0               |

| S.N.  | Description                          | Forces about toe |                |                |                 |                 | LC-10 |
|-------|--------------------------------------|------------------|----------------|----------------|-----------------|-----------------|-------|
|       |                                      | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |       |
|       |                                      | Tonne            | Tonne          | Tonne          | Tm              | Tm              |       |
| 1)    | Sub-structure & Foundation           | 1317.6           |                |                | -5480.8         | 0.0             | 1     |
| 2)    | Backfill                             | 1265.2           |                |                | -8398.4         | 0.0             | 1     |
| 3)    | Super-structure DL                   | 398.9            |                |                | -1366.4         | 0.0             | 1     |
| 4)    | SIDL (excluding surfacing)           | 117.0            |                |                | -400.7          | 0.0             | 1     |
| 5)    | Surfacing                            | 34.0             |                |                | -116.5          | -8.5            | 1     |
| 6.1)  | Live Load Vertical Load Max Reaction | 137.4            |                |                | -470.6          | 399.8           | 1     |
| 7)    | Live Load Horizontal Forces          |                  | 45.8           |                | 970.9           |                 | 1     |
| 8)    | Buoyancy                             | -67.0            |                |                | 74.5            | 0.0             | 1     |
| 9.3)  | Earth Pressure HFL (BP, SD)          |                  |                |                |                 |                 | 1     |
|       | Horizontal Component                 |                  | 649.4          |                | 3697.7          |                 | 1     |
|       | Vertical Component                   | 232.9            |                |                | -1117.9         |                 | 1     |
| 10.3) | Surcharge Pressure HFL(BP, SD)       |                  | 121.1          |                | 828.3           |                 | 1     |

| S.N.  | Description         | Forces about toe |                |                |                 |                 |
|-------|---------------------|------------------|----------------|----------------|-----------------|-----------------|
|       |                     | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|       |                     | Tonne            | Tonne          | Tonne          | Tm              | Tm              |
| LC-10 | NS, HFL, Max LL, EP | 3436.14          | 816.23         | 0              | -11780          | 391.329         |

| S.N.                        | Description                                     | Forces about toe |                |                |                 |                 | LC-11 |
|-----------------------------|---|------------------|----------------|----------------|-----------------|-----------------|-------|
|                             |   | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |       |
|                             |   | Tonne            | Tonne          | Tonne          | Tm              | Tm              |       |
| 1)                          | Sub-structure & Foundation                      | 1317.6           |                |                | -5480.8         | 0.0             | 1     |
| 2)                          | Backfill  | 1265.2           |                |                | -8398.4         | 0.0             | 1     |
| 8)                          | Buoyancy  | -67.0            |                |                | 74.5            | 0.0             | 1     |
| 9.3)                        | Earth Pressure HFL (BP, SD)                     |                  |                |                |                 |                 | 1     |
|                             | Horizontal Component                            |                  | 649.4          |                | 3697.7          |                 | 1     |
|                             | Vertical Component                              | 232.9            |                |                | -1117.9         |                 | 1     |
| 10.3)                       | Surcharge Pressure HFL(BP, SD)                  |                  | 121.1          |                | 828.3           |                 | 0.2   |
| <b>Seismic Longitudinal</b> |   |                  |                |                |                 |                 | 0.5   |
| 11)                         | Sub-structure Component                         |                  | 31.4           |                | 336.7           |                 | 0.5   |
| 12)                         | Earth fill component                            |                  | 42.5           |                | 420.3           |                 | 0.5   |
| 12)                         | Super-Structure DL, SIDL, & Surfacing Component |                  | 36.9           |                | 783.7           |                 | 0.5   |
| 13)                         | Dynamic Earth Pressure HFL                      |                  |                |                |                 |                 | 0.5   |
| 13)                         | 13.5)HFL Seismic Downward_BP/SD                 |                  |                |                |                 |                 | 0.5   |
|                             | Horizontal Component                            |                  | 126.5          |                | 1498.1          |                 | 0.5   |



|                                  |   |         |      |       |          |        |      |
|----------------------------------|---|---------|------|-------|----------|--------|------|
|                                  | Vertical Component                              | 46.0    |      |       | -221.0   |        | 0.5  |
| 14)                              | 14.2) Dynamic Surcharge Pressure BP/SD          |         |      |       |          |        | 0.2  |
|                                  | HFL Seismic Downward                            |         | 20.5 |       | 323.1    |        | 0.2  |
| <b>Seismic Transverses</b>       |   |         |      |       |          |        | 0.15 |
| 15)                              | Sub-structure Component                         |         |      | 119.1 |          | 1278.2 | 0.15 |
| 17)                              | Super-Structure DL, SIDL, & Surfacing Component |         |      | 70.1  |          | 1644.1 | 0.15 |
| <b>Seismic Vertical Downward</b> |   |         |      |       |          |        | 0.15 |
| 19)                              | Sub-structure Component                         | 26.47   |      |       | -110.931 |        | 0.15 |
| 20)                              | Earth fill                                      | 35.8    |      |       | -237.9   |        | 0.15 |
| 21)                              | Super-Structure DL, SIDL, & Surfacing           | 15.5776 |      |       | -53.3532 |        | 0.15 |

| S.N.  | Description                            | Forces about toe |                |                |                 |                 |
|-------|--|------------------|----------------|----------------|-----------------|-----------------|
|       |  | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|       |  | Tonne            | Tonne          | Tonne          | Tm              | Tm              |
| LC-11 | SIS,HFL, Span dislodge ,Seismic Sx=1,S | 2783.48          | 796.35         | 28.3821        | -9646.02        | 438.342         |

| LC-12                            | SIS, HFL,Span dislodge ,Seismic Sx=1,S          | Forces about toe |                |                |                 |                 |  | LC-12 |
|----------------------------------|---|------------------|----------------|----------------|-----------------|-----------------|--|-------|
| S.N.                             | Description                                     | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |  |       |
|                                  |   | Tonne            | Tonne          | Tonne          | Tm              | Tm              |  |       |
| 1)                               | Sub-structure & Foundation                      | 1317.6           |                |                | -5480.8         | 0.0             |  | 1     |
| 2)                               | Backfill  | 1265.2           |                |                | -8398.4         | 0.0             |  | 1     |
| 8)                               | Buoyancy  | -67.0            |                |                | 74.5            | 0.0             |  | 1     |
| 9.3)                             | Earth Pressure HFL (BP, SD)                     |                  |                |                |                 |                 |  | 1     |
|                                  | Horizontal Component                            |                  | 649.4          |                | 3697.7          |                 |  | 1     |
|                                  | Vertical Component                              | 232.9            |                |                | -1117.9         |                 |  | 1     |
| 10.3)                            | Surcharge Pressure HFL(BP, SD)                  |                  | 121.1          |                | 828.3           |                 |  | 0.2   |
| <b>Seismic Longitudinal</b>      |   |                  |                |                |                 |                 |  | 0.5   |
| 11)                              | Sub-structure Component                         |                  | 31.4           |                | 336.7           |                 |  | 0.5   |
| 12)                              | Earth fill component                            |                  | 42.5           |                | 420.3           |                 |  | 0.5   |
| 12)                              | Super-Structure DL, SIDL, & Surfacing Compone   |                  | 36.9           |                | 783.7           |                 |  | 0.5   |
| 13)                              | Dynamic Earth Pressure HFL                      |                  |                |                |                 |                 |  | 0.5   |
|                                  | 13.6) HFL Seismic Upward_BP/SD                  |                  |                |                |                 |                 |  | 0.5   |
|                                  | Horizontal Component                            |                  | 20.2           |                | 239.4           |                 |  | 0.5   |
|                                  | Vertical Component                              | 7.4              |                |                | -35.3           |                 |  | 0.5   |
| 14)                              | 14.2) Dynamic Surcharge Pressure BP/SD          |                  |                |                |                 |                 |  | 0.2   |
|                                  | HFL Seismic Upward                              |                  | 3.3            |                | 51.6            |                 |  | 0.2   |
| <b>Seismic Transverses</b>       |   |                  |                |                |                 |                 |  | 0.15  |
| 15)                              | Sub-structure Component                         |                  |                | 119.1          |                 | 1278.2          |  | 0.15  |
| 17)                              | Super-Structure DL, SIDL, & Surfacing Component |                  |                | 70.1           |                 | 1644.1          |  | 0.15  |
| <b>Seismic Vertical Downward</b> |   |                  |                |                |                 |                 |  | 0.15  |
| 19)                              | Sub-structure Component                         | 26.47            |                |                | -110.931        |                 |  | -0.15 |
| 21)                              | Super-Structure DL, SIDL, & Surfacing           | 15.5776          |                |                | -53.3532        |                 |  | -0.15 |

| S.N. | Description | Forces about toe |                |                |                 |                 |
|------|-------------|------------------|----------------|----------------|-----------------|-----------------|
|      |             | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|      |             | Tonne            | Tonne          | Tonne          | Tm              | Tm              |

|       |  |         |        |         |          |         |
|-------|--|---------|--------|---------|----------|---------|
| LC-12 | SIS, HFL,Span dislodge ,Seismic Sx=1,Sz=0.3,Sy=0.3 | 2746.15 | 739.78 | 28.3821 | -10151.9 | 438.342 |
|-------|--|---------|--------|---------|----------|---------|

| LC-13                            | SIS,HFL,Max LL,Seismic Sx=1,Sz=0.3,Sy=0.3       | Forces about toe |                |                |                 |                 | LC-13 |
|----------------------------------|---|------------------|----------------|----------------|-----------------|-----------------|-------|
| S.N.                             | Description                                     | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |       |
|                                  |   | Tonne            | Tonne          | Tonne          | Tm              | Tm              |       |
| 1)                               | Sub-structure & Foundation                      | 1317.6           |                |                | -5480.8         | 0.0             | 1     |
| 2)                               | Backfill  | 1265.2           |                |                | -8398.4         | 0.0             | 1     |
| 3)                               | Super-structure DL                              | 398.9            |                |                | -1366.4         | 0.0             | 1     |
| 4)                               | SIDL (excluding surfacing)                      | 117.0            |                |                | -400.7          | 0.0             | 1     |
| 5)                               | Surfacing                                       | 34.0             |                |                | -116.5          | -8.5            | 1     |
| 6.1)                             | Live Load Vertical Load Max Reaction            | 137.4            |                |                | -470.6          | 399.8           | 0.2   |
| 7)                               | Live Load Horizontal Forces                     |                  | 45.8           |                | 970.9           |                 | 0.2   |
| 8)                               | Buoyancy  | -67.0            |                |                | 74.5            | 0.0             | 1     |
| 9.3)                             | Earth Pressure HFL (BP, SD)                     |                  |                |                |                 |                 | 1     |
|                                  | Horizontal Component                            |                  | 649.4          |                | 3697.7          |                 | 1     |
|                                  | Vertical Component                              | 232.9            |                |                | -1117.9         |                 | 1     |
| 10.3)                            | Surcharge Pressure HFL(BP, SD)                  |                  | 121.1          |                | 828.3           |                 | 0.2   |
| <b>Seismic Longitudinal</b>      |   |                  |                |                |                 |                 | 1     |
| 11)                              | Sub-structure Component                         |                  | 31.4           |                | 336.7           |                 | 1     |
| 12)                              | Earth fill component                            |                  | 42.5           |                | 420.3           |                 | 1     |
| 12)                              | Super-Structure DL, SIDL, & Surfacing Component |                  | 36.9           |                | 783.7           |                 | 1     |
| 13)                              | Dynamic Earth Pressure HFL                      |                  |                |                |                 |                 | 1     |
| 13)                              | 13.5)HFL Seismic Downward_BP/SD                 |                  |                |                |                 |                 | 1     |
|                                  | Horizontal Component                            |                  | 126.5          |                | 1498.1          |                 | 1     |
|                                  | Vertical Component                              | 46.0             |                |                | -221.0          |                 | 1     |
| 14)                              | 14.2) Dynamic Surcharge Pressure BP/SD          |                  |                |                |                 |                 | 0.2   |
|                                  | HFL Seismic Downward                            |                  | 20.5           |                | 323.1           |                 | 0.2   |
| <b>Seismic Transveres</b>        |   |                  |                |                |                 |                 | 0.3   |
| 15)                              | Sub-structure Component                         |                  |                | 119.1          |                 | 1278.2          | 0.3   |
| 17)                              | Super-Structure DL, SIDL, & Surfacing Component |                  |                | 70.1           |                 | 1644.1          | 0.3   |
| 18.1)                            | Live Load Component (Max. Reaction)             |                  |                | 17.513         |                 | 435.871         | 0.06  |
| <b>Seismic Vertical Downward</b> |   |                  |                |                |                 |                 | 0.3   |
| 19)                              | Sub-structure Component                         | 26.47            |                |                | -110.931        |                 | 0.3   |
| 20)                              | Earth fill                                      | 35.8             |                |                | -237.9          |                 | 0.3   |
| 21)                              | Super-Structure DL, SIDL, & Surfacing           | 15.5776          |                |                | -53.3532        |                 | 0.3   |
| 22.1)                            | Live Load Component (Max. Reaction)             | 3.9              |                |                | -13.3           |                 | 0.06  |

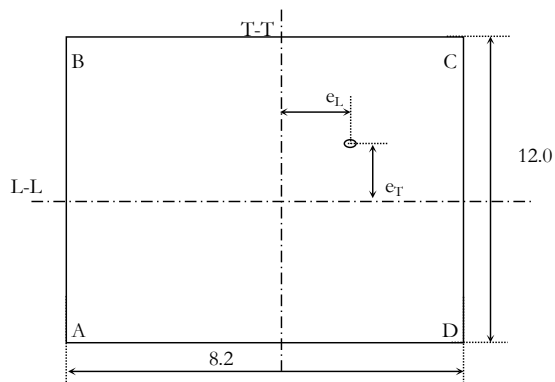
| S.N.  | Description                               | Forces about toe |                |                |                 |                 |
|-------|---|------------------|----------------|----------------|-----------------|-----------------|
|       |   | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|       |   | Tonne            | Tonne          | Tonne          | Tm              | Tm              |
| LC-13 | SIS,HFL,Max LL,Seismic Sx=1,Sz=0.3,Sy=0.3 | 3395.86          | 924.15         | 57.815         | -10081.8        | 974.297         |

| LC-14 | SIS, HFL,Max LL,Seismic Sx=1,Sz=0.3,Sy=0.3 | Forces about toe |                |                |                 |                 | LC-14 |
|-------|--|------------------|----------------|----------------|-----------------|-----------------|-------|
| S.N.  | Description                                | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |       |

|                                  |   | Tonne   | Tonne | Tonne  | Tm       | Tm      |  |       |
|----------------------------------|---|---------|-------|--------|----------|---------|--|-------|
| 1)                               | Sub-structure & Foundation                      | 1317.6  |       |        | -5480.8  | 0.0     |  | 1     |
| 2)                               | Backfill  | 1265.2  |       |        | -8398.4  | 0.0     |  | 1     |
| 3)                               | Super-structure DL                              | 398.9   |       |        | -1366.4  | 0.0     |  | 1     |
| 4)                               | SIDL (excluding surfacing)                      | 117.0   |       |        | -400.7   | 0.0     |  | 1     |
| 5)                               | Surfacing                                       | 34.0    |       |        | -116.5   | -8.5    |  | 1     |
| 6.1)                             | Live Load Vertical Load Max Reaction            | 137.4   |       |        | -470.6   | 399.8   |  | 0.2   |
| 7)                               | Live Load Horizontal Forces                     |         | 45.8  |        | 970.9    |         |  | 0.2   |
| 8)                               | Buoyancy  | -67.0   |       |        | 74.5     | 0.0     |  | 1     |
| 10.1)                            | Surcharge Pressure HFL(O/S)                     |         | 121.1 |        | 828.3    |         |  | 0.2   |
| 9.3)                             | Earth Pressure HFL (BP, SD)                     |         |       |        |          |         |  | 1     |
|                                  | Horizontal Component                            |         | 649.4 |        | 3697.7   |         |  | 1     |
|                                  | Vertical Component                              | 232.9   |       |        | -1117.9  |         |  | 1     |
| 10.3)                            | Surcharge Pressure HFL(BP, SD)                  |         | 121.1 |        | 828.3    |         |  | 0.2   |
| <b>Seismic Longitudinal</b>      |   |         |       |        |          |         |  | 1     |
| 11)                              | Sub-structure Component                         |         | 31.4  |        | 336.7    |         |  | 1     |
| 12)                              | Earth fill component                            |         | 42.5  |        | 420.3    |         |  | 1     |
| 12)                              | Super-Structure DL, SIDL, & Surfacing Component |         | 36.9  |        | 783.7    |         |  | 1     |
| 13)                              | Dynamic Earth Pressure HFL                      |         |       |        |          |         |  | 1     |
|                                  | 13.6) HFL Seismic Upward_BP/SD                  |         |       |        |          |         |  | 1     |
|                                  | Horizontal Component                            |         | 20.2  |        | 239.4    |         |  | 1     |
|                                  | Vertical Component                              | 7.4     |       |        | -35.3    |         |  | 1     |
| 14)                              | 14.2) Dynamic Surcharge Pressure BP/SD          |         |       |        |          |         |  | 0.2   |
|                                  | HFL Seismic Upward                              |         | 3.3   |        | 51.6     |         |  | 0.2   |
| <b>Seismic Transverses</b>       |   |         |       |        |          |         |  | 0.3   |
| 15)                              | Sub-structure Component                         |         |       | 119.1  |          | 1278.2  |  | 0.3   |
| 17)                              | Super-Structure DL, SIDL, & Surfacing Component |         |       | 70.1   |          | 1644.1  |  | 0.3   |
| 18.1)                            | Live Load Component (Max. Reaction)             |         |       | 17.513 |          | 435.871 |  | 0.06  |
| <b>Seismic Vertical Downward</b> |   |         |       |        |          |         |  | 0.3   |
| 19)                              | Sub-structure Component                         | 26.47   |       |        | -110.931 |         |  | -0.3  |
| 21)                              | Super-Structure DL, SIDL, & Surfacing           | 15.5776 |       |        | -53.3532 |         |  | -0.3  |
| 22.1)                            | Live Load Component (Max. Reaction)             | 3.9     |       |        | -13.3    |         |  | -0.06 |

| S.N.  | Description                         | Forces about toe |                |                |                 |                 |
|-------|-------------------------------------|------------------|----------------|----------------|-----------------|-----------------|
|       |                                     | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|       |                                     | Tonne            | Tonne          | Tonne          | Tm              | Tm              |
| LC-14 | SIS, HFL,Max LL,Seismic Sx=1,Sz=0.3 | 3320.73          | 838.66         | 57.815         | -10871.9        | 974.297         |

**CHECK FOR MAXIMUM BASE PRESSRE**  
**LOAD COMBINATION FOR MAXIMUM BASE PRESSURE**



| Coordinates of basecorner |        |        |
|---------------------------|--------|--------|
| Edges                     | x (m)  | z (m)  |
| A                         | -4.100 | 6.000  |
| B                         | -4.100 | -6.000 |
| C                         | 4.100  | -6.000 |
| D                         | 4.100  | 6.000  |

| Properties of Base |                         |   |                        |
|--------------------|-------------------------|---|------------------------|
| Area               | 8.2x12                  | = | 98.4 m <sup>2</sup>    |
| I <sub>TT</sub>    | 12x8.2 <sup>3</sup> /12 | = | 551.368 m <sup>4</sup> |
| I <sub>LL</sub>    | 8.2x12 <sup>3</sup> /12 | = | 1180.8 m <sup>4</sup>  |

| Maximum Base Pressure |               | Heel side |      | Toe Side |       | Bearing Capacity | Check |
|-----------------------|---------------|-----------|------|----------|-------|------------------|-------|
| Non-Seismic case      | LWL Condition | 21.1      | 21.1 | 36.0     | 35.97 | 90.0             | OK    |
| Seismic Case          | LWL Condition | 21.5      | 12.6 | 55.6     | 35.5  | 112.5            | OK    |
| Non-Seismic case      | HFL Condition | 17.9      | 8.0  | 60.6     | 50.7  | 90.0             | OK    |
| Seismic Case          | HFL Condition | 21.9      | 12.9 | 54.1     | 33.9  | 112.5            | OK    |

**CHECK FOR MAXIMUM BASE PRESSRE**

**SUMMARY OF FORCES :**

|       |  |                  |                |                |                 |                 | Eccentricity of Vertical load from toe point |                     | Eccentricity of Vertical load wrt cg of base |                 | Moment and forces at cg of base |                  | Base Pressure = $P/A \pm M_{TT} * x / I_{TT} \pm M_{LL} * z / I_{LL}$ |                  |                  |                  |
|-------|--|------------------|----------------|----------------|-----------------|-----------------|--|---------------------|--|-----------------|---------------------------------|------------------|---|------------------|------------------|------------------|
| S.N.  | Description                            | Forces about toe |                |                |                 |                 | e <sub>L1</sub>                              | e <sub>T1</sub>     | e <sub>L</sub>                               | e <sub>T</sub>  | M <sub>TT</sub>                 | M <sub>LL</sub>  | base pressure at footing corners                                      |                  |                  |                  |
|       |  | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> | M <sub>TT</sub> / V                          | M <sub>LL</sub> / V | B/2-e <sub>L1</sub>                          | e <sub>T1</sub> | V*e <sub>L</sub>                | V*e <sub>T</sub> | A   | B                | C                | D                |
|       |  | Tonne            | Tonne          | Tonne          | Tm              | Tm              | m  | m                   | m  | m               | Tm                              | Tm               | T/m <sup>2</sup>  | T/m <sup>2</sup> | T/m <sup>2</sup> | T/m <sup>2</sup> |
| LC-2  | NS, LWL, Span dislodge, EP             | 2807.39          | 772.056        | 0              | -10509.2        | 0               | -3.74  | 0.00                | 0.36   | 0.00            | 1001.0                          | 0.0              | 21.1  | 21.1             | 36.0             | 36.0             |
| LC-3  | NS, LWL, Max LL, FP                    | 3270.21          | 167.077        | 0              | -14434.2        | 391.329         | -4.41  | 0.12                | -0.31  | 0.12            | -1026.3                         | 391.3            | 42.9  | 38.9             | 23.6             | 27.6             |
| LC-4  | NS, LWL, Max LL, EP                    | 3494.75          | 817.809        | 0              | -11892.6        | 391.329         | -3.40  | 0.11                | 0.70   | 0.11            | 2435.9                          | 391.3            | 19.4  | 15.4             | 51.6             | 55.6             |
| LC-5  | SIS,LWL, Span dislodge ,Seismic Sx=1,S | 2842.06          | 797.834        | 28.3821        | -9758.56        | 438.342         | -3.43  | 0.15                | 0.67   | 0.15            | 1893.9                          | 438.3            | 17.0  | 12.6             | 40.7             | 45.2             |
| LC-6  | SIS, LWL,Span dislodge ,Seismic Sx=1,S | 2804.77          | 741.319        | 28.3821        | -10264.5        | 438.342         | -3.66  | 0.16                | 0.44   | 0.16            | 1235.0                          | 438.3            | 21.5  | 17.1             | 35.5             | 39.9             |
| LC-7  | SIS,LWL,Max LL,Seismic Sx=1,Sz=0.3,S   | 3454.41          | 925.645        | 57.815         | -10194.2        | 974.297         | -2.95  | 0.28                | 1.15   | 0.28            | 3968.9                          | 974.3            | 10.5  | 0.6              | 59.7             | 69.6             |
| LC-8  | SIS, LWL,Max LL,Seismic Sx=1,Sz=0.3    | 3379.36          | 840.298        | 57.815         | -10984.6        | 974.297         | -3.25  | 0.29                | 0.85   | 0.29            | 2870.8                          | 974.3            | 17.9  | 8.0              | 50.7             | 60.6             |
| LC-9  | NS, HFL, Span dislodge, EP             | 2748.78          | 770.478        | 0              | -10396.6        | 0               | -3.78  | 0.00                | 0.32   | 0.00            | 873.4                           | 0.0              | 21.4  | 21.4             | 34.4             | 34.4             |
| LC-10 | NS, HFL, Max LL, EP                    | 3436.14          | 816.231        | 0              | -11780          | 391.329         | -3.43  | 0.11                | 0.67   | 0.11            | 2308.2                          | 391.3            | 19.7  | 15.8             | 50.1             | 54.1             |
| LC-11 | SIS,HFL, Span dislodge ,Seismic Sx=1,S | 2783.48          | 796.352        | 28.3821        | -9646.02        | 438.342         | -3.47  | 0.16                | 0.63   | 0.16            | 1766.3                          | 438.3            | 17.4  | 12.9             | 39.2             | 43.6             |
| LC-12 | SIS, HFL,Span dislodge ,Seismic Sx=1,S | 2746.15          | 739.782        | 28.3821        | -10151.9        | 438.342         | -3.70  | 0.16                | 0.40   | 0.16            | 1107.4                          | 438.3            | 21.9  | 17.4             | 33.9             | 38.4             |
| LC-13 | SIS,HFL,Max LL,Seismic Sx=1,Sz=0.3,S   | 3395.86          | 924.148        | 57.815         | -10081.8        | 974.297         | -2.97  | 0.29                | 1.13   | 0.29            | 3841.3                          | 974.3            | 10.9  | 1.0              | 58.1             | 68.0             |
| LC-14 | SIS, HFL,Max LL,Seismic Sx=1,Sz=0.3    | 3320.73          | 838.66         | 57.815         | -10871.9        | 974.297         | -3.27  | 0.29                | 0.83   | 0.29            | 2743.1                          | 974.3            | 18.3  | 8.4              | 49.2             | 59.1             |



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DESIGN OF FOUNDATION  
ULS LOAD COMBINATION

| LC-2        | NS(1), LWL, Span dislodge, EP  | Forces about toe |                |                |                 |                 |  | LC-2 |
|-------------|--------------------------------|------------------|----------------|----------------|-----------------|-----------------|--|------|
| S.N.        | Description                    | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |  |      |
|             |                                | Tonne            | Tonne          | Tonne          | Tm              | Tm              |  |      |
| 1)          | Sub-structure & Foundation     | 1317.6           |                |                | -5480.8         | 0               |  | 1.35 |
| 2)          | Backfill                       | 1265.2           |                |                | -8398.41        | 0               |  | 1.35 |
| <b>9.3)</b> | Earth Pressure LWL (BP, SD)    |                  |                |                |                 |                 |  | 1.5  |
|             | Horizontal Component           |                  | 650.83         |                | 3619.41         |                 |  | 1.5  |
|             | Vertical Component             | 224.54           |                |                | -1077.79        |                 |  | 1.5  |
| 10.3)       | Surcharge Pressure LWL(BP, SD) |                  | 121.22         |                | 828.36          |                 |  | 1.2  |

| S.N. | Description                   | Forces about toe |                |                |                 |                 |
|------|-------------------------------|------------------|----------------|----------------|-----------------|-----------------|
|      |                               | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|      |                               | Tonne            | Tonne          | Tonne          | Tm              | Tm              |
| LC-2 | NS(1), LWL, Span dislodge, EP | 3823.66          | 1121.72        | 0              | -13930.5        | 0               |

| LC-4        | NS(1), LWL, Min LL acomp, EP         | Forces about toe |                |                |                 |                 |  | LC-4 |
|-------------|--------------------------------------|------------------|----------------|----------------|-----------------|-----------------|--|------|
| S.N.        | Description                          | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |  |      |
|             |                                      | Tonne            | Tonne          | Tonne          | Tm              | Tm              |  |      |
| 1)          | Sub-structure & Foundation           | 1317.6           |                |                | -5480.8         | 0               |  | 1.35 |
| 2)          | Backfill                             | 1265.2           |                |                | -8398.41        | 0               |  | 1.35 |
| 3)          | Super-structure DL                   | 398.9            |                |                | -1366.4         | 0               |  | 1.35 |
| 4)          | SIDL (excluding surfacing)           | 117.0            |                |                | -400.677        | 0               |  | 1.35 |
| 5)          | Surfacing                            | 34.0             |                |                | -116.536        | -8.50627        |  | 1.75 |
| 6.2)        | Live Load Vertical Load Min Reaction | 28.8             |                |                | -98.64          | 83.81           |  | 1.15 |
| 7)          | Live Load Horizontal Forces          |                  | 45.8           |                | 970.88          |                 |  | 1.15 |
| <b>9.3)</b> | Earth Pressure LWL (BP, SD)          |                  |                |                |                 |                 |  | 1.5  |
|             | Horizontal Component                 |                  | 650.83         |                | 3619.41         |                 |  | 1.5  |
|             | Vertical Component                   | 224.54           |                |                | -1077.79        |                 |  | 1.5  |
| 10.3)       | Surcharge Pressure LWL(BP, SD)       |                  | 121.22         |                | 828.36          |                 |  | 1.2  |

| S.N. | Description                  | Forces about toe |                |                |                 |                 |
|------|------------------------------|------------------|----------------|----------------|-----------------|-----------------|
|      |                              | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|      |                              | Tonne            | Tonne          | Tonne          | Tm              | Tm              |
| LC-4 | NS(1), LWL, Min LL acomp, EP | 4612.83          | 1174.33        | 0              | -15516.9        | 81.4922         |

| LC-6        | NS(1), LWL, Max LL Lead, EP          | Forces about toe |                |                |                 |                 |  | LC-6 |
|-------------|--------------------------------------|------------------|----------------|----------------|-----------------|-----------------|--|------|
| S.N.        | Description                          | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |  |      |
|             |                                      | Tonne            | Tonne          | Tonne          | Tm              | Tm              |  |      |
| 1)          | Sub-structure & Foundation           | 1317.6           |                |                | -5480.8         | 0               |  | 1.35 |
| 2)          | Backfill                             | 1265.2           |                |                | -8398.41        | 0               |  | 1.35 |
| 3)          | Super-structure DL                   | 398.9            |                |                | -1366.4         | 0               |  | 1.35 |
| 4)          | SIDL (excluding surfacing)           | 117.0            |                |                | -400.677        | 0               |  | 1.35 |
| 5)          | Surfacing                            | 34.0             |                |                | -116.536        | -8.50627        |  | 1.75 |
| 6.1)        | Live Load Vertical Load Max Reaction | 137.4            |                |                | -470.60         | 399.83          |  | 1.5  |
| 7)          | Live Load Horizontal Forces          |                  | 45.8           |                | 970.88          |                 |  | 1.5  |
| <b>9.3)</b> | Earth Pressure LWL (BP, SD)          |                  |                |                |                 |                 |  | 1    |
|             | Horizontal Component                 |                  | 650.83         |                | 3619.41         |                 |  | 1    |
|             | Vertical Component                   | 224.54           |                |                | -1077.79        |                 |  | 1    |
| 10.3)       | Surcharge Pressure LWL(BP, SD)       |                  | 121.22         |                | 828.36          |                 |  | 1.2  |

| S.N. | Description                 | Forces about toe |                |                |                 |                 |
|------|-----------------------------|------------------|----------------|----------------|-----------------|-----------------|
|      |                             | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|      |                             | Tonne            | Tonne          | Tonne          | Tm              | Tm              |
| LC-6 | NS(1), LWL, Max LL Lead, EP | 4673.54          | 864.93         | 0              | -17040.4        | 584.866         |

| LC-8        | NS(2), LWL, Span dislodge, EP  | Forces about toe |                |                |                 |                 |  | LC-8 |
|-------------|--------------------------------|------------------|----------------|----------------|-----------------|-----------------|--|------|
| S.N.        | Description                    | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |  |      |
|             |                                | Tonne            | Tonne          | Tonne          | Tm              | Tm              |  |      |
| 1)          | Sub-structure & Foundation     | 1317.6           |                |                | -5480.8         | 0               |  | 1    |
| 2)          | Backfill                       | 1265.2           |                |                | -8398.41        | 0               |  | 1    |
| <b>9.3)</b> | Earth Pressure LWL (BP, SD)    |                  |                |                |                 |                 |  | 1.3  |
|             | Horizontal Component           |                  | 650.83         |                | 3619.41         |                 |  | 1.3  |
|             | Vertical Component             | 224.54           |                |                | -1077.79        |                 |  | 1.3  |
| 10.3)       | Surcharge Pressure LWL(BP, SD) |                  | 121.22         |                | 828.36          |                 |  | 1    |

| S.N. | Description                   | Forces about toe |                |                |                 |                 |
|------|-------------------------------|------------------|----------------|----------------|-----------------|-----------------|
|      |                               | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|      |                               | Tonne            | Tonne          | Tonne          | Tm              | Tm              |
| LC-8 | NS(2), LWL, Span dislodge, EP | 2874.75          | 967.306        | 0              | -9746.76        | 0               |

| LC-10       | NS(2), LWL, Min LL acom, EP          | Forces about toe |                |                |                 |                 |  | LC-10 |
|-------------|--------------------------------------|------------------|----------------|----------------|-----------------|-----------------|--|-------|
| S.N.        | Description                          | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |  |       |
|             |                                      | Tonne            | Tonne          | Tonne          | Tm              | Tm              |  |       |
| 1)          | Sub-structure & Foundation           | 1317.6           |                |                | -5480.8         | 0               |  | 1     |
| 2)          | Backfill                             | 1265.2           |                |                | -8398.41        | 0               |  | 1     |
| 3)          | Super-structure DL                   | 398.9            |                |                | -1366.4         | 0               |  | 1     |
| 4)          | SIDL (excluding surfacing)           | 117.0            |                |                | -400.677        | 0               |  | 1     |
| 5)          | Surfacing                            | 34.0             |                |                | -116.536        | -8.50627        |  | 1     |
| 6.2)        | Live Load Vertical Load Min Reaction | 28.8             |                |                | -98.64          | 83.81           |  | 1     |
| 7)          | Live Load Horizontal Forces          |                  | 45.8           |                | 970.88          |                 |  | 1     |
| <b>9.3)</b> | Earth Pressure LWL (BP, SD)          |                  |                |                |                 |                 |  | 1.3   |
|             | Horizontal Component                 |                  | 650.83         |                | 3619.41         |                 |  | 1.3   |
|             | Vertical Component                   | 224.54           |                |                | -1077.79        |                 |  | 1.3   |
| 10.3)       | Surcharge Pressure LWL(BP, SD)       |                  | 121.22         |                | 828.36          |                 |  | 1     |

| S.N.  | Description                 | Forces about toe |                |                |                 |                 |
|-------|-----------------------------|------------------|----------------|----------------|-----------------|-----------------|
|       |                             | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|       |                             | Tonne            | Tonne          | Tonne          | Tm              | Tm              |
| LC-10 | NS(2), LWL, Min LL acom, EP | 3453.51          | 1013.06        | 0              | -10758.1        | 75.3009         |

| S.N.  | Description                          | Forces about toe |                |                |                 |                 | LC-12 |
|-------|--------------------------------------|------------------|----------------|----------------|-----------------|-----------------|-------|
|       |                                      | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |       |
|       |                                      | Tonne            | Tonne          | Tonne          | Tm              | Tm              |       |
| 1)    | Sub-structure & Foundation           | 1317.6           |                |                | -5480.8         | 0               | 1     |
| 2)    | Backfill                             | 1265.2           |                |                | -8398.41        | 0               | 1     |
| 3)    | Super-structure DL                   | 398.9            |                |                | -1366.4         | 0               | 1     |
| 4)    | SIDL (excluding surfacing)           | 117.0            |                |                | -400.677        | 0               | 1     |
| 5)    | Surfacing                            | 34.0             |                |                | -116.536        | -8.50627        | 1     |
| 6.1)  | Live Load Vertical Load Max Reaction | 137.4            |                |                | -470.60         | 399.83          | 1.3   |
| 7)    | Live Load Horizontal Forces          |                  | 45.8           |                | 970.88          |                 | 1.3   |
| 9.3)  | Earth Pressure LWL (BP, SD)          |                  |                |                |                 |                 | 0.85  |
|       | Horizontal Component                 |                  | 650.83         |                | 3619.41         |                 | 0.85  |
|       | Vertical Component                   | 224.54           |                |                | -1077.79        |                 | 0.85  |
| 10.3) | Surcharge Pressure LWL(BP, SD)       |                  | 121.22         |                | 828.36          |                 | 1     |

| S.N.  | Description                 | Forces about toe |                |                |                 |                 |
|-------|-----------------------------|------------------|----------------|----------------|-----------------|-----------------|
|       |                             | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|       |                             | Tonne            | Tonne          | Tonne          | Tm              | Tm              |
| LC-12 | NS(2), LWL, Max LL Lead, EP | 3502.29          | 733.91         | 0              | -12123.7        | 511.279         |

| S.N.  | Description                    | Forces about toe |                |                |                 |                 | LC-19 |
|-------|--------------------------------|------------------|----------------|----------------|-----------------|-----------------|-------|
|       |                                | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |       |
|       |                                | Tonne            | Tonne          | Tonne          | Tm              | Tm              |       |
| 1)    | Sub-structure & Foundation     | 1317.6           |                |                | -5480.8         | 0               | 1.35  |
| 2)    | Backfill                       | 1265.2           |                |                | -8398.41        | 0               | 1.35  |
| 8)    | Buoyancy                       | -67.0            |                |                | 74.5            | 0.0             | 0.15  |
| 9.3)  | Earth Pressure HFL (BP, SD)    |                  |                |                |                 |                 | 1.5   |
|       | Horizontal Component           |                  | 649.4          |                | 3697.7          |                 | 1.5   |
|       | Vertical Component             | 232.9            |                |                | -1117.9         |                 | 1.5   |
| 10.3) | Surcharge Pressure HFL(BP, SD) |                  | 121.1          |                | 828.3           |                 | 1.2   |

| S.N.  | Description                   | Forces about toe |                |                |                 |                 |
|-------|-------------------------------|------------------|----------------|----------------|-----------------|-----------------|
|       |                               | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|       |                               | Tonne            | Tonne          | Tonne          | Tm              | Tm              |
| LC-19 | NS(1), HFL, Span dislodge, EP | 3826.14          | 1119.39        | 0              | -13862.2        | 0               |

| S.N.  | Description                          | Forces about toe |                |                |                 |                 | LC-20 |
|-------|--------------------------------------|------------------|----------------|----------------|-----------------|-----------------|-------|
|       |                                      | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |       |
|       |                                      | Tonne            | Tonne          | Tonne          | Tm              | Tm              |       |
| 1)    | Sub-structure & Foundation           | 1317.6           |                |                | -5480.8         | 0               | 1.35  |
| 2)    | Backfill                             | 1265.2           |                |                | -8398.41        | 0               | 1.35  |
| 3)    | Super-structure DL                   | 398.9            |                |                | -1366.4         | 0               | 1.35  |
| 4)    | SIDL (excluding surfacing)           | 117.0            |                |                | -400.677        | 0               | 1.35  |
| 5)    | Surfacing                            | 34.0             |                |                | -116.536        | -8.50627        | 1.75  |
| 6.2)  | Live Load Vertical Load Min Reaction | 28.8             |                |                | -98.64          | 83.81           | 1.15  |
| 7)    | Live Load Horizontal Forces          |                  | 45.8           |                | 970.88          |                 | 1.15  |
| 8)    | Buoyancy                             | -67.0            |                |                | 74.5            | 0.0             | 0.15  |
| 9.3)  | Earth Pressure HFL (BP, SD)          |                  |                |                |                 |                 | 1.5   |
|       | Horizontal Component                 |                  | 649.4          |                | 3697.7          |                 | 1.5   |
|       | Vertical Component                   | 232.9            |                |                | -1117.9         |                 | 1.5   |
| 10.3) | Surcharge Pressure HFL(BP, SD)       |                  | 121.1          |                | 828.3           |                 | 1.2   |



| S.N.  | Description                  | Forces about toe |                |                |                 |                 |
|-------|------------------------------|------------------|----------------|----------------|-----------------|-----------------|
|       |                              | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|       |                              | Tonne            | Tonne          | Tonne          | Tm              | Tm              |
| LC-20 | NS(1), HFL, Min LL acomp, EP | 4615.32          | 1172.01        | 0              | -15448.6        | 81.4922         |

| S.N.  | Description                          | Forces about toe |                |                |                 |                 |  | LC-21 |
|-------|--------------------------------------|------------------|----------------|----------------|-----------------|-----------------|--|-------|
|       |                                      | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |  |       |
|       |                                      | Tonne            | Tonne          | Tonne          | Tm              | Tm              |  |       |
| 1)    | Sub-structure & Foundation           | 1317.6           |                |                | -5480.8         | 0               |  | 1.35  |
| 2)    | Backfill                             | 1265.2           |                |                | -8398.41        | 0               |  | 1.35  |
| 3)    | Super-structure DL                   | 398.9            |                |                | -1366.4         | 0               |  | 1.35  |
| 4)    | SIDL (excluding surfacing)           | 117.0            |                |                | -400.677        | 0               |  | 1.35  |
| 5)    | Surfacing                            | 34.0             |                |                | -116.536        | -8.50627        |  | 1.75  |
| 6.1)  | Live Load Vertical Load Max Reaction | 137.4            |                |                | -470.60         | 399.83          |  | 1.5   |
| 7)    | Live Load Horizontal Forces          |                  | 45.8           |                | 970.88          |                 |  | 1.5   |
| 8)    | Buoyancy                             | -67.0            |                |                | 74.5            | 0.0             |  | 0.15  |
| 9.3)  | Earth Pressure HFL (BP, SD)          |                  |                |                |                 |                 |  | 1     |
|       | Horizontal Component                 |                  | 649.4          |                | 3697.7          |                 |  | 1     |
|       | Vertical Component                   | 232.9            |                |                | -1117.9         |                 |  | 1     |
| 10.3) | Surcharge Pressure HFL(BP, SD)       |                  | 121.1          |                | 828.3           |                 |  | 1.2   |

| S.N.  | Description                 | Forces about toe |                |                |                 |                 |
|-------|-----------------------------|------------------|----------------|----------------|-----------------|-----------------|
|       |                             | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|       |                             | Tonne            | Tonne          | Tonne          | Tm              | Tm              |
| LC-21 | NS(1), HFL, Max LL Lead, EP | 4671.85          | 863.323        | 0              | -16991.1        | 584.866         |

| S.N.  | Description                    | Forces about toe |                |                |                 |                 |  | LC-22 |
|-------|--------------------------------|------------------|----------------|----------------|-----------------|-----------------|--|-------|
|       |                                | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |  |       |
|       |                                | Tonne            | Tonne          | Tonne          | Tm              | Tm              |  |       |
| 1)    | Sub-structure & Foundation     | 1317.6           |                |                | -5480.8         | 0               |  | 1     |
| 2)    | Backfill                       | 1265.2           |                |                | -8398.41        | 0               |  | 1     |
| 8)    | Buoyancy                       | -67.0            |                |                | 74.5            | 0.0             |  | 0.15  |
| 9.3)  | Earth Pressure HFL (BP, SD)    |                  |                |                |                 |                 |  | 1.3   |
|       | Horizontal Component           |                  | 649.4          |                | 3697.7          |                 |  | 1.3   |
|       | Vertical Component             | 232.9            |                |                | -1117.9         |                 |  | 1.3   |
| 10.3) | Surcharge Pressure HFL(BP, SD) |                  | 121.1          |                | 828.3           |                 |  | 1     |

| S.N.  | Description                   | Forces about toe |                |                |                 |                 |
|-------|-------------------------------|------------------|----------------|----------------|-----------------|-----------------|
|       |                               | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|       |                               | Tonne            | Tonne          | Tonne          | Tm              | Tm              |
| LC-22 | NS(2), HFL, Span dislodge, EP | 2875.57          | 965.298        | 0              | -9686.05        | 0               |

| S.N. | Description                          | Forces about toe |                |                |                 |                 |  | LC-23 |
|------|--------------------------------------|------------------|----------------|----------------|-----------------|-----------------|--|-------|
|      |                                      | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |  |       |
|      |                                      | Tonne            | Tonne          | Tonne          | Tm              | Tm              |  |       |
| 1)   | Sub-structure & Foundation           | 1317.6           |                |                | -5480.8         | 0               |  | 1     |
| 2)   | Backfill                             | 1265.2           |                |                | -8398.41        | 0               |  | 1     |
| 3)   | Super-structure DL                   | 398.9            |                |                | -1366.4         | 0               |  | 1     |
| 4)   | SIDL (excluding surfacing)           | 117.0            |                |                | -400.677        | 0               |  | 1     |
| 5)   | Surfacing                            | 34.0             |                |                | -116.536        | -8.50627        |  | 1     |
| 6.2) | Live Load Vertical Load Min Reaction | 28.8             |                |                | -98.64          | 83.81           |  | 1     |
| 7)   | Live Load Horizontal Forces          |                  | 45.8           |                | 970.88          |                 |  | 1     |
| 8)   | Buoyancy                             | -67.0            |                |                | 74.5            | 0.0             |  | 0.15  |
| 9.3) | Earth Pressure HFL (BP, SD)          |                  |                |                |                 |                 |  | 1.3   |
|      | Horizontal Component                 |                  | 649.4          |                | 3697.7          |                 |  | 1.3   |
|      | Vertical Component                   | 232.9            |                |                | -1117.9         |                 |  | 1.3   |

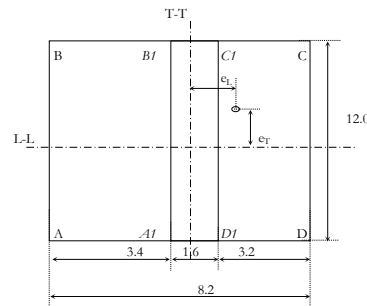
|       |                                |  |       |  |       |  |  |   |
|-------|--------------------------------|--|-------|--|-------|--|--|---|
| 10.3) | Surcharge Pressure HFL(BP, SD) |  | 121.1 |  | 828.3 |  |  | 1 |
|-------|--------------------------------|--|-------|--|-------|--|--|---|

| S.N.  | Description                 | Forces about toe |                |                |                 |                 |
|-------|-----------------------------|------------------|----------------|----------------|-----------------|-----------------|
|       |                             | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|       |                             | Tonne            | Tonne          | Tonne          | Tm              | Tm              |
| LC-23 | NS(2), HFL, Min LL acom, EP | 3454.33          | 1011.05        | 0              | -10697.4        | 75.3009         |

| S.N.  | Description                          | Forces about toe |                |                |                 |                 | LC-24 |
|-------|--------------------------------------|------------------|----------------|----------------|-----------------|-----------------|-------|
|       |                                      | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |       |
|       |                                      | Tonne            | Tonne          | Tonne          | Tm              | Tm              |       |
| LC-24 | NS(2), HFL, Max LL Lead, EP          |                  |                |                |                 |                 |       |
| 1)    | Sub-structure & Foundation           | 1317.6           |                |                | -5480.8         | 0               | 1     |
| 2)    | Backfill                             | 1265.2           |                |                | -8398.41        | 0               | 1     |
| 3)    | Super-structure DL                   | 398.9            |                |                | -1366.4         | 0               | 1     |
| 4)    | SIDL (excluding surfacing)           | 117.0            |                |                | -400.677        | 0               | 1     |
| 5)    | Surfacing                            | 34.0             |                |                | -116.536        | -8.50627        | 1     |
| 6.1)  | Live Load Vertical Load Max Reaction | 137.4            |                |                | -470.60         | 399.83          | 1.3   |
| 7)    | Live Load Horizontal Forces          |                  | 45.8           |                | 970.88          |                 | 1.3   |
| 8)    | Buoyancy                             | -67.0            |                |                | 74.5            | 0.0             | 0.15  |
| 9.3)  | Earth Pressure HFL (BP, SD)          |                  |                |                |                 |                 | 0.85  |
|       | Horizontal Component                 |                  | 649.4          |                | 3697.7          |                 | 0.85  |
|       | Vertical Component                   | 232.9            |                |                | -1117.9         |                 | 0.85  |
| 10.3) | Surcharge Pressure HFL(BP, SD)       |                  | 121.1          |                | 828.3           |                 | 1     |

| S.N.  | Description                 | Forces about toe |                |                |                 |                 |
|-------|-----------------------------|------------------|----------------|----------------|-----------------|-----------------|
|       |                             | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|       |                             | Tonne            | Tonne          | Tonne          | Tm              | Tm              |
| LC-24 | NS(2), HFL, Max LL Lead, EP | 3499.35          | 732.547        | 0              | -12080.2        | 511.279         |

**BASE PRESSRE CALCULATION**  
**ULS LOAD COMBINATIONS**



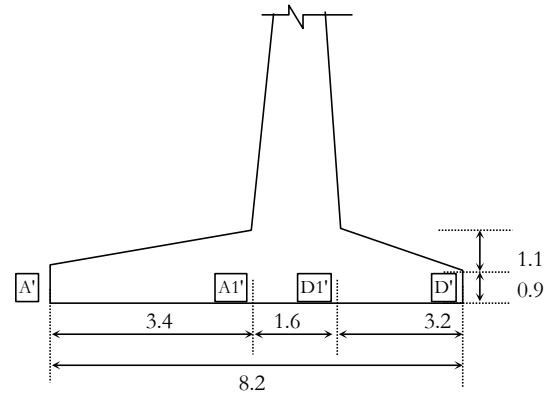
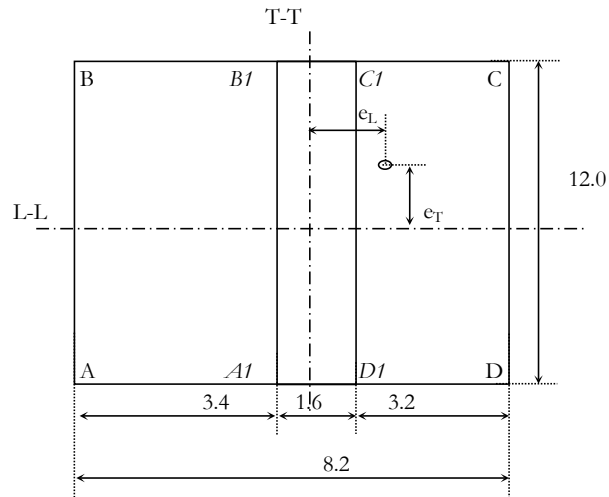
| Coordinates of basecorner |        |        |
|---------------------------|--------|--------|
| Edges                     | x (m)  | z (m)  |
| A                         | -4.100 | 6.000  |
| B                         | -4.100 | -6.000 |
| C                         | 4.100  | -6.000 |
| D                         | 4.100  | 6.000  |

| Properties of Base |                         |   |                        |
|--------------------|-------------------------|---|------------------------|
| Area               | 8.2x12                  | = | 98.4 m <sup>2</sup>    |
| I <sub>TT</sub>    | 12x8.2 <sup>3</sup> /12 | = | 551.368 m <sup>4</sup> |
| I <sub>LL</sub>    | 8.2x12 <sup>3</sup> /12 | = | 1180.8 m <sup>4</sup>  |

**CHECK FOR MAXIMUM BASE PRESSRE**

| SUMMARY OF FORCES : |  |                  |                |                |                 | Eccentricity of Vertical load from toe point |                     | Eccentricity of Vertical load wrt cg of base |                    | Moment and forces at cg of base |                  | Gross Base Pressure = $P/A \pm M_{TT} * x / I_{TT} \pm M_{LL} * z / I_{LL}$ |                                  |                  |                  |                  |
|---------------------|--|------------------|----------------|----------------|-----------------|--|---------------------|--|--------------------|---------------------------------|------------------|---|----------------------------------|------------------|------------------|------------------|
| S.N.                | Description                              | Forces about toe |                |                |                 |  | e <sub>L</sub>      | e <sub>T</sub>                               | e <sub>L</sub>     | e <sub>T</sub>                  | M <sub>TT</sub>  | M <sub>LL</sub>   | base pressure at footing corners |                  |                  |                  |
|                     |  | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub>                              | M <sub>TT</sub> / V | M <sub>LL</sub> / V                          | B/2-e <sub>L</sub> | e <sub>T</sub>                  | V*e <sub>L</sub> | V*e <sub>T</sub>  | A                                | B                | C                | D                |
|                     |  | Tonne            | Tonne          | Tonne          | Tm              | Tm   | m                   | m  | m                  | m                               | Tm               | Tm  | T/m <sup>2</sup>                 | T/m <sup>2</sup> | T/m <sup>2</sup> | T/m <sup>2</sup> |
| LC-1                | NS(1), LWL, Span dislodge, FP            | 3486.85          |                |                |                 |  |                     |  |                    |                                 |                  |   |                                  |                  |                  |                  |
| LC-2                | NS(1), LWL, Span dislodge, EP            | 3823.66          | 1121.72        | 0              | -13930          | 0  | -3.64               | 0.00   | 0.46               | 0.00                            | 1746.5           | 0.0   | 25.9                             | 25.9             | 51.8             | 51.8             |
| LC-3                | NS(1), LWL, Min LL acomp, FP             |                  |                |                |                 |  |                     |  |                    |                                 |                  |   |                                  |                  |                  |                  |
| LC-4                | NS(1), LWL, Min LL acomp, EP             | 4612.83          | 1174.33        | 0              | -15517          | 81.4922                                      | -3.36               | 0.02   | 0.74               | 0.02                            | 3395.7           | 81.5  | 22.0                             | 21.2             | 71.7             | 72.5             |
| LC-5                | NS(1), LWL, Max LL Lead, FP              |                  |                |                |                 |  |                     |  |                    |                                 |                  |   |                                  |                  |                  |                  |
| LC-6                | NS(1), LWL, Max LL Lead, EP              | 4673.54          | 864.93         | 0              | -17040          | 584.866                                      | -3.65               | 0.13   | 0.45               | 0.13                            | 2121.2           | 584.9   | 34.7                             | 28.8             | 60.3             | 66.2             |
| LC-7                | NS(2), LWL, Span dislodge, FP            |                  |                |                |                 |  |                     |  |                    |                                 |                  |   |                                  |                  |                  |                  |
| LC-8                | NS(2), LWL, Span dislodge, EP            | 2874.75          | 967.306        | 0              | -9746.8         | 0  | -3.39               | 0.00   | 0.71               | 0.00                            | 2039.7           | 0.0   | 14.0                             | 14.0             | 44.4             | 44.4             |
| LC-9                | NS(2), LWL, Min LL acomp, FP             |                  |                |                |                 |  |                     |  |                    |                                 |                  |   |                                  |                  |                  |                  |
| LC-10               | NS(2), LWL, Min LL acom, EP              | 3453.51          | 1013.06        | 0              | -10758          | 75.3009                                      | -3.12               | 0.02   | 0.98               | 0.02                            | 3401.3           | 75.3  | 10.2                             | 9.4              | 60.0             | 60.8             |
| LC-11               | NS(2), LWL, Max LL Lead, FP              |                  |                |                |                 |  |                     |  |                    |                                 |                  |   |                                  |                  |                  |                  |
| LC-12               | NS(2), LWL, Max LL Lead, EP              | 3502.29          | 733.91         | 0              | -12124          | 511.279                                      | -3.46               | 0.15   | 0.64               | 0.15                            | 2235.7           | 511.3   | 21.6                             | 16.4             | 49.6             | 54.8             |
| LC-13               | SIS,LWL, Span dislodge ,Seismic Sx=1,Sz= | 3778.97          | 920.894        | 57.6968        | -13200          | 893.192                                      | -3.49               | 0.24   | 0.61               | 0.24                            | 2293.6           | 893.2   | 25.9                             | 16.8             | 50.9             | 60.0             |
| LC-14               | SIS, LWL,Span dislodge ,Seismic Sx=1,Sz= | 3706.03          | 808.772        | 57.6968        | -14199          | 893.192                                      | -3.83               | 0.24   | 0.27               | 0.24                            | 995.7            | 893.2   | 34.8                             | 25.7             | 40.5             | 49.6             |
| LC-15               | SIS,LWL,Min LL Acc,Seismic Sx=1,Sz=      | 4613.74          | 1170.33        | 115.394        | -12895          | 1788.26                                      | -2.79               | 0.39   | 1.31               | 0.39                            | 6021.0           | 1788.3  | 11.2                             | -7.0             | 82.6             | 100.7            |
| LC-16               | SIS, LWL,Min LL Acc,Seismic Sx=1,Sz=     | 4462.49          | 950.73         | 115.394        | -14797          | 1788.26                                      | -3.32               | 0.40   | 0.78               | 0.40                            | 3498.9           | 1788.3  | 28.4                             | 10.2             | 62.3             | 80.5             |
| LC-17               | SIS,LWL,Max LL Acc,Seismic Sx=1,Sz=      | 4635.83          | 1170.33        | 117.075        | -12971          | 1893.32                                      | -2.80               | 0.41   | 1.30               | 0.41                            | 6035.9           | 1893.3  | 11.8                             | -7.4             | 82.4             | 101.6            |
| LC-18               | SIS, LWL,Max LL Acc,Seismic Sx=1,Sz=     | 4483.84          | 950.73         | 117.075        | -14870          | 1893.32                                      | -3.32               | 0.42   | 0.78               | 0.42                            | 3513.3           | 1893.3  | 29.1                             | 9.8              | 62.1             | 81.3             |
| LC-19               | NS(1), HFL, Span dislodge, EP            | 3826.14          | 1119.39        | 0              | -13862          | 0  | -3.62               | 0.00   | 0.48               | 0.00                            | 1825.0           | 0.0   | 25.3                             | 25.3             | 52.5             | 52.5             |
| LC-20               | NS(1), HFL, Min LL acomp, EP             | 4615.32          | 1172.01        | 0              | -15449          | 81.4922                                      | -3.35               | 0.02   | 0.75               | 0.02                            | 3474.2           | 81.5  | 21.5                             | 20.7             | 72.3             | 73.2             |
| LC-21               | NS(1), HFL, Max LL Lead, EP              | 4671.85          | 863.323        | 0              | -16991          | 584.866                                      | -3.64               | 0.13   | 0.46               | 0.13                            | 2163.5           | 584.9   | 34.4                             | 28.4             | 60.6             | 66.5             |
| LC-22               | NS(2), HFL, Span dislodge, EP            | 2875.57          | 965.298        | 0              | -9686.1         | 0  | -3.37               | 0.00   | 0.73               | 0.00                            | 2103.8           | 0.0   | 13.6                             | 13.6             | 44.9             | 44.9             |
| LC-23               | NS(2), HFL, Min LL acomp, EP             | 3454.33          | 1011.05        | 0              | -10697          | 75.3009                                      | -3.10               | 0.02   | 1.00               | 0.02                            | 3465.3           | 75.3  | 9.7                              | 9.0              | 60.5             | 61.3             |
| LC-24               | NS(2), HFL, Max LL Lead, EP              | 3499.35          | 732.547        | 0              | -12080          | 511.279                                      | -3.45               | 0.15   | 0.65               | 0.15                            | 2267.1           | 511.3   | 21.3                             | 16.1             | 49.8             | 55.0             |
| LC-25               | SIS,HFL, Span dislodge ,Seismic Sx=1,Sz= | 3777.33          | 919.396        | 57.6968        | -13151          | 893.192                                      | -3.48               | 0.24   | 0.62               | 0.24                            | 2336.0           | 893.2   | 25.6                             | 16.5             | 51.2             | 60.3             |
| LC-26               | SIS, HFL,Span dislodge ,Seismic Sx=1,Sz= | 3704.32          | 807.161        | 57.6968        | -14150          | 893.192                                      | -3.82               | 0.24   | 0.28               | 0.24                            | 1038.0           | 893.2   | 34.5                             | 25.4             | 40.8             | 49.9             |
| LC-27               | SIS,HFL,Min LL Acc,Seismic Sx=1,Sz=      | 4612.15          | 1168.8         | 115.394        | -12847          | 1788.26                                      | -2.79               | 0.39   | 1.31               | 0.39                            | 6063.2           | 1788.3  | 10.9                             | -7.3             | 82.9             | 101.0            |
| LC-28               | SIS, HFL,Min LL Acc,Seismic Sx=1,Sz=     | 4460.77          | 948.973        | 115.394        | -14748          | 1788.26                                      | -3.31               | 0.40   | 0.79               | 0.40                            | 3541.1           | 1788.3  | 28.1                             | 9.9              | 62.6             | 80.8             |
| LC-29               | SIS,HFL,Max LL Acc,Seismic Sx=1,Sz=      | 4634.24          | 1168.8         | 117.075        | -12922          | 1893.32                                      | -2.79               | 0.41   | 1.31               | 0.41                            | 6078.2           | 1893.3  | 11.5                             | -7.7             | 82.7             | 101.9            |
| LC-30               | SIS, HFL,Max LL Acc,Seismic Sx=1,Sz=     | 4482.12          | 948.973        | 117.075        | -14821          | 1893.32                                      | -3.31               | 0.42   | 0.79               | 0.42                            | 3555.5           | 1893.3  | 28.7                             | 9.5              | 62.4             | 81.6             |

**NET BASE PRESSRE CALCULATION**  
**ULS LOAD COMBINATIONS**



**Deduction due to overburden pressure LWL:**

| LWL           | A'           | A1'          | D'          | D1'         | Comb-1 | Comb-2 | Comb-3 |
|---------------|--------------|--------------|-------------|-------------|--------|--------|--------|
| Earth fill    | 45.576       | 43.376       | 0           | 0           | 1.35   | 1      | 1.35   |
| footing       | 2.25         | 5            | 2.25        | 5           | 1.35   | 1      | 1.35   |
| <b>Comb-1</b> | <b>64.57</b> | <b>65.31</b> | <b>3.04</b> | <b>6.75</b> |        |        |        |
| <b>Comb-2</b> | <b>47.83</b> | <b>48.38</b> | <b>2.25</b> | <b>5.00</b> |        |        |        |
| <b>Comb-3</b> | <b>64.57</b> | <b>65.31</b> | <b>3.04</b> | <b>6.75</b> |        |        |        |

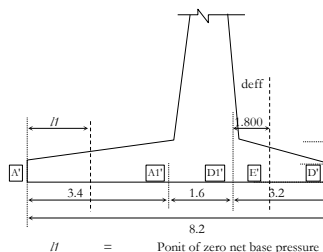
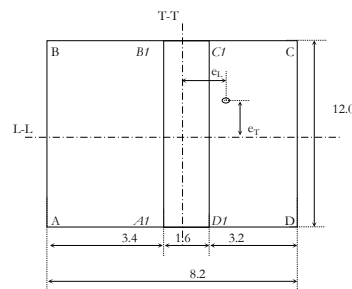
**Deduction due to overburden pressure HFL:**

| LWL           | A'           | A1'          | D'          | D1'         | Comb-1 | Comb-2 | Comb-3 |
|---------------|--------------|--------------|-------------|-------------|--------|--------|--------|
| Earth fill    | 45.576       | 43.376       | 0           | 0           | 1.35   | 1      | 1.35   |
| footing       | 2.25         | 5            | 2.25        | 5           | 1.35   | 1      | 1.35   |
| Bouency       | -0.188       | -0.188       | -0.9        | -2          | 0.15   | 0.15   | 0.15   |
| <b>Comb-1</b> | <b>64.54</b> | <b>65.28</b> | <b>2.90</b> | <b>6.45</b> |        |        |        |
| <b>Comb-2</b> | <b>47.80</b> | <b>48.35</b> | <b>2.12</b> | <b>4.70</b> |        |        |        |
| <b>Comb-3</b> | <b>64.54</b> | <b>65.28</b> | <b>2.90</b> | <b>6.45</b> |        |        |        |

**DESIGN OF HEEL SLAB**

| <b>SUMMARY OF FORCES :</b> |   | <b>Gross Base Pressure = <math>P/A \pm M_{TT} *x / I_{TT} \pm M_{LL} *z / I_{LL}</math></b> |                        |                        |                        | <b>Average Gross Base Pressure at Critical points</b> |                        |                        |                        | <b>NET BASE PRESSURE</b>                |                        |                        |                        |
|----------------------------|---|---|------------------------|------------------------|------------------------|---|------------------------|------------------------|------------------------|---|------------------------|------------------------|------------------------|
| <b>S.No.</b>               | <b>Description</b>                        | <b>base pressure at footing corners</b>   |                        |                        |                        | <b>base pressure at footing corners</b>               |                        |                        |                        | <b>base pressure at footing corners</b> |                        |                        |                        |
|                            |   | <b>A</b>  | <b>B</b>               | <b>C</b>               | <b>D</b>               | <b>A'</b>   | <b>A1'</b>             | <b>D'</b>              | <b>D1'</b>             | <b>A'</b>                               | <b>A1'</b>             | <b>D'</b>              | <b>D1'</b>             |
|                            |   | <b>T/m<sup>2</sup></b>  | <b>T/m<sup>2</sup></b> | <b>T/m<sup>2</sup></b> | <b>T/m<sup>2</sup></b> | <b>T/m<sup>2</sup></b>                                | <b>T/m<sup>2</sup></b> | <b>T/m<sup>2</sup></b> | <b>T/m<sup>2</sup></b> | <b>T/m<sup>2</sup></b>                  | <b>T/m<sup>2</sup></b> | <b>T/m<sup>2</sup></b> | <b>T/m<sup>2</sup></b> |
| LC-1                       | NS(1), LWL, Span dislodge, FP             | 0.0   | 0.0                    | 0.0                    | 0.0                    | 0.0   | 0.0                    | 0.0                    | 0.0                    |   |                        |                        |                        |
| LC-2                       | NS(1), LWL, Span dislodge, EP             | 25.9  | 25.9                   | 51.8                   | 51.8                   | 25.9  | 36.6                   | 51.8                   | 41.7                   | -38.7                                   | -28.7                  | 48.8                   | 35.0                   |
| LC-3                       | NS(1), LWL, Min LL acomp, FP              | 0.0   | 0.0                    | 0.0                    | 0.0                    | 0.0   | 0.0                    | 0.0                    | 0.0                    |   |                        |                        |                        |
| LC-4                       | NS(1), LWL, Min LL acomp, EP              | 22.0  | 21.2                   | 71.7                   | 72.5                   | 21.6  | 42.6                   | 72.1                   | 52.4                   | -42.9                                   | -22.7                  | 69.1                   | 45.7                   |
| LC-5                       | NS(1), LWL, Max LL Lead, FP               | 0.0   | 0.0                    | 0.0                    | 0.0                    | 0.0   | 0.0                    | 0.0                    | 0.0                    | -64.6                                   | -65.3                  | -3.0                   | -6.8                   |
| LC-6                       | NS(1), LWL, Max LL Lead, EP               | 34.7  | 28.8                   | 60.3                   | 66.2                   | 31.7  | 44.8                   | 63.3                   | 51.0                   | -32.8                                   | -20.5                  | 60.2                   | 44.2                   |
| LC-7                       | NS(2), LWL, Span dislodge, FP             | 0.0   | 0.0                    | 0.0                    | 0.0                    | 0.0   | 0.0                    | 0.0                    | 0.0                    | -47.8                                   | -48.4                  | -2.3                   | -5.0                   |
| LC-8                       | NS(2), LWL, Span dislodge, EP             | 14.0  | 14.0                   | 44.4                   | 44.4                   | 14.0  | 26.6                   | 44.4                   | 32.5                   | -33.8                                   | -21.8                  | 42.1                   | 27.5                   |
| LC-9                       | NS(2), LWL, Min LL acomp, FP              | 0.0   | 0.0                    | 0.0                    | 0.0                    | 0.0   | 0.0                    | 0.0                    | 0.0                    | -47.8                                   | -48.4                  | -2.3                   | -5.0                   |
| LC-10                      | NS(2), LWL, Min LL acom, EP               | 10.2  | 9.4                    | 60.0                   | 60.8                   | 9.8   | 30.8                   | 60.4                   | 40.6                   | -38.0                                   | -17.6                  | 58.1                   | 35.6                   |
| LC-11                      | NS(2), LWL, Max LL Lead, FP               | 0.0   | 0.0                    | 0.0                    | 0.0                    | 0.0   | 0.0                    | 0.0                    | 0.0                    | -47.8                                   | -48.4                  | -2.3                   | -5.0                   |
| LC-12                      | NS(2), LWL, Max LL Lead, EP               | 21.6  | 16.4                   | 49.6                   | 54.8                   | 19.0  | 32.8                   | 52.2                   | 39.2                   | -28.9                                   | -15.6                  | 50.0                   | 34.2                   |
| LC-13                      | SIS,LWL, Span dislodge ,Seismic Sx=1,Sz=0 | 25.9  | 16.8                   | 50.9                   | 60.0                   | 21.3  | 35.5                   | 55.5                   | 42.1                   | -26.5                                   | -12.9                  | 53.2                   | 37.1                   |
| LC-14                      | SIS, LWL,Span dislodge ,Seismic Sx=1,Sz=0 | 34.8  | 25.7                   | 40.5                   | 49.6                   | 30.3  | 36.4                   | 45.1                   | 39.3                   | -17.6                                   | -12.0                  | 42.8                   | 34.3                   |
| LC-15                      | SIS,LWL,Min LL Acc,Seismic Sx=1,Sz=0      | 11.2  | -7.0                   | 82.6                   | 100.7                  | 2.1   | 39.2                   | 91.7                   | 56.7                   | -45.7                                   | -9.1                   | 89.4                   | 51.7                   |
| LC-16                      | SIS, LWL,Min LL Acc,Seismic Sx=1,Sz=0     | 28.4  | 10.2                   | 62.3                   | 80.5                   | 19.3  | 40.9                   | 71.4                   | 51.1                   | -28.5                                   | -7.5                   | 69.1                   | 46.1                   |
| LC-17                      | SIS,LWL,Max LL Acc,Seismic Sx=1,Sz=0      | 11.8  | -7.4                   | 82.4                   | 101.6                  | 2.2   | 39.4                   | 92.0                   | 57.0                   | -45.6                                   | -8.9                   | 89.7                   | 52.0                   |
| LC-18                      | SIS, LWL,Max LL Acc,Seismic Sx=1,Sz=0     | 29.1  | 9.8                    | 62.1                   | 81.3                   | 19.4  | 41.1                   | 71.7                   | 51.3                   | -28.4                                   | -7.3                   | 69.4                   | 46.3                   |
| LC-19                      | NS(1), HFL, Span dislodge, EP             | 25.3  | 25.3                   | 52.5                   | 52.5                   | 25.3  | 36.6                   | 52.5                   | 41.9                   | -39.2                                   | -28.7                  | 49.6                   | 35.4                   |
| LC-20                      | NS(1), HFL, Min LL acomp, EP              | 21.5  | 20.7                   | 72.3                   | 73.2                   | 21.1  | 42.5                   | 72.7                   | 52.6                   | -43.5                                   | -22.8                  | 69.8                   | 46.1                   |
| LC-21                      | NS(1), HFL, Max LL Lead, EP               | 34.4  | 28.4                   | 60.6                   | 66.5                   | 31.4  | 44.7                   | 63.6                   | 51.0                   | -33.1                                   | -20.5                  | 60.7                   | 44.6                   |
| LC-22                      | NS(2), HFL, Span dislodge, EP             | 13.6  | 13.6                   | 44.9                   | 44.9                   | 13.6  | 26.6                   | 44.9                   | 32.7                   | -34.2                                   | -21.8                  | 42.8                   | 28.0                   |
| LC-23                      | NS(2), HFL, Min LL acom, EP               | 9.7   | 9.0                    | 60.5                   | 61.3                   | 9.3   | 30.7                   | 60.9                   | 40.8                   | -38.5                                   | -17.6                  | 58.8                   | 36.1                   |
| LC-24                      | NS(2), HFL, Max LL Lead, EP               | 21.3  | 16.1                   | 49.8                   | 55.0                   | 18.7  | 32.7                   | 52.4                   | 39.3                   | -29.1                                   | -15.7                  | 50.3                   | 34.6                   |
| LC-25                      | SIS,HFL, Span dislodge ,Seismic Sx=1,Sz=0 | 25.6  | 16.5                   | 51.2                   | 60.3                   | 21.0  | 35.4                   | 55.8                   | 42.2                   | -26.8                                   | -13.0                  | 53.5                   | 37.2                   |
| LC-26                      | SIS, HFL,Span dislodge ,Seismic Sx=1,Sz=0 | 34.5  | 25.4                   | 40.8                   | 49.9                   | 29.9  | 36.3                   | 45.4                   | 39.3                   | -17.9                                   | -12.0                  | 43.1                   | 34.3                   |
| LC-27                      | SIS,HFL,Min LL Acc,Seismic Sx=1,Sz=0      | 10.9  | -7.3                   | 82.9                   | 101.0                  | 1.8   | 39.2                   | 92.0                   | 56.8                   | -46.0                                   | -9.2                   | 89.7                   | 51.8                   |
| LC-28                      | SIS, HFL,Min LL Acc,Seismic Sx=1,Sz=0     | 28.1  | 9.9                    | 62.6                   | 80.8                   | 19.0  | 40.8                   | 71.7                   | 51.1                   | -28.8                                   | -7.5                   | 69.4                   | 46.1                   |
| LC-29                      | SIS,HFL,Max LL Acc,Seismic Sx=1,Sz=0      | 11.5  | -7.7                   | 82.7                   | 101.9                  | 1.9   | 39.4                   | 92.3                   | 57.0                   | -45.9                                   | -9.0                   | 90.0                   | 52.0                   |
| LC-30                      | SIS, HFL,Max LL Acc,Seismic Sx=1,Sz=0     | 28.7  | 9.5                    | 62.4                   | 81.6                   | 19.1  | 41.0                   | 72.0                   | 51.4                   | -28.7                                   | -7.3                   | 69.7                   | 46.4                   |

**FINDING BENDING MOMENT & SHEAR FORCE AT CRITICAL SECTION  
ULS LOAD COMBINATIONS**



Overall depth at deff = 1.381 m  
deff at critical section = 1.800 m

| Design Bending Moment & Shear Force :   |              |          |              |          |
|---|--------------|----------|--------------|----------|
| Description                             | Max BM<br>Tm | SF.<br>T | Max SF.<br>T | BM<br>Tm |
| Heel Slab (BM. Downward)                | -211.4       | -112.6   | -115.5       | -206.5   |
| Heel Slab (BM. upward)                  | 1914.6       |          |              |          |
| Toe slab (face of support)              | 456.1        | 295.3    | 295.3        | 456.1    |
| Toe slab (at deff from face of support) |              |          | 84.3         | 81.0     |

**DESIGN OF HEEL SLAB**

**SUMMARY OF FORCES :**

| DESIGN OF THE SLAB |   | NET BASE PRESSURE                |                  |                  |                  |                  | Point of<br>zero net<br>base<br>pressure | BM<br>at<br>Point of<br>zero base<br>pressure | BENDING MOMENT & SHEAR FORCE |        |                      |                      |                      |                      |  |
|--------------------|---|----------------------------------|------------------|------------------|------------------|------------------|--|---|------------------------------|--------|----------------------|----------------------|----------------------|----------------------|--|
| S.N.               | Description                               | base pressure at footing corners |                  |                  |                  |                  |  |   | Heel Slab                    |        | Toe Slab             |                      |                      |                      |  |
|                    |   | A'                               | A1'              | D'               | D1'              | E1'              |  |   | BM                           | SF     | BM   <sub>face</sub> | SF   <sub>face</sub> | SF   <sub>deff</sub> | BM   <sub>deff</sub> |  |
|                    |   | T/m <sup>2</sup>                 | T/m <sup>2</sup> | T/m <sup>2</sup> | T/m <sup>2</sup> | T/m <sup>2</sup> |  |   |                              |        |                      |                      |                      |                      |  |
|                    |   |                                  |                  |                  |                  |                  | H  | BM  |                              |        |                      |                      |                      |                      |  |
|                    |   |                                  |                  |                  |                  |                  | m  | Tm  |                              |        |                      |                      |                      |                      |  |
| LC-1               | NS(1), LWL, Span dislodge, FP             |                                  |                  |                  |                  |                  |  |   |                              |        |                      |                      |                      |                      |  |
| LC-2               | NS(1), LWL, Span dislodge, EP             | -38.7                            | -28.7            | 48.8             | 35.0             | 41.0             | 0.00                                     | 0.00  | -204.3                       | -114.5 | 226.3                | 134.0                | 53.2                 | 45.3                 |  |
| LC-3               | NS(1), LWL, Min LL accomp, FP             |                                  |                  |                  |                  |                  |  |   |                              |        |                      |                      |                      |                      |  |
| LC-4               | NS(1), LWL, Min LL accomp, EP             | -42.9                            | -22.7            | 69.1             | 45.7             | 55.9             | 0.00                                     | 0.00  | -209.3                       | -111.7 | 313.8                | 183.6                | 71.1                 | 63.4                 |  |
| LC-5               | NS(1), LWL, Max LL Lead, FP               |                                  |                  |                  |                  |                  |  |   |                              |        |                      |                      |                      |                      |  |
| LC-6               | NS(1), LWL, Max LL Lead, EP               | -32.8                            | -20.5            | 60.2             | 44.2             | 51.2             | 0.00                                     | 0.00  | -166.1                       | -90.7  | 281.0                | 167.1                | 66.8                 | 56.1                 |  |
| LC-7               | NS(2), LWL, Span dislodge, FP             |                                  |                  |                  |                  |                  |  |   |                              |        |                      |                      |                      |                      |  |
| LC-8               | NS(2), LWL, Span dislodge, EP             | -33.8                            | -21.8            | 42.1             | 27.5             | 33.9             | 0.00                                     | 0.00  | -172.1                       | -94.4  | 190.8                | 111.5                | 43.0                 | 38.6                 |  |
| LC-9               | NS(2), LWL, Min LL accomp, FP             |                                  |                  |                  |                  |                  |  |   |                              |        |                      |                      |                      |                      |  |
| LC-10              | NS(2), LWL, Min LL acom, EP               | -38.0                            | -17.6            | 58.1             | 35.6             | 45.5             | 0.00                                     | 0.00  | -180.4                       | -94.6  | 259.3                | 150.1                | 56.8                 | 52.8                 |  |
| LC-11              | NS(2), LWL, Max LL Lead, FP               |                                  |                  |                  |                  |                  |  |   |                              |        |                      |                      |                      |                      |  |
| LC-12              | NS(2), LWL, Max LL Lead, EP               | -28.9                            | -15.6            | 50.0             | 34.2             | 41.1             | 0.00                                     | 0.00  | -141.3                       | -75.6  | 229.0                | 134.7                | 52.8                 | 46.1                 |  |
| LC-13              | SISJ,LWL, Span dislodge ,Seismic Sx=1,Sz= | -26.5                            | -12.9            | 53.2             | 37.1             | 44.2             | 0  | 0   | -126.8                       | -66.9  | 245.0                | 144.6                | 56.9                 | 49.2                 |  |
| LC-14              | SIS, LWL,Span dislodge ,Seismic Sx=1,Sz=  | -17.6                            | -12.0            | 42.8             | 34.3             | 38.0             | 0  | 0   | -90.8                        | -50.2  | 204.7                | 123.4                | 50.6                 | 40.4                 |  |
| LC-15              | SISJ,LWL,Min LL Acc,Seismic Sx=1,Sz=      | -45.7                            | -9.1             | 89.4             | 51.7             | 68.2             | 0  | 0   | -193.7                       | -93.2  | 393.4                | 225.8                | 83.9                 | 80.7                 |  |
| LC-16              | SIS, LWL,Min LL Acc,Seismic Sx=1,Sz=      | -28.5                            | -7.5             | 69.1             | 46.1             | 56.1             | 0  | 0   | -124.2                       | -61.1  | 314.5                | 184.3                | 71.5                 | 63.5                 |  |
| LC-17              | SISJ,LWL,Max LL Acc,Seismic Sx=1,Sz=      | -45.6                            | -8.9             | 89.7             | 52.0             | 68.5             | 0  | 0   | -192.9                       | -92.7  | 395.0                | 226.7                | 84.3                 | 81.0                 |  |
| LC-18              | SIS, LWL,Max LL Acc,Seismic Sx=1,Sz=      | -28.4                            | -7.3             | 69.4             | 46.3             | 56.4             | 0  | 0   | -123.4                       | -60.6  | 316.1                | 185.2                | 71.9                 | 63.8                 |  |
| LC-19              | NS(1), HFL, Span dislodge, EP             | -39.2                            | -28.7            | 49.6             | 35.4             | 41.6             | 0.00                                     | 0.00  | -206.5                       | -115.5 | 229.6                | 135.9                | 53.9                 | 46.0                 |  |
| LC-20              | NS(1), HFL, Min LL accomp, EP             | -43.5                            | -22.8            | 69.8             | 46.1             | 56.5             | 0.00                                     | 0.00  | -211.4                       | -112.6 | 317.1                | 185.5                | 71.8                 | 64.1                 |  |
| LC-21              | NS(1), HFL, Max LL Lead, EP               | -33.1                            | -20.5            | 60.7             | 44.6             | 51.6             | 0.00                                     | 0.00  | -167.3                       | -91.3  | 283.1                | 168.4                | 67.3                 | 56.5                 |  |
| LC-22              | NS(2), HFL, Span dislodge, EP             | -34.2                            | -21.8            | 42.8             | 28.0             | 34.4             | 0.00                                     | 0.00  | -173.8                       | -95.2  | 193.6                | 113.1                | 43.7                 | 39.2                 |  |
| LC-23              | NS(2), HFL, Min LL acom, EP               | -38.5                            | -17.6            | 58.8             | 36.1             | 46.0             | 0.00                                     | 0.00  | -182.2                       | -95.4  | 262.1                | 151.7                | 57.4                 | 53.4                 |  |
| LC-24              | NS(2), HFL, Max LL Lead, EP               | -29.1                            | -15.7            | 50.3             | 34.6             | 41.5             | 0.00                                     | 0.00  | -142.3                       | -76.1  | 230.7                | 135.8                | 53.2                 | 46.4                 |  |
| LC-25              | SIS,HFL, Span dislodge ,Seismic Sx=1,Sz=  | 25.6                             | 16.5             | 51.2             | 60.3             | 21.0             | 9.57                                     | 780.54  | 130.2                        | 71.5   | 277.7                | 178.4                | 56.9                 | 40.3                 |  |
| LC-26              | SIS, HFL,Span dislodge ,Seismic Sx=1,Sz=  | 34.5                             | 25.4             | 40.8             | 49.9             | 29.9             | 12.91                                    | 1914.61                                       | 181.7                        | 101.8  | 224.5                | 145.2                | 55.9                 | 36.4                 |  |
| LC-27              | SIS,HFL,Min LL Acc,Seismic Sx=1,Sz=       | 10.9                             | -7.3             | 82.9             | 101.0            | 1.8              | 2.03                                     | 14.99   | 27.8                         | 6.1    | 455.3                | 294.3                | 72.0                 | 54.7                 |  |
| LC-28              | SIS, HFL,Min LL Acc,Seismic Sx=1,Sz=      | 28.1                             | 9.9              | 62.6             | 80.8             | 19.0             | 5.25                                     | 258.53  | 127.3                        | 64.6   | 351.4                | 229.3                | 69.8                 | 47.1                 |  |
| LC-29              | SIS,HFL,Max LL Acc,Seismic Sx=1,Sz=       | 11.5                             | -7.7             | 82.7             | 101.9            | 1.9              | 2.04                                     | 15.91   | 29.5                         | 6.5    | 456.1                | 295.3                | 72.7                 | 54.6                 |  |
| LC-30              | SIS, HFL,Max LL Acc,Seismic Sx=1,Sz=      | 28.7                             | 9.5              | 62.4             | 81.6             | 19.1             | 5.08                                     | 246.86  | 129.0                        | 65.0   | 352.2                | 230.4                | 70.5                 | 47.0                 |  |

## DESIGN OF TOE SLAB :

### (ULS) CHECK FOR BENDING MOMENT

Design Bending Moment  $M_{ED} = 456.1 \text{ Tm}$

$a_l = d$  (shifting moment curve by a distance  $a_l$ )

$D = 2 \text{ m}$  \*/ overall depth at face of support

$d = 1.882 \text{ m}$  \*/ deff at face of support

$D' = 1.353 \text{ m}$  \*/ overall depth at  $d$  from face of support

$d' = 1.235 \text{ m}$  \*/ deff at  $d$  from face of support

Clear Cover = 75 mm

Ast Provided = 32  $\phi$  @ 150 c/c  
+ 28  $\phi$  @ 150 c/c LAYER-2  
= 9467 mm<sup>2</sup>/m

Grade of Concrete  $f_{ck} = 45 \text{ Mpa}$

Grade of steel  $f_{yk} = 500 \text{ Mpa}$

$x_u = 0.87 f_{yk} A_{st} / 0.362 f_{ck} b$   
= 253 mm

$x_{u_{max}} = 0.456 d'$   
= 563 mm UNDER REINFORCED

Ast calculated =  $M / 0.87 f_{yk} (d' - 0.416 x_u)$

= 9279 mm<sup>2</sup>/m

Ast minimum = 0.15% \*  $b * d$

= 2823 mm<sup>2</sup>/m

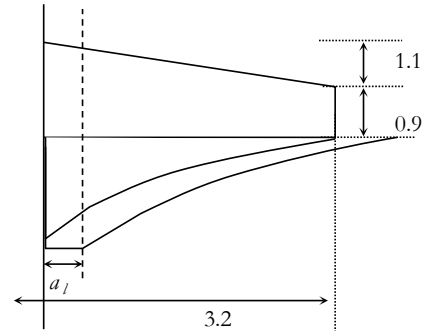
Ast required = Max( 9279 , 2823 )  
= 9279 mm<sup>2</sup>/m < 9467 mm<sup>2</sup>/m OK

Distribution steel = 20% of Ast.main (Refer clause 16.6.1 of IRC :112-2011)

= 1893 mm<sup>2</sup>/m

Provide distribution steel as 20  $\phi$  @ 150 c/c

2094 mm<sup>2</sup>/m OK



|                  |   |         |
|------------------|---|---------|
| $f_{yk}$         | = | 500 Mpa |
| $\epsilon_{uk}$  | = | 0.0025  |
| $\epsilon_{ud}$  | = | 0.00225 |
| $f_{ck}$         | = | 45 Mpa  |
| $\epsilon_{cu2}$ | = | 0.0035  |
| $x_{u_{max}}/d$  | = | 0.4560  |

**(SLS) CHECK FOR STRESSES (RARE & QUASI PERMANENT LOAD COMBINATIONS)**

$$\begin{aligned}
 \text{Design Bending Moment } M_{\text{RARE}} &= 231.65 \text{ Tm} \\
 M_{\text{QP}} &= 173.80 \text{ Tm} \\
 M_{\text{ST}} &= M_{\text{RARE}} - M_{\text{QP}} \quad (\text{Bending Moment due to short term loading}) \\
 &= 57.85 \text{ Tm}
 \end{aligned}$$

$$\begin{aligned}
 \text{Modulus of Elasticity for Concrete} \\
 \text{For short term loading } E_{\text{cm}} &= 34313 \text{ Mpa} \\
 \text{Creep coefficient } \phi &= 1 \\
 \text{For long term loading } E_{\text{cm}}' &= 17156 \text{ Mpa}
 \end{aligned}$$

$$\text{Reinf. modulus of elasticity } E_s = 200000 \text{ N/mm}^2$$

$$\text{Modular ratio for QP Combination} = E_s / E_{\text{cm}}' = 11.66$$

Equavelent Modulus of Elasticity for Rare Combination :

$$E_{\text{c,eq}} = \frac{E_{\text{cm}}' (M_{\text{QP}} + M_{\text{ST}})}{M_{\text{ST}} + (1 + \phi) M_{\text{QP}}} = 19605 \text{ MPa}$$

$$\text{Modular ratio for Rare Combination} = E_s / E_{\text{c,eq}} = 10.20$$

| Formula used for calculation of stress    |   |
|---|---|
| dc (depth of neutral axis)                | $= \frac{-m * A_s + \sqrt{(m^2 * A_s^2 + 2 * m * A_s * b * d)}}{b}$ |
| $I_{\text{NA}}$ (Transformed)             | $= b * dc^3 / 3 + m * A_s * (d - dc)^2$                             |
| Compressive stress in concrete $\sigma_c$ | $= M_{\text{RARE}} * dc / I_{\text{NA}}$                            |
| Tensile stress in steel $\sigma_s$        | $= m * M_{\text{RARE}} * (d - dc) / I_{\text{NA}}$                  |

| <i>Description</i>                        | <i>Stress Check For Rare Combination</i> | <i>Stress Check For QP Combination</i> |
|---|--|--|
| Design Moment                             | = 231.65 Tm                              | = 173.80 Tm                            |
| Total Depth at section                    | = 2 m                                    | = 2 m                                  |
| deff                                      | = 1.88212 m                              | = 1.88212 m                            |
| width b                                   | = 1 m                                    | = 1 m                                  |
| $A_{\text{st, provided}}$                 | = 9467 mm <sup>2</sup> /m                | = 9467 mm <sup>2</sup> /m              |
| Modular ratio                             | = 10.20                                  | = 11.66                                |
| dc (depth of neutral axis)                | = 514 mm                                 | = 544 mm                               |
| $I_{\text{NA}}$ (Transformed)             | = 2.26E+11 mm <sup>4</sup>               | = 2.51E+11 mm <sup>4</sup>             |
| Compressive stress in concrete $\sigma_c$ | = 5.27 N/mm <sup>2</sup>                 | = 3.76 N/mm <sup>2</sup>               |
| Permissible Compressive stress            | = 21.6 N/mm <sup>2</sup> OK              | = 16.2 N/mm <sup>2</sup> OK            |
| Tensile stress in steel $\sigma_s$        | = 143 N/mm <sup>2</sup>                  | = 108 N/mm <sup>2</sup>                |
| Permissible tensile stress                | = 300 N/mm <sup>2</sup> OK               | = 400 N/mm <sup>2</sup> OK             |



**(SLS) CHECK FOR CRACK WIDTH (QUASI PERMANENT LOAD COMBINATIONS)**

Minimum Reinforcement for crack control :

$$A_{s,min} = k_c k f_{ct,eff} A_{ct} / \sigma_s \quad (IRC 112 / clause 12.3.3 (2))$$

For Web

$$k_c = 0.4 \text{ For Bending member}$$

$$h = 2 \text{ m}, \quad b = 1 \text{ m}$$

$$k = 0.65$$

$$f_{ct,eff} = f_{ctm} = 3.28 \text{ Mpa}$$

$A_{ct}$  = Area of concrete within tensile zone just before the first crack form, section behaves elastically until the tensile fiber stress reaches  $f_{ctm}$ . hence Neutral axis depth will be considered for gross section

$$A_{ct} = b * h / 2 = 1 \text{ m}^2$$

$$\sigma_s = \text{Maximum stress permitted in reinf. Immediately after formation of crack} = f_{yk} = 500 \text{ Mpa}$$

$$A_{s,min} = 1704 \text{ mm}^2/\text{m} < 9467 \text{ mm}^2/\text{m} \quad \text{OK}$$

Calculation of crack width : (IRC 112 / clause 12.3.4)

$$w_{k,max} = 0.3 \text{ mm}$$

$$\text{Clear cover } c = 75 \text{ mm}$$

$$\text{Bar dia } \phi_{eq} = 32.00 \text{ mm}$$

$$5(c + \phi_{eq}/2) = 455 \text{ mm}$$

$$\text{Spacing b/w bars} = 150 \text{ mm} < 455 \text{ mm}$$

$$s_{rmax} = \text{Maximum crack spacing} = 3.4c + 0.17 \phi / \rho_{Peff} = 424.356 \text{ mm}$$

The Following formula can be used for calculation of maximum crack spacing.

$$h_{c,eff} = \text{Min} \begin{cases} 2.5 (h - d) \\ (h - x)/3 \\ h/2 \end{cases} = 0.29471 \text{ m}$$

|     |     |              |
|-----|-----|--------------|
| $h$ | $=$ | 2 m          |
| $d$ | $=$ | 1.88211504 m |
| $x$ | $=$ | 0.54354429 m |

\*/ (for Quasi Permanent Load combination)

$$\text{width } b = 1 \text{ m}$$

$$A_{c,eff} = h_{c,eff} * b = 0.29471 \text{ m}^2$$

$$\begin{aligned}
\rho_{p,eff} &= A_s / A_{c,eff} \\
&= 9467 / 294712 \\
&= 0.0321 \\
\sigma_{sc} &= \text{Stress in tension Reinforcement assuming cracked section} \\
&= 107.94 \text{ Mpa} \quad */ \text{ (for Quasi Permanent Load combination)} \\
E_s &= 200000 \text{ Mpa} \\
E_{cm}' &= 17156 \text{ Mpa} \quad */ \text{ (for Long term loading)} \\
\alpha_e &= E_s / E_{cm} \\
\alpha_e &= 11.66 \\
k_t &= 0.5 \quad (\text{factor dependent on duration of load}) \\
\varepsilon_{sm} - \varepsilon_{cm} &= \text{Max} \left\{ \begin{array}{l} \frac{\sigma_{sc} - k_t f_{ct,eff} (1 + \alpha_e \rho_{p,eff}) / \rho_{p,eff}}{E_s} \\ 0.6 \sigma_{sc} / E_s \end{array} \right. \\
&= 0.00032 \\
w_k &= s_{rmax} (\varepsilon_{sm} - \varepsilon_{cm}) \\
&= 0.137 \text{ mm} < 0.300 \text{ mm} \quad \text{OK}
\end{aligned}$$

**(ULS) CHECK FOR SHEAR FORCE** (Section At deff from face of Support)

$$\begin{aligned}
\text{Factored Shear Force } V_{ED} &= 84.32 \text{ T} \\
\text{Corresponding BM } M_{ED} &= 81.01 \text{ Tm}
\end{aligned}$$

$$\begin{aligned}
V_{CCD} &= \text{Reductin in Shear force due to inclined compression chord} \\
&= M_{ED} / d * \sin \beta
\end{aligned}$$

$$\beta = 18.970 \text{ deg} \quad */ \text{Inclination angle of compression chord.}$$

$$V_{CCD} = 21.321 \text{ T}$$

$$\begin{aligned}
\text{Design Shear Force } V_{NS} &= V_{ED} - V_{CCD} \\
&= 63.00 \text{ Tonne}
\end{aligned}$$

Reduction in Design Shear For Within Zone (  $a_v = 0.5d$  to  $2d$ )

$$a_v = 1.882 \text{ m}$$

$$\begin{aligned}
\text{Reduction factor } \beta_1 &= a_v / 2d \\
&= 0.5
\end{aligned}$$

$$\begin{aligned}
\text{Design Shear Force } V_{NS}' &= \beta_1 * V_{NS} \\
&= 31.50 \text{ Tonne}
\end{aligned}$$

**Max Shear Capacity of section**

$$v = 0.6 * (1 - f_{ck} / 310) \quad \text{*/ } f_{ck} \text{ in Mpa}$$

$$= 0.5129$$

$$f_{cd} = 0.447 * f_{ck}$$

$$= 20.10 \text{ Mpa}$$

$$V_{RDC, \max} = 0.5 b_w d v f_{cd}$$

$$= 637 \text{ Tonne} > 31.50 \text{ Tonne} \quad \text{OK}$$

$$D' = 1.353 \text{ m} \quad \text{*/ overall depth at face of support}$$

$$d' = 1.235 \text{ m} \quad \text{*/ deff at face of support}$$

**Check for Design Shear Reinforcement :**

$$k = \text{Min} \left\{ \begin{array}{l} 1 + \sqrt{200/d} \\ 2 \end{array} \right. \quad d \text{ is depth in mm}$$

$$k = 1.402$$

$$\rho_1 = \text{Min} \left\{ \begin{array}{l} A_{sl} / b_w d \\ 0.02 \end{array} \right.$$

$$\rho_1 = 0.00766$$

$$\sigma_{cp} = 0 \text{ Mpa}$$

$$v_{\min} = 0.031 k^{3/2} f_{ck}^{1/2}$$

$$= 0.345$$

$$V_{Rdc} = \text{Max} \left\{ \begin{array}{l} (0.12 k (80 \rho_1 f_{ck})^{0.33} + 0.15 \sigma_{cp}) b_w d \\ (v_{\min} + 0.15 \sigma_{cp}) b_w d \end{array} \right. \quad (IRC 112 / \text{ clause } 10.3.2 (2))$$

$$= 62.12 \text{ Tonne} > 31.50 \text{ Tonne} \quad \text{NO SHEAR REINFORCEMENT REQUIRED}$$

## DESIGN OF HEEL SLAB :

### (ULS) CHECK FOR BENDING MOMENT

Design Bending Moment  $M_{ED} = 211.40 \text{ Tm}$

$a_l = d$  (shifting moment curve by a distance  $a_l$ )

$D = 2 \text{ m}$  \*/ overall depth at face of support

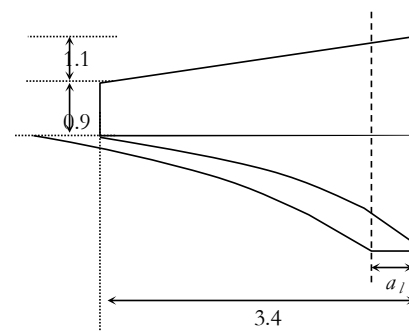
$d = 1.913 \text{ m}$  \*/ deff at face of support

$D' = 1.381 \text{ m}$  \*/ overall depth at d from face of support

$d' = 1.294 \text{ m}$  \*/ deff at d from face of support

Clear Cover = 75 mm

Ast Provided = 25  $\phi$  @ 100 c/c  
 + 0  $\phi$  @ 100 c/c  
 = 4909  $\text{mm}^2/\text{m}$



ALTERNATE

Grade of Concrete  $f_{ck} = 45 \text{ Mpa}$

Grade of steel  $f_{yk} = 500 \text{ Mpa}$

$x_u = 0.87 f_{yk} A_{st} / 0.362 f_{ck} b$   
 = 131 mm

$f_{yk} = 500 \text{ Mpa}$

$\epsilon_{uk} = 0.0025$

$\epsilon_{ud} = 0.00225$

$f_{ck} = 45 \text{ Mpa}$

$\epsilon_{cu2} = 0.0035$

$x_{u_{max}}/d = 0.6087$

$x_{u_{max}} = 0.609 d$   
 = 788 mm UNDER REINFORCED

Ast calculated =  $M / 0.87 f_{yk} (d - 0.416 x_u)$   
 = 3922  $\text{mm}^2/\text{m}$

Ast minimum =  $0.15\% \cdot b \cdot d$   
 = 2869  $\text{mm}^2/\text{m}$

Ast required = Max( 3922 , 2869 )  
 = 3922  $\text{mm}^2/\text{m} < 4909 \text{ mm}^2/\text{m}$  OK

Distribution steel = 20% of Ast.main (Refer clause 16.6.1 of IRC :112-2011)  
 = 982  $\text{mm}^2/\text{m}$

Provide distribution steel as 16  $\phi$  @ 150 c/c  
 1340  $\text{mm}^2/\text{m}$  OK

**(ULS) CHECK FOR SHEAR FORCE**

(Section At Face of Support)

$$\text{Factored Shear Force } V_{ED} = 115.49 \text{ T}$$

$$\text{Corresponding BM } M_{ED} = 206.46 \text{ Tm}$$

$$V_{CCD} = \text{Reduction in Shear force due to inclined compression chord}$$

$$= M_{ED} / d * \sin \beta$$

$$\beta = 17.928 \text{ deg} \quad */ \text{Inclination angle of compression chord.}$$

$$V_{CCD} = 33.231 \text{ T}$$

$$\text{Design Shear Force } V_{NS} = V_{ED} - V_{CCD}$$

$$= 82.26 \text{ Tonne}$$

Reduction in Design Shear For Within Zone (  $a_v = 0.5d$  to 0

$$\text{Reduction factor } \beta_1 = 0.5$$

$$\text{Design Shear Force } V_{NS}' = \beta_1 * V_{NS}$$

$$= 41.13 \text{ Tonne}$$

**Max Shear Capacity of section**

$$v = 0.6 * (1 - f_{ck} / 310) \quad */ \text{ fck in Mpa}$$

$$= 0.513$$

$$f_{cd} = 0.447 * f_{ck}$$

$$= 20.10 \text{ Mpa}$$

$$V_{RDC, \max} = 0.5 b_w d v f_{cd}$$

$$= 986 \text{ Tonne} > 41.13 \text{ Tonne} \quad \text{OK}$$

$$D = 2.000 \text{ m} \quad */ \text{ overall depth at face of support}$$

$$d = 1.913 \text{ m} \quad */ \text{ deff at face of support}$$

**Check for Design Shear Reinforcement :**

$$k = \text{Min} \left\{ \begin{array}{l} 1 + \sqrt{200/d} \\ 2 \end{array} \right. \quad d \text{ is depth in mm}$$

$$k = 1.323$$

$$\rho_1 = \text{Min} \left\{ \begin{array}{l} A_{sl} / b_w d \\ 0.02 \end{array} \right.$$

$$\rho_1 = 0.00257$$

$$\sigma_{cp} = 0 \text{ Mpa}$$

$$v_{\min} = 0.031 k^{3/2} f_{ck}^{1/2}$$

$$= 0.317$$

c

$$V_{Rdc} = \text{Max} \left\{ \begin{array}{l} (0.12 k (80 \rho_1 f_{ck})^{0.33} + 0.15 \sigma_{cp}) b w d \\ (v_{min} + 0.15 \sigma_{cp}) b w d \end{array} \right. \quad (\text{IRC 112 / clause 10.3.2 (2)})$$

$$= 63 \text{ Tonne} > 41.1 \text{ Tonne} \quad \text{NO SHEAR REINFORCEMENT REQUIRED}$$

#### (SLS) CHECK FOR STRESSES (RARE & QUASI PERMANENT LOAD COMBINATIONS)

Design Bending Moment

$$\begin{aligned} M_{RARE} &= 144.07 \text{ Tm} \\ M_{QP} &= 97.20 \text{ Tm} \\ M_{ST} &= M_{RARE} - M_{QP} \quad (\text{Bending Moment due to short term loading}) \\ &= 46.87 \text{ Tm} \end{aligned}$$

Modulus of Elasticity for Concrete

For short term loading  $E_{cm} = 34313 \text{ Mpa}$

Creep coefficient  $\phi = 1$

For long term loading  $E_{cm}' = 17156 \text{ Mpa}$

Reinf. modulus of elasticity  $E_s = 200000 \text{ N/mm}^2$

Modular ratio for QP Combination  $= E_s / E_{cm} = 5.829$

Equavelent Modulus of Elasticity for Rare Combination :

$$E_{c,eq} = \frac{E_{cm} * (M_{QP} + M_{ST})}{M_{ST} + (1 + \phi) * M_{QP}} = 20489 \text{ MPa}$$

Modular ratio for Rare Combination  $= E_s / E_{c,eq} = 9.76$

| Formula used for calculation of stress    |   |
|---|---|
| dc (depth of neutral axis)                | $= \frac{-m * A_s + \sqrt{(m^2 * A_s^2 + 2 * m * A_s * b * d)}}{b}$ |
| $I_{NA}$ (Transformed)                    | $= b * dc^3 / 3 + m * A_s * (d - dc)^2$                             |
| Compressive stress in concrete $\sigma_c$ | $= M_{RARE} * dc / I_{NA}$  |
| Tensile stress in steel $\sigma_s$        | $= m * M_{RARE} * (d - dc) / I_{NA}$                                |

| Description                               | Stress Check For Rare Combination | Stress Check For QP Combination |
|---|-----------------------------------|---------------------------------|
| Design Moment                             | = 144.07 Tm                       | = 97.20 Tm                      |
| Total Depth at section                    | = 2 m                             | = 2 m                           |
| deff                                      | = 1.9125 m                        | = 1.9125 m                      |
| width b                                   | = 1 m                             | = 1 m                           |
| $A_{st, provided}$                        | = 4908.74 mm <sup>2</sup> /m      | = 4908.74 mm <sup>2</sup> /m    |
| Modular ratio                             | = 9.76                            | = 5.83                          |
| dc (depth of neutral axis)                | = 382.86 mm                       | = 303.44 mm                     |
| $I_{NA}$ (Transformed)                    | = 1.31E+11 mm <sup>4</sup>        | = 8.34E+10 mm <sup>4</sup>      |
| Compressive stress in concrete $\sigma_c$ | = 4.22 N/mm <sup>2</sup>          | = 3.54 N/mm <sup>2</sup>        |
| Permissible Compressive stress            | = 21.6 N/mm <sup>2</sup> OK       | = 16.2 N/mm <sup>2</sup> OK     |
| Tensile stress in steel $\sigma_s$        | = 164.43 N/mm <sup>2</sup>        | = 109.32 N/mm <sup>2</sup>      |
| Permissible tensile stress                | = 300 N/mm <sup>2</sup> OK        | = 400 N/mm <sup>2</sup> OK      |



**(SLS) CHECK FOR CRACK WIDTH (QUASI PERMANENT LOAD COMBINATIONS)**

Minimum Reinforcement for crack control:

$$A_{s,min} = k_c k f_{ct,eff} A_{ct} / \sigma_s \quad (IRC 112 / clause 12.3.3 (2))$$

$$k_c = 0.4 \text{ For Bending member}$$

$$h = 2 \text{ m}, \quad b = 1 \text{ m}$$

$$k = 0.65$$

$$f_{ct,eff} = f_{ctm} = 3.28 \text{ Mpa}$$

$$A_{ct} = b * h / 2 = 1 \text{ m}^2$$

$$\sigma_s = f_{yk} = 500 \text{ Mpa}$$

$$A_{s,min} = 1704 \text{ mm}^2/\text{m} < 4909 \text{ mm}^2/\text{m} \quad \text{OK}$$

Calculation of crack width: (IRC 112 / clause 12.3.4)

$$w_{k,max} = 0.3 \text{ mm}$$

$$\text{Clear cover } c = 75 \text{ mm}$$

$$\text{Bar dia } \phi_{eq} = 25.00 \text{ mm}$$

$$5 (c + \phi_{eq} / 2) = 437.5 \text{ mm}$$

$$\text{Spacing b/w bars} = 50 \text{ mm} < 437.5 \text{ mm}$$

$$s_{rmax} = \text{Maximum crack spacing}$$

$$= 3.4c + 0.17 \phi / \rho_{Peff}$$

$$= 444.394 \text{ mm}$$

The Following formula can be used for calculation of maximum crack spacing.

$$h_{c,eff} = \text{Min} \begin{cases} 2.5 (h - d) \\ (h - x) / 3 \\ h / 2 \end{cases}$$

$$= 0.219 \text{ m}$$

|     |     |  |
|-----|-----|--|
| $h$ | $=$ | $2 \text{ m}$  |
| $d$ | $=$ | $1.913 \text{ m}$  |
| $x$ | $=$ | $0.30343936 \text{ m} \quad */ \text{ (for Quasi Permanent Load combination)}$ |

$$\text{width } b = 1 \text{ m}$$

$$A_{c,eff} = h_{c,eff} * b = 0.21875 \text{ m}^2$$

$$\rho_{P,eff} = A_s / A_{c,eff}$$

$$= 4908.74 / 218750$$

$$= 0.02244$$

$$\sigma_{sc} = \text{Stress in tension Reinforcement assuming cracked section}$$

$$= 109.32 \text{ Mpa} \quad */ \text{ (for Quasi Permanent Load combination)}$$

$$E_s = 200000 \text{ Mpa}$$

$$E_{cm}' = 17156.5 \text{ Mpa} \quad */ \text{ (for Long term loading)}$$

$$\alpha_c = E_s / E_{cm}$$

$$\alpha_c = 11.6574$$

$$k_t = 0.5 \quad (\text{factor dependent on duration of load})$$



$$\begin{aligned}
\varepsilon_{sm} - \varepsilon_{cm} &= \text{Max} \left\{ \frac{(1 + \alpha_e \rho_{P,eff}) / \rho_{P,eff}}{E_s} \right. \\
&= 0.00033 \\
w_k &= s_{rmax} (\varepsilon_{sm} - \varepsilon_{cm}) \\
&= 0.146 \text{ mm} < 0.300 \text{ mm} \quad \text{OK}
\end{aligned}$$

LOAD COMBINATION  
FOR FOOTING DESIGN

| LC-1 | QP, LWL, FP                | Forces about toe |                |                |                 |                 |  | LC-1 |
|------|----------------------------|------------------|----------------|----------------|-----------------|-----------------|--|------|
| S.N. | Description                | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |  |      |
|      |                            | Tonne            | Tonne          | Tonne          | Tm              | Tm              |  |      |
| 1)   | Sub-structure & Foundation | 1317.6142        |                |                | -5480.803       | 0               |  | 1    |
| 2)   | Backfill                   | 1265.2343        |                |                | -8398.412       | 0               |  | 1    |
| 3)   | Super-structure DL         | 398.94974        |                |                | -1366.403       | 0               |  | 1    |
| 4)   | SIDL (excluding surfacing) | 116.98594        |                |                | -400.6768       | 0               |  | 1    |
| 5)   | Surfacing                  | 34.025063        |                |                | -116.5358       | -8.506266       |  | 1    |
| 9)   | Fluid Pressure             |                  | 0.102          |                | 0.0063789       |                 |  | 1    |

| S.N. | Description | Forces about toe |                |                |                 |                 |
|------|-------------|------------------|----------------|----------------|-----------------|-----------------|
|      |             | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|      |             | Tonne            | Tonne          | Tonne          | Tm              | Tm              |
| LC-1 | QP, LWL, FP | 3132.8092        | 0.1017907      | 0              | -15762.82       | -8.506266       |

| LC-2 | QP, LWL, EP                 | Forces about toe |                |                |                 |                 |  | LC-2 |
|------|-----------------------------|------------------|----------------|----------------|-----------------|-----------------|--|------|
| S.N. | Description                 | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |  |      |
|      |                             | Tonne            | Tonne          | Tonne          | Tm              | Tm              |  |      |
| 1)   | Sub-structure & Foundation  | 1317.6142        |                |                | -5480.803       | 0               |  | 1    |
| 2)   | Backfill                    | 1265.2343        |                |                | -8398.412       | 0               |  | 1    |
| 3)   | Super-structure DL          | 398.94974        |                |                | -1366.403       | 0               |  | 1    |
| 4)   | SIDL (excluding surfacing)  | 116.98594        |                |                | -400.6768       | 0               |  | 1    |
| 5)   | Surfacing                   | 34.025063        |                |                | -116.5358       | -8.506266       |  | 1    |
| 9.3) | Earth Pressure LWL (BP, SD) |                  |                |                |                 |                 |  | 1    |
|      | Horizontal Component        |                  | 650.83         |                | 3619.41         |                 |  | 1    |
|      | Vertical Component          | 224.54002        |                |                | -1077.79        |                 |  | 1    |

| S.N. | Description | Forces about toe |                |                |                 |                 |
|------|-------------|------------------|----------------|----------------|-----------------|-----------------|
|      |             | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|      |             | Tonne            | Tonne          | Tonne          | Tm              | Tm              |
| LC-2 | QP, LWL, EP | 3357.3493        | 650.83372      | 0              | -13221.21       | -8.506266       |

| LC-3  | RARE, LWL, Span dislodge FP    | Forces about toe |                |                |                 |                 |  | LC-3 |
|-------|--------------------------------|------------------|----------------|----------------|-----------------|-----------------|--|------|
| S.N.  | Description                    | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |  |      |
|       |                                | Tonne            | Tonne          | Tonne          | Tm              | Tm              |  |      |
| 1)    | Sub-structure & Foundation     | 1317.6142        |                |                | -5480.803       | 0               |  | 1    |
| 2)    | Backfill                       | 1265.2343        |                |                | -8398.412       | 0               |  | 1    |
| 9)    | Fluid Pressure                 |                  | 0.102          |                | 0.0063789       |                 |  | 1    |
| 10.3) | Surcharge Pressure LWL(BP, SD) |                  | 121.22         |                | 828.36          |                 |  | 0.8  |

| S.N. | Description                 | Forces about toe |                |                |                 |                 |
|------|-----------------------------|------------------|----------------|----------------|-----------------|-----------------|
|      |                             | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|      |                             | Tonne            | Tonne          | Tonne          | Tm              | Tm              |
| LC-3 | RARE, LWL, Span dislodge FP | 2582.8485        | 97.079363      | 0              | -13216.52       | 0               |

|  |  |  |  |  |  |  |
|--|--|--|--|--|--|--|
|  |  |  |  |  |  |  |
|--|--|--|--|--|--|--|

| LC-4        | RARE, LWL, Span dislodge EP    | Forces about toe |                |                |                 |                 | LC-4 |
|-------------|--------------------------------|------------------|----------------|----------------|-----------------|-----------------|------|
| S.N.        | Description                    | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |      |
|             |                                | Tonne            | Tonne          | Tonne          | Tm              | Tm              |      |
| 1)          | Sub-structure & Foundation     | 1317.6142        |                |                | -5480.803       | 0               | 1    |
| 2)          | Backfill                       | 1265.2343        |                |                | -8398.412       | 0               | 1    |
| <b>9.3)</b> | Earth Pressure LWL (BP, SD)    |                  |                |                |                 |                 | 1    |
|             | Horizontal Component           |                  | 650.83         |                | 3619.41         |                 | 1    |
|             | Vertical Component             | 224.54002        |                |                | -1077.79        |                 | 1    |
| 10.3)       | Surcharge Pressure LWL(BP, SD) |                  | 121.22         |                | 828.36          |                 | 0.8  |

| S.N. | Description                 | Forces about toe |                |                |                 |                 |
|------|-----------------------------|------------------|----------------|----------------|-----------------|-----------------|
|      |                             | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|      |                             | Tonne            | Tonne          | Tonne          | Tm              | Tm              |
| LC-4 | RARE, LWL, Span dislodge EP | 2807.3885        | 747.81129      | 0              | -10674.91       | 0               |

| LC-5  | RARE, LWL, Min LL acomp, FP          | Forces about toe |                |                |                 |                 | LC-5 |
|-------|--------------------------------------|------------------|----------------|----------------|-----------------|-----------------|------|
| S.N.  | Description                          | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |      |
|       |                                      | Tonne            | Tonne          | Tonne          | Tm              | Tm              |      |
| 1)    | Sub-structure & Foundation           | 1317.6142        |                |                | -5480.803       | 0               | 1    |
| 2)    | Backfill                             | 1265.2343        |                |                | -8398.412       | 0               | 1    |
| 3)    | Super-structure DL                   | 398.94974        |                |                | -1366.403       | 0               | 1    |
| 4)    | SIDL (excluding surfacing)           | 116.98594        |                |                | -400.6768       | 0               | 1    |
| 5)    | Surfacing                            | 34.025063        |                |                | -116.5358       | -8.506266       | 1    |
| 6.2)  | Live Load Vertical Load Min Reaction | 28.799702        |                |                | -98.64          | 83.81           | 0.75 |
| 7)    | Live Load Horizontal Forces          |                  | 45.753         |                | 970.87976       |                 | 0.75 |
| 9)    | Fluid Pressure                       |                  | 0.102          |                | 0.0063789       |                 | 1    |
| 10.3) | Surcharge Pressure LWL(BP, SD)       |                  | 121.22         |                | 828.36          |                 | 0.8  |

| S.N. | Description                 | Forces about toe |                |                |                 |                 |
|------|-----------------------------|------------------|----------------|----------------|-----------------|-----------------|
|      |                             | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|      |                             | Tonne            | Tonne          | Tonne          | Tm              | Tm              |
| LC-5 | RARE, LWL, Min LL acomp, FP | 3154.409         | 131.39415      | 0              | -14445.96       | 54.349084       |

| LC-6        | RARE, LWL, Min LL acomp, EP          | Forces about toe |                |                |                 |                 | LC-6 |
|-------------|--------------------------------------|------------------|----------------|----------------|-----------------|-----------------|------|
| S.N.        | Description                          | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |      |
|             |                                      | Tonne            | Tonne          | Tonne          | Tm              | Tm              |      |
| 1)          | Sub-structure & Foundation           | 1317.6142        |                |                | -5480.803       | 0               | 1    |
| 2)          | Backfill                             | 1265.2343        |                |                | -8398.412       | 0               | 1    |
| 3)          | Super-structure DL                   | 398.94974        |                |                | -1366.403       | 0               | 1    |
| 4)          | SIDL (excluding surfacing)           | 116.98594        |                |                | -400.6768       | 0               | 1    |
| 5)          | Surfacing                            | 34.025063        |                |                | -116.5358       | -8.506266       | 1    |
| 6.2)        | Live Load Vertical Load Min Reaction | 28.799702        |                |                | -98.64          | 83.81           | 0.75 |
| 7)          | Live Load Horizontal Forces          |                  | 45.753         |                | 970.87976       |                 | 0.75 |
| <b>9.3)</b> | Earth Pressure LWL (BP, SD)          |                  |                |                |                 |                 | 1    |
|             | Horizontal Component                 |                  | 650.83         |                | 3619.41         |                 | 1    |
|             | Vertical Component                   | 224.54002        |                |                | -1077.79        |                 | 1    |
| 10.3)       | Surcharge Pressure LWL(BP, SD)       |                  | 121.22         |                | 828.36          |                 | 0.8  |

| S.N. | Description                 | Forces about toe |                |                |                 |                 |
|------|-----------------------------|------------------|----------------|----------------|-----------------|-----------------|
|      |                             | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|      |                             | Tonne            | Tonne          | Tonne          | Tm              | Tm              |
| LC-6 | RARE, LWL, Min LL acomp, EP | 3378.949         | 782.12608      | 0              | -11904.35       | 54.349084       |

| S.N.  | Description                          | Forces about toe |                |                |                 |                 | LC-7 |
|-------|--------------------------------------|------------------|----------------|----------------|-----------------|-----------------|------|
|       |                                      | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |      |
|       |                                      | Tonne            | Tonne          | Tonne          | Tm              | Tm              |      |
| 1)    | Sub-structure & Foundation           | 1317.6142        |                |                | -5480.803       | 0               | 1    |
| 2)    | Backfill                             | 1265.2343        |                |                | -8398.412       | 0               | 1    |
| 3)    | Super-structure DL                   | 398.94974        |                |                | -1366.403       | 0               | 1    |
| 4)    | SIDL (excluding surfacing)           | 116.98594        |                |                | -400.6768       | 0               | 1    |
| 5)    | Surfacing                            | 34.025063        |                |                | -116.5358       | -8.506266       | 1    |
| 6.1)  | Live Load Vertical Load Max Reaction | 137.4003         |                |                | -470.60         | 399.83          | 1    |
| 7)    | Live Load Horizontal Forces          |                  | 45.753         |                | 970.87976       |                 | 1    |
| 9)    | Fluid Pressure                       |                  | 0.102          |                | 0.0063789       |                 | 1    |
| 10.3) | Surcharge Pressure LWL(BP, SD)       |                  | 121.22         |                | 828.36          |                 | 0.8  |

| S.N. | Description                | Forces about toe |                |                |                 |                 |
|------|----------------------------|------------------|----------------|----------------|-----------------|-----------------|
|      |                            | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|      |                            | Tonne            | Tonne          | Tonne          | Tm              | Tm              |
| LC-7 | RARE, LWL, Max LL lead, FP | 3270.2095        | 142.83241      | 0              | -14599.86       | 391.3286        |

| S.N.        | Description                          | Forces about toe |                |                |                 |                 | LC-8 |
|-------------|--------------------------------------|------------------|----------------|----------------|-----------------|-----------------|------|
|             |                                      | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |      |
|             |                                      | Tonne            | Tonne          | Tonne          | Tm              | Tm              |      |
| 1)          | Sub-structure & Foundation           | 1317.6142        |                |                | -5480.803       | 0               | 1    |
| 2)          | Backfill                             | 1265.2343        |                |                | -8398.412       | 0               | 1    |
| 3)          | Super-structure DL                   | 398.94974        |                |                | -1366.403       | 0               | 1    |
| 4)          | SIDL (excluding surfacing)           | 116.98594        |                |                | -400.6768       | 0               | 1    |
| 5)          | Surfacing                            | 34.025063        |                |                | -116.5358       | -8.506266       | 1    |
| 6.1)        | Live Load Vertical Load Max Reaction | 137.4003         |                |                | -470.60         | 399.83          | 1    |
| 7)          | Live Load Horizontal Forces          |                  | 45.753         |                | 970.87976       |                 | 1    |
| <b>9.3)</b> | Earth Pressure LWL (BP, SD)          |                  |                |                |                 |                 | 1    |
|             | Horizontal Component                 |                  | 650.83         |                | 3619.41         |                 | 1    |
|             | Vertical Component                   | 224.54002        |                |                | -1077.79        |                 | 1    |
| 10.3)       | Surcharge Pressure LWL(BP, SD)       |                  | 121.22         |                | 828.36          |                 | 0.8  |

| S.N. | Description                | Forces about toe |                |                |                 |                 |
|------|----------------------------|------------------|----------------|----------------|-----------------|-----------------|
|      |                            | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|      |                            | Tonne            | Tonne          | Tonne          | Tm              | Tm              |
| LC-8 | RARE, LWL, Max LL lead, EP | 3494.7496        | 793.56435      | 0              | -12058.25       | 391.3286        |

| S.N. | Description                | Forces about toe |                |                |                 |                 | LC-9 |
|------|----------------------------|------------------|----------------|----------------|-----------------|-----------------|------|
|      |                            | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |      |
|      |                            | Tonne            | Tonne          | Tonne          | Tm              | Tm              |      |
| 1)   | Sub-structure & Foundation | 1317.6142        |                |                | -5480.803       | 0               | 1    |
| 2)   | Backfill                   | 1265.2343        |                |                | -8398.412       | 0               | 1    |
| 3)   | Super-structure DL         | 398.94974        |                |                | -1366.403       | 0               | 1    |

|      |                             |           |       |  |           |           |  |      |
|------|-----------------------------|-----------|-------|--|-----------|-----------|--|------|
| 4)   | SIDL (excluding surfacing)  | 116.98594 |       |  | -400.6768 | 0         |  | 1    |
| 5)   | Surfacing                   | 34.025063 |       |  | -116.5358 | -8.506266 |  | 1    |
| 8)   | Buoyancy                    | -67.0     |       |  | 74.5      | 0.0       |  | 0.15 |
| 9.3) | Earth Pressure HFL (BP, SD) |           |       |  |           |           |  | 1    |
|      | Horizontal Component        |           | 649.4 |  | 3697.7    |           |  | 1    |
|      | Vertical Component          | 232.9     |       |  | -1117.9   |           |  | 1    |

| S.N. | Description | Forces about toe |                |                |                 |                 |
|------|-------------|------------------|----------------|----------------|-----------------|-----------------|
|      |             | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|      |             | Tonne            | Tonne          | Tonne          | Tm              | Tm              |
| LC-9 | QP, HFL, EP | 3355.6595        | 649.40018      | 0              | -13171.89       | -8.506266       |

| S.N.  | Description                    | Forces about toe |                |                |                 |                 | LC-10 |
|-------|--------------------------------|------------------|----------------|----------------|-----------------|-----------------|-------|
|       |                                | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |       |
|       |                                | Tonne            | Tonne          | Tonne          | Tm              | Tm              |       |
| 1)    | Sub-structure & Foundation     | 1317.6142        |                |                | -5480.803       | 0               | 1     |
| 2)    | Backfill                       | 1265.2343        |                |                | -8398.412       | 0               | 1     |
| 8)    | Buoyancy                       | -67.0            |                |                | 74.5            | 0.0             | 0.15  |
| 9.3)  | Earth Pressure HFL (BP, SD)    |                  |                |                |                 |                 | 1     |
|       | Horizontal Component           |                  | 649.4          |                | 3697.7          |                 | 1     |
|       | Vertical Component             | 232.9            |                |                | -1117.9         |                 | 1     |
| 10.3) | Surcharge Pressure HFL(BP, SD) |                  | 121.1          |                | 828.3           |                 | 0.8   |

| S.N.  | Description                 | Forces about toe |                |                |                 |                 |
|-------|-----------------------------|------------------|----------------|----------------|-----------------|-----------------|
|       |                             | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|       |                             | Tonne            | Tonne          | Tonne          | Tm              | Tm              |
| LC-10 | RARE, HFL, Span dislodge EP | 2805.6988        | 746.26255      | 0              | -10625.64       | 0               |

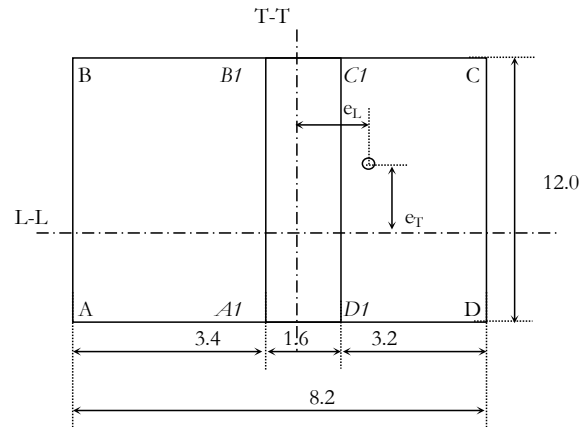
| S.N.  | Description                          | Forces about toe |                |                |                 |                 | LC-11 |
|-------|--------------------------------------|------------------|----------------|----------------|-----------------|-----------------|-------|
|       |                                      | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |       |
|       |                                      | Tonne            | Tonne          | Tonne          | Tm              | Tm              |       |
| 1)    | Sub-structure & Foundation           | 1317.6142        |                |                | -5480.803       | 0               | 1     |
| 2)    | Backfill                             | 1265.2343        |                |                | -8398.412       | 0               | 1     |
| 3)    | Super-structure DL                   | 398.94974        |                |                | -1366.403       | 0               | 1     |
| 4)    | SIDL (excluding surfacing)           | 116.98594        |                |                | -400.6768       | 0               | 1     |
| 5)    | Surfacing                            | 34.025063        |                |                | -116.5358       | -8.506266       | 1     |
| 6.2)  | Live Load Vertical Load Min Reaction | 28.799702        |                |                | -98.64          | 83.81           | 0.75  |
| 7)    | Live Load Horizontal Forces          |                  | 45.753         |                | 970.87976       |                 | 0.75  |
| 8)    | Buoyancy                             | -67.0            |                |                | 74.5            | 0.0             | 0.15  |
| 9.3)  | Earth Pressure HFL (BP, SD)          |                  |                |                |                 |                 | 1     |
|       | Horizontal Component                 |                  | 649.4          |                | 3697.7          |                 | 1     |
|       | Vertical Component                   | 232.9            |                |                | -1117.9         |                 | 1     |
| 10.3) | Surcharge Pressure HFL(BP, SD)       |                  | 121.1          |                | 828.3           |                 | 0.8   |

| S.N.  | Description                 | Forces about toe |                |                |                 |                 |
|-------|-----------------------------|------------------|----------------|----------------|-----------------|-----------------|
|       |                             | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|       |                             | Tonne            | Tonne          | Tonne          | Tm              | Tm              |
| LC-11 | RARE, HFL, Min LL acomp, EP | 3377.2593        | 780.57734      | 0              | -11855.07       | 54.349084       |

| LC-12 | RARE, HFL, Max LL lead, EP           | Forces about toe |                |                |                 |                 |  | LC-12 |
|-------|--------------------------------------|------------------|----------------|----------------|-----------------|-----------------|--|-------|
| S.N.  | Description                          | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |  |       |
|       |                                      | Tonne            | Tonne          | Tonne          | Tm              | Tm              |  |       |
| 1)    | Sub-structure & Foundation           | 1317.6142        |                |                | -5480.803       | 0               |  | 1     |
| 2)    | Backfill                             | 1265.2343        |                |                | -8398.412       | 0               |  | 1     |
| 3)    | Super-structure DL                   | 398.94974        |                |                | -1366.403       | 0               |  | 1     |
| 4)    | SIDL (excluding surfacing)           | 116.98594        |                |                | -400.6768       | 0               |  | 1     |
| 5)    | Surfacing                            | 34.025063        |                |                | -116.5358       | -8.506266       |  | 1     |
| 6.1)  | Live Load Vertical Load Max Reaction | 137.4003         |                |                | -470.60         | 399.83          |  | 1     |
| 7)    | Live Load Horizontal Forces          |                  | 45.753         |                | 970.87976       |                 |  | 1     |
| 8)    | Buoyancy                             | -67.0            |                |                | 74.5            | 0.0             |  | 0.15  |
| 9.3)  | Earth Pressure HFL (BP, SD)          |                  |                |                |                 |                 |  | 1     |
|       | Horizontal Component                 |                  | 649.4          |                | 3697.7          |                 |  | 1     |
|       | Vertical Component                   | 232.9            |                |                | -1117.9         |                 |  | 1     |
| 10.3) | Surcharge Pressure HFL(BP, SD)       |                  | 121.1          |                | 828.3           |                 |  | 0.8   |

| S.N.  | Description                | Forces about toe |                |                |                 |                 |
|-------|----------------------------|------------------|----------------|----------------|-----------------|-----------------|
|       |                            | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|       |                            | Tonne            | Tonne          | Tonne          | Tm              | Tm              |
| LC-12 | RARE, HFL, Max LL lead, EP | 3493.0598        | 792.0156       | 0              | -12008.97       | 391.3286        |

**BASE PRESSRE CALCULATION**  
**SLS LOAD COMBINATIONS**



| Coordinates of basecorner |        |        |
|---------------------------|--------|--------|
| Edges                     | x (m)  | z (m)  |
| A                         | -4.100 | 6.000  |
| B                         | -4.100 | -6.000 |
| C                         | 4.100  | -6.000 |
| D                         | 4.100  | 6.000  |

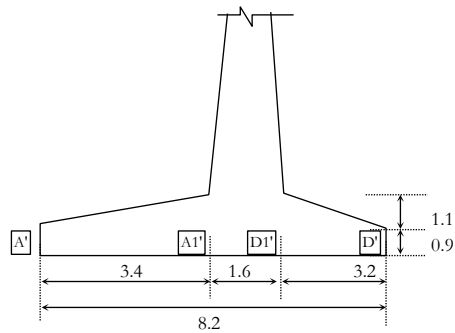
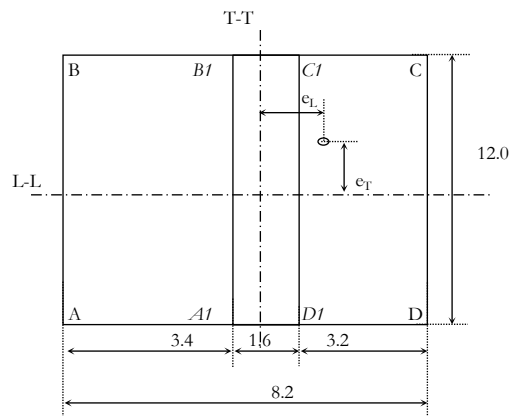
| Properties of Base |                         |   |                        |
|--------------------|-------------------------|---|------------------------|
| Area               | 8.2x12                  | = | 98.4 m <sup>2</sup>    |
| I <sub>TT</sub>    | 12x8.2 <sup>3</sup> /12 | = | 551.37 m <sup>4</sup>  |
| I <sub>LL</sub>    | 8.2x12 <sup>3</sup> /12 | = | 1180.80 m <sup>4</sup> |

**CHECK FOR MAXIMUM BASE PRESSRE**

**SUMMARY OF FORCES :**

|       |                             |                  |                |                |                 |                 | <i>Eccentricity of Vertical load wrt from toe point</i> |                     | <i>Eccentricity of Vertical load wrt cg of base</i> |                 | <i>Moment and forces at cg of base</i> |                  | <i>Gross Base Pressure = <math>P/A \pm M_{TT} * x / I_{TT} \pm M_{LL} * z / I_{LL}</math></i> |                  |                  |                  |
|-------|-----------------------------|------------------|----------------|----------------|-----------------|-----------------|---|---------------------|---|-----------------|--|------------------|---|------------------|------------------|------------------|
| S.N.  | Description                 | Forces about toe |                |                |                 |                 | e <sub>L1</sub>   | e <sub>T1</sub>     | e <sub>L</sub>                                      | e <sub>T</sub>  | M <sub>TT</sub>                        | M <sub>LL</sub>  | <i>base pressure at footing corners</i>   |                  |                  |                  |
|       |                             | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> | M <sub>TT</sub> / V                                     | M <sub>LL</sub> / V | B/2-e <sub>L1</sub>                                 | e <sub>T1</sub> | V*e <sub>L</sub>                       | V*e <sub>T</sub> | A   | B                | C                | D                |
|       |                             | Tonne            | Tonne          | Tonne          | Tm              | Tm              | m   | m                   | m   | m               | Tm                                     | Tm               | T/m <sup>2</sup>  | T/m <sup>2</sup> | T/m <sup>2</sup> | T/m <sup>2</sup> |
| LC-1  | QP, LWL, FP                 | 3132.81          | 0.10179        | 0              | -15763          | -8.5063         |   |                     |   |                 |  |                  |   |                  |                  |                  |
| LC-2  | QP, LWL, EP                 | 3357.35          | 650.834        | 0              | -13221          | -8.5063         | -3.94   | 0.00                | 0.16  | 0.00            | 543.9                                  | -8.5             | 30.0  | 30.1             | 38.2             | 38.1             |
| LC-3  | RARE, LWL, Span dislodge FP | 2582.85          | 97.0794        | 0              | -13217          | 0               |   |                     |   |                 |  |                  |   |                  |                  |                  |
| LC-4  | RARE, LWL, Span dislodge EP | 2807.39          | 747.811        | 0              | -10675          | 0               | -3.80   | 0.00                | 0.30  | 0.00            | 835.4                                  | 0.0              | 22.3  | 22.3             | 34.7             | 34.7             |
| LC-5  | RARE, LWL, Min LL acomp, FP | 3154.41          | 131.394        | 0              | -14446          | 54.3491         |   |                     |   |                 |  |                  |   |                  |                  |                  |
| LC-6  | RARE, LWL, Min LL acomp, EP | 3378.95          | 782.126        | 0              | -11904          | 54.3491         | -3.52   | 0.02                | 0.58  | 0.02            | 1949.3                                 | 54.3             | 20.1  | 19.6             | 48.6             | 49.1             |
| LC-7  | RARE, LWL, Max LL lead, FP  | 3270.21          | 142.832        | 0              | -14600          | 391.329         |   |                     |   |                 |  |                  |   |                  |                  |                  |
| LC-8  | RARE, LWL, Max LL lead, EP  | 3494.75          | 793.564        | 0              | -12058          | 391.329         | -3.45   | 0.11                | 0.65  | 0.11            | 2270.2                                 | 391.3            | 20.6  | 16.6             | 50.4             | 54.4             |
| LC-9  | QP, HFL, EP                 | 3355.66          | 649.4          | 0              | -13172          | -8.5063         | -3.93   | 0.00                | 0.17  | 0.00            | 586.3                                  | -8.5             | 29.7  | 29.8             | 38.5             | 38.4             |
| LC-10 | RARE, HFL, Span dislodge EP | 2805.7           | 746.263        | 0              | -10626          | 0               | -3.79   | 0.00                | 0.31  | 0.00            | 877.7                                  | 0.0              | 22.0  | 22.0             | 35.0             | 35.0             |
| LC-11 | RARE, HFL, Min LL acomp, EP | 3377.26          | 780.577        | 0              | -11855          | 54.3491         | -3.51   | 0.02                | 0.59  | 0.02            | 1991.7                                 | 54.3             | 19.8  | 19.2             | 48.9             | 49.4             |
| LC-12 | RARE, HFL, Max LL lead, EP  | 3493.06          | 792.016        | 0              | -12009          | 391.329         | -3.44   | 0.11                | 0.66  | 0.11            | 2312.6                                 | 391.3            | 20.3  | 16.3             | 50.7             | 54.7             |

**NET BASE PRESSRE CALCULATION**  
**SLS LOAD COMBINATIONS**



Deduction due to over burden LWL

| LWL           | A'           | A1'          | D'          | D1'         | Comb-1 |
|---------------|--------------|--------------|-------------|-------------|--------|
| Earth fill    | 45.576       | 43.376       | 0           | 0           | 1      |
| footing       | 2.25         | 5            | 2.25        | 5           | 1      |
| <b>Comb-1</b> | <b>47.83</b> | <b>48.38</b> | <b>2.25</b> | <b>5.00</b> |        |

Deduction due to over burden HFL

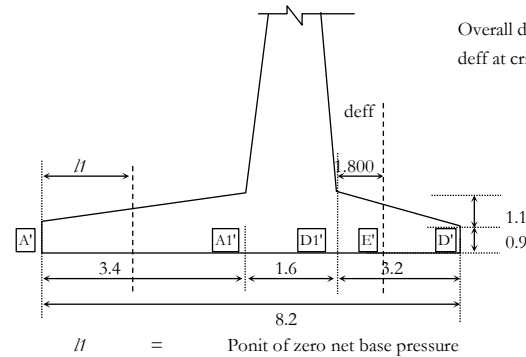
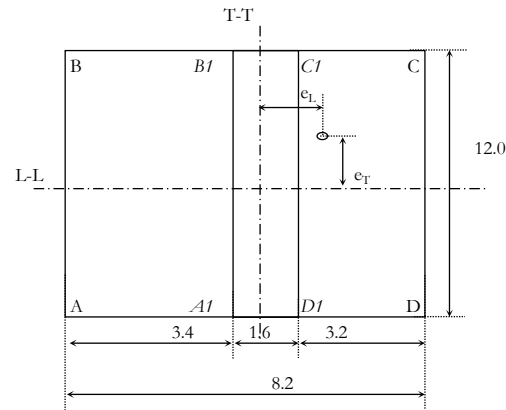
| LWL           | A'           | A1'          | D'          | D1'         | Comb-1 |
|---------------|--------------|--------------|-------------|-------------|--------|
| Earth fill    | 45.576       | 43.376       | 0           | 0           | 1      |
| footing       | 2.25         | 5            | 2.25        | 5           | 1      |
| Buoyancy      | -0.188       | -0.188       | -0.9        | -2          | 0.15   |
| <b>Comb-1</b> | <b>47.80</b> | <b>48.35</b> | <b>2.12</b> | <b>4.70</b> |        |



DESIGN FORCES FOR BASE SLAB

| SUMMARY OF FORCES : |             | <i>Gross Base Pressure = <math>P/A \pm M_{TT} *x / I_{TT} \pm M_{LL} *z / I_{LL}</math></i> |                  |                  |                  | <i>Average Gross Base Pressure at Critical points</i> |                  |                  |                  | <i>NET BASE PRESSURE</i>                |                  |                  |                  |
|---------------------|-------------|---|------------------|------------------|------------------|---|------------------|------------------|------------------|---|------------------|------------------|------------------|
| S.N.                | Description | <i>base pressure at footing corners</i>   |                  |                  |                  | <i>base pressure at footing corners</i>               |                  |                  |                  | <i>base pressure at footing corners</i> |                  |                  |                  |
|                     |             | A   | B                | C                | D                | A'  | A1'              | D'               | D1'              | A'                                      | A1'              | D'               | D1'              |
|                     |             | T/m <sup>2</sup>  | T/m <sup>2</sup> | T/m <sup>2</sup> | T/m <sup>2</sup> | T/m <sup>2</sup>                                      | T/m <sup>2</sup> | T/m <sup>2</sup> | T/m <sup>2</sup> | T/m <sup>2</sup>                        | T/m <sup>2</sup> | T/m <sup>2</sup> | T/m <sup>2</sup> |
| #REF!               | #REF!       | 30.0  | 30.1             | 38.2             | 38.1             | 30.1  | 33.4             | 38.2             | 35.01            | -17.8                                   | -14.9            | 35.9             | 30.0             |
| #REF!               | #REF!       |   |                  |                  |                  |   |                  |                  |                  |   |                  |                  |                  |
| #REF!               | #REF!       | 22.3  | 22.3             | 34.7             | 34.7             | 22.3  | 27.5             | 34.7             | 29.89            | -25.5                                   | -20.9            | 32.5             | 24.9             |
| #REF!               | #REF!       |   |                  |                  |                  |   |                  |                  |                  |   |                  |                  |                  |
| #REF!               | #REF!       | 20.1  | 19.6             | 48.6             | 49.1             | 19.8  | 31.9             | 48.8             | 37.52            | -28.0                                   | -16.5            | 46.6             | 32.5             |
| #REF!               | #REF!       |   |                  |                  |                  |   |                  |                  |                  |   |                  |                  |                  |
| #REF!               | #REF!       | 20.6  | 16.6             | 50.4             | 54.4             | 18.6  | 32.6             | 52.4             | 39.22            | -29.2                                   | -15.7            | 50.1             | 34.2             |
| #REF!               | #REF!       |   |                  |                  |                  |   |                  |                  |                  |   |                  |                  |                  |
| #REF!               | #REF!       | 29.7  | 29.8             | 38.5             | 38.4             | 29.7  | 33.4             | 38.5             | 35.06            | -18.1                                   | -15.0            | 36.3             | 30.4             |
| #REF!               | #REF!       |   |                  |                  |                  |   |                  |                  |                  |   |                  |                  |                  |
| #REF!               | #REF!       | 22.0  | 22.0             | 35.0             | 35.0             | 22.0  | 27.4             | 35.0             | 29.95            | -25.8                                   | -20.9            | 32.9             | 25.2             |
| #REF!               | #REF!       | 19.8  | 19.2             | 48.9             | 49.4             | 19.5  | 31.8             | 49.1             | 37.57            | -28.3                                   | -16.6            | 47.0             | 32.9             |
| #REF!               | #REF!       | 20.3  | 16.3             | 50.7             | 54.7             | 18.3  | 32.6             | 52.7             | 39.27            | -29.5                                   | -15.8            | 50.6             | 34.6             |

**FINDING BENDING MOMENT & SHEAR FORCE AT CRITICAL SECTION**  
**SLS LOAD COMBINATIONS**



Overall depth at deff = 1.381 m  
 deff at critical section = 1.800 m

| Design Bending Moment & Shear Force : |      |            |          |
|---------------------------------------|------|------------|----------|
| Description                           |      | Rare<br>Tm | QS<br>Tm |
| Heel Slab (BM. Downward)              | I.WL | -144.1     | -97.2    |
| Toe slab (face of support)            | I.WL | 231.7      | 173.8    |

**DESIGN FORCES FOR BASE SLAB**

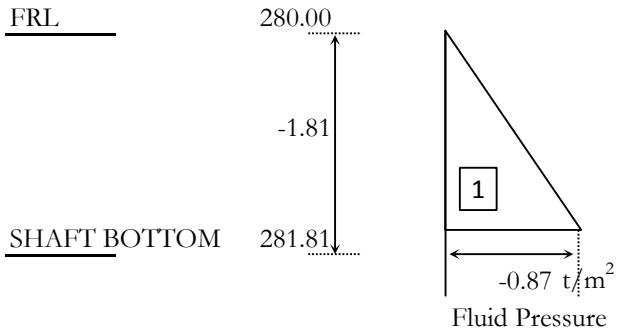
| SUMMARY OF FORCES : |             | NET BASE PRESSURE                |                  |                  |                  |                  |
|---------------------|-------------|----------------------------------|------------------|------------------|------------------|------------------|
| S.N.                | Description | base pressure at footing corners |                  |                  |                  |                  |
|                     |             | A'                               | A1'              | D'               | D1'              | E1'              |
|                     |             | T/m <sup>2</sup>                 | T/m <sup>2</sup> | T/m <sup>2</sup> | T/m <sup>2</sup> | T/m <sup>2</sup> |
| #REF!               | #REF!       | 0.0                              | 0.0              | 0.0              | 0.0              | 0                |
| #REF!               | #REF!       | -17.8                            | -14.9            | 35.9             | 30.0             | 32.5915          |
| #REF!               | #REF!       | -25.5                            | -20.9            | 32.5             | 24.9             | 28.2182          |
| #REF!               | #REF!       | -28.0                            | -16.5            | 46.6             | 32.5             | 38.6736          |
| #REF!               | #REF!       | -29.2                            | -15.7            | 50.1             | 34.2             | 41.189           |
| #REF!               | #REF!       | -18.1                            | -15.0            | 36.3             | 30.4             | 32.9789          |
| #REF!               | #REF!       | -25.8                            | -20.9            | 32.9             | 25.2             | 28.6055          |
| #REF!               | #REF!       | -28.3                            | -16.6            | 47.0             | 32.9             | 39.0609          |
| #REF!               | #REF!       | -29.5                            | -15.8            | 50.6             | 34.6             | 41.5763          |

| Ponit of<br>zero net<br>base<br>pressure | BM at<br>Point of<br>zero base<br>pressure |
|--|--|
| l/l                                      | BM   |
| m  | Tm   |
| 0.00                                     | 0.00                                       |
| 0.00                                     | 0.00                                       |
| 0.00                                     | 0.00                                       |
| 0.00                                     | 0.00                                       |
| 0.00                                     | 0.00                                       |
| 0.00                                     | 0.00                                       |
| 0.00                                     | 0.00                                       |
| 0.00                                     | 0.00                                       |
| 0.00                                     | 0.00                                       |
| 0.00                                     | 0  |

| BENDING MOMENT & SHEAR FORCE |       |  |                      |                      |                      |                      |
|------------------------------|-------|--|----------------------|----------------------|----------------------|----------------------|
| Heel Slab                    |       |  | Toe Slab             |                      |                      |                      |
| BM                           | SF    |  | BM   <sub>face</sub> | SF   <sub>face</sub> | SF   <sub>deff</sub> | BM   <sub>deff</sub> |
| Tm                           | T     |  | Tm                   | T                    | T                    | Tm                   |
| 0.0                          | 0.0   |  | 0.0                  | 0.0                  | 0.00                 | 0.00                 |
| -97.2                        | -55.6 |  | 173.8                | 105.5                | 43.82                | 34.11                |
| -138.6                       | -78.9 |  | 153.4                | 91.8                 | 37.18                | 30.45                |
| -139.6                       | -75.6 |  | 214.5                | 126.6                | 49.84                | 43.07                |
| -142.8                       | -76.4 |  | 229.6                | 135.0                | 52.79                | 46.22                |
| -98.5                        | -56.2 |  | 175.9                | 106.7                | 44.34                | 34.52                |
| -139.8                       | -79.5 |  | 155.5                | 93.1                 | 37.70                | 30.86                |
| -140.9                       | -76.2 |  | 216.6                | 127.8                | 50.35                | 43.48                |
| -144.1                       | -77.0 |  | 231.7                | 136.2                | 53.30                | 46.63                |

### FLUID PRESSURE CALCULATION FOR SHAFT DESIGN :

Fluid density = 0.48 t/m<sup>3</sup>  
 Abutment Length L = 12 m



Total Fluid Pressure

| Component | Factor | p                | h      | L  | F       | ey     |
|-----------|--------|------------------|--------|----|---------|--------|
|           |        | T/m <sup>2</sup> | m      | m  | Tonne   | m      |
| 1         | 0.5    | -0.86976         | -1.812 | 12 | 9.46    | -0.604 |
| Total     |        |                  |        |    | 9.45603 | -0.604 |

|                                  |   |                   |
|----------------------------------|---|-------------------|
| <b>Total fluid Pressure</b>      | = | <b>9.46 Tonne</b> |
| <b>Lever arm</b>                 | = | <b>-0.60</b>      |
| <b>Moment M<sub>TT</sub></b>     | = | <b>-5.71 Tm</b>   |
| <b>Net Moment M<sub>TT</sub></b> | = | <b>-5.71 Tm</b>   |

### SUMMARY FLUID PRESSURE :

| Description      | Fluid Pressure               |                        |
|------------------|------------------------------|------------------------|
|                  | Horizontal (H <sub>L</sub> ) | M <sub>TT</sub> (Dest) |
|                  | Tonne                        | Tm                     |
| 1) LWL Condition | 9.46                         | -5.71                  |

## **EARTH PRESSURE CALCULATION FOR SHAFT DESIGN :**

### **A) Non-Seismic Case :**

Coefficient of Active Earth Pressure

$$\text{Active earth pressure } Ka = \frac{\sin^2(\alpha + \phi)}{\sin^2 \alpha \cdot \sin(\alpha - \delta) \cdot \left[ 1 + \sqrt{\frac{\sin(\phi + \delta) \cdot \sin(\phi - i)}{\sin(\alpha - \delta) \cdot \sin(\alpha + i)}} \right]^2}$$

Backfill Soil Parameter

|                             |   |                    |   |               |
|-----------------------------|---|--------------------|---|---------------|
| $\phi$                      | = | 30 °               | = | 0.524 Radians |
| $\delta$                    | = | 20 °               | = | 0.349 Radians |
| $\delta_{\text{submerged}}$ | = | 10 °               | = | 0.175 Radians |
| $i$                         | = | 0 °                | = | 0 Radians     |
| $\alpha$                    | = | 88.70 °            | = | 1.548 Radians |
| $\gamma_{\text{dry}}$       | = | 2 t/m <sup>3</sup> |   |               |
| $\gamma_{\text{sat}}$       | = | 2 t/m <sup>3</sup> |   |               |
| $\gamma_{\text{sub}}$       | = | 1 t/m <sup>3</sup> |   |               |

|                        |   |   |                      |
|------------------------|---|---|----------------------|
| LL surcharge intensity | q | = | 2.4 t/m <sup>2</sup> |
|------------------------|---|---|----------------------|

|                 |   |   |      |
|-----------------|---|---|------|
| Abutment Length | L | = | 12 m |
|-----------------|---|---|------|

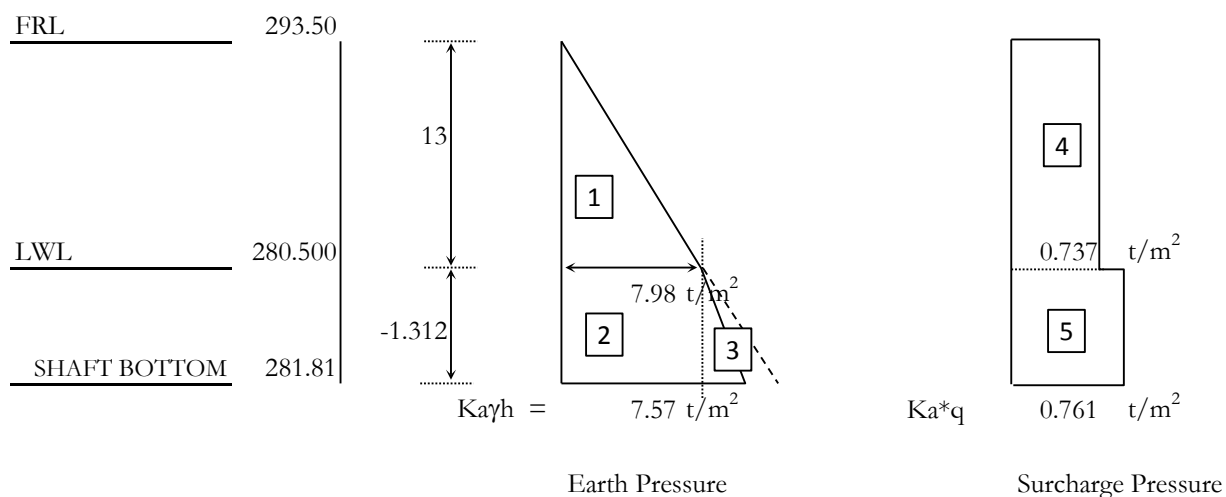
|             |   |   |       |
|-------------|---|---|-------|
| Shaft width | B | = | 1.6 m |
|-------------|---|---|-------|

|                   |   |       |
|-------------------|---|-------|
| $Ka_{\text{Dry}}$ | = | 0.307 |
|-------------------|---|-------|

|                          |   |       |
|--------------------------|---|-------|
| $Ka'_{\text{Submerged}}$ | = | 0.317 |
|--------------------------|---|-------|

### **1) LWL CONDITION**

|                             |   |                      |
|-----------------------------|---|----------------------|
| Ka                          | = | 0.307                |
| Ka'                         | = | 0.317                |
| $\gamma_{\text{dry}}$       | = | 2 t/m <sup>3</sup>   |
| $\gamma_{\text{sub}}$       | = | 1 t/m <sup>3</sup>   |
| $\delta$                    | = | 20 °                 |
| $\delta_{\text{submerged}}$ | = | 10 °                 |
| q                           | = | 2.4 t/m <sup>2</sup> |
| L                           | = | 12 m                 |
| B                           | = | 1.6 m                |



Total Earth Pressure at rest

| Component | Factor | p                | h      | L  | F       | $\delta$ | $F \cdot \cos \delta$ | ey     | $F \cdot \sin \delta$ | ex   |
|-----------|--------|------------------|--------|----|---------|----------|-----------------------|--------|-----------------------|------|
|           |        | T/m <sup>2</sup> | m      | m  | Tonne   | deg      | Tonne                 | m      | Tonne                 | m    |
| 1         | 0.5    | 7.982            | 13     | 12 | 622.60  | 20       | 585.05                | 4.148  | 212.94                | -0.8 |
| 2         | 1      | 7.982            | -1.312 | 12 | -125.67 | 10       | -123.76               | -0.656 | -21.82                | -0.8 |
| 3         | 0.5    | -0.4159          | -1.312 | 12 | 3.27    | 10       | 3.22                  | -0.437 | 0.57                  | -0.8 |
| Total     |        |                  |        |    | 500.201 |          | 464.514               | 5.011  | 191.6868              | -0.8 |

|                                       |   |                     |
|---------------------------------------|---|---------------------|
| <b>Total Earth Pressure at rest</b>   | = | <b>500.20 Tonne</b> |
| <b>Horizontal Component</b>           | = | <b>464.51</b>       |
| <b>Lever arm</b>                      | = | <b>5.01</b>         |
| <b>Moment <math>M_{TT}</math></b>     | = | <b>2327.72 Tm</b>   |
| <b>Vertical Component</b>             | = | <b>191.69</b>       |
| <b>Lever arm</b>                      | = | <b>-0.80 m</b>      |
| <b>Moment <math>M_{TT}</math></b>     | = | <b>-153.35 Tm</b>   |
| <b>Net Moment <math>M_{TT}</math></b> | = | <b>2174.37 Tm</b>   |

Total Surcharge pressure

| Component | Factor | p                | h      | L  | F       | ey      |
|-----------|--------|------------------|--------|----|---------|---------|
|           |        | T/m <sup>2</sup> | m      | m  | Tonne   | m       |
| 4         | 1      | 0.7368           | 13     | 12 | 114.94  | 5.188   |
| 5         | 1      | 0.7608           | -1.312 | 12 | -11.978 | -0.656  |
| Total     |        |                  |        |    | 102.963 | 5.86785 |

|                                   |          |                     |
|-----------------------------------|----------|---------------------|
| <b>Total Surcharge Pressure</b>   | <b>=</b> | <b>102.96 Tonne</b> |
| <b>Lever arm above base</b>       | <b>=</b> | <b>5.87 m</b>       |
| <b>Moment <math>M_{TT}</math></b> | <b>=</b> | <b>604.17 Tm</b>    |

**SUMMARY EARTH PRESSURE :**

| Description      | Earth Pressure       |                 |                |                 |
|------------------|----------------------|-----------------|----------------|-----------------|
|                  | Horizontal ( $H_L$ ) | $M_{TT}$ (Dest) | Vertical ( V ) | $M_{TT}$ (Steb) |
|                  | Tonne                | Tm              | Tonne          | Tm              |
| 1) LWL Condition | 464.51               | 2327.72         | 191.69         | -153.3          |

**SUMMARY SURCHARGE PRESSURE :**

| Description      | Surcharge Pressure   |                 |
|------------------|----------------------|-----------------|
|                  | Horizontal ( $H_L$ ) | $M_{TT}$ (Dest) |
|                  | Tonne                | Tm              |
| 1) LWL Condition | 102.96               | 604.17          |

## DYNAMIC EARTH PRESSURE CALCULATION FOR SHAFT DESIGN :

### A) Non-Seismic Case :

Coefficient of Earth Pressure at rest

$$K_o \text{ Dry} = 0.307$$

$$K_o' \text{ Submerged} = 0.317$$

Backfill Soil Parameter

|                             |   |                   |   |               |
|-----------------------------|---|-------------------|---|---------------|
| $\phi$                      | = | $30^\circ$        | = | 0.524 Radians |
| $\delta$                    | = | $20^\circ$        | = | 0.349 Radians |
| $\delta_{\text{submerged}}$ | = | $10^\circ$        | = | 0.175 Radians |
| $i$                         | = | $0^\circ$         | = | 0 Radians     |
| $\alpha$                    | = | $90^\circ$        | = | 1.571 Radians |
| $\gamma_{\text{dry}}$       | = | $2 \text{ t/m}^3$ |   |               |
| $\gamma_{\text{sat}}$       | = | $2 \text{ t/m}^3$ |   |               |
| $\gamma_{\text{sub}}$       | = | $1 \text{ t/m}^3$ |   |               |

$$\text{LL surcharge intensity } q = 2.4 \text{ t/m}^2$$

$$\text{Abutment Length } (1 \pm \alpha_v) * \sin^2(\alpha + \phi - \lambda) = 12 \text{ m}$$

$$\text{Shaft width } \frac{B}{\cos \lambda * \sin^2 \alpha \cdot \sin(\alpha - \delta - \lambda) \cdot \left[ 1 + \sqrt{\frac{\sin(\phi + \delta) \cdot \sin(\phi - i - \lambda)}{\sin(\alpha - \delta - \lambda) \cdot \sin(\alpha + i)}} \right]} = 1.6 \text{ m}$$

$$\alpha_h = 0.03358$$

$$\alpha_v = 0.02832$$

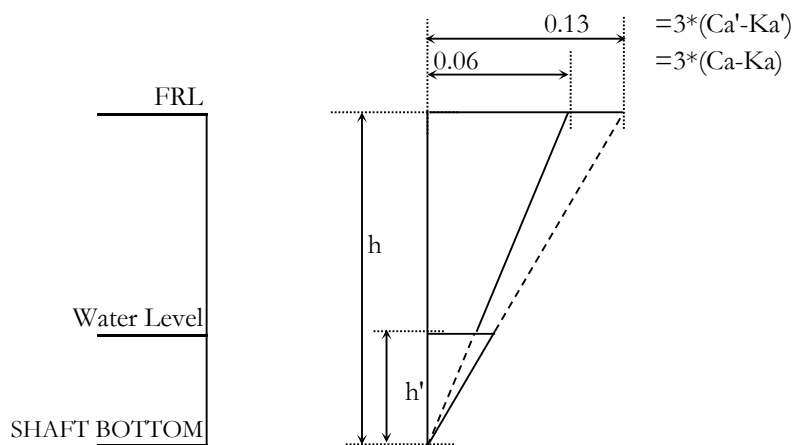
| $\lambda$                    | Formula used  | For | $+\alpha_v$ | $-\alpha_v$ |     |
|------------------------------|---|-----|-------------|-------------|-----|
| $\lambda_{\text{dry}}$       | $= \tan^{-1} \frac{\alpha_h}{1 \pm \alpha_v}$   |     | 1.87        | 1.98        | deg |
| $\lambda_{\text{submerged}}$ | $= \tan^{-1} \frac{\gamma_{\text{sat}} * \alpha_h}{(\gamma_{\text{sat}} - 1) (1 \pm \alpha_v)}$ |     | 3.74        | 3.95376     | deg |

| $+\alpha_v$ | $-\alpha_v$ |         |
|-------------|-------------|---------|
| 0.03        | 0.03        | Radians |
| 0.07        | 0.07        | Radians |

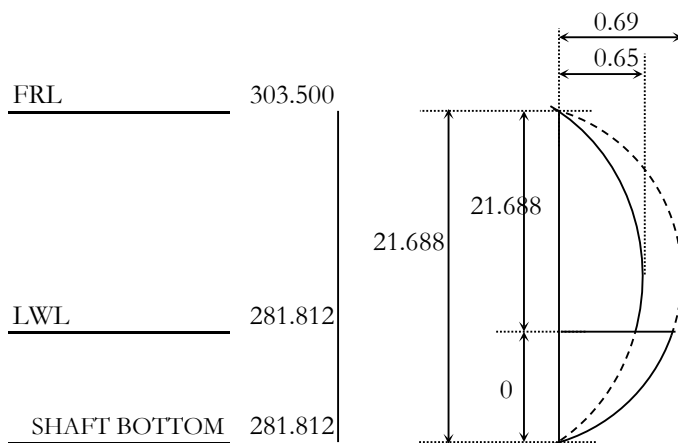
| Seismic case (Coefficient of Earth Pressure) |         |       |
|--|---------|-------|
| For Seismic downward dry condition           | $C_a$   | 0.327 |
| For Seismic downward submerged condition     | $C_a'$  | 0.359 |
| For Seismic upward dry condition             | $C_a-$  | 0.310 |
| For Seismic upward submerged condition       | $C_a-'$ | 0.342 |

### 1) LWL Seismic Downward

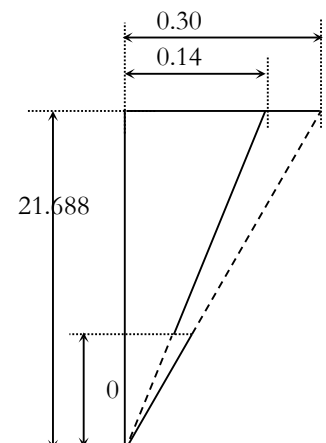
|                             |   |                      |
|-----------------------------|---|----------------------|
| $K_a$                       | = | 0.307                |
| $K_a'$                      | = | 0.317                |
| $C_a$                       | = | 0.327                |
| $C_a'$                      | = | 0.359                |
| $\gamma_{\text{dry}}$       | = | 2 t/m <sup>3</sup>   |
| $\gamma_{\text{sat}}$       | = | 2 t/m <sup>3</sup>   |
| $\gamma_{\text{sub}}$       | = | 1 t/m <sup>3</sup>   |
| $\delta$                    | = | 20 deg               |
| $\delta_{\text{submerged}}$ | = | 10 deg               |
| $q$                         | = | 2.4 t/m <sup>2</sup> |
| $L$                         | = | 12 m                 |
| $B$                         | = | 1.6 m                |



Dynamic Earth Pressure Coeff. Variation



Dynamic Earth Pressure



Dynamic Surcharge Pressure



#### Dyanmic Earth Pressure Calculation

Parabola above Water Level

|                         |   |                       |
|-------------------------|---|-----------------------|
| p <sub>mid_height</sub> | = | 0.65 t/m <sup>2</sup> |
| h                       | = | 21.688 m              |
| y                       | = | 10.844 m              |
| L                       | = | 12 m                  |

Parabola below Water Level

|                         |   |                       |
|-------------------------|---|-----------------------|
| p <sub>mid_height</sub> | = | 0.69 t/m <sup>2</sup> |
| h                       | = | 21.688 m              |
| y                       | = | -10.844 m             |
| L                       | = | 12 m                  |

| Dyanmic Earth Pressure              | Pa           | δ    | Pa*Cosδ      | ey          | Pa*Sinδ     | ex          |
|-------------------------------------|--------------|------|--------------|-------------|-------------|-------------|
|                                     | T            | deg. | T            | m           | T           | m           |
| Parabola above Water Level          | 112.8        | 20   | 106.0        | 10.8        | 38.6        | -0.8        |
| Parabola below Water Level          | 0.0          | 10   | 0.0          | 0.0         | 0.0         | -0.8        |
| <b>Total Dynamic Earth Pressure</b> | <b>112.8</b> |      | <b>106.0</b> | <b>10.8</b> | <b>38.6</b> | <b>-0.8</b> |

|                                     |   |                     |
|-------------------------------------|---|---------------------|
| <b>Total Dynamic Earth Pressure</b> | = | <b>112.84 Tonne</b> |
| <b>Horizontal Component</b>         | = | <b>106.03</b>       |
| <b>Lever arm</b>                    | = | <b>10.84</b>        |
| <b>Moment M<sub>TT</sub></b>        | = | <b>1149.79 Tm</b>   |
| <b>Vertical Component</b>           | = | <b>38.59</b>        |
| <b>Lever arm</b>                    | = | <b>-0.80 m</b>      |
| <b>Moment M<sub>TT</sub></b>        | = | <b>-30.8735 Tm</b>  |
| <b>Net Moment M<sub>TT</sub></b>    | = | <b>1118.92 Tm</b>   |

#### Dyanmic Surcharge Pressure Calculation

Pressure Distribution above water level

|                          |   |                        |
|--------------------------|---|------------------------|
| Intensity at top         | = | 0.14 t/m <sup>2</sup>  |
| Intensity at water Level | = | 0.000 t/m <sup>2</sup> |
| h-h'                     | = | 21.688 m               |
| L                        | = | 12 m                   |

Pressure Distribution below water level

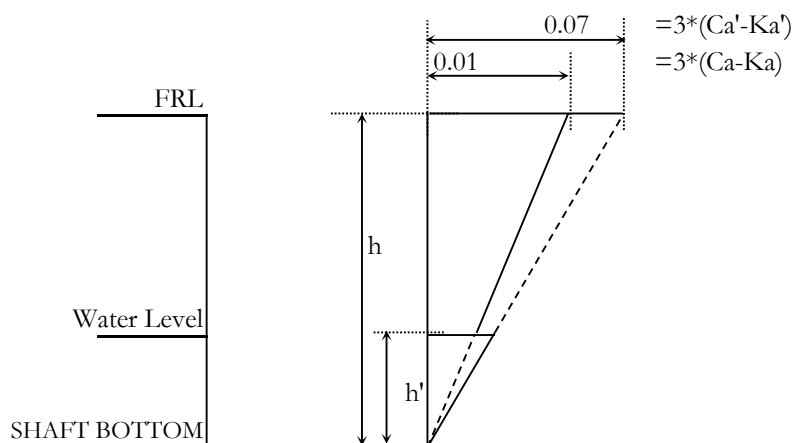
|                          |   |                       |
|--------------------------|---|-----------------------|
| Intensity at water Level | = | 0.00 t/m <sup>2</sup> |
| Intensity at base        | = | 0 t/m <sup>2</sup>    |
| h                        | = | 0 m                   |
| L                        | = | 12 m                  |

| Dyanmic Surcharge Pressure              | Pa           | Lever arm above Base |
|---|--------------|----------------------|
|   | T/m          | m                    |
| Trapezoidal Portion above water Level   | 18.73        | 14.4587              |
| Triangular Portion below water Level    | 0.00         | 0.00                 |
| <b>Total Dynamic Surcharge Pressure</b> | <b>18.73</b> | <b>14.46</b>         |

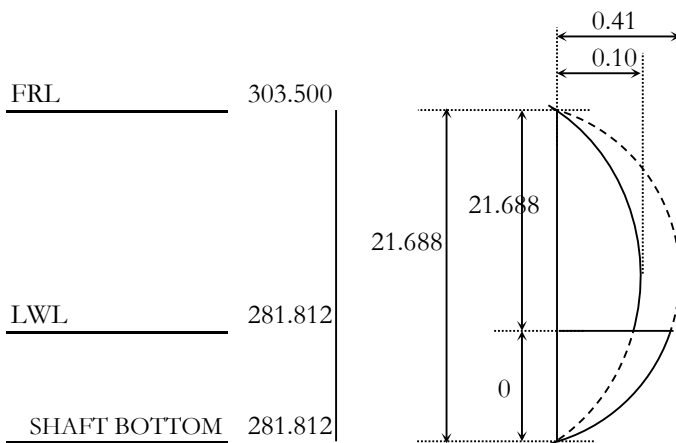
|                                 |   |                    |
|---------------------------------|---|--------------------|
| <b>Total Surcharge Pressure</b> | = | <b>18.73 Tonne</b> |
| <b>Lever arm above base</b>     | = | <b>14.46 m</b>     |
| <b>Moment M<sub>TT</sub></b>    | = | <b>270.80 Tm</b>   |

## 2) LWL Seismic Upward

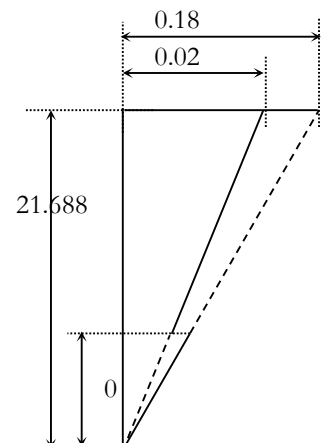
|                      |   |                      |
|----------------------|---|----------------------|
| $K_a$                | = | 0.307                |
| $K_a'$               | = | 0.317                |
| $C_a$                | = | 0.310                |
| $C_a'$               | = | 0.342                |
| $\gamma_{dry}$       | = | 2 t/m <sup>3</sup>   |
| $\gamma_{sat}$       | = | 2 t/m <sup>3</sup>   |
| $\gamma_{sub}$       | = | 1 t/m <sup>3</sup>   |
| $\delta$             | = | 20 deg               |
| $\delta_{submerged}$ | = | 10 deg               |
| $q$                  | = | 2.4 t/m <sup>2</sup> |
| $L$                  | = | 12 m                 |
| $B$                  | = | 1.6 m                |



Dynamic Earth Pressure Coeff. Variation



Dynamic Earth Pressure



Dynamic Surcharge Pressure

### Dyanmic Earth Pressure Calculation

Parabola above Water Level

|                         |   |                       |
|-------------------------|---|-----------------------|
| p <sub>mid_height</sub> | = | 0.10 t/m <sup>2</sup> |
| h                       | = | 21.688 m              |
| y                       | = | 10.844 m              |
| L                       | = | 12 m                  |

Parabola below Water Level

|                         |   |                       |
|-------------------------|---|-----------------------|
| p <sub>mid_height</sub> | = | 0.41 t/m <sup>2</sup> |
| h                       | = | 21.688 m              |
| y                       | = | -10.844 m             |
| L                       | = | 12 m                  |

| Dyanmic Earth Pressure              | Pa          | δ    | Pa*cosδ     | ey          | Pa*sinδ    | ex          |
|-------------------------------------|-------------|------|-------------|-------------|------------|-------------|
|                                     | T           | deg. | T           | m           | T          | m           |
| Parabola above Water Level          | 18.0        | 20   | 16.9        | 10.8        | 6.2        | -0.8        |
| Parabola below Water Level          | 0.0         | 10   | 0.0         | 0.0         | 0.0        | -0.8        |
| <b>Total Dynamic Earth Pressure</b> | <b>18.0</b> |      | <b>16.9</b> | <b>10.8</b> | <b>6.2</b> | <b>-0.8</b> |

|                                     |   |                    |
|-------------------------------------|---|--------------------|
| <b>Total Dynamic Earth Pressure</b> | = | <b>18.03 Tonne</b> |
| <b>Horizontal Component</b>         | = | <b>16.94</b>       |
| <b>Lever arm</b>                    | = | <b>10.84</b>       |
| <b>Moment M<sub>TT</sub></b>        | = | <b>183.73 Tm</b>   |
| <b>Vertical Component</b>           | = | <b>6.17</b>        |
| <b>Lever arm</b>                    | = | <b>-0.80 m</b>     |
| <b>Moment M<sub>TT</sub></b>        | = | <b>-4.93352 Tm</b> |
| <b>Net Moment M<sub>TT</sub></b>    | = | <b>178.80 Tm</b>   |

### Dyanmic Surcharge Pressure Calculation

Pressure Distribution above water level

|                          |   |                        |
|--------------------------|---|------------------------|
| Intensity at top         | = | 0.02 t/m <sup>2</sup>  |
| Intensity at water Level | = | 0.000 t/m <sup>2</sup> |
| h-h'                     | = | 21.688 m               |
| L                        | = | 12 m                   |

Pressure Distribution below water level

|                          |   |                       |
|--------------------------|---|-----------------------|
| Intensity at water Level | = | 0.00 t/m <sup>2</sup> |
| Intensity at base        | = | 0 t/m <sup>2</sup>    |
| h                        | = | 0 m                   |
| L                        | = | 12 m                  |

| Dyanmic Surcharge Pressure              | Pa          | Lever arm above Base |
|---|-------------|----------------------|
|   | T/m         | m                    |
| Trapezoidal Portion above water Level   | 2.99        | 14.46                |
| Triangular Portion below water Level    | 0.00        | 0.00                 |
| <b>Total Dynamic Surcharge Pressure</b> | <b>2.99</b> | <b>14.46</b>         |

|                                 |   |                   |
|---------------------------------|---|-------------------|
| <b>Total Surcharge Pressure</b> | = | <b>2.99 Tonne</b> |
| <b>Lever arm above base</b>     | = | <b>14.46 m</b>    |
| <b>Moment M<sub>TT</sub></b>    | = | <b>43.27 Tm</b>   |

***SUMMARY DYNAMIC EARTH PRESSURE :***

| Description   | Dynamic Earth Pressure |                         |              |                         |
|---|------------------------|-------------------------|--------------|-------------------------|
|   | Horizontal ( $H_L$ )   | $M_{TT} \text{ (Dest)}$ | Vertical (V) | $M_{TT} \text{ (Steb)}$ |
|   | Tonne                  | Tm                      | Tonne        | Tm                      |
| 1) LWL Seismic Downward<br>Horizontal Component<br>Vertical Component | 0.00                   | 0.00                    | 0.00         | 0                       |
| 2) LWL Seismic Upward<br>Horizontal Component<br>Vertical Component   | 0.00                   | 0.00                    | 0.00         | 0.00                    |

***SUMMARY DYNAMIC SURCHARGE PRESSURE :***

| Description             | Dynamic Surcharge Pressure |                         |
|-------------------------|----------------------------|-------------------------|
|                         | Horizontal ( $H_L$ )       | $M_{TT} \text{ (Dest)}$ |
|                         | Tonne                      | Tm                      |
| 1) LWL Seismic Downward | 0.00                       | 0.00                    |
| 2) LWL Seismic Upward   | 0.00                       | 0.00                    |

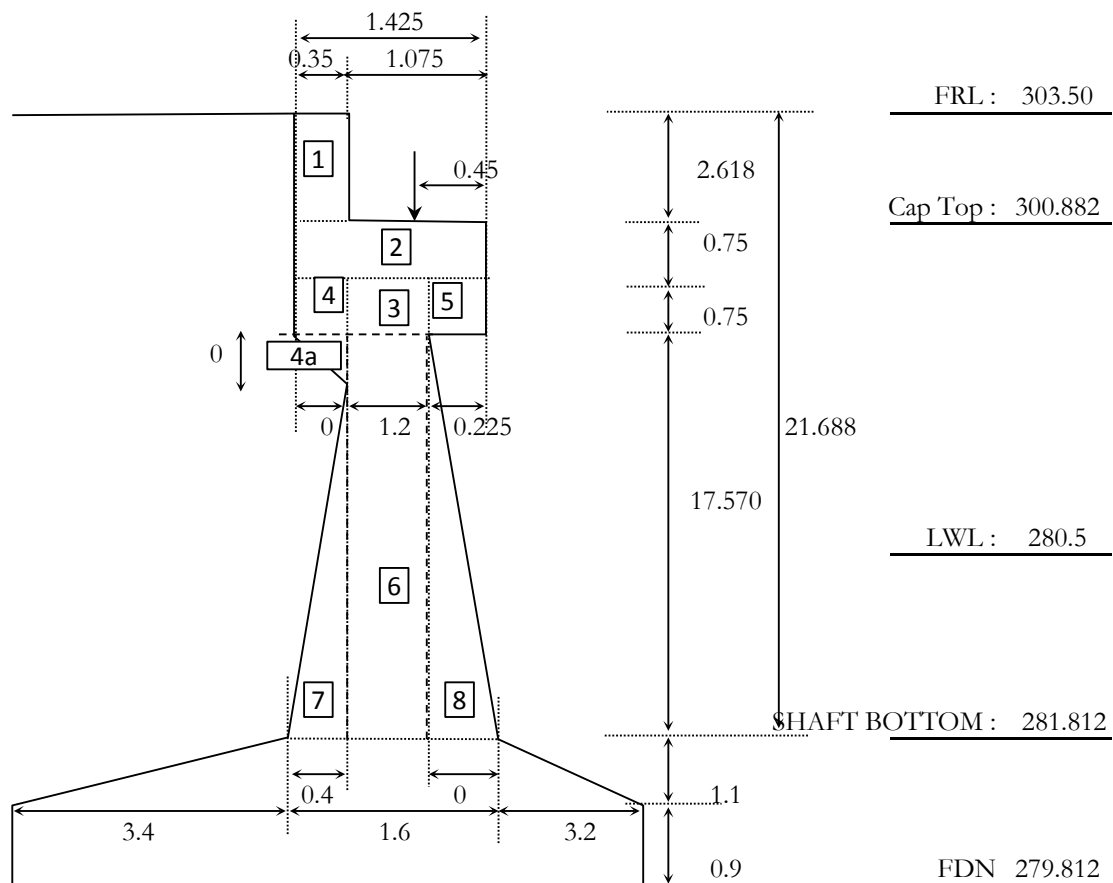
## UNFACTORED FORCES FOR DESIGN OF SHAFT :

### SELFWEIGHT OF ABUTMENT

|                           |                           |       |                  |
|---------------------------|---------------------------|-------|------------------|
| RCC Density               | =                         | 2.5   | t/m <sup>3</sup> |
| water density             | $\gamma_{\text{water}}$ = | 1     | t/m <sup>3</sup> |
| Soil Density              | $\gamma_{\text{soil}}$ =  | 2     | t/m <sup>3</sup> |
| Thickness of wearing coat | =                         | 0.065 | m                |
| Depth of super-structure  | =                         | 2.403 | m                |

### ABUTMENT COMPONENT :-

Length of Abutment = 12 m



### Calculating Selfweight of Sub-structure :

Forces @ Base of abutment shaft

$e_L$  = Cg. w.r.t. c/L of shaft, at bottom of abutment shaft.  
 $e_Y$  = Cg. From base of abutment shaft.

| Element                                  | Area Factor | B     | H   | L  | V              | W      | e <sub>Y</sub> | e <sub>L</sub> |
|--|-------------|-------|---|----|----------------|--------|----------------|----------------|
|  |             | m     | m   | m  | m <sup>3</sup> | Tonne  | m              | m              |
| Dirt Wall & Abutment Cap                 |             |       |   |    |                |        |                |                |
| 1  | 1           | 0.35  | 2.618   | 12 | 11.00          | 27.49  | 20.38          | -0.225         |
| 2  | 1           | 1.425 | 0.75  | 12 | 12.825         | 32.06  | 18.69          | 0.3125         |
| 3  | 1           | 1.425 | 0.75  | 12 | 12.825         | 32.06  | 18.69          | 0.3125         |
| 4  | 0           | 0     | 0.75  | 12 | 0.00           | 0.00   | 18.07          | -0.4           |
| 4a                                       | 0           | 0     | 0   | 12 | 0.00           | 0.00   | 17.57          | -0.4           |
| 5  | 0           | 0.225 | 0.75  | 12 | 0.00           | 0.00   | 18.07          | 0.875          |
|  | Total       |       |   |    | 36.65          | 91.62  | 19.20          | 0.15           |
| */ Increase Abutment cap weight by       |             |       | 20% on account of bearing, bearing pedestal, stopper etc. |    |                |        |                |                |
| <i>Abutment Cap weight Considered</i>    |             |       |   |    | 43.98          | 109.94 | 19.20          | 0.15           |
| Abutment Shaft                           |             |       |   |    |                |        |                |                |
| 6  | 1           | 1.2   | 17.57   | 12 | 253.00         | 632.5  | 8.78           | 0.2            |
| 7  | 0.5         | 0.4   | 17.57   | 12 | 42.17          | 105.4  | 5.86           | -0.53333       |
| 8  | 0.5         | 0     | 17.57   | 12 | 0.00           | 0.0    | 5.86           | 0.800          |
| <i>Abutment shaft weight considered.</i> |             |       |   |    | 295.17         | 737.92 | 8.37           | 0.10           |

|   |               |               |             |             |
|---|---------------|---------------|-------------|-------------|
| <b>Total Sub-structure self weight at base of shaft</b> | <b>339.14</b> | <b>847.86</b> | <b>9.77</b> | <b>0.10</b> |
|---|---------------|---------------|-------------|-------------|

|   |          |                   |
|---|----------|-------------------|
| <b>Total Weight of sub-structure &amp; foundation</b> | <b>=</b> | <b>847.86 T</b>   |
| <b>Lever arm about toe (along L-L axis)</b>           | <b>=</b> | <b>0.10 m</b>     |
| <b>Moment M<sub>TT</sub></b>                          | <b>=</b> | <b>86.9014 Tm</b> |

***Forces due to Super-Structure DL, at Shaft Bottom:***

|   |   |              |
|---|---|--------------|
| Vertical Load (Sup DL Reaction)           | = | 398.95 Tonne |
| Cg. From Deck Top                         | = | 0.33 m       |
| Lever arm about toe (along L-L axis)      | = | 0.575 m      |
| Moment M <sub>TT</sub>                    | = | 229.396 Tm   |
| Lever arm about c/L base (along T-T axis) | = | 0.00 m       |
| Moment M <sub>LL</sub>                    | = | 0 Tm         |
| Cg. From base slab bottom                 | = | 21.296 m     |

***Forces due to Super-Structure SIDL, at Shaft Bottom:***

|   |   |              |
|---|---|--------------|
| Vertical Load (Sup SIDL Reaction)         | = | 116.99 Tonne |
| Cg. above Deck Top                        | = | 0.31 m       |
| Lever arm about toe (along L-L axis)      | = | 0.575 m      |
| Moment $M_{TT}$                           | = | 67.2669 Tm   |
| Lever arm about c/L base (along T-T axis) | = | 0.00 m       |
| Moment $M_{LL}$                           | = | 0.00 Tm      |
| Cg. From base Slab bottom                 | = | 21.933 m     |

***Forces due to Super-Structure Surfacing , at Shaft Bottom:***

|   |   |             |
|---|---|-------------|
| Vertical Load (Sup Surfacing Reaction)    | = | 34.03 Tonne |
| Cg. above Deck Top                        | = | 0.03 m      |
| Lever arm about toe (along L-L axis)      | = | 0.575 m     |
| Moment $M_{TT}$                           | = | 19.5644 Tm  |
| Lever arm about c/L base (along T-T axis) | = | -0.25 m     |
| Moment $M_{LL}$                           | = | -8.51 Tm    |
| Cg. From base Slab bottom                 | = | 21.656 m    |

| <b>Forces due to LL , at Shaft Bottom:</b> |   | <b>Max Reaction</b> | <b>Min Reaction</b> |
|--|---|---------------------|---------------------|
| Vertical Load (CW LL Reaction)             | = | 137.40 Tonne        | 28.80 Tonne         |
| Lever arm about toe (along L-L axis)       | = | 0.575 m             | 0.575 m             |
| Moment $M_{TT}$                            | = | 79.0052 Tm          | 16.5598 Tm          |
| Lever arm about c/L base (along T-T axis)  | = | 2.91 m              | 2.91 m              |
| Moment $M_{LL}$                            | = | 399.83 Tm           | 83.81 Tm            |

| <b>Forces due to LL Longitudinal Forces, at Shaft Bottom:</b> |   |                   |
|---|---|-------------------|
| Longitudinal Force  | = | <b>45.8 Tonne</b> |
| Lever arm from footing base                                   | = | 19.220 m          |
| Moment in about transverse axis $M_{TT}$                      | = | <b>879.4 tm</b>   |

**Seismic Component of Permanent Load (DL+SIDL+SURFACING), at Shaft Bottom:**

| At Fixed End, Force about toe | V<br>T | $H_L$<br>T | $H_T$<br>T | ey<br>m | $e_L$<br>m | $M_{LL}$<br>Tm | $M_{TT}$<br>Tm |
|-------------------------------|--------|------------|------------|---------|------------|----------------|----------------|
| Seismic Longitudinal          |        | 36.9       |            | 19.220  |            |                | 709.9          |
| Seismic Transverse            |        |            | 70.1       | 21.454  |            | 1503.9         |                |
| Seismic Vertical              | 15.6   |            |            |         | 0.575      |                | 9.0            |

**Summery of LL seismic component transferred from super-structure, at Shaft Bottom:**

**Max Live Load Reaction Case :**

| At Fixed/ Free End   | V<br>T | $H_L$<br>T | $H_T$<br>T | ey<br>m | $e_L$<br>m | $M_{LL}$<br>Tm | $M_{TT}$<br>Tm |
|----------------------|--------|------------|------------|---------|------------|----------------|----------------|
| Seismic Longitudinal |        | 0.0        |            | 0.0     |            |                | 0.0            |
| Seismic Transverse   |        |            | 17.5       | 22.888  |            | 400.8          |                |
| Seismic Vertical     | 3.9    |            |            |         | 0.6        |                | 2.2            |



Min Live Load Reaction Case :

| At Fixed/ Free End   | V<br>T | H <sub>L</sub><br>T | H <sub>T</sub><br>T | ey<br>m | e <sub>L</sub><br>m | M <sub>LL</sub><br>Tm | M <sub>TT</sub><br>Tm |
|----------------------|--------|---------------------|---------------------|---------|---------------------|-----------------------|-----------------------|
| Seismic Longitudinal |        | 0.0                 |                     | 0.0     |                     |                       | 0.0                   |
| Seismic Transverse   |        |                     | 3.7                 | 22.888  |                     | 84.0                  |                       |
| Seismic Vertical     | 0.8    |                     |                     | 0.6     |                     |                       | 0.5                   |

**SEISMIC COMPONENT OF SUB-STRUCTURE :**

Longitudinal Horizontal seismic coefficient       $A_{hL}$       =      0.03358

Transverse Horizontal seismic coefficient       $A_{hT}$       =      0.12746

Vertical seismic coefficient       $A_v$       =      0.02832

**Sub-structure seismic component :**

Sub-structure seismic component:

|                 |       |     |     |    |   |                                      |
|-----------------|-------|-----|-----|----|---|--------------------------------------|
| Description     | W     | ey  | ex  | W  | = | Weight of sub-structure              |
|                 | Tonne | m   | m   | ey | = | Cg. above base slab in vertical dir. |
| Sub-structure = | 847.9 | 9.8 | 0.1 |    |   |                                      |

|                      |       |                |                |     |                |                 |                 |
|----------------------|-------|----------------|----------------|-----|----------------|-----------------|-----------------|
| Seismic Component    | V     | H <sub>L</sub> | H <sub>T</sub> | ey  | e <sub>L</sub> | M <sub>LL</sub> | M <sub>TT</sub> |
|                      | T     | T              | T              | m   | m              | Tm              | Tm              |
| Seismic Longitudinal | 28.5  |                |                | 9.8 |                | 278.2           |                 |
| Seismic Transverse   | 108.1 |                |                | 9.8 |                | 1056.0          |                 |
| Seismic Vertical     | 24.0  |                |                | 0.1 |                | 2.5             |                 |

**SUMMARY OF FORCES :**

| S.N.  | Description                          | Forces about toe |                |                |                 |                 |
|-------|--------------------------------------|------------------|----------------|----------------|-----------------|-----------------|
|       |                                      | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|       |                                      | Tonne            | Tonne          | Tonne          | Tm              | Tm              |
| 1)    | Sub-structure                        | 847.9            |                |                | 86.9            | 0.0             |
| 3)    | Super-structure DL                   | 398.9            |                |                | 229.4           | 0.0             |
| 4)    | SIDL (excluding surfacing)           | 117.0            |                |                | 67.3            | 0.0             |
| 5)    | Surfacing                            | 34.0             |                |                | 19.6            | -8.5            |
| 6.1)  | Live Load Vertical Load Max Reaction | 137.4            |                |                | 79.0            | 399.8           |
| 6.2)  | Live Load Vertical Load Min Reaction | 28.8             |                |                | 16.6            | 83.8            |
| 7)    | Live Load Horizontal Forces          |                  | 45.8           |                | 879.4           |                 |
| 9)    | Fluid Pressure                       |                  | 9.45603        |                | -5.7            |                 |
| 9.1)  | Earth Pressure LWL                   |                  |                |                |                 |                 |
|       | Horizontal Component                 |                  | 464.5          |                | 2327.7          |                 |
|       | Vertical Component                   | 191.7            |                |                | -153.3          |                 |
| 10.1) | Surcharge Pressure LWL               |                  | 103.0          |                | 604.2           |                 |

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LOAD COMBINATION  
FOR DESIGN OF PIER SHAFT

| LC-1  | NS, LWL, Span dislodge, FP | Forces about toe |                |                |                 |                 | LC-1 |
|-------|----------------------------|------------------|----------------|----------------|-----------------|-----------------|------|
| S.N.  | Description                | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |      |
|       |                            | Tonne            | Tonne          | Tonne          | Tm              | Tm              |      |
| 1)    | Sub-structure              | 847.86           |                |                | 86.901          | 0               | 1.35 |
| 9)    | Fluid Pressure             |                  | 9.456          |                | -5.711          |                 | 1.5  |
| 10.1) | Surcharge Pressure LWL     |                  | 102.96         |                | 604.17          |                 | 1.2  |

| S.N. | Description                | Forces at bottom of abutment shaft |                |                |                 |                 |
|------|----------------------------|------------------------------------|----------------|----------------|-----------------|-----------------|
|      |                            | V                                  | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|      |                            | Tonne                              | Tonne          | Tonne          | Tm              | Tm              |
| LC-1 | NS, LWL, Span dislodge, FP | 1144.6                             | 137.74         | 0              | 833.75          | 0               |

| LC-2  | NS, LWL, Span dislodge, EP | Forces about toe |                |                |                 |                 | LC-2 |
|-------|----------------------------|------------------|----------------|----------------|-----------------|-----------------|------|
| S.N.  | Description                | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |      |
|       |                            | Tonne            | Tonne          | Tonne          | Tm              | Tm              |      |
| 1)    | Sub-structure              | 847.86           |                |                | 86.901          | 0               | 1.35 |
| 9.1)  | Earth Pressure LWL         |                  |                |                |                 |                 | 1.5  |
|       | Horizontal Component       |                  | 464.51         |                | 2327.7          |                 | 1.5  |
| 10.1) | Surcharge Pressure LWL     |                  | 102.96         |                | 604.17          |                 | 1.2  |

| S.N. | Description                | Forces at bottom of abutment shaft |                |                |                 |                 |
|------|----------------------------|------------------------------------|----------------|----------------|-----------------|-----------------|
|      |                            | V                                  | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|      |                            | Tonne                              | Tonne          | Tonne          | Tm              | Tm              |
| LC-2 | NS, LWL, Span dislodge, EP | 1144.6                             | 820.33         | 0              | 4333.9          | 0               |

| LC-3 | NS, LWL, Min LL Lead, FP   | Forces about toe |                |                |                 |                 | LC-3 |
|------|----------------------------|------------------|----------------|----------------|-----------------|-----------------|------|
| S.N. | Description                | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |      |
|      |                            | Tonne            | Tonne          | Tonne          | Tm              | Tm              |      |
| 1)   | Sub-structure              | 847.86           |                |                | 86.901          | 0               | 1.35 |
| 3)   | Super-structure DL         | 398.95           |                |                | 229.4           | 0               | 1.35 |
| 4)   | SIDL (excluding surfacing) | 116.99           |                |                | 67.267          | 0               | 1.35 |
| 5)   | Surfacing                  | 34.025           |                |                | 19.564          | -8.506          | 1.75 |

|       |                                   |      |        |  |        |        |  |      |
|-------|-----------------------------------|------|--------|--|--------|--------|--|------|
| 6.2)  | Live Load Vertical Load Min React | 28.8 |        |  | 16.56  | 83.807 |  | 1.15 |
| 7)    | Live Load Horizontal Forces       |      | 45.753 |  | 879.37 |        |  | 1.15 |
| 9)    | Fluid Pressure                    |      | 9.456  |  | -5.711 |        |  | 1.5  |
| 10.1) | Surcharge Pressure LWL            |      | 102.96 |  | 604.17 |        |  | 1.2  |

| S.N. | Description              | Forces at bottom of abutment shaft |                |                |                 |                 |
|------|--------------------------|------------------------------------|----------------|----------------|-----------------|-----------------|
|      |                          | V                                  | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|      |                          | Tonne                              | Tonne          | Tonne          | Tm              | Tm              |
| LC-3 | NS, LWL, Min LL Lead, FP | 1933.8                             | 190.36         | 0              | 2298.8          | 81.492          |

| LC-4  | NS, LWL, Min LL Lead, EP          | Forces about toe |                |                |                 |                 |  | LC-4 |
|-------|-----------------------------------|------------------|----------------|----------------|-----------------|-----------------|--|------|
| S.N.  | Description                       | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |  |      |
|       |                                   | Tonne            | Tonne          | Tonne          | Tm              | Tm              |  |      |
| 1)    | Sub-structure                     | 847.86           |                |                | 86.901          | 0               |  | 1.35 |
| 3)    | Super-structure DL                | 398.95           |                |                | 229.4           | 0               |  | 1.35 |
| 4)    | SIDL (excluding surfacing)        | 116.99           |                |                | 67.267          | 0               |  | 1.35 |
| 5)    | Surfacing                         | 34.025           |                |                | 19.564          | -8.506          |  | 1.75 |
| 6.2)  | Live Load Vertical Load Min React | 28.8             |                |                | 16.56           | 83.807          |  | 1.15 |
| 7)    | Live Load Horizontal Forces       |                  | 45.753         |                | 879.37          |                 |  | 1.15 |
| 9.1)  | Earth Pressure LWL                |                  |                |                |                 |                 |  | 1.5  |
|       | Horizontal Component              |                  | 464.51         |                | 2327.7          |                 |  | 1.5  |
| 10.1) | Surcharge Pressure LWL            |                  | 102.96         |                | 604.17          |                 |  | 1.2  |

| S.N. | Description              | Forces at bottom of abutment shaft |                |                |                 |                 |
|------|--------------------------|------------------------------------|----------------|----------------|-----------------|-----------------|
|      |                          | V                                  | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|      |                          | Tonne                              | Tonne          | Tonne          | Tm              | Tm              |
| LC-4 | NS, LWL, Min LL Lead, EP | 1933.8                             | 872.94         | 0              | 5799            | 81.492          |

| LC-5 | NS, LWL, Max LL, FP               | Forces about toe |                |                |                 |                 |  | LC-5 |
|------|-----------------------------------|------------------|----------------|----------------|-----------------|-----------------|--|------|
| S.N. | Description                       | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |  |      |
|      |                                   | Tonne            | Tonne          | Tonne          | Tm              | Tm              |  |      |
| 1)   | Sub-structure                     | 847.86           |                |                | 86.901          | 0               |  | 1.35 |
| 3)   | Super-structure DL                | 398.95           |                |                | 229.4           | 0               |  | 1.35 |
| 4)   | SIDL (excluding surfacing)        | 116.99           |                |                | 67.267          | 0               |  | 1.35 |
| 5)   | Surfacing                         | 34.025           |                |                | 19.564          | -8.506          |  | 1.75 |
| 6.1) | Live Load Vertical Load Max React | 137.4            |                |                | 79.005          | 399.83          |  | 1.5  |
| 7)   | Live Load Horizontal Forces       |                  | 45.753         |                | 879.37          |                 |  | 1.5  |
| 9)   | Fluid Pressure                    |                  | 9.456          |                | -5.711          |                 |  | 1    |

|       |                        |  |        |  |        |  |     |
|-------|------------------------|--|--------|--|--------|--|-----|
| 10.1) | Surcharge Pressure LWL |  | 102.96 |  | 604.17 |  | 1.2 |
|-------|------------------------|--|--------|--|--------|--|-----|

| S.N. | Description         | Forces at bottom of abutment shaft |                |                |                 |                 |
|------|---------------------|------------------------------------|----------------|----------------|-----------------|-----------------|
|      |                     | V                                  | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|      |                     | Tonne                              | Tonne          | Tonne          | Tm              | Tm              |
| LC-5 | NS, LWL, Max LL, FP | 2106.8                             | 201.64         | 0              | 2708.9          | 584.87          |

|       |                                  |                  |                |                |                 |                 |      |
|-------|----------------------------------|------------------|----------------|----------------|-----------------|-----------------|------|
| LC-6  | NS, LWL, Max LL, EP              | Forces about toe |                |                |                 |                 | LC-6 |
| S.N.  | Description                      | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |      |
|       |                                  | Tonne            | Tonne          | Tonne          | Tm              | Tm              |      |
| 1)    | Sub-structure                    | 847.86           |                |                | 86.901          | 0               | 1.35 |
| 3)    | Super-structure DL               | 398.95           |                |                | 229.4           | 0               | 1.35 |
| 4)    | SIDL (excluding surfacing)       | 116.99           |                |                | 67.267          | 0               | 1.35 |
| 5)    | Surfacing                        | 34.025           |                |                | 19.564          | -8.506          | 1.75 |
| 6.1)  | Live Load Vertical Load Max Reac | 137.4            |                |                | 79.005          | 399.83          | 1.5  |
| 7)    | Live Load Horizontal Forces      |                  | 45.753         |                | 879.37          |                 | 1.5  |
| 9.1)  | Earth Pressure LWL               |                  |                |                |                 |                 | 1    |
|       | Horizontal Component             |                  | 464.51         |                | 2327.7          |                 | 1    |
| 10.1) | Surcharge Pressure LWL           |                  | 102.96         |                | 604.17          |                 | 1.2  |

| S.N. | Description         | Forces at bottom of abutment shaft |                |                |                 |                 |
|------|---------------------|------------------------------------|----------------|----------------|-----------------|-----------------|
|      |                     | V                                  | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|      |                     | Tonne                              | Tonne          | Tonne          | Tm              | Tm              |
| LC-6 | NS, LWL, Max LL, EP | 2106.8                             | 656.7          | 0              | 5042.3          | 584.87          |

|                             |   |                  |                |                |                 |                 |      |
|-----------------------------|---|------------------|----------------|----------------|-----------------|-----------------|------|
| LC-7                        | SIS,LWL, Span dislodge ,Seismic S         | Forces about toe |                |                |                 |                 | LC-7 |
| S.N.                        | Description                               | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |      |
|                             |   | Tonne            | Tonne          | Tonne          | Tm              | Tm              |      |
| 1)                          | Sub-structure                             | 847.86           |                |                | 86.901          | 0               | 1.35 |
| 9.1)                        | Earth Pressure LWL                        |                  |                |                |                 |                 | 1    |
|                             | Horizontal Component                      |                  | 464.51         |                | 2327.7          |                 | 1    |
| 10.1)                       | Surcharge Pressure LWL                    |                  | 102.96         |                | 604.17          |                 | 0.2  |
| <b>Seismic Longitudinal</b> |   |                  |                |                |                 |                 | 0.75 |
| 11)                         | Sub-structure Component                   |                  | 28.47          |                | 278.19          |                 | 0.75 |
| 12)                         | Backfill                                  |                  | 109.43         |                | 1582.2          |                 | 0.75 |
| 12)                         | Super-Structure DL, SIDL, & Surfacing Cor |                  | 36.934         |                | 709.88          |                 | 0.75 |
| 13)                         | Dynamic Earth Pressure                    |                  |                |                |                 |                 | 0.75 |
|                             | Horizontal Component                      |                  | 0              |                | 0               |                 | 0.75 |

|                                  |   |        |   |        |        |        |       |
|----------------------------------|---|--------|---|--------|--------|--------|-------|
| 14)                              | Dynamic Surcharge Pressure                      |        |   |        |        |        | 0.15  |
|                                  | 14.1) LWL Seismic Downward                      |        | 0 |        | 0      |        | 0.15  |
| <b>Seismic Transverses</b>       |   |        |   |        |        |        | 0.225 |
| 15)                              | Sub-structure Component                         |        |   | 108.07 |        | 1056   | 0.225 |
| 17)                              | Super-Structure DL, SIDL, & Surfacing Component |        |   | 70.099 |        | 1503.9 | 0.225 |
| <b>Seismic Vertical Downward</b> |   |        |   |        |        |        | 0.225 |
| 19)                              | Sub-structure Component                         | 24.016 |   |        | 2.4615 |        | 0.225 |
| 21)                              | Super-Structure DL, SIDL, & Surf                | 15.578 |   |        | 8.9571 |        | 0.225 |

| S.N. | Description                       | Forces at bottom of abutment shaft |                |                |                 |                 |
|------|-----------------------------------|------------------------------------|----------------|----------------|-----------------|-----------------|
|      |                                   | V                                  | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|      |                                   | Tonne                              | Tonne          | Tonne          | Tm              | Tm              |
| LC-7 | SIS,LWL, Span dislodge ,Seismic S | 1153.5                             | 616.23         | 40.088         | 4496.1          | 575.97          |

|                                  |   |                  |                |                |                 |                 |        |
|----------------------------------|---|------------------|----------------|----------------|-----------------|-----------------|--------|
| LC-8                             | SIS, LWL,Span dislodge ,Seismic S               | Forces about toe |                |                |                 |                 | LC-8   |
| S.N.                             | Description                                     | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |        |
|                                  |   | Tonne            | Tonne          | Tonne          | Tm              | Tm              |        |
| 1)                               | Sub-structure                                   | 847.86           |                |                | 86.901          | 0               | 1.35   |
| 9.1)                             | Earth Pressure LWL                              |                  |                |                |                 |                 | 1      |
|                                  | Horizontal Component                            |                  | 464.51         |                | 2327.7          |                 | 1      |
| 10.1)                            | Surcharge Pressure LWL                          |                  | 102.96         |                | 604.17          |                 | 0.2    |
| <b>Seismic Longitudinal</b>      |   |                  |                |                |                 |                 | 0.75   |
| 11)                              | Sub-structure Component                         |                  | 28.47          |                | 278.19          |                 | 0.75   |
| 12)                              | Backfill  |                  | 109.43         |                | 1582.2          |                 | 0.75   |
| 12)                              | Super-Structure DL, SIDL, & Surfacing Co        |                  | 36.934         |                | 709.88          |                 | 0.75   |
| 13)                              | Dynamic Earth Pressure                          |                  |                |                |                 |                 | 0.75   |
|                                  | Horizontal Component                            |                  | 0              |                | 0               |                 | 0.75   |
| 14)                              | Dynamic Surcharge Pressure                      |                  |                |                |                 |                 | 0.15   |
|                                  | 14.2) LWL Seismic Upward                        |                  | 0              |                | 0               |                 | 0.15   |
| <b>Seismic Transverses</b>       |   |                  |                |                |                 |                 | 0.225  |
| 15)                              | Sub-structure Component                         |                  |                | 108.07         |                 | 1056            | 0.225  |
| 17)                              | Super-Structure DL, SIDL, & Surfacing Component |                  |                | 70.099         |                 | 1503.9          | 0.225  |
| <b>Seismic Vertical Downward</b> |   |                  |                |                |                 |                 | 0.225  |
| 19)                              | Sub-structure Component                         | 24.016           |                |                | 2.4615          |                 | -0.225 |
| 21)                              | Super-Structure DL, SIDL, & Surf                | 15.578           |                |                | 8.9571          |                 | -0.225 |

| S.N. | Description                       | Forces at bottom of abutment shaft |                |                |                 |                 |
|------|-----------------------------------|------------------------------------|----------------|----------------|-----------------|-----------------|
|      |                                   | V                                  | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|      |                                   | Tonne                              | Tonne          | Tonne          | Tm              | Tm              |
| LC-8 | SIS, LWL,Span dislodge ,Seismic S | 1135.7                             | 616.23         | 40.088         | 4491            | 575.97          |

|  |  |  |  |  |  |  |
|--|--|--|--|--|--|--|
|  |  |  |  |  |  |  |
|--|--|--|--|--|--|--|

| LC-9                             | SIS,LWL,Min LL Acc,Seismic Sx=                  | Forces about toe |                |                |                 |                 | LC-9 |
|----------------------------------|---|------------------|----------------|----------------|-----------------|-----------------|------|
| S.N.                             | Description                                     | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |      |
|                                  |   | Tonne            | Tonne          | Tonne          | Tm              | Tm              |      |
| 1)                               | Sub-structure                                   | 847.86           |                |                | 86.901          | 0               | 1.35 |
| 3)                               | Super-structure DL                              | 398.95           |                |                | 229.4           | 0               | 1.35 |
| 4)                               | SIDL (excluding surfacing)                      | 116.99           |                |                | 67.267          | 0               | 1.35 |
| 5)                               | Surfacing                                       | 34.025           |                |                | 19.564          | -8.506          | 1.35 |
| 6.2)                             | Live Load Vertical Load Min React               | 28.8             |                |                | 16.56           | 83.807          | 0.2  |
| 7)                               | Live Load Horizontal Forces                     |                  | 45.753         |                | 879.37          |                 | 0.2  |
| 9.1)                             | Earth Pressure LWL                              |                  |                |                |                 |                 | 1    |
|                                  | Horizontal Component                            |                  | 464.51         |                | 2327.7          |                 | 1    |
| 10.1)                            | Surcharge Pressure LWL                          |                  | 102.96         |                | 604.17          |                 | 0.2  |
| <b>Seismic Longitudinal</b>      |   |                  |                |                |                 |                 | 1.5  |
| 11)                              | Sub-structure Component                         |                  | 28.47          |                | 278.19          |                 | 1.5  |
| 12)                              | Backfill  |                  | 109.43         |                | 1582.2          |                 | 1.5  |
| 12)                              | Super-Structure DL, SIDL, & Surfacing Component |                  | 36.934         |                | 709.88          |                 | 1.5  |
| 13)                              | Dynamic Earth Pressure                          |                  |                |                |                 |                 | 1.5  |
|                                  | Horizontal Component                            |                  | 0              |                | 0               |                 | 1.5  |
| 14)                              | Dynamic Surcharge Pressure                      |                  |                |                |                 |                 | 0.3  |
|                                  | 14.1) LWL Seismic Downward                      |                  | 0              |                | 0               |                 | 0.3  |
| <b>Seismic Transverses</b>       |   |                  |                |                |                 |                 | 0.45 |
| 15)                              | Sub-structure Component                         |                  |                | 108.07         |                 | 1056            | 0.45 |
| 17)                              | Super-Structure DL, SIDL, & Surfacing Component |                  |                | 70.099         |                 | 1503.9          | 0.45 |
| 18.2)                            | Live Load Component (Min. Reaction)             |                  |                | 3.6709         |                 | 84.019          | 0.09 |
| <b>Seismic Vertical Downward</b> |   |                  |                |                |                 |                 | 0.45 |
| 19)                              | Sub-structure Component                         | 24.016           |                |                | 2.4615          |                 | 0.45 |
| 21)                              | Super-Structure DL, SIDL, & Surfacing Component | 15.578           |                |                | 8.9571          |                 | 0.45 |
| 22.2)                            | Live Load Component (Min. Reaction)             | 0.8157           |                |                | 0.4691          |                 | 0.09 |

| S.N. | Description                    | Forces at bottom of abutment shaft |                |                |                 |                 |
|------|--------------------------------|------------------------------------|----------------|----------------|-----------------|-----------------|
|      |                                | V                                  | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|      |                                | Tonne                              | Tonne          | Tonne          | Tm              | Tm              |
| LC-9 | SIS,LWL,Min LL Acc,Seismic Sx= | 1910.7                             | 756.51         | 80.507         | 7032.5          | 1164.8          |

| LC-10 | SIS, LWL,Min LL Acc,Seismic Sx= | Forces about toe |                |                |                 |                 | LC-10 |
|-------|---------------------------------|------------------|----------------|----------------|-----------------|-----------------|-------|
| S.N.  | Description                     | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |       |
|       |                                 | Tonne            | Tonne          | Tonne          | Tm              | Tm              |       |
| 1)    | Sub-structure                   | 847.86           |                |                | 86.901          | 0               | 1.35  |
| 3)    | Super-structure DL              | 398.95           |                |                | 229.4           | 0               | 1.35  |
| 4)    | SIDL (excluding surfacing)      | 116.99           |                |                | 67.267          | 0               | 1.35  |

|                                  |   |        |        |        |        |        |  |       |
|----------------------------------|---|--------|--------|--------|--------|--------|--|-------|
| 5)                               | Surfacing                                       | 34.025 |        |        | 19.564 | -8.506 |  | 1.35  |
| 6.2)                             | Live Load Vertical Load Min Reaction            | 28.8   |        |        | 16.56  | 83.807 |  | 0.2   |
| 7)                               | Live Load Horizontal Forces                     |        | 45.753 |        | 879.37 |        |  | 0.2   |
| 9.1)                             | Earth Pressure LWL                              |        |        |        |        |        |  | 1     |
|                                  | Horizontal Component                            |        | 464.51 |        | 2327.7 |        |  | 1     |
| 10.1)                            | Surcharge Pressure LWL                          |        | 102.96 |        | 604.17 |        |  | 0.2   |
| <b>Seismic Longitudinal</b>      |   |        |        |        |        |        |  | 1.5   |
| 11)                              | Sub-structure Component                         |        | 28.47  |        | 278.19 |        |  | 1.5   |
| 12)                              | Backfill  |        | 109.43 |        | 1582.2 |        |  | 1.5   |
| 12)                              | Super-Structure DL, SIDL, & Surfacing Component |        | 36.934 |        | 709.88 |        |  | 1.5   |
| 13)                              | Dynamic Earth Pressure                          |        |        |        |        |        |  | 1.5   |
|                                  | Horizontal Component                            |        | 0      |        | 0      |        |  | 1.5   |
| 14)                              | Dynamic Surcharge Pressure                      |        |        |        |        |        |  | 0.3   |
|                                  | 14.2) LWL Seismic Upward                        |        | 0      |        | 0      |        |  | 0.3   |
| <b>Seismic Transverses</b>       |   |        |        |        |        |        |  | 0.45  |
| 15)                              | Sub-structure Component                         |        |        | 108.07 |        | 1056   |  | 0.45  |
| 17)                              | Super-Structure DL, SIDL, & Surfacing Component |        |        | 70.099 |        | 1503.9 |  | 0.45  |
| 18.2)                            | Live Load Component (Min. Reaction)             |        |        | 3.6709 |        | 84.019 |  | 0.09  |
| <b>Seismic Vertical Downward</b> |   |        |        |        |        |        |  | 0.45  |
| 19)                              | Sub-structure Component                         | 24.016 |        |        | 2.4615 |        |  | -0.45 |
| 21)                              | Super-Structure DL, SIDL, & Surfacing Component | 15.578 |        |        | 8.9571 |        |  | -0.45 |
| 22.2)                            | Live Load Component (Min. Reaction)             | 0.8157 |        |        | 0.4691 |        |  | -0.09 |

| S.N.  | Description                                    | Forces at bottom of abutment shaft |                |                |                 |                 |
|-------|--|------------------------------------|----------------|----------------|-----------------|-----------------|
|       |  | V                                  | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|       |  | Tonne                              | Tonne          | Tonne          | Tm              | Tm              |
| LC-10 | SIS, LWL, Min LL Acc, Seismic S <sub>x</sub> = | 1874.9                             | 756.51         | 80.507         | 7022.2          | 1164.8          |

| S.N.                        | Description                          | Forces about toe |                |                |                 |                 | LC-11 |
|-----------------------------|--------------------------------------|------------------|----------------|----------------|-----------------|-----------------|-------|
|                             |                                      | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |       |
|                             |                                      | Tonne            | Tonne          | Tonne          | Tm              | Tm              |       |
| 1)                          | Sub-structure                        | 847.86           |                |                | 86.901          | 0               | 1.35  |
| 3)                          | Super-structure DL                   | 398.95           |                |                | 229.4           | 0               | 1.35  |
| 4)                          | SIDL (excluding surfacing)           | 116.99           |                |                | 67.267          | 0               | 1.35  |
| 5)                          | Surfacing                            | 34.025           |                |                | 19.564          | -8.506          | 1.35  |
| 6.1)                        | Live Load Vertical Load Max Reaction | 137.4            |                |                | 79.005          | 399.83          | 0.2   |
| 7)                          | Live Load Horizontal Forces          |                  | 45.753         |                | 879.37          |                 | 0.2   |
| 9.1)                        | Earth Pressure LWL                   |                  |                |                |                 |                 | 1     |
|                             | Horizontal Component                 |                  | 464.51         |                | 2327.7          |                 | 1     |
| 10.1)                       | Surcharge Pressure LWL               |                  | 102.96         |                | 604.17          |                 | 0.2   |
| <b>Seismic Longitudinal</b> |                                      |                  |                |                |                 |                 | 1.5   |
| 11)                         | Sub-structure Component              |                  | 28.47          |                | 278.19          |                 | 1.5   |
| 12)                         | Backfill                             |                  | 109.43         |                | 1582.2          |                 | 1.5   |



|                                  |   |        |        |        |        |      |
|----------------------------------|---|--------|--------|--------|--------|------|
| 12)                              | Super-Structure DL, SIDL, & Surfacing Component | 36.934 |        | 709.88 |        | 1.5  |
| 13)                              | Dynamic Earth Pressure                          |        |        |        |        | 1.5  |
|                                  | Horizontal Component                            | 0      |        | 0      |        | 1.5  |
| 14)                              | Dynamic Surcharge Pressure                      |        |        |        |        | 0.3  |
|                                  | 14.1) LWL Seismic Downward                      | 0      |        | 0      |        | 0.3  |
| <b>Seismic Transverses</b>       |   |        |        |        |        | 0.45 |
| 15)                              | Sub-structure Component                         |        | 108.07 |        | 1056   | 0.45 |
| 17)                              | Super-Structure DL, SIDL, & Surfacing Component |        | 70.099 |        | 1503.9 | 0.45 |
| 18.1)                            | Live Load Component (Max. Reaction)             |        | 17.513 |        | 400.84 | 0.09 |
| <b>Seismic Vertical Downward</b> |   |        |        |        |        | 0.45 |
| 19)                              | Sub-structure Component                         | 24.016 |        | 2.4615 |        | 0.45 |
| 21)                              | Super-Structure DL, SIDL, & Surfacing Component | 15.578 |        | 8.9571 |        | 0.45 |
| 22.1)                            | Live Load Component (Max. Reaction)             | 3.8918 |        | 2.2378 |        | 0.09 |

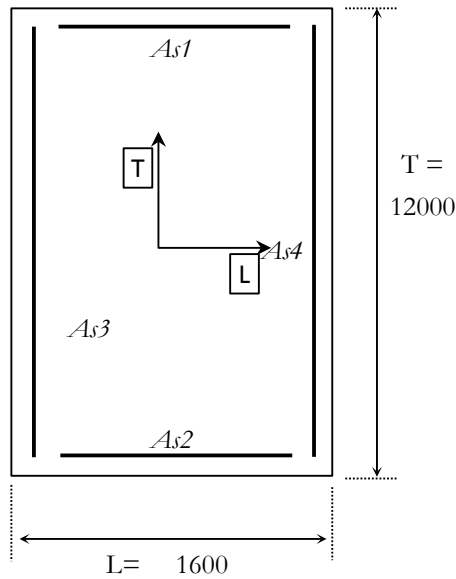
| S.N.  | Description                    | Forces at bottom of abutment shaft |                |                |                 |                 |
|-------|--------------------------------|------------------------------------|----------------|----------------|-----------------|-----------------|
|       |                                | V                                  | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|       |                                | Tonne                              | Tonne          | Tonne          | Tm              | Tm              |
| LC-11 | SIS,LWL,Max LL,Seismic Sx=1,Sz | 1932.7                             | 756.51         | 81.752         | 7045.2          | 1256.5          |

| LC-12                       | SIS, LWL,Max LL,Seismic Sx=1,Sz                 | Forces about toe |                |                |                 |                 | LC-12 |
|-----------------------------|---|------------------|----------------|----------------|-----------------|-----------------|-------|
| S.N.                        | Description                                     | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |       |
|                             |   | Tonne            | Tonne          | Tonne          | Tm              | Tm              |       |
| 1)                          | Sub-structure                                   | 847.86           |                |                | 86.901          | 0               | 1.35  |
| 3)                          | Super-structure DL                              | 398.95           |                |                | 229.4           | 0               | 1.35  |
| 4)                          | SIDL (excluding surfacing)                      | 116.99           |                |                | 67.267          | 0               | 1.35  |
| 5)                          | Surfacing                                       | 34.025           |                |                | 19.564          | -8.506          | 1.35  |
| 6.1)                        | Live Load Vertical Load Max Reaction            | 137.4            |                |                | 79.005          | 399.83          | 0.2   |
| 7)                          | Live Load Horizontal Forces                     |                  | 45.753         |                | 879.37          |                 | 0.2   |
| 9.1)                        | Earth Pressure LWL                              |                  |                |                |                 |                 | 1     |
|                             | Horizontal Component                            |                  | 464.51         |                | 2327.7          |                 | 1     |
| 10.1)                       | Surcharge Pressure LWL                          |                  | 102.96         |                | 604.17          |                 | 0.2   |
| <b>Seismic Longitudinal</b> |   |                  |                |                |                 |                 | 1.5   |
| 11)                         | Sub-structure Component                         |                  | 28.47          |                | 278.19          |                 | 1.5   |
| 12)                         | Backfill  |                  | 109.43         |                | 1582.2          |                 | 1.5   |
| 12)                         | Super-Structure DL, SIDL, & Surfacing Component |                  | 36.934         |                | 709.88          |                 | 1.5   |
| 13)                         | Dynamic Earth Pressure                          |                  |                |                |                 |                 | 1.5   |
|                             | Horizontal Component                            |                  | 0              |                | 0               |                 | 1.5   |
| 14)                         | Dynamic Surcharge Pressure                      |                  |                |                |                 |                 | 0.3   |
|                             | 14.2) LWL Seismic Upward                        |                  | 0              |                | 0               |                 | 0.3   |
| <b>Seismic Transverses</b>  |   |                  |                |                |                 |                 | 0.45  |
| 15)                         | Sub-structure Component                         |                  |                | 108.07         |                 | 1056            | 0.45  |
| 17)                         | Super-Structure DL, SIDL, & Surfacing Component |                  |                | 70.099         |                 | 1503.9          | 0.45  |
| 18.1)                       | Live Load Component (Max. Reaction)             |                  |                | 17.513         |                 | 400.84          | 0.09  |

|                                  |                                  |        |  |  |        |       |
|----------------------------------|----------------------------------|--------|--|--|--------|-------|
| <b>Seismic Vertical Downward</b> |                                  |        |  |  |        | 0.45  |
| 19)                              | Sub-structure Component          | 24.016 |  |  | 2.4615 | -0.45 |
| 21)                              | Super-Structure DL, SIDL, & Surf | 15.578 |  |  | 8.9571 | -0.45 |
| 22.1)                            | Live Load Component (Max. React  | 3.8918 |  |  | 2.2378 | -0.09 |

| S.N.  | Description  | Forces at bottom of abutment shaft |                |                |                 |                 |
|-------|--|------------------------------------|----------------|----------------|-----------------|-----------------|
|       |  | V                                  | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|       |  | Tonne                              | Tonne          | Tonne          | Tm              | Tm              |
| LC-12 | SIS, LWL,Max LL,Seismic S <sub>x</sub> =1,S <sub>y</sub> | 1896.4                             | 756.51         | 81.752         | 7034.5          | 1256.5          |

**ULS CHECK FOR ABUTMENT SHAFT :**



**Check For Biaxial Bending Moment**

$$N_{RD} = A_c f_{cd} + A_s f_{yd}$$

$$= 47543.6 \text{ Tonne}$$

$$\left( \frac{M_{EDT}}{M_{EDT}} \right)^\alpha + \left( \frac{M_{EDL}}{M_{RDL}} \right)^\alpha \leq 1$$

$$f_{ck} = 45 \text{ Mpa}$$

$$f_{cd} = 20.1 \text{ Mpa}$$

$$f_{yd} = 434.8 \text{ Mpa}$$

$$A_c = 19200000 \text{ mm}^2$$

$$A_s = 205887 \text{ mm}^2$$

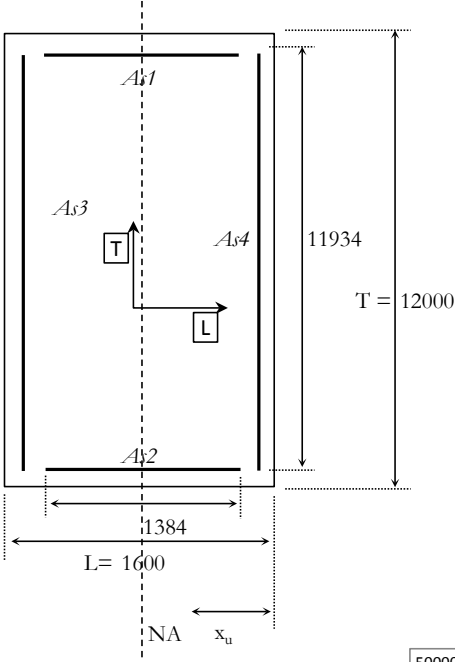
**ULS CHECK FOR ABUTMENT SHAFT :**

| S.N.  | Description                                      | Forces at bottom of abutment shaft |          |         |           |           | CHECK FOR MOMENT CAPACITY |          |           |           |   |
|-------|--|------------------------------------|----------|---------|-----------|-----------|---------------------------|----------|-----------|-----------|---|
|       |  | $N_{ED}$                           | $H_L$    | $H_T$   | $M_{ETT}$ | $M_{ELL}$ | $N_{ED}/N_{RD}$           | $\alpha$ | $M_{RIT}$ | $M_{RLL}$ | $(M_{EDT}/M_{RDT})^\alpha + (M_{EDL}/M_{RDL})^\alpha$ |
|       |  | Tonne                              | Tonne    | Tonne   | Tm        | Tm        |                           |          | Tm        | Tm        | Check   |
| LC-1  | NS, LWL, Span dislodge, FP                       | 1144.61                            | 137.7394 | 0       | 833.754   | 0         |                           |          |           |           |   |
| LC-2  | NS, LWL, Span dislodge, EP                       | 1144.61                            | 820.3259 | 0       | 4333.91   | 0         | 0.0                       | 1        | 8740.9    | 49815.8   | 0.50 OK   |
| LC-4  | NS, LWL, Min LL Lead, EP                         | 1933.79                            | 872.9419 | 0       | 5798.96   | 81.4922   | 0.0                       | 1        | 9290.2    | 51890.5   | 0.63 OK   |
| LC-6  | NS, LWL, Max LL, EP                              | 2106.77                            | 656.6986 | 0       | 5042.35   | 584.866   | 0.0                       | 1        | 9410.6    | 52345.2   | 0.55 OK   |
|       |  |                                    |          |         |           |           |                           |          |           |           |   |
| LC-7  | SIS,LWL, Span dislodge ,Seismic $S_x=1, S_z=0.3$ | 1153.52                            | 616.2309 | 40.0881 | 4496.13   | 575.966   | 0.0                       | 1        | 8747.1    | 49839.2   | 0.53 OK   |
| LC-8  | SIS, LWL,Span dislodge ,Seismic $S_x=1, S_z=0.3$ | 1135.71                            | 616.2309 | 40.0881 | 4491      | 575.966   | 0.0                       | 1        | 8734.7    | 49792.4   | 0.53 OK   |
| LC-9  | SIS,LWL,Min LL Acc,Seismic $S_x=1, S_z=0.3$      | 1910.71                            | 756.5061 | 80.5065 | 7032.53   | 1164.77   | 0.0                       | 1        | 9274.2    | 51829.8   | 0.78 OK   |
| LC-10 | SIS, LWL,Min LL Acc,Seismic $S_x=1, S_z=0.3$     | 1874.93                            | 756.5061 | 80.5065 | 7022.17   | 1164.77   | 0.0                       | 1        | 9249.3    | 51735.7   | 0.78 OK   |
| LC-11 | SIS,LWL,Max LL,Seismic $S_x=1, S_z=0.3$          | 1932.71                            | 756.5061 | 81.7524 | 7045.18   | 1256.49   | 0.0                       | 1        | 9289.5    | 51887.6   | 0.78 OK   |

|       |                                     |         |          |         |        |         |     |   |        |         |      |    |
|-------|-------------------------------------|---------|----------|---------|--------|---------|-----|---|--------|---------|------|----|
| LC-12 | SIS, LWL,Max LL,Seismic Sx=1,Sz=0.3 | 1896.37 | 756.5061 | 81.7524 | 7034.5 | 1256.49 | 0.0 | 1 | 9264.2 | 51792.1 | 0.78 | OK |
|-------|-------------------------------------|---------|----------|---------|--------|---------|-----|---|--------|---------|------|----|

INTERACTION DIAGRAM : (P : M<sub>TT</sub>)

SECTION AT SHAFT BOTTOM



| xu/D  | Pu      | Mu      |
|-------|---------|---------|
|       | T       | Tm      |
| 1E-09 | -8956.1 | 1710.34 |
| 0.2   | 2906.67 | 9967.41 |
| 0.4   | 9436.52 | 12541.7 |
| 0.6   | 16694.2 | 12862   |
| 0.8   | 26552.3 | 9662.91 |
| 1     | 34964.6 | 5807.74 |
| 1.2   | 39378.3 | 3177.69 |
| 1.4   | 41525   | 1886.24 |
| 1.6   | 42756.7 | 1139.18 |
| 1.8   | 43541   | 659.456 |
| 2     | 44078.5 | 328.665 |

Section Dimensions:

|   |   |       |    |
|---|---|-------|----|
| D | = | 1600  | mm |
| B | = | 12000 | mm |

Material Properties:

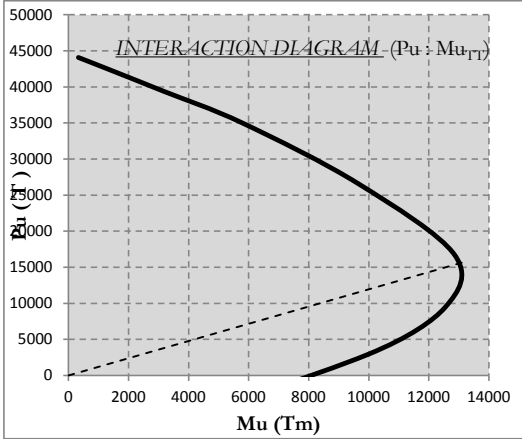
|     |   |        |                   |
|-----|---|--------|-------------------|
| fck | = | 45     | N/mm <sup>2</sup> |
| fyk | = | 500    | N/mm <sup>2</sup> |
| Es  | = | 200000 | N/mm <sup>2</sup> |

Reinforcement Details:

| Reinf.                                | Dia | Spacing | Cover | From | To    | Y_Cg  | Nos. | Spacing | Remark  |
|---------------------------------------|-----|---------|-------|------|-------|-------|------|---------|---------|
|                                       | mm  | mm      | mm    | m    | m     | m     |      |         |         |
| REINFORCEMENT ACROSS AXIS OF BENDING: |     |         |       |      |       |       |      |         |         |
| As1                                   | 32  | 150     | 50    | 305  | 1384  | 5934  | 8    | 154     |         |
| As2                                   | 32  | 150     | 50    | 305  | 1384  | -5934 | 8    | 154     |         |
| REINFORCEMENT ALONG AXIS OF BENDING:  |     |         |       |      |       |       |      |         |         |
| As3                                   | 32  | 150     | 75    | 66   | 11934 | -709  | 80   | 150     | LAYER-2 |
|                                       | 32  | 150     | 139   | 66   | 11934 | -645  | 80   | 150     |         |
| As4                                   | 32  | 150     | 50    | 66   | 11934 | 734   | 80   | 150     |         |

|                              |   |         |                 |
|------------------------------|---|---------|-----------------|
| As tension face (Length)     | = | 128680  | mm <sup>2</sup> |
| As Compression face (Length) | = | 64339.8 | mm <sup>2</sup> |
| As tension face (width)      | = | 6433.98 | mm <sup>2</sup> |
| As Compression face (width)  | = | 6433.98 | mm <sup>2</sup> |
| Total As                     | = | 205887  | mm <sup>2</sup> |
|                              | = | 1.07    | %               |

|                 |            |
|-----------------|------------|
| Balance Failure |            |
| d1              | 1509 mm    |
| xu              | 931.481 mm |
| xu/D            | 0.58218    |
| Pu              | 15693.4 T  |
| Mu              | 13145.3 Tm |



**Formula Used In Construction of Intraction Diagram :**

$$P_u = C_c + C_s$$

$$M_u = M_c + M_s$$

$$C_c = \begin{cases} 0.361 * f_{ck} * x_u * b & x_u \leq D \\ 0.447 * f_{ck} * (1 - 4 * g / 21) * b * D & x_u > D \end{cases}$$

$$g = 16 / (7 x_u / D - 3)^2$$

$$C_s = \Sigma (f_{si} - f_{ci}) A_{si}$$

$$f_{ci} = \begin{cases} 0 & \epsilon_{si} \leq 0 \\ 0.447 f_{ck} & \epsilon_{si} \geq 0.002 \\ 0.447 f_{ck} [2 * (\epsilon_{si} / 0.002) - (\epsilon_{si} / 0.002)^2] & \text{otherwise} \end{cases}$$

$$f_{si} = \begin{cases} -0.87 f_y & \epsilon_{si} \leq -0.00217 \\ \epsilon_{si} * E_s & \epsilon_{si} > -0.00217 \\ 0.87 f_y & \epsilon_{si} > 0.00217 \end{cases} \quad \epsilon_{si} \leq 0.00217$$

$$M_c = C_c * (0.5D - x)$$

$$M_s = \Sigma C_{si} * y_i$$

$$x = \begin{cases} 0.416 x_u & x_u \leq D \\ (0.5 - 8 * g / 49) * \{D / (1 - 4 * g / 21)\} & x_u > D \end{cases}$$

$$x = \text{Centroid of stress blok area from most compressed edge}$$

$$\epsilon_{si} = \begin{cases} 0.0035 * \left[ \frac{x_u - D / 2 + y_i}{x_u} \right] & x_u \leq D \\ 0.002 * \left[ 1 + \frac{y_i - D / 14}{x_u - 3D / 7} \right] & x_u > D \end{cases}$$

| Pu      | Mu      |
|---------|---------|
| T       | Tm      |
| 1144.61 | 833.754 |
| 1144.61 | 4333.91 |
| 1933.79 | 2298.81 |
| 1933.79 | 5798.96 |
| 2106.77 | 5042.35 |
| 0       | 0       |
| 1153.52 | 4496.13 |
| 1135.71 | 4491    |

**Reinforcement in Transverse Direction :**

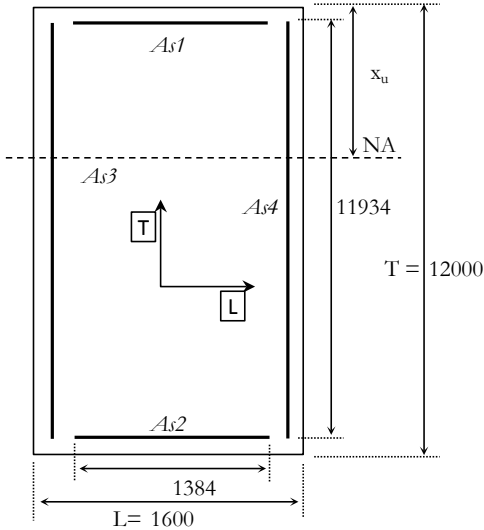
Total vertical reinf. = 205887 mm<sup>2</sup>  
Length of abutment = 12 m  
Reinf. /m length = 17157 mm<sup>2</sup>/m  
Reinforcement in transverse direction = 0.25 times vertical reinf  
= 4289 mm<sup>2</sup>/m ( Total on both face)

Cross -sectional area Ac per meter length/ heighth = 1600000 mm<sup>2</sup> /m  
Minimum reinf. = 0.001 Ac  
= 1600 mm<sup>2</sup>/m

Reinforcement required = 4289 mm<sup>2</sup>/m (Total on both face)

Provide 20  $\phi$  @ 120 c/c on each face  
= 2618 mm<sup>2</sup>/m on each face  
 $\cong$  5236 mm<sup>2</sup>/m (total on both faces ) OK

INTRACTION DIAGRAM : (P : M<sub>LL</sub>)



| xu/D  | Pu      | Mu      |
|-------|---------|---------|
|       | T       | Tm      |
| 1E-09 | -8956.1 | 0.00019 |
| 0.2   | 1132.09 | 49782.9 |
| 0.4   | 10661   | 74833.3 |
| 0.6   | 20189.8 | 78468.6 |
| 0.8   | 29148.6 | 65006.1 |
| 1     | 37005.4 | 41972.1 |
| 1.2   | 40918.9 | 25391.1 |
| 1.4   | 42762.2 | 17589   |
| 1.6   | 43789.2 | 13237.7 |
| 1.8   | 44426.3 | 10532.2 |
| 2     | 44852   | 8717.2  |
| 100   | 46436.9 | 93.9578 |

SECTION AT SHAFT BOTTOM

Section Dimensions:

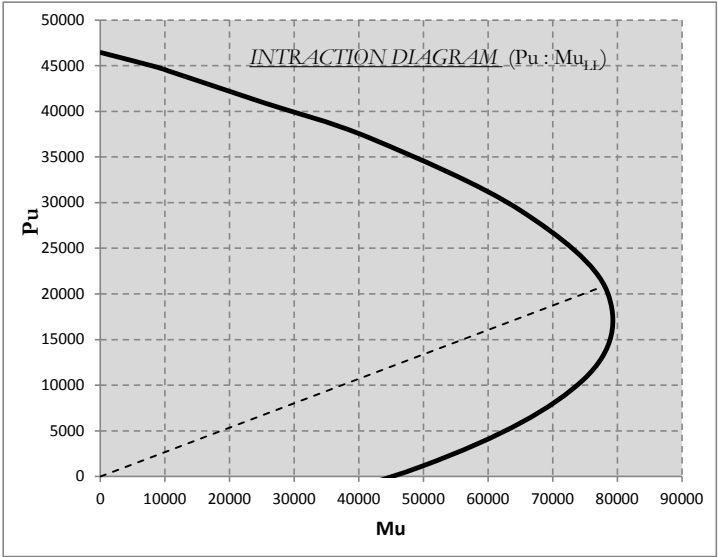
D = 12000 mm  
B = 1600 mm

Material Properties:

f<sub>ck</sub> = 45 N/mm<sup>2</sup>  
f<sub>yk</sub> = 500 N/mm<sup>2</sup>  
E<sub>s</sub> = 200000 N/mm<sup>2</sup>

Reinforcement Details :

| Reinf.                                | Dia | Spacing | Cover | From | To    | Y_Cg  | Nos. | Spacing | Remark  |
|---------------------------------------|-----|---------|-------|------|-------|-------|------|---------|---------|
|                                       | mm  | mm      | mm    | m    | m     | m     |      |         |         |
| REINFORCEMENT ACROSS AXIS OF BENDING: |     |         |       |      |       |       |      |         |         |
| As3                                   | 32  | 150     | 75    | 66   | 11934 | -709  | 80   | 150.228 | LAYER-2 |
|                                       | 32  | 150     | 139   | 66   | 11934 | -645  | 80   | 150.228 |         |
| As4                                   | 32  | 150     | 50    | 66   | 11934 | 734   | 80   | 150.228 |         |
| REINFORCEMENT ALONG AXIS OF BENDING:  |     |         |       |      |       |       |      |         |         |
| As1                                   | 32  | 150     | 50    | 305  | 1384  | 5934  | 8    | 154.143 |         |
| As2                                   | 32  | 150     | 50    | 305  | 1384  | -5934 | 8    | 154.143 |         |



Balance Failure

d1 = 11934  
xu = 7366.6667 mm  
xu/D = 0.6138889  
Pu = 20852.164 T  
Mu = 77923.869 Tm



**Confinement Reinforcement of Abutment:**

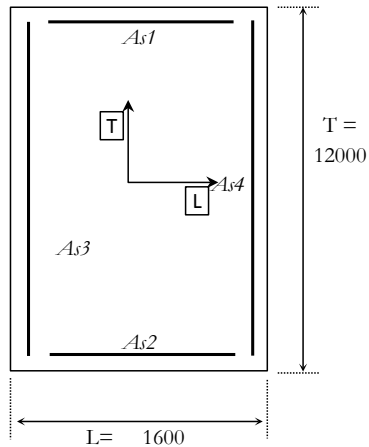
|   |    |   |  |
|---|----|---|--|
| Width of abutment shaft                               | b  | = | 1600 mm  |
| Length of abutment shaft                              | L  | = | 12000 mm   |
| Clear cover to earth face                             |    | = | 75 mm  |
| Clear cover to other face                             |    | = | 50 mm  |
| Confined area of concrete                             |    | = | 17552500 mm <sup>2</sup>   |
| $N_{ED}$  |    | = | 2107 Tonne   |
| Ac  |    | = | 19200000 mm <sup>2</sup>   |
| fck   |    | = | 45 Mpa   |
| fcd   |    | = | 20.10 Mpa  |
| fyd   |    | = | 435 Mpa  |
| Normalized axial force                                |    |   |  |
| $\eta_k$  |    | = | Max $N_{ED}/Ac fck$  |
| $\eta_k$  |    | = | 0.024 < 0.08   |
|   |    | = | < 0.3  |
| Extent of confinement                                 |    | = | Depth of section within the plane of bending                               |
|   |    | = | 1.6 m  |
| Required volumetric ratio of transverse reinforcement |    |   |  |
| $\omega_{w,req}$                                      |    | = | 0.37 Ac/ Acc $\eta_k$ +0.13 fyd/fcd ( $\rho_L$ -0.01)                      |
| Ac  |    | = | Area of gross concrete section   |
|   |    | = | 19.20 m <sup>2</sup>   |
| Acc   |    | = | Confined core concrete area of the section within the outside dia of loop. |
|   |    | = | 17.55 m <sup>2</sup>   |
| $\rho_L$  |    | = | Reinforcement ratio of the longitudinal reinforcement                      |
|   |    | = | As/Acc   |
| Area of steel provided                                | As | = | 205887 mm <sup>2</sup>   |
| $\rho_L$  |    | = | 0.01173 mm <sup>2</sup>  |
| $\omega_{w,req}$                                      |    | = | 0.01473  |
| Minimum Confining Reinforcement                       |    |   |  |
| $\omega_{w,d}$  |    | = | Max(1.4* $\omega_{w,req}$ , 0.12)  |
|   |    | = | 0.12   |
| Volumetric ratio of transverse reinforcement          |    |   |  |
| $\rho_w$  |    | = | $\omega_{w,d}fcd/fyd$  |
|   |    | = | 0.00555  |

|   |    |  |
|---|----|--|
| Volumetric ratio of transverse reinforcement  | =  | $\rho_w / b S_L$   |
| $\rho_w$                                      | =  | $A_{sw} / b S_L$   |
| Area of the spiral or hoop bar                | =  | $\rho_w * b * S_L$   |
| $A_{sw}$                                      | =  |  |
| b   | =  | Dimension of the core perpendicular to the direction of confinement.       |
|   | =  | 1475 mm  |
| $S_L$   | =  | Spacing of hoops or ties in longitudinal direction (in vertical direction) |
|   | <= | $1/5 * \text{smallest dimension of confined core}$                         |
|   | =  | $0.2 \times 1475 = 295 \text{ mm}$   |
|   | =  | 300 mm   |
| $A_{sw}$                                      | =  | 2455 mm <sup>2</sup>   |
| Provide                                       |    | 16 dia 20 Nos. @ 300 mm c/c  |
| Area of reinforcement provided at one section | =  | 4021 mm <sup>2</sup> OK  |

**Transverse distance b/w hoops legs or supplementary cross ties :**

|       |   |     |   |
|-------|---|-----|---|
| $S_T$ | = | Min | $\left\{ \begin{array}{l} 1/3 * \text{smallest dimension of confined core} \\ 200 \text{ mm} \end{array} \right.$ |
|       | = | Min |   |
|       | = |     | $\left\{ \begin{array}{l} 0.33 \times 1475 \\ 200 \text{ mm} \end{array} \right. = 492 \text{ mm}$                |
|       | = |     | 200 mm  |

# **ULS SHEAR CHECK FOR ABUTMENT SHAFT :**



|          |   |          |        |
|----------|---|----------|--------|
| $f_{ck}$ | = | 45       | Mpa    |
| $f_{cd}$ | = | 20.1     | Mpa    |
| $f_{yk}$ | = | 500      | Mpa    |
| $A_c$    | = | 19200000 | $mm^2$ |
| $A_s$    | = | 205887   | $mm^2$ |

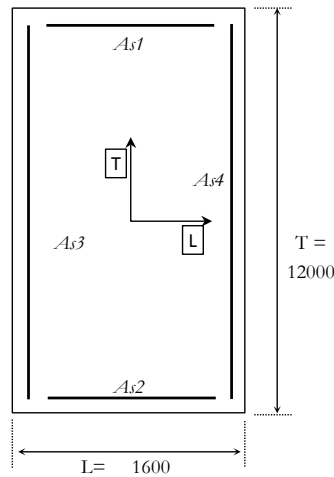
Reduction factor  $\beta = 0.5$  for  $a_v < 0.5d$

|   |   |                                  |  |
|---|---|----------------------------------|--|
| <b>Design Shear Resitance</b> (IRC 112 / clause 10.3.2 (2)) |   |                                  |  |
| $k$   | = | Min                              | $\left\{ \begin{array}{l} 1 + \sqrt{200/d} \\ 2 \end{array} \right.$ d is depth in mm  |
| $k$   | = | 1.35355                          |  |
| $\rho_1$  | = | Min                              | $\left\{ \begin{array}{l} As1 / bw \ d \\ 0.02 \end{array} \right.$  |
| $As1$   | = | 128680                           | $mm^2$ */ Reinforcement on tension face  |
| $\rho_1$  | = | 0.0067                           |  |
| $\sigma_{cp}$   | = | Axial stress                     |  |
| $v_{min}$   | = | $0.031 \ k^{3/2} \ f_{ck}^{1/2}$ |  |
|   | = | 0.32748                          |  |
| $V_{Rdc}$   | = | Max                              | $\left\{ \begin{array}{l} (0.12 \ k \ (80 \ \rho_1 \ f_{ck})^{0.33} + 0.15 \ \sigma_{cp}) \ bw \ d \\ (v_{min} + 0.15 \ \sigma_{cp}) \ bw \ d \end{array} \right.$ |
| <b>Max Shear Capacity</b>                                   |   |                                  |  |
| $v$   | = | $0.6 * (1 - f_{ck} / 310)$       | */ fck in Mpa  |
|   | = | 0.5129                           |  |
| $V_{RDC, \ max}$  | = | $0.5 \ bw \ d \ v \ f_{cd}$      |  |
|   | = | 9896.98                          | Tonne  |



**CHECK FOR ABUTMENT SHAFT SLENDERNESS RATIO:**

(IRC 112 / clause 8.3.2 (3))



$$\begin{aligned} A_c &= 19200000 \text{ mm}^2 \\ A_s &= 205887 \text{ mm}^2 \\ f_{cd} &= 20.1 \text{ Mpa} \\ f_{yd} &= 435 \text{ Mpa} \end{aligned}$$

**Slenderness criteria**

$$\begin{aligned} \text{Moment of Inertia about TT axis } I_{TT} &= 4.096\text{E}+12 \text{ mm}^4 \\ \text{Moment of Inertia about LL axis } I_{LL} &= 2.304\text{E}+14 \text{ mm}^4 \\ \text{Radius of gyration along LL axis } i_L &= \sqrt{I_{TT} / A} = 461.9 \text{ mm} \\ \text{Radius of gyration along TT axis } i_T &= \sqrt{I_{LL} / A} = 3464.1 \text{ mm} \end{aligned}$$

$$\begin{aligned} \text{Clear Height of compression member } l_o &= 19.07 \text{ m} \\ \text{Effective Length of column along LL -axis } l_{eL} &= 1.4 * l_o = 26.70 \text{ m} \end{aligned}$$

$$\begin{aligned} \text{Slenderness ratio along L-L axis } \lambda_L &= l_{eL} / i_L = 57.8014 \end{aligned}$$

$$\begin{aligned} \text{Effective Length of column along TT -axis } l_{eT} &= 2.3 * l_o = 43.86 \text{ m} \end{aligned}$$

$$\begin{aligned} \text{Slenderness ratio along TT' axis } \lambda_T &= l_{eT} / i_T = 12.66 \end{aligned}$$

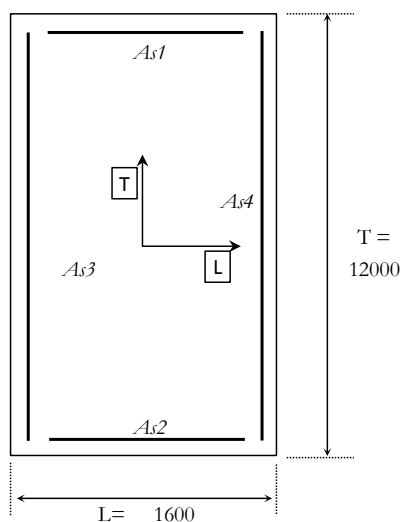
$$\begin{aligned} \text{Check } \lambda_L / \lambda_T &= 4.57 > 2 && \text{Check for limiting slenderness ratio} \\ \text{And } \lambda_T / \lambda_L &= 0.22 < 2 && \text{Ignore second order effect} \end{aligned}$$

| SUMMARY OF FORCES AT BOTTOM OF SHAFT: |                            |                                    |                |                |                  |                  |  | CHECK FOR SLENDERNESS RATIO |                       |           |           |                     |                     |                                      |
|---------------------------------------|----------------------------|------------------------------------|----------------|----------------|------------------|------------------|--|-----------------------------|-----------------------|-----------|-----------|---------------------|---------------------|--------------------------------------|
| S.N.                                  | Description                | Forces at bottom of abutment shaft |                |                |                  |                  |  | $e_L = M_{TT}/N_{ED}$       | $e_T = M_{LL}/N_{ED}$ | $e_L / L$ | $e_T / T$ | $(e_L/L) / (e_T/T)$ | $(e_T/T) / (e_L/L)$ | CHECK                                |
|                                       |                            | N <sub>ED</sub>                    | H <sub>L</sub> | H <sub>T</sub> | M <sub>ETT</sub> | M <sub>ELL</sub> |  |                             |                       |           |           |                     |                     |                                      |
|                                       |                            | Tonne                              | Tonne          | Tonne          | Tm               | Tm               |  |                             |                       |           |           |                     |                     |                                      |
| LC-1                                  | NS, LWL, Span dislodge, FP | 1144.6                             | 137.7          | 0.0            | 833.8            | 0.0              |  | 0.7                         | 0.0                   | 0.5       | 0.000     | 100.0               | 0.000               | Check for limiting slenderness ratio |
| LC-2                                  | NS, LWL, Span dislodge, EP | 1144.6                             | 820.3          | 0.0            | 4333.9           | 0.0              |  | 3.8                         | 0.0                   | 2.4       | 0.000     | 100.0               | 0.000               | Check for limiting slenderness ratio |
| LC-3                                  | NS, LWL, Min LL Lead, FP   | 1933.8                             | 190.4          | 0.0            | 2298.8           | 81.5             |  | 1.2                         | 0.0                   | 0.7       | 0.004     | 211.6               | 0.005               | Check for limiting slenderness ratio |
| LC-4                                  | NS, LWL, Min LL Lead, EP   | 1933.8                             | 872.9          | 0.0            | 5799.0           | 81.5             |  | 3.0                         | 0.0                   | 1.9       | 0.004     | 533.7               | 0.002               | Check for limiting slenderness ratio |
| LC-5                                  | NS, LWL, Max LL, FP        | 2106.8                             | 201.6          | 0.0            | 2708.9           | 584.9            |  | 1.3                         | 0.3                   | 0.8       | 0.023     | 34.7                | 0.029               | Check for limiting slenderness ratio |

|       |  |        |       |      |        |        |  |     |     |     |       |      |       |                                      |
|-------|--|--------|-------|------|--------|--------|--|-----|-----|-----|-------|------|-------|--------------------------------------|
| LC-6  | NS, LWL, Max LL, EP                    | 2106.8 | 656.7 | 0.0  | 5042.3 | 584.9  |  | 2.4 | 0.3 | 1.5 | 0.023 | 64.7 | 0.015 | Check for limiting slenderness ratio |
| 0.0   | 0.0                                    |        |       |      |        |        |  |     |     |     |       |      |       |                                      |
| LC-7  | SIS,LWL, Span dislodge ,Seismic Sx=1,S | 1153.5 | 616.2 | 40.1 | 4496.1 | 576.0  |  | 3.9 | 0.5 | 2.4 | 0.042 | 58.5 | 0.017 | Check for limiting slenderness ratio |
| LC-8  | SIS, LWL,Span dislodge ,Seismic Sx=1,S | 1135.7 | 616.2 | 40.1 | 4491.0 | 576.0  |  | 4.0 | 0.5 | 2.5 | 0.042 | 58.5 | 0.017 | Check for limiting slenderness ratio |
| LC-9  | SIS,LWL,Min LL Acc,Seismic Sx=1,Sz=    | 1910.7 | 756.5 | 80.5 | 7032.5 | 1164.8 |  | 3.7 | 0.6 | 2.3 | 0.051 | 45.3 | 0.022 | Check for limiting slenderness ratio |
| LC-10 | SIS, LWL,Min LL Acc,Seismic Sx=1,Sz=   | 1874.9 | 756.5 | 80.5 | 7022.2 | 1164.8 |  | 3.7 | 0.6 | 2.3 | 0.052 | 45.2 | 0.022 | Check for limiting slenderness ratio |
| LC-11 | SIS,LWL,Max LL,Seismic Sx=1,Sz=0.3,S   | 1932.7 | 756.5 | 81.8 | 7045.2 | 1256.5 |  | 3.6 | 0.7 | 2.3 | 0.054 | 42.1 | 0.024 | Check for limiting slenderness ratio |
| LC-12 | SIS, LWL,Max LL,Seismic Sx=1,Sz=0.3,S  | 1896.4 | 756.5 | 81.8 | 7034.5 | 1256.5 |  | 3.7 | 0.7 | 2.3 | 0.055 | 42.0 | 0.024 | Check for limiting slenderness ratio |

**CHECK FOR ABUTMENT SHAFT SECOND ORDER FORCES:**

( IRC 112 / clause 11.2.1)



$$\begin{aligned} A_c &= 19200000 \text{ mm}^2 \\ A_s &= 205887 \text{ mm}^2 \\ f_{cd} &= 20.1 \text{ Mpa} \\ f_{yd} &= 434.8 \text{ Mpa} \end{aligned}$$

*Slenderness criteria*

$$\begin{aligned} \text{Moment of Inertia about TT axis } I_{TT} &= 4.096\text{E}+12 \text{ mm}^4 \\ \text{Moment of Inertia about LL axis } I_{LL} &= 2.304\text{E}+14 \text{ mm}^4 \\ \text{Radius of gyration along LL axis } i_L &= \sqrt{I_{TT} / A} \\ &= 462 \text{ mm} \\ \text{Radius of gyration along TT axis } i_T &= \sqrt{I_{LL} / A} \\ &= 3464 \text{ mm} \end{aligned}$$

$$\begin{aligned} \text{Clear Height of compression member } l_o &= 19.07 \text{ m} \\ \text{Effective length of column along L-L } l_{eL} &= 1.4 * l_o \\ &= 26.70 \text{ m} \\ \text{Slenderness ratio along L-L axis } \lambda_L &= l_{eL} / i_L \\ &= 57.80 \\ \text{Effective Length of column along TT -axis } l_{eT} &= 2.3 * l_o \\ &= 43.86 \text{ m} \\ \text{Slenderness ratio along TT axis } \lambda_T &= l_{eT} / i_T \\ &= 12.66 \end{aligned}$$

Finding Limiting Value of Slenderness Ratio.

$$\lambda_{lim} = 20 A B C / \sqrt{n}$$

$$\phi(\infty, t_0) = 1.21 \text{ Creep for abutment shaft}$$

$$M_{OEqp}/M_{OEd} = \text{Ratio of BM in Quasi Permanent LC of SLS to BM in Design LC of ULS}$$

$$\phi_{ef} = \phi(\infty, t_0) * M_{OEqp}/M_{OEd}$$

$$A = 1 / (1 + 0.2 \phi_{ef})$$

$$\omega = \frac{A_s f_{yd}}{A_c f_{cd}} = 0.232$$

$$B = \sqrt{1 + 2\omega} = 1.210$$

$$r_m = \frac{M_{o1}}{M_{o2}} \quad (\text{Ratio of First order moments at two ends of members})$$

$$= 0$$

$$C = 1.7 - r_m = 1.7$$

$$n = \frac{N_{ED}}{A_c f_{cd}}$$

$$= \frac{N_{ED}}{38592} \quad */ (N_{ED} \text{ in Tonne})$$

| SUMMARY OF FORCES AT BOTTOM OF SHAFT: |                 |                  |                  |                  |                  |
|---------------------------------------|-----------------|------------------|------------------|------------------|------------------|
| S.N.                                  | ULS FORCES      |                  |                  | SLS (QP LC)      |                  |
|                                       | N <sub>ED</sub> | M <sub>ETT</sub> | M <sub>ELL</sub> | M <sub>ETT</sub> | M <sub>ELL</sub> |
|                                       | Tonne           | Tm               | Tm               | Tm               | Tm               |
| LC-2                                  | 1144.6          | 4333.9           | 0.0              | 2577.5           | -8.5             |
| LC-4                                  | 1933.8          | 5799.0           | 81.5             | 2577.5           | -8.5             |
| LC-6                                  | 2106.8          | 5042.3           | 584.9            | 2577.5           | -8.5             |
|                                       |                 |                  |                  |                  |                  |

| CHECK FOR SECOND ORDER EFFECT ( along LL Axis) |                 |      |      |                  |  |
|--|-----------------|------|------|------------------|--|
| M <sub>OEqp</sub> / M <sub>OEd</sub>           | φ <sub>ef</sub> | A    | n    | λ <sub>lim</sub> | Second Order Effect  |
|  |                 |      |      |                  | (λ < λ <sub>lim</sub> ) : Ignore<br>(λ > λ <sub>lim</sub> ) : Consider |
| 0.59   | 0.72            | 0.87 | 0.03 | 208.88           | Ignore second order effect   |
| 0.44   | 0.54            | 0.90 | 0.05 | 165.97           | Ignore second order effect   |
| 0.51   | 0.62            | 0.89 | 0.05 | 156.73           | Ignore second order effect   |
|  |                 |      |      |                  |  |

| Load Case | CHECK FOR SECOND ORDER EFFECT ( along TT Axis) |                 |      |      |                  |  |
|-----------|--|-----------------|------|------|------------------|--|
|           | Mo <sub>Exp</sub> / Mo <sub>Ed</sub>           | ϕ <sub>ef</sub> | A    | n    | λ <sub>lim</sub> | Second Order Effect  |
|           |  |                 |      |      |                  | (λ < λ <sub>lim</sub> ) : Ignore<br>(λ > λ <sub>lim</sub> ) : Consider |
| LC-2      | 0.00   | 0.00            | 1.00 | 0.03 | 238.87           | Ignore second order effect   |
| LC-4      | 0.00   | 0.00            | 1.00 | 0.05 | 183.77           | Ignore second order effect   |
| LC-6      | 0.00   | 0.00            | 1.00 | 0.05 | 176.07           | Ignore second order effect   |





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DESIGN OF SHAFT  
SLS LOAD COMBINATION

| LC-1 | QP, LWL, FP                | Forces about toe |                |                |                 |                 |  | LC-1 |
|------|----------------------------|------------------|----------------|----------------|-----------------|-----------------|--|------|
| S.N. | Description                | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |  |      |
|      |                            | Tonne            | Tonne          | Tonne          | Tm              | Tm              |  |      |
| 1)   | Sub-structure & Foundation | 847.86           |                |                | 86.901          | 0               |  | 1    |
| 3)   | Super-structure DL         | 398.95           |                |                | 229.4           | 0               |  | 1    |
| 4)   | SIDL (excluding surfacing) | 116.99           |                |                | 67.267          | 0               |  | 1    |
| 5)   | Surfacing                  | 34.025           |                |                | 19.564          | -8.506          |  | 1    |
| 9)   | Fluid Pressure             |                  | 1060.4         |                | 6782            |                 |  | 1    |

| S.N. | Description | Forces at bottom of abutment shaft |                |                |                 |                 |  |  |
|------|-------------|------------------------------------|----------------|----------------|-----------------|-----------------|--|--|
|      |             | V                                  | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |  |  |
|      |             | Tonne                              | Tonne          | Tonne          | Tm              | Tm              |  |  |
| LC-1 | QP, LWL, FP | 1397.8                             | 1060.4         | 0              | 7185.2          | -8.506          |  |  |

| LC-2 | QP, LWL, EP                | Forces about toe |                |                |                 |                 |  | LC-2 |
|------|----------------------------|------------------|----------------|----------------|-----------------|-----------------|--|------|
| S.N. | Description                | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |  |      |
|      |                            | Tonne            | Tonne          | Tonne          | Tm              | Tm              |  |      |
| 1)   | Sub-structure & Foundation | 847.86           |                |                | 86.901          | 0               |  | 1    |
| 3)   | Super-structure DL         | 398.95           |                |                | 229.4           | 0               |  | 1    |
| 4)   | SIDL (excluding surfacing) | 116.99           |                |                | 67.267          | 0               |  | 1    |
| 5)   | Surfacing                  | 34.025           |                |                | 19.564          | -8.506          |  | 1    |
| 9.1) | Earth Pressure LWL         |                  |                |                |                 |                 |  | 1    |
|      | Horizontal Component       |                  | 464.51         |                | 2327.7          |                 |  | 1    |
|      | Vertical Component         | 191.69           |                |                | -153.3          |                 |  | 1    |

| S.N. | Description | Forces at bottom of abutment shaft |                |                |                 |                 |  |  |
|------|-------------|------------------------------------|----------------|----------------|-----------------|-----------------|--|--|
|      |             | V                                  | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |  |  |
|      |             | Tonne                              | Tonne          | Tonne          | Tm              | Tm              |  |  |
| LC-2 | QP, LWL, EP | 1589.5                             | 464.51         | 0              | 2577.5          | -8.506          |  |  |

| LC-3 | RARE, LWL, Span dislodge FP | Forces about toe |                |                |                 |                 |  | LC-3 |
|------|-----------------------------|------------------|----------------|----------------|-----------------|-----------------|--|------|
| S.N. | Description                 | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |  |      |
|      |                             | Tonne            | Tonne          | Tonne          | Tm              | Tm              |  |      |
| 1)   | Sub-structure & Foundation  | 847.86           |                |                | 86.901          | 0               |  | 1    |

|       |                        |  |        |  |        |  |     |
|-------|------------------------|--|--------|--|--------|--|-----|
| 9)    | Fluid Pressure         |  | 1060.4 |  | 6782   |  | 1   |
| 10.1) | Surcharge Pressure LWL |  | 102.96 |  | 604.17 |  | 0.8 |

| S.N. | Description                 | Forces at bottom of abutment shaft |                |                |                 |                 |
|------|-----------------------------|------------------------------------|----------------|----------------|-----------------|-----------------|
|      |                             | V                                  | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|      |                             | Tonne                              | Tonne          | Tonne          | Tm              | Tm              |
| LC-3 | RARE, LWL, Span dislodge FP | 847.86                             | 1142.7         | 0              | 7352.3          | 0               |

| LC-4  | RARE, LWL, Span dislodge EP | Forces about toe |                |                |                 |                 |  | LC-4 |
|-------|-----------------------------|------------------|----------------|----------------|-----------------|-----------------|--|------|
| S.N.  | Description                 | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |  |      |
|       |                             | Tonne            | Tonne          | Tonne          | Tm              | Tm              |  |      |
| 1)    | Sub-structure & Foundation  | 847.86           |                |                | 86.901          | 0               |  | 1    |
| 9.1)  | Earth Pressure LWL          |                  |                |                |                 |                 |  | 1    |
|       | Horizontal Component        |                  | 464.51         |                | 2327.7          |                 |  | 1    |
|       | Vertical Component          | 191.69           |                |                | -153.3          |                 |  | 1    |
| 10.1) | Surcharge Pressure LWL      |                  | 102.96         |                | 604.17          |                 |  | 0.8  |

| S.N. | Description                 | Forces at bottom of abutment shaft |                |                |                 |                 |
|------|-----------------------------|------------------------------------|----------------|----------------|-----------------|-----------------|
|      |                             | V                                  | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|      |                             | Tonne                              | Tonne          | Tonne          | Tm              | Tm              |
| LC-4 | RARE, LWL, Span dislodge EP | 1039.5                             | 546.88         | 0              | 2744.6          | 0               |

| LC-6        | RARE, LWL, Min LL acomp, EP          | Forces about toe |                |                |                 |                 |  | LC-6 |
|-------------|--------------------------------------|------------------|----------------|----------------|-----------------|-----------------|--|------|
| S.N.        | Description                          | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |  |      |
|             |                                      | Tonne            | Tonne          | Tonne          | Tm              | Tm              |  |      |
| 1)          | Sub-structure & Foundation           | 847.86           |                |                | 86.901          | 0               |  | 1    |
| 3)          | Super-structure DL                   | 398.95           |                |                | 229.4           | 0               |  | 1    |
| 4)          | SIDL (excluding surfacing)           | 116.99           |                |                | 67.267          | 0               |  | 1    |
| 5)          | Surfacing                            | 34.025           |                |                | 19.564          | -8.506          |  | 1    |
| 6.2)        | Live Load Vertical Load Min Reaction | 28.8             |                |                | 16.56           | 83.807          |  | 0.75 |
| 7)          | Live Load Horizontal Forces          |                  | 45.753         |                | 879.37          |                 |  | 0.75 |
| <b>9.1)</b> | Earth Pressure LWL                   |                  |                |                |                 |                 |  | 1    |
|             | Horizontal Component                 |                  | 464.51         |                | 2327.7          |                 |  | 1    |
|             | Vertical Component                   | 191.69           |                |                | -153.3          |                 |  | 1    |
| 10.1)       | Surcharge Pressure LWL               |                  | 102.96         |                | 604.17          |                 |  | 0.8  |

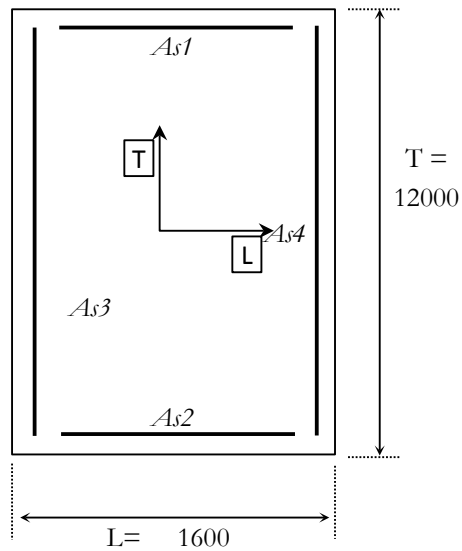
| S.N. | Description                 | Forces at bottom of abutment shaft |                |                |                 |                 |
|------|-----------------------------|------------------------------------|----------------|----------------|-----------------|-----------------|
|      |                             | V                                  | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|      |                             | Tonne                              | Tonne          | Tonne          | Tm              | Tm              |
| LC-6 | RARE, LWL, Min LL acomp, EP | 1611.1                             | 581.2          | 0              | 3732.8          | 54.349          |

| LC-8        | RARE, LWL, Max LL lead, EP           | Forces about toe |                |                |                 |                 |  | LC-8 |
|-------------|--------------------------------------|------------------|----------------|----------------|-----------------|-----------------|--|------|
| S.N.        | Description                          | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |  |      |
|             |                                      | Tonne            | Tonne          | Tonne          | Tm              | Tm              |  |      |
| 1)          | Sub-structure & Foundation           | 847.86           |                |                | 86.901          | 0               |  | 1    |
| 3)          | Super-structure DL                   | 398.95           |                |                | 229.4           | 0               |  | 1    |
| 4)          | SIDL (excluding surfacing)           | 116.99           |                |                | 67.267          | 0               |  | 1    |
| 5)          | Surfacing                            | 34.025           |                |                | 19.564          | -8.506          |  | 1    |
| 6.1)        | Live Load Vertical Load Max Reaction | 137.4            |                |                | 79.005          | 399.83          |  | 1    |
| 7)          | Live Load Horizontal Forces          |                  | 45.753         |                | 879.37          |                 |  | 1    |
| <b>9.1)</b> | Earth Pressure LWL                   |                  |                |                |                 |                 |  | 1    |
|             | Horizontal Component                 |                  | 464.51         |                | 2327.7          |                 |  | 1    |
|             | Vertical Component                   | 191.69           |                |                | -153.3          |                 |  | 1    |
| 10.1)       | Surcharge Pressure LWL               |                  | 102.96         |                | 604.17          |                 |  | 0.8  |

| S.N. | Description                | Forces at bottom of abutment shaft |                |                |                 |                 |
|------|----------------------------|------------------------------------|----------------|----------------|-----------------|-----------------|
|      |                            | V                                  | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|      |                            | Tonne                              | Tonne          | Tonne          | Tm              | Tm              |
| LC-8 | RARE, LWL, Max LL lead, EP | 1726.9                             | 592.64         | 0              | 4019.2          | 391.33          |

**FORCES AT SHAFT BOTTOM:**

**SLS LOAD COMBINATION :**

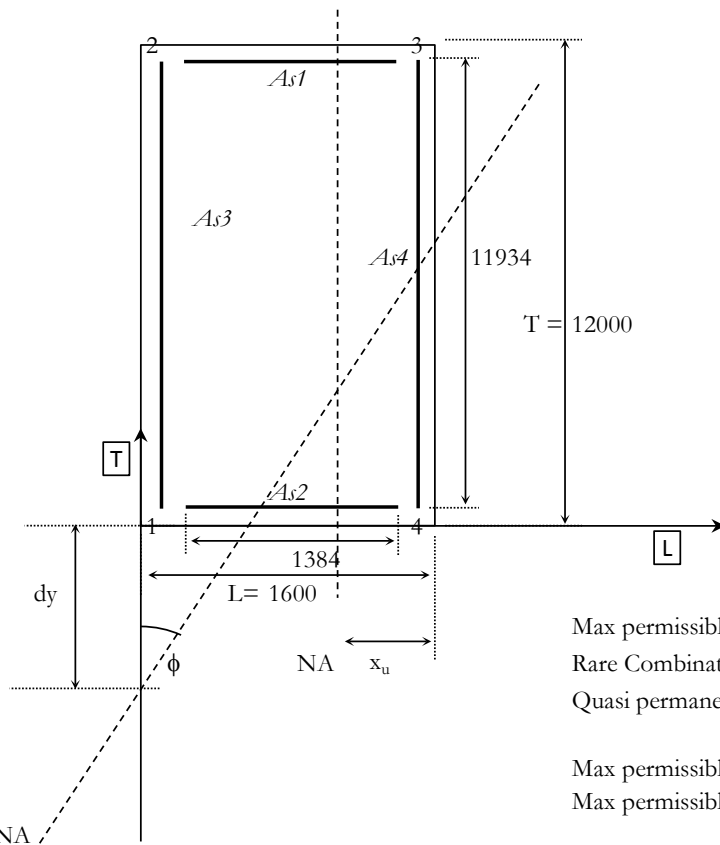


**SLS CHECK FOR ABUTMENT SHAFT :**

| S.N. | Description                 | Forces at bottom of abutment shaft |         |       |           |             |
|------|-----------------------------|------------------------------------|---------|-------|-----------|-------------|
|      |                             | $N_{ED}$                           | $H_L$   | $H_T$ | $M_{ETT}$ | $M_{ELL}$   |
|      |                             | Tonne                              | Tonne   | Tonne | Tm        | Tm          |
| LC-3 | RARE, LWL, Span dislodge FP | 847.862                            | 1142.73 | 0     | 7352.28   | 0           |
| LC-4 | RARE, LWL, Span dislodge EP | 1039.55                            | 546.884 | 0     | 2744.61   | 0           |
| LC-5 | RARE, LWL, Min LL acomp, FP | 1419.42                            | 1177.04 | 0     | 8340.46   | 54.34908353 |
| LC-6 | RARE, LWL, Min LL acomp, EP | 1611.11                            | 581.199 | 0     | 3732.79   | 54.34908353 |
| LC-7 | RARE, LWL, Max LL lead, FP  | 1535.22                            | 1188.48 | 0     | 8626.88   | 391.3286022 |
| LC-8 | RARE, LWL, Max LL lead, EP  | 1726.91                            | 592.637 | 0     | 4019.22   | 391.3286022 |

# STRESS CHECK

# SECTION AT SHAFT BOTTOM



## Section Dimensions:

|   |   |       |    |
|---|---|-------|----|
| D | = | 1600  | mm |
| B | = | 12000 | mm |

## Material Properties:

|     |   |        |                   |
|-----|---|--------|-------------------|
| fck | = | 45     | N/mm <sup>2</sup> |
| fyk | = | 500    | N/mm <sup>2</sup> |
| Es  | = | 200000 | N/mm <sup>2</sup> |

Max permissible Stress in Concrete

Rare Combination = 21.6 Mpa

Quasi permanent Combination = 16.2 Mpa

Max permissible Stress in Steel (QLS) = 400 Mpa

Max permissible Stress in Steel (Rare) = 300 Mpa

## Reinforcement Details :

| Reinf. | Dia | Spacing | Cover | Eff. cover | Nos. | Spacing | Total As | From |       | To   |       | As per unit |
|--------|-----|---------|-------|------------|------|---------|----------|------|-------|------|-------|-------------|
|        |     |         |       |            |      |         |          | L    | T     | L    | T     |             |
| As1    | 32  | 150     | 50    | 66         | 8    | 154.1   | 6434.0   | 305  | 11934 | 1384 | 11934 | 6.0         |
| As2    | 32  | 150     | 50    | 66         | 8    | 154.1   | 6434.0   | 305  | 66    | 1384 | 66    | 6.0         |
| As3    | 32  | 150     | 75    | 91         | 80   | 150.2   | 64340    | 91   | 66    | 91   | 11934 | 5.4         |
|        | 32  | 150     | 139   | 155        | 80   | 150.2   | 64339.8  | 155  | 66    | 155  | 11934 | 5.4         |
| As4    | 32  | 150     | 50    | 66         | 80   | 150.2   | 64340    | 1534 | 66    | 1534 | 11934 | 5.4         |
| Closed |     |         |       |            |      |         |          |      |       |      |       |             |

## SECTION COORDINATE

| S.N    | x    | y     |
|--------|------|-------|
| 1      | 0    | 0     |
| 2      | 0    | 12000 |
| 3      | 1600 | 12000 |
| 4      | 1600 | 0     |
| 5      | 0    | 0     |
| Closed |      |       |

## Properties of Gross Cross-section

| Properties      | @ XY axis                | @ centroidal axis      |
|-----------------|--------------------------|------------------------|
| A               | = 2E+07 mm <sup>2</sup>  | 2E+07 mm <sup>2</sup>  |
| cgL             | = 800 mm                 | 800 mm                 |
| cgT             | = 6000 mm                | 6000 mm                |
| I <sub>LL</sub> | = 9E+14 mm <sup>4</sup>  | 2E+14 mm <sup>4</sup>  |
| I <sub>TT</sub> | = 2.E+13 mm <sup>4</sup> | 4.E+12 mm <sup>4</sup> |
| I <sub>LT</sub> | = 9.E+13 mm <sup>4</sup> | 0.E+00 mm <sup>4</sup> |

### Modulus of Elasticity for Concrete

|   |            |   |   |  |              |
|---|------------|---|---|--|--------------|
| Design Bending Moment                                   | $M_{RARE}$ | = | 8626.88   | Tm   |              |
|   | $M_{QP}$   | = | 7185.17   | Tm   |              |
|   | $M_{ST}$   | = | $M_{RARE} - M_{QP}$   | (Bending Moment due to short term loading) |              |
|   |            | = | 1441.72   | Tm   |              |
| Modulus of Elasticity for Concrete                      |            |   |   |  |              |
| For short term loading                                  | $E_{cm}$   | = | 34313   | Mpa  |              |
| Creep coefficient                                       | $\phi$     | = | 1   |  |              |
| For long term loading                                   | $E_{cm}'$  | = | 17156.5   | Mpa  |              |
| Reinf. modulus of elasticity                            | $E_s$      | = | 200000  | N/mm <sup>2</sup>                          |              |
| Modular ratio for QP Combination                        |            | = | $E_s / E_{cm}'$   | =  | 11.66        |
| Equivalent Modulus of Elasticity for Rare Combination : |            |   |   |  |              |
|   | $E_{c,eq}$ | = | $\frac{E_{cm} * (M_{QP} + M_{ST})}{M_{ST} + (1 + \phi) * M_{QP}}$ | =  | 18720.79 MPa |
| Modular ratio for Rare Combination                      |            | = | $E_s / E_{c,eq}$  | =  | 10.68        |

| LC   | Forces  |          |          | Modular ratio | Finding Position of Neutral Axis |        |                |        |                            |        |           |
|------|---------|----------|----------|---------------|----------------------------------|--------|----------------|--------|----------------------------|--------|-----------|
|      | P       | $M_{TT}$ | $M_{LL}$ |               | First Trail                      |        | Valuse Adopted |        | Value suggested by program |        |           |
|      | T       | Tm       | Tm       |               | $\phi$                           | dy     | $\phi$         | dy     | $\phi$                     | dy     | NA_stress |
|      |         |          |          |               | radian                           | mm     | radian         | mm     | radian                     | mm     | Mpa       |
| LC-1 | 1397.82 | 7185.17  | -8.41    | 11.66         | 4.7                              | 4E+07  | 4.7            | 7E+06  | 1.6                        | 3E+07  | -6.97     |
| LC-2 | 1589.51 | 2577.50  | -8.41    | 11.66         | 4.7                              | 1E+07  | 4.7            | -7E+07 | 1.6                        | 2E+07  | -37.32    |
| LC-3 | 847.86  | 7352.28  | 0.10     | 10.68         | 4.7                              | -3E+09 | 4.7            | -5E+06 | 4.7                        | -1E+08 | -11.14    |
| LC-4 | 1039.55 | 2744.61  | 0.10     | 10.68         | 4.7                              | -1E+09 | 4.7            | -1E+08 | 4.7                        | -1E+09 | -11.32    |
| LC-5 | 1419.42 | 8340.46  | 54.45    | 10.68         | 4.7                              | -7E+06 | 4.7            | -2E+06 | 4.7                        | -5E+06 | -21.82    |
| LC-6 | 1611.11 | 3732.79  | 54.45    | 10.68         | 4.7                              | -3E+06 | 4.7            | -4E+06 | 4.7                        | -4E+06 | 1.14      |
| LC-7 | 1535.22 | 8626.88  | 391.43   | 10.68         | 4.7                              | -1E+06 | 4.7            | -2E+05 | 4.7                        | -6E+05 | -23.18    |
| LC-8 | 1726.91 | 4019.22  | 391.43   | 10.68         | 4.7                              | -5E+05 | 4.7            | -5E+05 | 4.7                        | -5E+05 | -1.23     |

| LOAD COMBIANTIONS |                          | x                             | y                                  |  | x                            | y                                   |  | Dist.<br>from<br>N.A<br>(mm) (4) |
|-------------------|--------------------------|-------------------------------|------------------------------------|--|------------------------------|-------------------------------------|--|----------------------------------|
|                   |                          | 1600                          | 0                                  |  | 0                            | 12000                               |  |                                  |
|                   |                          | Max. Concrete<br>Stress (Mpa) | Permissible conc.<br>stresses(Mpa) |  | Max. Tensile Stress<br>(Mpa) | Permissible steel<br>stresses (Mpa) |  |                                  |
| LC-1              | QP, LWL, FP              | 11.2                          | 16.2 OK                            |  | -107.9                       | -400 OK                             |  | 876.9                            |
| LC-2              | QP, LWL, EP              | 5.9                           | 16.2 OK                            |  | -87.4                        | -400 OK                             |  | 706.6                            |
| LC-3              | RARE, LWL, Span dislodge | 12.2                          | 21.6 OK                            |  | -124.5                       | -400 OK                             |  | -817.8                           |
| LC-4              | RARE, LWL, Span dislodge | 6.4                           | 21.6 OK                            |  | -135.4                       | -400 OK                             |  | -537.6                           |
| LC-5              | RARE, LWL, Min LL        | 19.6                          | 21.6 OK                            |  | -360.2                       | -400 OK                             |  | -589.0                           |
| LC-6              | RARE, LWL, Min LL        | 9.0                           | 21.6 OK                            |  | -163.7                       | -400 OK                             |  | -593.3                           |
| LC-7              | RARE, LWL, Max LL lead,  | 20.6                          | 21.6 OK                            |  | -381.0                       | -400 OK                             |  | -593.1                           |
| LC-8              | RARE, LWL, Max LL lead,  | 9.8                           | 21.6 OK                            |  | -186.8                       | -400 OK                             |  | -583.3                           |

First Trail NA

$$\tan(\phi) = \frac{M_{LL} * I_{TT} / M_{TT} / I_{LL}}{}$$

$$\tan(\phi) = \frac{(e_L - e_L') * I_{LL} - (e_T - e_T') * I_{LT}}{(e_T - e_T') * I_{TT} - (e_L - e_L') * I_{LT}}$$

$$\sigma_{(L1, T1)} = \frac{P}{A_{eff}} + \frac{P * (e_L - e_L') - P * (e_T - e_T') * (I_{LTeff} / I_{Leff})}{I_{Teff} - (I_{LTeff}^2 / I_{Leff})} (L1 - Cg_{Leff}) + \frac{P * (e_T - e_T') - P * (e_L - e_L') * (I_{LTeff} / I_{Teff})}{I_{Leff} - (I_{LTeff}^2 / I_{Teff})} (T1 - Cg_{Teff})$$



**(SLS) CHECK FOR CRACK WIDTH (QUASI PERMANENT LOAD COMBINATIONS)**

Minimum Reinforcement for crack control :

$$A_{s,min} = k_c k_{ct,eff} A_{ct} / \sigma_s \quad (IRC 112 / clause 12.3.3 (2))$$

For Web

$$k_c = 0.4 \text{ For Bending member}$$

$$h = 1.6 \text{ m}, \quad b = 1 \text{ m}$$

$$k = 0.65$$

$$f_{ct,eff} = \text{Max} (f_{ctm}, 2.9)$$

$$= 3.28 \text{ Mpa}$$

$A_{ct}$  = Area of concrete within tensile zone just before the first crack form, section behaves elastically until the tensile fiber stress reaches  $f_{ctm}$ . hence Neutral axis depth will be considered for gross section

$$A_{ct} = b * h / 2$$

$$= 0.8 \text{ m}^2$$

$\sigma_s$  = Maximum stress permitted in reinf. Immediately after formation of crack

$$= f_{yk}$$

$$= 500 \text{ Mpa}$$

$$A_{s,min} = 1363.12 \text{ mm}^2/\text{m} < 10723 \text{ mm}^2/\text{m} \text{ on tension face} \quad \text{OK}$$

$$< 5362 \text{ mm}^2/\text{m} \text{ on compression face} \quad \text{OK}$$

**Calculation of crack width :** (IRC 112 / clause 12.3.4)

$$w_{k,max} = 0.3 \text{ mm}$$

$$\text{Clear cover } c = 75 \text{ mm}$$

$$\text{Bar dia } \phi_{eq} = 32.00 \text{ mm}$$

$$5 (c + \phi_{eq} / 2) = 455 \text{ mm}$$

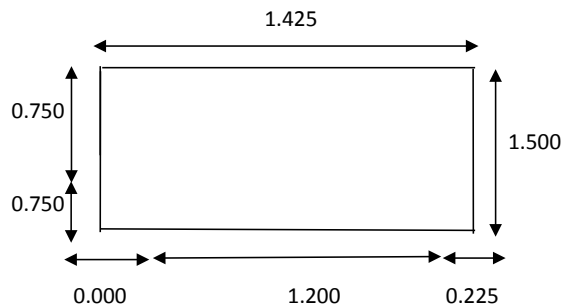
$$\text{Spacing b/w bars} = 150 \text{ mm} < 455 \text{ mm}$$

$$s_{rmax} = \text{Maximum crack spacing}$$

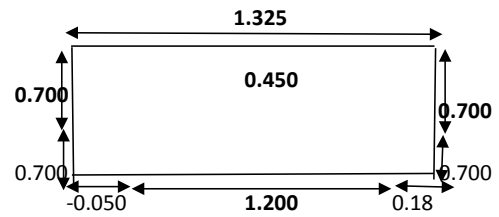
The Following formula can be used for calculation of maximum crack spacing.

$$\begin{aligned}
&= 3.4c + 0.17 \phi / \rho_{P,eff} \\
&= 425.274 \text{ mm} \\
h_{c,eff} &= \text{Min} \begin{cases} 2.5 (h - d) \\ (h - x)/3 \\ h/2 \end{cases} \\
&= 0.33564 \text{ m} \\
&\quad \begin{array}{lcl} h & = & 1.6 \text{ m} \\ d & = & 1.347 \text{ m} \\ x & = & 0.59 \text{ m} \end{array} \quad \text{*/ (for Quasi Permanent Load combination)} \\
\text{width } b &= 1 \text{ m} \\
A_{c,eff} &= h_{c,eff} * b = 0.33564 \text{ m}^2 \\
\rho_{P,eff} &= A_s / A_{c,eff} \\
&= 10723.3 / 335643 \\
&= 0.03195 \\
\sigma_{sc} &= \text{Stress in tension Reinforcement assuming cracked section} \\
&= 107.87 \text{ Mpa} \quad \text{*/ (for Quasi Permanent Load combination)} \\
E_s &= 200000 \text{ Mpa} \\
E_{cm}' &= 17156 \text{ Mpa} \quad \text{*/ (for Long term loading)} \\
\alpha_e &= E_s / E_{cm} \\
\alpha_e &= 11.657 \\
k_t &= 0.5 \quad \text{(factor dependent on duration of load)} \\
\varepsilon_{sm} - \varepsilon_{cm} &= \text{Max} \begin{cases} \frac{\sigma_{sc} - k_t f_{ct,eff} (1 + \alpha_e \rho_{P,eff}) / \rho_{P,eff}}{E_s} \\ 0.6 \sigma_{sc} / E_s \end{cases} \\
&= 0.00032 \\
w_k &= s_{rmax} (\varepsilon_{sm} - \varepsilon_{cm}) \\
&= 0.138 \text{ mm} < 0.300 \text{ mm} \quad \text{OK}
\end{aligned}$$

## DESIGN OF ABUTMENT CAP



**Abutment Cap Concrete Dimension**



**Transverse Reinforcement in Cap**

The Abutment Cap is designed as per Cl. 710.8.7 of IRC:78-2014

|   |   |                   |   |               |
|---|---|-------------------|---|---------------|
| Concrete Vol. per m width of cap                | = | 1.425 x 0.225     | = | 0.321 Cum/M   |
| Vol. of steel to be provided = 1% of cap volume | = |                   | = | 0.00321 Cum/M |
| Wt. of Steel required                           | = | 0.00320625 x 7850 | = | 26.00 Kg/M    |
| Longitudinal steel required                     | = | 0.5 x 26          | = | 13.00 Kg/M    |
| Transverse steel required                       | = | 0.5 x 26          | = | 13.00 Kg/M    |
| Length of outer stirrup                         | = |                   | = | 5.450 m       |
| Providing 12 mm dia bar Wt. of each stirrup     | = | 5.45 x 0.889      | = | 4.845 Kg      |
| No. of stirrup required per m width of cap      | = |                   | = | 3.0           |
| Required spacing of stirrup                     | = | 1000/3            | = | 333 mm C/C    |

**Provide 12 mm dia 2 Legged Stirrups @ 150 mm C/C = 32.30 Kg/M OK**

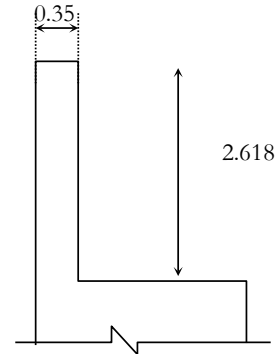
Providing 12 mm bars in longitudinal direction, wt of each bar 0.889 Kg/M

No. of Longitudinal bars required = 13/0.889 = 15 Nos.

**Provide 12 mm dia 20 Nos. Long. bar distributed at top and bottom = 17.78 Kg/M OK**

### DESIGN OF DIRT WALL :

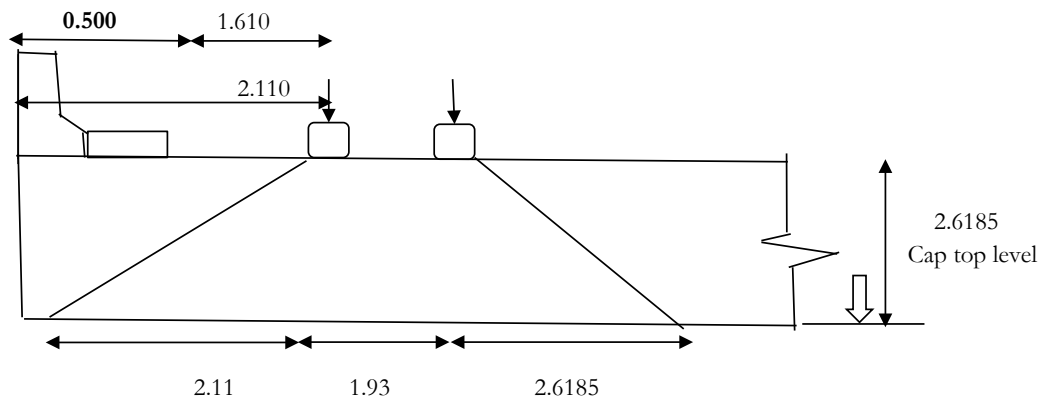
|                                 |                 |                      |
|---------------------------------|-----------------|----------------------|
| Density of Earth                | =               | 2.0 T/m <sup>3</sup> |
| Earth Pressure coefficient Ka   | =               | 0.307                |
| Earth Pressure                  | =               | $1/2 K_a \gamma h^2$ |
|                                 | =               | 2.105 T/m            |
| Lever arm                       | =               | 0.42 *h              |
|                                 | =               | 1.100 m              |
| Moment at bottom                | M <sub>EP</sub> | = 2.315 Tm/m         |
| Live Load surcharge intensity q | =               | 2.4 t/m <sup>2</sup> |
| Live load surcharge Pressure    | =               | K <sub>a</sub> *q*h  |
|                                 | =               | 1.929 T/m            |
| Lever arm                       | =               | 0.5 *h               |
|                                 | =               | 1.309 m              |
| Moment at bottom                | M <sub>SP</sub> | = 2.526 Tm/m         |



### Braking force on dirt wall

20T 70R Axle load is considered over dirt wall

|               |   |       |
|---------------|---|-------|
| Braking force | = | 4.0 T |
|---------------|---|-------|



|  |   |                |   |           |
|--|---|----------------|---|-----------|
| Effective width of Dispersion          | = | 2.11+1.93+2.62 | = | 6.66      |
| Braking Force per m width of Dirt wall | = | 4/6.66         | = | 0.60 T/m  |
| Moment due to Braking Force            | = | 0.6*(2.62+1.2) | = | 2.29 Tm/m |

### ULS DESIGN FORCES:

| LOADS              |   | Unfactored |      | Load Factor | Factored Forces |             |
|--------------------|---|------------|------|-------------|-----------------|-------------|
|                    |   | Force      | BM   |             | Force           | BM          |
|                    |   | T          | Tm   |             | T               | Tm          |
| Earth Pressure     | = | 2.10       | 2.31 | 1.5         | 3.16            | 3.47        |
| Surcharge Pressure | = | 1.93       | 2.53 | 1.2         | 2.32            | 3.03        |
| Braking force      | = | 0.60       | 2.29 | 1.5         | 0.90            | 3.44        |
| <b>Total</b>       |   |            |      |             | <b>6.37</b>     | <b>9.94</b> |

***SLS DESIGN FORCES:***

| LOADS              |   | Unfactored |       | SLS RARE COMB. |             |             | SLS QUASI PER. COMB. |             |             |
|--------------------|---|------------|-------|----------------|-------------|-------------|----------------------|-------------|-------------|
|                    |   | Force      | BM    | Load Factor    | Force       | BM          | Load Factor          | Force       | BM          |
|                    |   | T          | Tm    |                | T           | Tm          |                      | T           | Tm          |
| Earth Pressure     | = | 2.105      | 2.315 | 1              | 2.10        | 2.31        | 1                    | 2.10        | 2.31        |
| Surcharge Pressure | = | 1.929      | 2.526 | 0.8            | 1.54        | 2.02        | 0                    | 0           | 0           |
| Braking force      | = | 0.60       | 2.29  | 1              | 0.60        | 2.29        | 0                    | 0           | 0           |
| <b>Total</b>       |   |            |       |                | <b>4.25</b> | <b>6.63</b> |                      | <b>2.10</b> | <b>2.31</b> |

***ULS DESIGN FORCES:***

| LOADS                 |   | Unfactored |       | Load Factor | Factored Forces |      |
|-----------------------|---|------------|-------|-------------|-----------------|------|
|                       |   | Force      | BM    |             | Force           | BM   |
|                       |   | T          | Tm    |             | T               | Tm   |
| NON-SEISMIC COMPONENT |   |            |       |             |                 |      |
| Earth Pressure        | = | 2.105      | 2.315 | 1.0         | 2.105           | 2.31 |
| Surcharge Pressure    | = | 1.929      | 2.526 | 0.2         | 0.386           | 0.51 |
| Braking force         | = | 0.120      | 0.459 | 0.2         | 0.024           | 0.09 |
| SEISMIC COMPONENT     |   |            |       |             |                 |      |
| Earth Pressure        | = | 0.000      | 0.000 | 1.5         | 0.000           | 0.00 |
| Surcharge Pressure    | = | 0.000      | 0.000 | 0.3         | 0.000           | 0.00 |
| Total                 |   |            |       |             | 2.51            | 2.91 |

**ULS DESIGN :**

Design Bending Moment  $M_{ED}$  = 9.94 Tm

D = 0.35 m \*/ overall depth at d from face of support

d = 0.308 m \*/ deff at d from face of support

Clear Cover = 50 mm

Ast Provided = 16  $\phi$  @ 150 c/c  
= 1340 mm<sup>2</sup>/m

Grade of Concrete fck = 45 Mpa

Grade of steel fyk = 500 Mpa

xu = 0.87 fyk Ast / 0.362 fck b  
= 36 mm

x<sub>u</sub>max = 0.609 d'  
= 187 mm

UNDER REINFORCED

|                      |   |         |
|----------------------|---|---------|
| fyk                  | = | 500 Mpa |
| ε <sub>uk</sub>      | = | 0.0025  |
| ε <sub>ud</sub>      | = | 0.00225 |
| fck                  | = | 45 Mpa  |
| ε <sub>cu2</sub>     | = | 0.0035  |
| xu <sub>max</sub> /d | = | 0.6087  |

$$\begin{aligned}
 A_{st} \text{ calculated} &= M / 0.87 f_{yk} (d' - 0.416 x_u) \\
 &= 780 \text{ mm}^2/\text{m} \\
 A_{st} \text{ minimum} &= 0.15\% * b * d \\
 &= 525 \text{ mm}^2/\text{m} \\
 A_{st} \text{ required} &= \text{Max}(780, 525) \\
 &= 780 \text{ mm}^2/\text{m} \\
 \text{Increase required reinforcement by 50\%} &= 1170 \text{ mm}^2/\text{m} < 1340 \text{ mm}^2/\text{m} \quad \text{OK} \\
 \text{Provide } 16 \text{ mm dia bars @ } 150 \text{ mm C/C vertical bars on both faces}
 \end{aligned}$$

### Horizontal Reinforcement

$$\begin{aligned}
 \text{Total horiz steel required} &= 25\% \text{ of vertical bars or } 0.001 A_c \text{ whichever is more on each face} \\
 &= 350 \text{ mm}^2 \\
 \text{Provide } 10 \text{ mm dia @ } 150 \text{ C/C horz bars on each face} &= 523 \text{ mm}^2 \quad \text{OK}
 \end{aligned}$$

### (ULS) CHECK FOR SHEAR FORCE

$$\text{Factored Shear Force } V_{ED} = 6.37 \text{ Tonne}$$

$$\begin{aligned}
 D &= 0.350 \text{ m} \quad */ \text{ overall depth at face of support} \\
 d &= 0.308 \text{ m} \quad */ \text{ deff at face of support}
 \end{aligned}$$

Design Shear Resitance

$$\begin{aligned}
 k &= \text{Min} \left\{ \begin{array}{l} 1 + \sqrt{200/d} \\ 2 \end{array} \right. \quad d \text{ is depth in mm} \\
 &= 1.806
 \end{aligned}$$

$$\begin{aligned}
 \rho_1 &= \text{Min} \left\{ \begin{array}{l} A_{sl} / b_w d \\ 0.02 \end{array} \right. \\
 &= 0.0044
 \end{aligned}$$

$$\sigma_{cp} = 0 \text{ Mpa}$$

$$\begin{aligned}
 v_{\min} &= 0.031 k^{3/2} f_{ck}^{1/2} \\
 &= 0.505
 \end{aligned}$$

$$\begin{aligned}
 V_{Rdc} &= \text{Max} \left\{ \begin{array}{l} (0.12 k (80 \rho_1 f_{ck})^{0.33} + 0.15 \sigma_{cp}) b_w d \\ (v_{\min} + 0.15 \sigma_{cp}) b_w d \end{array} \right. \quad (\text{IRC 112 / clause 10.3.2 (2)}) \\
 &= 16.55 \text{ Tonne} > 6.37 \text{ Tonne} \quad \text{OK}
 \end{aligned}$$

### Max Shear Capacity of section

$$\begin{aligned}
 v &= 0.6 * (1 - f_{ck} / 310) \quad */ \text{ fck in Mpa} \\
 &= 0.513
 \end{aligned}$$

$$\begin{aligned}
 f_{cd} &= 0.4467 * f_{ck} \\
 &= 20.10 \text{ Mpa}
 \end{aligned}$$

$$V_{RDC, \max} = 0.5 b w d v_{fd} = 159 \text{ Tonne} > 6.4 \text{ Tonne OK}$$

### (SLS) CHECK FOR STRESSES (RARE & QUASI PERMANENT LOAD COMBINATIONS)

$$\begin{aligned} \text{Design Bending Moment } M_{RARE} &= 6.63 \text{ Tm} \\ M_{QP} &= 2.31 \text{ Tm} \\ M_{ST} &= M_{RARE} - M_{QP} \quad (\text{Bending Moment due to short term loading}) \\ &= 4.31 \text{ Tm} \end{aligned}$$

Modulus of Elasticity for Concrete

$$\text{For short term loading } E_{cm} = 34313 \text{ Mpa}$$

$$\text{Creep coefficient } \phi = 1.21$$

$$\text{For long term loading } E_{cm}' = 15549 \text{ Mpa}$$

$$\text{Reinf. modulus of elasticity } E_s = 200000 \text{ N/mm}^2$$

$$\text{Modular ratio for QP Combination} = E_s / E_{cm}' = 12.86$$

Equavalent Modulus of Elasticity for Rare Combination :

$$E_{c,eq} = \frac{E_{cm} * (M_{QP} + M_{ST})}{M_{ST} + (1 + \phi) * M_{QP}} = 24140 \text{ MPa}$$

$$\text{Modular ratio for Rare Combination} = E_s / E_{c,eq} = 8.28$$

| Formula used for calculation of stress    |   |
|---|---|
| dc (depth of neutral axis)                | $= \frac{-m * A_s + \sqrt{(m^2 * A_s^2 + 2 * m * A_s * b * d)}}{b}$ |
| $I_{NA}$ (Transformed)                    | $= b * dc^3 / 3 + m * A_s * (d - dc)^2$                             |
| Compressive stress in concrete $\sigma_c$ | $= M_{RARE} * dc / I_{NA}$  |
| Tensile stress in steel $\sigma_s$        | $= m * M_{RARE} * (d - dc) / I_{NA}$                                |

| <i>Description</i>                        | <i>Stress Check For Rare Combination</i> | <i>Stress Check For QP Combination</i> |
|---|--|--|
| Design Moment                             | = 6.63 Tm                                | = 2.31 Tm                              |
| Total Depth at section                    | = 0.35 m                                 | = 0.35 m                               |
| deff                                      | = 0.308 m                                | = 0.308 m                              |
| width b                                   | = 1 m                                    | = 1 m                                  |
| $A_{st, provided}$                        | = 1340.413 mm <sup>2</sup> /m            | = 1340.41 mm <sup>2</sup> /m           |
| Modular ratio                             | = 8.28                                   | = 12.86                                |
| dc (depth of neutral axis)                | = 72.35 mm                               | = 87.25 mm                             |
| $I_{NA}$ (Transformed)                    | = 7.43E+08 mm <sup>4</sup>               | = 1.06E+09 mm <sup>4</sup>             |
| Compressive stress in concrete $\sigma_c$ | = 6.46 N/mm <sup>2</sup>                 | = 1.90 N/mm <sup>2</sup>               |
| Permissible Compressive stress            | = 21.6 N/mm <sup>2</sup> OK              | = 16.2 N/mm <sup>2</sup> OK            |
| Tensile stress in steel $\sigma_s$        | = 174 N/mm <sup>2</sup>                  | = 62 N/mm <sup>2</sup>                 |

|                            |   |                          |   |                          |
|----------------------------|---|--------------------------|---|--------------------------|
| Permissible tensile stress | = | 300 N/mm <sup>2</sup> OK | = | 400 N/mm <sup>2</sup> OK |
|----------------------------|---|--------------------------|---|--------------------------|

### **(SLS) CHECK FOR CRACK WIDTH (QUASI PERMANENT LOAD COMBINATIONS)**

#### **Minimum Reinforcement for crack control :**

$$A_{s,min} = k_c k_{ct,eff} A_{ct} / \sigma_s \quad (IRC 112 / clause 12.3.3 (2))$$

For Web

$$k_c = 0.4 \text{ For Bending member}$$

$$h = 0.35 \text{ m}, \quad b = 1 \text{ m}$$

$$k = 1$$

$$f_{ct,eff} = f_{ctm}$$

$$= 3.28 \text{ Mpa}$$

$A_{ct}$  = Area of concrete within tensile zone just before the first crack form, section behaves elastically until the tensile fiber stress reaches  $f_{ctm}$ . hence Neutral axis depth will be considered for gross section

$$A_{ct} = b * h/2$$

$$= 0.175 \text{ m}^2$$

$\sigma_s$  = Maximum stress permitted in reinf. Immediately after formation of crack

$$= f_{yk}$$

$$= 500 \text{ Mpa}$$

$$A_{s,min} = 459 \text{ mm}^2/\text{m} < 1340 \text{ mm}^2/\text{m} \text{ OK}$$

#### **Calculation of Crack Width :** (IRC 112 / clause 12.3.4)

$$w_{k,max} = 0.3 \text{ mm}$$

Clear cover  $c = 50 \text{ mm}$

Bar dia  $\phi_{eq} = 16 \text{ mm}$

$$5 (c + \phi_{eq}/2) = 290 \text{ mm}$$

Spacing b/w bars = 150 mm < 290 mm

$s_{rmax}$  = Maximum crack spacing

=  $3.4c + 0.17 \phi / \rho_{Peff}$

= 348 mm

The Following formula can be used for calculation of maximum crack spacing.

$$h_{c,eff} = \text{Min} \begin{cases} 2.5 (h - d) \\ (h - x)/3 \\ h/2 \end{cases}$$

$$= 0.0876 \text{ m}$$

|     |   |           |                             |
|-----|---|-----------|-----------------------------|
| $h$ | = | 0.35 m    |                             |
| $d$ | = | 0.308 m   | */ (for Quasi               |
| $x$ | = | 0.08725 m | Permanent Load combination) |

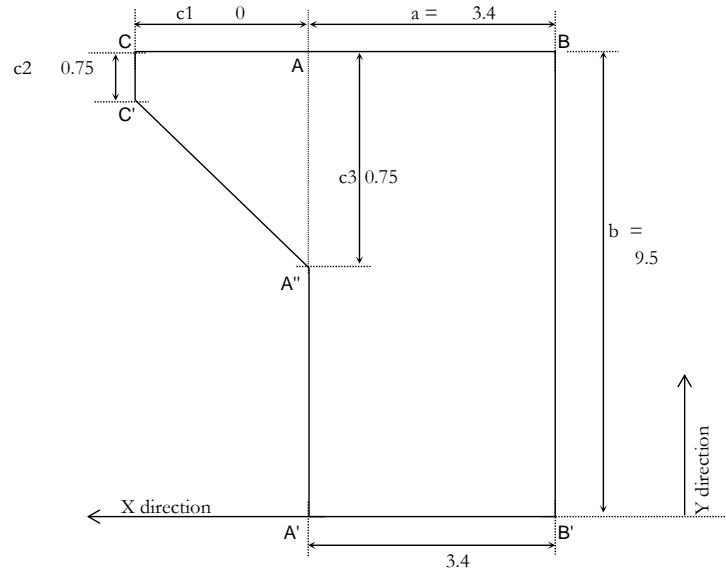
width  $b = 1 \text{ m}$

$$A_{c,eff} = h_{c,eff} * b = 0.0876 \text{ m}^2$$



|                                 |   |  |   |
|---------------------------------|---|--|---|
| $\rho_{P,eff}$                  | = | $A_s / A_{c,eff}$  |   |
|                                 | = | 1340 /   | 87584   |
|                                 | = | 0.015304   |   |
| $\sigma_{sc}$                   | = | Stress in tension Reinforcement assuming cracked section |   |
|                                 | = | 62 Mpa   | */ (for Quasi Permanent Load combination)   |
| $E_s$                           | = | 200000 Mpa   |   |
| $E_{cm}'$                       | = | 15549 Mpa  | */ (for Long term loading)  |
| $\alpha_e$                      | = | $E_s / E_{cm}$   |   |
| $\alpha_e$                      | = | 12.86  |   |
| $k_t$                           | = | 0.5  | (factor dependent on duration of load)  |
| $\epsilon_{sm} - \epsilon_{cm}$ | = | Max  | $\left\{ \frac{\sigma_{sc} - k_t f_{ct,eff} (1 + \alpha_e \rho_{P,eff}) / \rho_{P,eff}}{E_s} \right.$ |
|                                 |   |  | $\left. 0.6 \sigma_{sc} / E_s \right\}$   |
|                                 | = | 0.000186   |   |
| $w_k$                           | = | $s_{rmax} (\epsilon_{sm} - \epsilon_{cm})$               |   |
|                                 | = | 0.065 mm   | < 0.300 mm OK   |

## DESIGN OF RETURN WALL



Width of Solid return wall (a) = 3.4 m  
Height of Solid return wall (b) = 9.5 m

Width of Cantilever return wall c1 = 0 m  
Height of Cantilever return at Tip c2 = 0.75 m  
Height of Cantilever return taper c3-c2 = 0.00 m  
Height of Cantilever return at Root c3 = 0.75 m

Thickness of Solid Return at farther end t1 = 0.5 m  
Thickness of Solid Return at top t2 = 0.5 m  
Thickness of Solid Return at bottom t3 = 0.5 m  
Thickness of Cantilever return = 0.5 m  
Unit wt of Soil = 2.0 t/m<sup>3</sup>

a/b = 0.358

### Case (1) For Uniformly Distributed Load Over Entire Plate

|            |   |       |            |   |       |            |   |       |
|------------|---|-------|------------|---|-------|------------|---|-------|
| For a/b    | = | 0.25  | For a/b    | = | 0.375 | For a/b    | = | 0.358 |
| $\beta_1$  | = | 0.182 | $\beta_1$  | = | 0.353 | $\beta_1$  | = | 0.330 |
| $\beta_2$  | = | 0.188 | $\beta_2$  | = | 0.398 | $\beta_2$  | = | 0.369 |
| $\gamma_1$ | = | 0.572 | $\gamma_1$ | = | 0.671 | $\gamma_1$ | = | 0.657 |
| $\gamma_2$ | = | 0.264 | $\gamma_2$ | = | 0.413 | $\gamma_2$ | = | 0.393 |

Live Load Surcharge:

$$q = 0.307 \times 2 \times 1.2 = 0.737 \text{ t/m}^2$$

$$\sigma_{bmax} = \frac{\beta_1 \times q \times b^2}{t^2} = \frac{0.330 \times 0.737 \times 90.250}{0.25} = 87.67 \text{ t/m}^2$$

For 1000 mm of width

$$Z = \frac{1000 \times 250000}{6} = 4.17E+07 \text{ mm}^3 = 0.04167 \text{ m}^3$$

Hence Moment /m width along Y direction

$$M_Y / \text{m width} = 87.669 \times 0.042 = 3.653 \text{ t-m/m}$$

$$\sigma_{\text{amax}} = \frac{\beta_2 \times q \times b^2}{t^2} = \frac{0.369 \times 0.737 \times 90.250}{0.25} = 98.22 \text{ t/m}^2$$

For 1000 mm of width

$$Z = \frac{1000 \times 250000}{6} = 41666667 \text{ mm}^3 = 0.042 \text{ m}^3$$

Hence Moment /m width along X direction

$$M_X / \text{m width} = 98.218 \times 0.042 = 4.092 \text{ t-m/m}$$

#### Case (2) For Triangular Loading Due to Earth Pressure

|            |   |       |            |   |       |            |   |       |
|------------|---|-------|------------|---|-------|------------|---|-------|
| For a/b    | = | 0.25  | For a/b    | = | 0.375 | For a/b    | = | 0.358 |
| $\beta_1$  | = | 0.133 | $\beta_1$  | = | 0.212 | $\beta_1$  | = | 0.201 |
| $\beta_2$  | = | 0.09  | $\beta_2$  | = | 0.148 | $\beta_2$  | = | 0.140 |
| $\gamma_1$ | = | 0.423 | $\gamma_1$ | = | 0.419 | $\gamma_1$ | = | 0.420 |
| $\gamma_2$ | = | 0.151 | $\gamma_2$ | = | 0.205 | $\gamma_2$ | = | 0.198 |

Earth pressure:

$$q = 0.307 \times 2 \times 9.5 = 5.833 \text{ t/m}^2$$

$$\sigma_{\text{bmax}} = \frac{\beta_1 \times q \times b^2}{t^2} = \frac{0.201 \times 5.833 \times 90.250}{0.25} = 424 \text{ t/m}^2$$

For 1000 mm of width

$$Z = \frac{1000 \times 250000}{6} = 4.167E+07 \text{ mm}^3 = 0.042 \text{ m}^3$$

Hence Moment /m width along Y direction

$$M_Y / \text{m width} = 424 \times 0.042 = 17.652 \text{ t-m/m}$$

$$\sigma_{\text{amax}} = \frac{\beta_2 \times q \times b^2}{t^2} = \frac{0.140 \times 5.83 \times 90.25}{0.25} = 294.93 \text{ t/m}^2$$

For 1000 mm of width

$$Z = \frac{1000 \times 250000}{6} = 4.167 \text{E}+07 \text{ mm}^3$$

$$= 0.042 \text{ m}^3$$

Hence Moment /m width along X direction

$$M_X / \text{m width} = 294.933 \times 0.0417 = 12.289 \text{ t-m/m}$$

Total Moment in Solid Return /m height = 16.38 t-m/m Along X-direction

Total Moment in Solid Return /m width = 21.30 t-m/m Along Y-direction

**Forces at the cantilever return wall (AA') :**

| Forces at                   | Due to Earth Pressure  | Due to Surcharge Pressure                                   |
|-----------------------------|--|---|
| Force at CC'                | $1/2 \times 0.307 \times 2 \times 0.75^2$<br>= 0.173 t/m       | $0.307 \times 1.2 \times 2 \times 0.75$<br>= 0.553 t/m      |
| Force at AA''               | $1/2 \times 0.307 \times 2 \times 0.75^2$<br>= 0.173 t/m       | $0.307 \times 1.2 \times 2 \times 0.75$<br>= 0.553 t/m      |
| Total Force                 | $(0.173+0.173)/2 \times 0$<br>= 0.000 T                        | $(0.553+0.553)/2 \times 0$<br>= 0.000 T                     |
| Lever arm from AA''         | $(2 \times 0.1726875 + 0) / ( + 0)$<br>$\times 0 / 3$<br>= 0 m | $(2 \times 0.5526 + 0) / ( + 0) \times 0$<br>$/ 3$<br>= 0 m |
| Moment at Face AA''         | 0*0<br>0.000 Tm  | 0*0<br>0.000 Tm   |
| Moment at AA' per m /height | 0/0.75<br>= 0.000 tm/m   | 0/0.75<br>= 0.000 tm/m                                      |
|                             |  |   |

|   |                                  |                               |
|---|----------------------------------|-------------------------------|
| Lever arm from BB'  | 3.4 + 0<br>= 3.4 m               | 3.4 + 0<br>= 3.4 m            |
| Moment at Face BB'  | 0*3.4<br>= 0.000 Tm              | 0*3.4<br>= 0.000 Tm           |
| Moment at BB' per m /height<br>*/ Assumed 50% height is effective | 0/4.75<br>= 0.00 tm/m            | 0/4.75<br>= 0.00 tm/m         |
|   |                                  |                               |
| Lever arm from A'B'   | 9.5-(0.75+0.75)*2/3<br>= 8.500 m | 9.5-(0.75+0.75)/2<br>= 8.75 m |
| Moment at Face BB'  | 0*8.5<br>= 0.000 Tm              | 0*8.75<br>= 0.000 Tm          |
| Moment at AB' per m /width<br>*/ Assumed 50% width is effective   | 0/1.7<br>= 0.00 tm/m             | 0/1.7<br>= 0.00 tm/m          |

**Design Bending Moment at Face of Cantilever Return Wall (Horizontal Reinforcement):**

| Force due to                               | Unfactored<br>Bending Moment<br>at Face AA" | Load Factor |      |    |
|--|---|-------------|------|----|
|  |   | ULS         | SLS  |    |
|  |   |             | Rare | QP |
| Earth Pressure                             | 0.00 tm/m                                   | 1.5         | 1    | 1  |
| Surcharge Pressure                         | 0.00 tm/m                                   | 1.2         | 0.8  | 0  |
| ULS Design Bending moment = 0.00 Tm/m      |   |             |      |    |
| SLS Rare Design Bending moment = 0.00 Tm/m |   |             |      |    |
| SLS QP Design Bending moment = 0.00 Tm/m   |   |             |      |    |

**Design Forces for Solid Return wall:****Bending Moment At Face BB' (Horizontal Reinforcement)**

| Force due to                                   | Unfactored<br>Bending Moment<br>at Face BB' | Load Factor |      |    |
|--|---|-------------|------|----|
|  |   | ULS         | SLS  |    |
|  |   |             | Rare | QP |
| Earth Pressure From cantilever return wall     | 0.00 tm/m                                   | 1.5         | 1    | 1  |
| Earth Pressure over solid return wall          | 12.289 tm/m                                 | 1.5         | 1    | 1  |
| Surcharge Pressure From cantilever return wall | 0.00 tm/m                                   | 1.2         | 0.8  | 0  |
| Surcharge Pressure over solid return wall      | 4.092 tm/m                                  | 1.2         | 0.8  | 0  |
| ULS Design Bending moment = 23.34 Tm           |   |             |      |    |
| SLS Rare Design Bending moment = 15.56 Tm      |   |             |      |    |
| SLS QP Design Bending moment = 12.29 Tm        |   |             |      |    |

**Design Bending Moment At Face A'B' (Vertical Reinforcement)**

| Force due to                                   | Unfactored<br>Bending Moment<br>at Face A'B' | Load Factor |      |    |
|--|--|-------------|------|----|
|  |  | ULS         | SLS  |    |
|  |  |             | Rare | QP |
| Earth Pressure From cantilever return wall     | 0.00 tm/m                                    | 1.5         | 1    | 1  |
| Earth Pressure over solid return wall          | 17.65 tm/m                                   | 1.5         | 1    | 1  |
| Surcharge Pressure From cantilever return wall | 0.00 tm/m                                    | 1.2         | 0.8  | 0  |
| Surcharge Pressure over solid return wall      | 3.65 tm/m                                    | 1.2         | 0.8  | 0  |
| ULS Design Bending moment = 30.86 Tm           |  |             |      |    |
| SLS Rare Design Bending moment = 20.57 Tm      |  |             |      |    |
| SLS QP Design Bending moment = 17.65 Tm        |  |             |      |    |

**SHEAR FORCE CALCULATION FOR RETURN WALL :***Case (1) For uniformly distributed load over entire plate*

$$R1 = \gamma_1 q_b = 0.657 \times 0.737 \times 9.5 = 4.60 \text{ t-m/m}^2$$

$$R2 = \gamma_2 q_b = 0.393 \times 0.737 \times 9.5 = 2.75 \text{ t-m/m}^2$$

*Case (2) For Triangular loading due to earth pressure*

$$R1 = \gamma_1 q_b = 0.420 \times 5.833 \times 9.5 = 23.25 \text{ t-m/m}^2$$

$$R2 = \gamma_2 q_b = 0.198 \times 5.833 \times 9.5 = 10.95 \text{ t-m/m}^2$$

*Design Shear Force At Face A'B' (Vertical Reinforcement)*

| Force due to  | Unfactored<br>Bending Moment<br>at Face A'B' | ULS Load Factor |
|---|--|-----------------|
| Earth Pressure over solid return wall               | 23.25 tm/m                                   | 1.50            |
| Surcharge Pressure over solid return wall           | 4.60 tm/m                                    | 1.20            |
| Design Shear Force $V_{ED} = 40.40 \text{ t-m/m}^2$ |  |                 |

*Design Shear Force At Face A'B' (Vertical Reinforcement)*

| Force due to  | Unfactored<br>Bending Moment<br>at Face BB' | ULS Load Factor |
|---|---|-----------------|
| Earth Pressure over solid return wall               | 10.95 tm/m                                  | 1.50            |
| Surcharge Pressure over solid return wall           | 2.75 tm/m                                   | 1.20            |
| Design Shear Force $V_{ED} = 19.72 \text{ t-m/m}^2$ |   |                 |

### DESIGN OF RETURN WALL :

#### MATERIAL PROPERTIES :

|   |   |    |            |
|---|---|----|------------|
| Grade of concrete                               | = | M  | 30 MPa     |
| Grade of Reinforcement                          | = | Fe | 500 MPa    |
| fywd = 0.8 fyk                                  | = |    | 400 MPa    |
| Clear cover                                     | = |    | 75 mm      |
| Modulus of Elasticity steel Es                  | = |    | 200000 Mpa |
| For short Term loading Ecm                      | = |    | 34313 Mpa  |
| For long Term loading Ecm'                      | = |    | 17156 Mpa  |
| f <sub>cteff</sub> Mean tensile strength = fctm | = |    | 3.28 Mpa   |
| fed   | = |    | 20.10 Mpa  |
| Creep factor $\phi$                             | = |    | 1.00       |
| $\epsilon_{uk}$                                 | = |    | 0.0025     |
| $\epsilon_{ud}$                                 | = |    | 0.0022     |
| $\epsilon_{cu2}$                                | = |    | 0.0035     |
| $x_{u,max}/d$                                   | = |    | 0.6167     |

#### PERMISSIBLE STRESSES

##### 1) Permissible concrete compressive stresses

| Load Combi | Permissible Stress |            |
|------------|--------------------|------------|
| SLS Rare   | 0.48 fck           | = 14.4 Mpa |
| SLS QP     | 0.36 fck           | = 10.8 Mpa |

2) Permissible Tensile stress in steel (Rare) = 0.6 fy = 300 Mpa

Permissible Tensile stress in steel (QLS) = 0.8 fy = 400 Mpa

##### 3) Permissible crack width w<sub>k</sub>

SLS QP Load combination = 0.3 mm

#### A) ULS CAPACITY CHECK

| Load comb.                               | M <sub>ED</sub> | b    | Overall<br>depth D | d   | Area of steel provided |         |  | x <sub>max</sub> | xu = 0.87 fyk<br>Ast / 0.362 fck<br>b | Check  | Λ <sub>st,calc</sub> = M / 0.87<br>fyk (d'-0.416<br>xu) | Check   | Λ <sub>st min</sub> | Check   | ΔF <sub>d</sub> | z = d-<br>0.416 xu | M <sub>ED</sub> /z<br>+ΔF <sub>D</sub> | M <sub>Rd</sub> =0.87 fyk<br>Ast (d-0.416<br>xu) | M <sub>RD</sub> /z | Check   |
|--|-----------------|------|--------------------|-----|------------------------|---------|--|------------------|---------------------------------------|--------|---|---|---------------------|---|-----------------|--------------------|--|--|--------------------|---|
|  | Tm              | mm   | mm                 | mm  | Dia                    | Spacing | Λ <sub>st</sub> ,<br>Provided<br>mm <sup>2</sup> |                  |                                       |        |   | Λ <sub>st</sub> Cal.c ≤ Λ <sub>st</sub><br>Provided |                     | Λ <sub>st</sub> provided > Λ <sub>st</sub><br>min |                 |                    |  |  |                    | M <sub>Rd</sub> /z<br>^<br>M <sub>ED</sub> /z + ΔF <sub>D</sub> |
|  |                 |      |                    |     |                        |         |  |                  |                                       |        |   |   |                     |   |                 |                    |  |  |                    |   |
| Face of cantilever wing wall<br>ULS BM   | 0.00            | 1000 | 500                | 419 | 12                     | 100     | 1131   | 258              | 45                                    | UR, OK | 0   | OK  | 628.5               | OK  | 0.00            | 400                | 0                                      | 20   | 49                 | OK  |
| Design of Section At Face BB''<br>ULS BM | 23.34           | 1000 | 500                | 415 | 20                     | 100     | 3142   | 256              | 126                                   | UR, OK | 1480  | OK  | 623                 | OK  | 0.00            | 363                | 64                                     | 50   | 137                | OK  |
| Design of Section At Face AB''<br>ULS BM | 30.86           | 1000 | 500                | 413 | 25                     | 100     | 4909   | 254              | 197                                   | UR, OK | 2145  | OK  | 619                 | OK  | 0.00            | 331                | 93                                     | 71   | 214                | OK  |



## B) SLS STRESS CHECK

Rare Load combination.

$$E_{c,eq} = \frac{E_{cm} * (M_{QP} + M_{ST})}{M_{ST} + (1 + \phi) * M_{QP}}$$

$$M_{ST} = M_{RARE} - M_{QP}$$

$$m = E_s / E_{c,eq}$$

Quasi Permanent Load Combination

$$m = E_s / E_{cm}'$$

| Formula used for calculation of stress    |   |
|---|---|
| dc (depth of neutral axis)                | $= \frac{-m * A_s + \sqrt{(m^2 * A_s^2 + 2 * m * A_s * b * d)}}{b}$ |
| $I_{NA}$ (Transformed)                    | $= b * dc^3 / 3 + m * A_s * (d - dc)^2$                             |
| Compressive stress in concrete $\sigma_c$ | $= M_{RARE} * dc / I_{NA}$  |
| Tensile stress in steel $\sigma_s$        | $= m * M_{RARE} * (d - dc) / I_{NA}$                                |

Stress Check for SLS Load Combinations

| Load comb.                                  | M<br>(tm/m) | b<br>mm | d<br>mm | $A_{st,}$<br>Provided<br>mm <sup>2</sup> | modular<br>ratio | N.A.<br>depth<br>(dc)<br>mm | $I_{NA}$<br>mm <sup>4</sup> | Comp<br>stress<br>Mpa | Max C.<br>Stress<br>Mpa | Check | Tensile<br>stress<br>Mpa | Max T<br>Stress<br>Mpa | Check |
|---|-------------|---------|---------|--|------------------|-----------------------------|-----------------------------|-----------------------|-------------------------|-------|--------------------------|------------------------|-------|
| <i>Face of cantilever wing wall</i>         |             |         |         |  |                  |                             |                             |                       |                         |       |                          |                        |       |
| SLS (R Comb.)                               | 0.00        | 1000    | 419     | 1131                                     | 5.83             | 68.02                       | 9E+08                       | 0.00                  | 14.4                    | OK    | 0.00                     | 300                    | OK    |
| SLS (QP Comb.)                              | 0.00        | 1000    | 419     | 1131                                     | 11.66            | 92.75                       | 2E+09                       | 0.00                  | 10.8                    | OK    | 0.00                     | 400                    | OK    |
| <i>Section at deff from face of colonne</i> |             |         |         |  |                  |                             |                             |                       |                         |       |                          |                        |       |
| SLS (R Comb.)                               | 15.56       | 1000    | 415     | 3142                                     | 10.43            | 135.38                      | 3E+09                       | 6.22                  | 14.4                    | OK    | 134                      | 300                    | OK    |
| SLS (QP Comb.)                              | 12.29       | 1000    | 415     | 3142                                     | 11.66            | 141.53                      | 4E+09                       | 4.72                  | 10.8                    | OK    | 106                      | 400                    | OK    |
| <i>Section just below bearing</i>           |             |         |         |  |                  |                             |                             |                       |                         |       |                          |                        |       |
| SLS (R Comb.)                               | 20.57       | 1000    | 413     | 4909                                     | 10.83            | 162.90                      | 5E+09                       | 7.05                  | 14.4                    | OK    | 117                      | 300                    | OK    |
| SLS (QP Comb.)                              | 17.65       | 1000    | 413     | 4909                                     | 11.66            | 167.46                      | 5E+09                       | 5.91                  | 10.8                    | OK    | 101                      | 400                    | OK    |

**C) SLS CRACK WIDTH CHECK (QUASI PERMANENT LOAD COMBINATION)**

**1) CHECK  $A_{st,min}$  for crack control**

| Load comb.                           | b    | h   | d   | Act =bh/2       | σs = fyk | k    | kc  | A <sub>s,min</sub> =k <sub>c</sub> k f <sub>ct,eff</sub> | A <sub>s,provided</sub> | check |
|--------------------------------------|------|-----|-----|-----------------|----------|------|-----|--|-------------------------|-------|
|                                      | mm   | mm  | mm  | mm <sup>2</sup> | Mpa      |      |     | A <sub>ct</sub> / σ <sub>s</sub>                         |                         |       |
|                                      | mm   | mm  | mm  | mm <sup>2</sup> | Mpa      |      |     | mm <sup>2</sup>  | mm <sup>2</sup>         |       |
| Section at face of columne           |      |     |     |                 |          |      |     |  |                         |       |
| SLS QP                               | 1000 | 500 | 349 | 250000          | 500      | 0.86 | 0.4 | 564  | 1131                    | OK    |
| Section at deff from face of columne |      |     |     |                 |          |      |     |  |                         |       |
| SLS QP                               | 1000 | 500 | 345 | 250000          | 500      | 0.86 | 0.4 | 564  | 3142                    | OK    |
| Section just below bearing           |      |     |     |                 |          |      |     |  |                         |       |
| SLS QP                               | 1000 | 500 | 343 | 250000          | 500      | 0.86 | 0.4 | 564  | 4909                    | OK    |

| h   | k    |
|-----|------|
| 0   | 1    |
| 0.3 | 1    |
| 0.8 | 0.65 |
| 3   | 0.65 |
|     |      |

**2) CHECK FOR MAXIMUM SPACING b/w bars.**

| Load comb.                                   | Bar dia     | cover | Spacing b/w bars |            | Check |
|--|-------------|-------|------------------|------------|-------|
|  |             |       | Provided         | Calculated |       |
|  | $\phi_{eq}$ | c     | mm               | mm         |       |
| <i>Section at face of columnne</i>           |             |       |                  |            |       |
| SLS QP                                       | 12          | 75    | 100              | 405        | OK    |
| <i>Section at deff from face of columnne</i> |             |       |                  |            |       |
| SLS QP                                       | 12          | 75    | 100              | 405        | OK    |
| <i>Section just below bearing</i>            |             |       |                  |            |       |
| SLS QP                                       | 12          | 75    | 100              | 405        | OK    |

### 3) CHECK FOR CRACK WIDTH

| Load comb.                                     | $h_{c,eff} = \text{Min} [ 2.5 ( h - d ) , ( h - x/3 ) , h/2 ]$ | $A_{c,eff} = h_{c,eff} * b$ | $A_{s,provided}$ | $\rho_{peff} = A_s / A_{c,eff}$ | $s_{max} = 3.4c + 0.17 \phi / \rho_{peff}$ | $\sigma_{sc}$ | $x = \text{neutral axis depth}$ | kt  | $\alpha_e = E_s / E_{cm}$ | $\epsilon_{sm} - \epsilon_{cm} = \text{Max} [ [ \sigma_{sc} - k_t f_{ct,eff} ( 1 + \alpha_e \rho_{peff} ) / \rho_{peff} ] / E_s , 0.6 \sigma_{sc} / E_s ]$ | $w_k$ | check |
|--|--|-----------------------------|------------------|---------------------------------|--|---------------|---------------------------------|-----|---------------------------|--|-------|-------|
|  | mm   | mm <sup>2</sup>             | mm <sup>2</sup>  |                                 | mm   | Mpa           | mm                              |     |                           |  |       |       |
| Section at face of columne<br>SLS QP           | 250  | 250000                      | 1130.97          | 0.005                           | 705.939                                    | 0.00          | 92.75                           | 0.5 | 11.66                     | 0  | 0.000 | OK    |
| Section at deff from face of columne<br>SLS QP | 250  | 250000                      | 3142             | 0.013                           | 417.338                                    | 106.35        | 141.53                          | 0.5 | 11.66                     | 0.0003   | 0.133 | OK    |
| Section just below bearing<br>SLS QP           | 250  | 250000                      | 4908.74          | 0.020                           | 358.896                                    | 100.82        | 167.46                          | 0.5 | 11.66                     | 0.0003   | 0.109 | OK    |

### D) CHECK FOR SHEAR: (IRC 112 / clause 10.3.2 (2) )

Check of Shear Reinforcement Requirement

| Load comb.          | $V_{ED}$ | $\beta$ | $\beta V_{ED}$ | d      | bw   | $k = \text{Min} [ 1 + \sqrt{200/d} , 2 ]$ | $A_{sl}$        | $\rho 1 = \text{Min} [ A_{sl} / bw d , 0.02 ]$ | $v_{min} = 0.031 k^{3/2} f_{ck}^{1/2}$ | $\sigma_{cp}$ | $V_{kac} = \text{Max} [ ( 0.12 k ( 80 \rho 1 f_{ck} )^{0.33} + 0.15 \sigma_{cp} ) bw d , ( v_{min} + 0.15 \sigma_{cp} ) bw d ]$ | Check                    |
|---------------------|----------|---------|----------------|--------|------|---|-----------------|--|--|---------------|---|--------------------------|
|                     | T        |         | T              | mm     | mm   |   | mm <sup>2</sup> |  |  | Mpa           | Tonne   |                          |
| At face BB'<br>ULS  | 19.72    | 0.25    | 4.93           | 419    | 1000 | 1.69                                      | 1130.97         | 0.0027   | 0.373                                  | 0             | 15.75   | No Shear reinf. Required |
| At face A'B'<br>ULS | 40.40    | 0.25    | 10.10          | 415.00 | 1000 | 1.69                                      | 3141.59         | 0.0076   | 0.374                                  | 0             | 21.97   | No Shear reinf. Required |

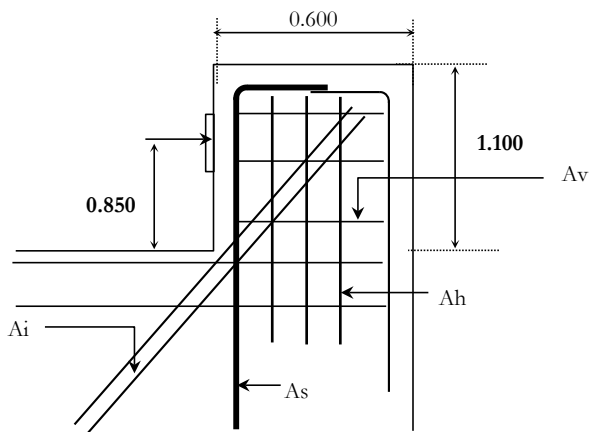
| <b>Check for Maximum Shear Capacity :</b> |          |      |     |            |               |     |   |       | $\theta = 0.5 \sin^{-1} \left[ \frac{2 * V_{NS}}{(\alpha_{cw} * b_w * z * v1 * f_{cd})} \right]$ | $\theta$ adopted | $\Delta F_d = 0.5 V_{ED} \cot \theta$ |
|---|----------|------|-----|------------|---------------|-----|---|-------|--|------------------|---------------------------------------|
| Load comb.                                | $V_{ED}$ | bw   | d   | $z = 0.9d$ | $\alpha_{cw}$ | v1  | $V_{edmax} = \alpha_{cw} * b_w * z * v1 * f_{cd} / 2$ | Check |  |                  |                                       |
|   | T        | mm   | mm  | mm         |               |     | Tonne   |       | deg  | deg              | T                                     |
| At face A'B<br>ULS                        | 19.72    | 1000 | 419 | 377.1      | 1             | 0.6 | 227   | OK    | 2.49   | 45               | 9.86                                  |
| At face BB'<br>ULS                        | 40.40    | 1000 | 415 | 374        | 1             | 0.6 | 225   | OK    | 5.17   | 45               | 20.20                                 |

$\Delta F_d$  = Additional Tensile force, to be accounted in longitudinal reinforcement

## Design of Seismic Stopper in Transverse Direction

### Stopper Details :

|                              |   |           |
|------------------------------|---|-----------|
| Width of stopper             | = | 1020 mm   |
| Overall depth h              | = | 600 mm    |
| Clear cover to Reinforcement | = | 50 mm     |
| Dia of main reinforcement    | = | 32 mm     |
| Effective Depth provided d   | = | 534 mm    |
| Shear span $a_v$             | = | 850 mm    |
| $a_v/d$                      | = | 1.592 > 1 |
| Design as Flexural Member    |   |           |



### Material properties :

|                        |                     |   |          |
|------------------------|---------------------|---|----------|
| Grade of concrete      | $f_{ck}$            | = | 45 Mpa   |
|                        | $f_{cd}$            | = | 20.1 Mpa |
| Grade of reinforcement | $f_y$               | = | 500 Mpa  |
|                        | $f_{yd} = 0.87 f_y$ | = | 435 Mpa  |

### Design Load calculation :

|  |   |              |
|--|---|--------------|
| Seismic Zone   | = | V            |
| Type of soil   | = | medium       |
| Zone factor Z  | = | 0.36         |
| Importance factor I  | = | 1.2          |
| Sa/g -Transverse Seismic Case                                | = | 1            |
| Seis. Coeff. -Trans., $A_{hT} = (Z/2)*(I)*(Sa/g)_{(Trans.)}$ | = | 0.216        |
| Response Reduction Factor, $R_{trans.}$                      | = | 1            |
| Design Seis. Coeff. -Trans. $A_{hT} = A_h'/R_{(Trans.)}$     | = | 0.216        |
| Total weight of super-structure DL+SIDL                      | = | 1100 Tonne   |
| Seismic Component in Transverse direction                    | = | 238 Tonne    |
| Total Horizontal force                                       | = | 238 Tonne    |
| Nos. of Stopper sharing loads                                | = | 2 Nos        |
| Horizontal force over each stopper                           | = | 118.79 Tonne |
| Unfactored Vertical force V                                  | = | 118.79 Tonne |
| Unfactored Horizontal Force H                                | = | 23.76 Tonne  |
| Load factor  | = | 1.5          |
| Factored Vertical Load $V_u$                                 | = | 178.19 T     |
| Factored Horizontal Force $H_u$                              | = | 35.64 T      |
| Lever arm  | = | 2140.85 mm   |

**Design of Stopper :**

|                       |          |                            |                                     |
|-----------------------|----------|----------------------------|-------------------------------------|
| Design Bending Moment | $M_{ED}$ | =                          | 151.46 Tm                           |
| D                     | =        | 0.6 m                      | */ overall depth at face of support |
| d                     | =        | 0.534 m                    | */ deff at face of support          |
| Clear Cover           | =        | 50 mm                      |                                     |
| Ast Provided          | =        | 32 $\phi$ @ 10 Nos         |                                     |
|                       | =        | 8042 mm <sup>2</sup> /m    |                                     |
|                       | =        | 1.506 %                    |                                     |
| Grade of Concrete fck | =        | 45 Mpa                     |                                     |
| Grade of steel fyk    | =        | 500 Mpa                    |                                     |
| xu                    | =        | 0.87 fyk Ast / 0.362 fck b |                                     |
|                       | =        | 211 mm                     |                                     |
| x <sub>umax</sub>     | =        | 0.609 d'                   |                                     |
|                       | =        | 325 mm                     | UNDER REINFORCED                    |
| Ast calculated        | =        | M/ 0.87 fyk (d'-0.416 xu)  |                                     |
|                       | =        | 7800 mm <sup>2</sup> /m    |                                     |
| Ast minimum           | =        | 0.15% * b*d                |                                     |
|                       | =        | 918 mm <sup>2</sup> /m     |                                     |
| Ast required          | =        | Max( 7800 , 918 )          |                                     |
|                       | =        | 7800 mm <sup>2</sup> /m    | < 8042 mm <sup>2</sup> /m OK        |

**(ULS) CHECK FOR SHEAR FORCE**

$$\text{Factored Shear Force } V_{ED} = 178.2 \text{ T/m}$$

$$\begin{aligned} \text{Reduction factor } \beta_1 &= a_v/2d \\ &= 1 \quad \text{*/ no reduction is applied} \end{aligned}$$

$$\begin{aligned} \text{Design Shear Force } V_{NS}' &= \beta_1 * V_{NS} \\ &= 178.19 \text{ Tonne} \end{aligned}$$

**Max Shear Capacity of section**

$$\begin{aligned} v &= 0.6 * (1 - f_{ck} / 310) \quad \text{*/ } f_{ck} \text{ in mm} \\ &= 0.513 \end{aligned}$$

$$\begin{aligned} f_{cd} &= 20.10 * f_{ck} \\ &= 905 \text{ Mpa} \end{aligned}$$

$$\begin{aligned} V_{RDC, \max} &= 0.5 b_w d v f_{cd} \\ &= 12634 \text{ Tonne} > 178.2 \text{ Tonne} \quad \text{OK} \end{aligned}$$

$$\begin{aligned} D &= 0.6 \text{ m} \quad \text{*/ overall depth at face of support} \\ d &= 0.534 \text{ m} \quad \text{*/ deff at face of support} \end{aligned}$$

**Check for Design Shear Reinforcement :**

$$k = \text{Min} \left\{ \begin{array}{l} 1 + \sqrt{200/d} \\ 2 \end{array} \right. \quad d \text{ is depth in mm}$$

$$k = 1.612$$

$$\rho_1 = \text{Min} \left\{ \begin{array}{l} A_{sl} / b_w d \\ 0.02 \end{array} \right.$$

$$\rho_1 = 0.0148$$

$$\sigma_{cp} = 0 \text{ Mpa}$$

$$\begin{aligned} v_{\min} &= 0.031 k^{3/2} f_{ck}^{1/2} \\ &= 0.426 \end{aligned}$$

$$V_{Rdc} = \text{Max} \left\{ \begin{array}{l} (0.12 k (80 \rho_1 f_{ck})^{0.33} + 0.15 \sigma_{cp}) b_w d \\ (v_{\min} + 0.15 \sigma_{cp}) b_w d \end{array} \right. \quad (\text{IRC 112 / clause 10.3.2 (2)})$$

$$= 39.1 \text{ Tonne} < 178.2 \text{ Tonne} \quad \text{PROVIDE DESIGN SHEAR REINF.}$$

***FINDING VALUE OF  $\theta$  AT DESIGN SECTIONS FOR DESIGN SHEAR REINFORCEMENT***

$$\begin{aligned} V_{Rd\max} &= V_{NS} \\ \theta &= 0.5 \sin^{-1} (2 V_{NS} / \alpha_{cw} b_w z v_1 f_{cd}) \\ &= 0.39 \text{ deg} \end{aligned}$$

$$\theta \text{ adopted} = 45 \text{ deg}$$

|               |   |           |
|---------------|---|-----------|
| $\alpha_{cw}$ | = | 1         |
| $v_1$         | = | 0.6       |
| $z$           | = | $0.9 * d$ |
|               | = | 0.481 m   |

***FINDING DESIGN SHEAR REINFORCEMENT REQUIREMENT***

$$V_{NS} = V_{Rds} = (A_{sw}/s) * z * f_{ywd} * \cot \theta \quad (\text{IRC 112 / clause 10.3.3.2 Eq 10.7})$$

$$A_{sw} = V_{NS} * s / z f_{ywd} \cot \theta$$

$$f_{ywd} = 0.8 f_{yk} / \gamma_s$$

$$f_{ywd} = 348 \text{ Mpa}$$

$$A_{sw} = 1066 \text{ mm}^2$$

|            |   |      |
|------------|---|------|
| $\gamma_s$ | = | 1.15 |
|------------|---|------|

**Minimum shear reinforcement (IRC 112 / clause 10.3.3.5 Eq 10.20)**

$$A_{sw, \min} = \rho_{w, \min} * s * b_w$$

$$\rho_{w, \min} = (0.072 \sqrt{f_{ck}}) / f_{yk}$$

$$= 0.00097$$

$$A_{sw, \min} = 97 \text{ mm}^2$$

$$\text{Provide } 16 \text{ dia } 6 \text{ legged stp. /m @ } 100 \text{ c/c} \quad \text{216}$$

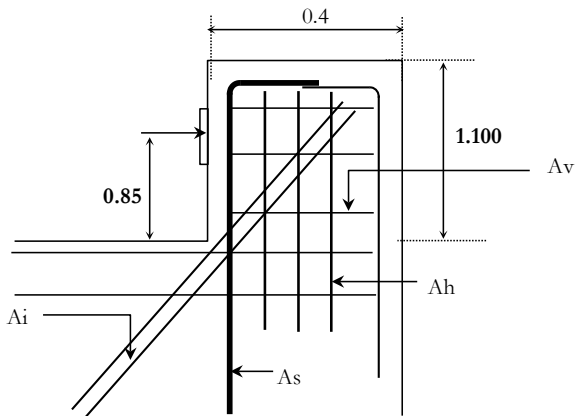
$\Rightarrow$  1206 mm<sup>2</sup> @ 100 mm c/c > 1066 mm<sup>2</sup> OK



## Design of Seismic Stopper in Longitudinal direction action in Dirt Wall

### Stopper Details :

|                              |   |           |
|------------------------------|---|-----------|
| Width of stopper             | = | 800 mm    |
| Overall depth h              | = | 400 mm    |
| Clear cover to Reinforcement | = | 50 mm     |
| Dia of main reinforcement    | = | 32 mm     |
| Effective Depth provided d   | = | 334 mm    |
| Shear span $a_v$             | = | 850 mm    |
| $a_v/d$                      | = | 2.545 > 1 |
| Design as Flexural Member    |   |           |



### Material properties :

|                        |                     |   |          |
|------------------------|---------------------|---|----------|
| Grade of concrete      | $f_{ck}$            | = | 45 Mpa   |
|                        | $f_{cd}$            | = | 20.1 Mpa |
| Grade of reinforcement | $f_y$               | = | 500 Mpa  |
|                        | $f_{yd} = 0.87 f_y$ | = | 435 Mpa  |

### Design Load calculation :

|   |   |             |
|---|---|-------------|
| Seismic Zone  | = | V           |
| Type of soil  | = | medium      |
| Zone factor Z   | = | 0.36        |
| Importance factor I   | = | 1.2         |
| Sa/g -Transverse Seismic Case                                     | = | 1           |
| Seis. Coeff. -Trans., $A_{hT} = (Z/2) * (I) * (S_a/g)_{(Trans.)}$ | = | 0.216       |
| Response Reduction Factor, $R_{trans.}$                           | = | 1           |
| Design Seis. Coeff. -Trans. $A_{hT} = A_h' / R_{(Trans.)}$        | = | 0.216       |
| Total weight of super-structure DL+SIDL                           | = | 1100 Tonne  |
| Seismic Component in Transverse direction                         | = | 238 Tonne   |
| Total Horizontal force  | = | 238 Tonne   |
| Nos. of Stopper sharing loads                                     | = | 4 Nos       |
| Horizontal force over each stopper                                | = | 59.40 Tonne |
| Unfactored Vertical force V                                       | = | 59.40 Tonne |
| Unfactored Horizontal Force H                                     | = | 11.88 Tonne |
| Load factor   | = | 1.5         |
| Factored Vertical Load $V_u$                                      | = | 89.09 T     |
| Factored Horizontal Force $N_u$                                   | = | 17.82 T     |
| Lever arm   | = | 0.85 m      |
| LL Dispersion in Dirt Wall through Girder                         | = | 1.4 m       |

**Design of Stopper :**

|                       |          |   |                                     |
|-----------------------|----------|---|-------------------------------------|
| Design Bending Moment | $M_{ED}$ | =   | 54.09 Tm                            |
| D                     | =        | 0.4 m   | */ overall depth at face of support |
| d                     | =        | 0.334 m   | */ deff at face of support          |
| Clear Cover           | =        | 50 mm   |                                     |
| Ast Provided          | =        | 32 $\phi$ @ 6 Nos                                 |                                     |
|                       | =        | 4825 mm <sup>2</sup> /m                           |                                     |
|                       | =        | 1.445 %   |                                     |
| Grade of Concrete fck | =        | 45 Mpa  |                                     |
| Grade of steel fyk    | =        | 500 Mpa   |                                     |
| xu                    | =        | 0.87 fyk Ast / 0.362 fck b                        |                                     |
|                       | =        | 161 mm  |                                     |
| x <sub>umax</sub>     | =        | 0.609 d'  |                                     |
|                       | =        | 203 mm  | UNDER REINFORCED                    |
| Ast calculated        | =        | M/ 0.87 fyk (d'-0.416 xu)                         |                                     |
|                       | =        | 4657 mm <sup>2</sup> /m                           |                                     |
| Ast minimum           | =        | 0.15% * b*d                                       |                                     |
|                       | =        | 480 mm <sup>2</sup> /m                            |                                     |
| Ast required          | =        | Max( 4657 , 480 )                                 |                                     |
|                       | =        | 4657 mm <sup>2</sup> /m < 4825 mm <sup>2</sup> /m | OK                                  |

**(ULS) CHECK FOR SHEAR FORCE**

$$\text{Factored Shear Force } V_{ED} = 89.1 \text{ T/m}$$

$$\begin{aligned} \text{Reduction factor } \beta_1 &= \frac{a_v}{2d} \\ &= 1 \quad \text{*/ no reduction is applied} \end{aligned}$$

$$\begin{aligned} \text{Design Shear Force } V_{NS}' &= \beta_1 * V_{NS} \\ &= 89.09 \text{ Tonne} \end{aligned}$$

**Max Shear Capacity of section**

$$\begin{aligned} v &= 0.6 * (1 - f_{ck} / 310) \quad \text{*/ } f_{ck} \text{ in mm} \\ &= 0.513 \end{aligned}$$

$$\begin{aligned} f_{cd} &= 20.10 * f_{ck} \\ &= 905 \text{ Mpa} \end{aligned}$$

$$\begin{aligned} V_{RDC, \max} &= 0.5 b_w d v f_{cd} \\ &= 6198 \text{ Tonne} > 89.1 \text{ Tonne} \quad \text{OK} \end{aligned}$$

$$\begin{aligned} D &= 0.4 \text{ m} \quad \text{*/ overall depth at face of support} \\ d &= 0.33 \text{ m} \quad \text{*/ deff at face of support} \end{aligned}$$

**Check for Design Shear Reinforcement :**

$$\begin{aligned} k &= \text{Min} \left\{ \begin{array}{l} 1 + \sqrt{200/d} \\ 2 \end{array} \right. \quad d \text{ is depth in mm} \\ k &= 1.774 \end{aligned}$$

$$\begin{aligned} \rho_1 &= \text{Min} \left\{ \begin{array}{l} A_{sl} / b_w d \\ 0.02 \end{array} \right. \\ \rho_1 &= 0.0181 \end{aligned}$$

$$\sigma_{cp} = 0 \text{ Mpa}$$

$$\begin{aligned} v_{\min} &= 0.031 k^{3/2} f_{ck}^{1/2} \\ &= 0.491 \end{aligned}$$

$$\begin{aligned} V_{Rdc} &= \text{Max} \left\{ \begin{array}{l} (0.12 k (80 \rho_1 f_{ck})^{0.33} + 0.15 \sigma_{cp}) b_w d \\ (v_{\min} + 0.15 \sigma_{cp}) b_w d \end{array} \right. \quad (\text{IRC 112 / clause 10.3.2 (2)}) \\ &= 22.6 \text{ Tonne} < 89.1 \text{ Tonne} \quad \text{PROVIDE DESIGN SHEAR REINF.} \end{aligned}$$

***FINDING VALUE OF  $\theta$  AT DESIGN SECTIONS FOR DESIGN SHEAR REINFORCEMENT***

$$\begin{aligned} V_{Rd\max} &= V_{NS} \\ \theta &= 0.5 \sin^{-1} (2 V_{NS} / \alpha_{cw} b_w z v_1 f_{cd}) \\ &= 0.31 \text{ deg} \\ \theta \text{ adopted} &= 45 \text{ deg} \end{aligned}$$

|               |   |         |
|---------------|---|---------|
| $\alpha_{cw}$ | = | 1       |
| $v_1$         | = | 0.6     |
| $z$           | = | 0.9*d   |
|               | = | 0.301 m |

***FINDING DESIGN SHEAR REINFORCEMENT REQUIREMENT***

$$\begin{aligned} V_{NS} &= V_{Rds} = (A_{sw}/s) * z * f_{ywd} * \cot \theta \quad (\text{IRC 112 / clause 10.3.3.2 Eq 10.7}) \\ A_{sw} &= V_{NS} * s / z f_{ywd} \cot \theta \\ f_{ywd} &= 0.8 f_{yk} / \gamma_s \\ f_{ywd} &= 348 \text{ Mpa} \\ A_{sw} &= 1193 \text{ mm}^2 \end{aligned}$$

|            |   |      |
|------------|---|------|
| $\gamma_s$ | = | 1.15 |
|------------|---|------|

**Minimum shear reinforcement (IRC 112 / clause 10.3.3.5 Eq 10.20)**

$$\begin{aligned} A_{sw, \min} &= \rho_{w, \min} * s * b_w \\ \rho_{w, \min} &= (0.072 \sqrt{f_{ck}}) / f_{yk} \\ &= 0.00097 \\ A_{sw, \min} &= 135.2 \text{ mm}^2 \end{aligned}$$

$$\begin{aligned} \text{Provide } 20 \text{ dia } 4 \text{ legged stp. / m @ } 140 \text{ c/c} & \quad 220 \\ \Rightarrow 1257 \text{ mm}^2 @ 140 \text{ mm c/c} & > 1193 \text{ mm}^2 \quad \text{OK} \end{aligned}$$

## *Design of Pier P1 of Major Bridge*

| Sr.N o. | Chainage |
|---------|----------|
| 1       | 2+645    |

| BASIC DESIGN DATA  |                         |   |  |  |  |          |                  |                              |                        |  |
|--|-------------------------|---|--|--|--|----------|------------------|------------------------------|------------------------|--|
| 1 Basic Design Data                                      |                         |   |  |  |  |          |                  |                              |                        |  |
| 1.1 <u>Span and Cross section Data</u>                   |                         |   |  |  |  |          |                  |                              |                        |  |
| C/C of bearing   | =                       |   |  |  |  | 50.300   | m                |                              |                        |  |
| C/C of expansion gap                                     | =                       |   |  |  |  | 51.450   | m                |                              |                        |  |
| Distance of bearing to expansion gap                     | =                       |   |  |  |  | 0.600    | m                |                              |                        |  |
| Exp. Gap   | =                       |   |  |  |  | 50       | mm               |                              |                        |  |
| Carriageway width  | =                       |   |  |  |  | 7.50     | m                |                              |                        |  |
| Total width  | =                       |   |  |  |  | 12.00    | m                |                              |                        |  |
| Footpath Width (Left side)                               | =                       |   |  |  |  | 1.50     | m                |                              |                        |  |
| Footpath Width (Right side)                              | =                       |   |  |  |  | 1.50     | m                |                              |                        |  |
| Crash Barrier Width (Left side)                          | =                       |   |  |  |  | 0.50     | m                |                              |                        |  |
| Crash Barrier Width (Right side)                         | =                       |   |  |  |  | 0.50     | m                |                              |                        |  |
| Handrail Width (Left side)                               | =                       |   |  |  |  | 0.00     | m                |                              |                        |  |
| Handrail Width (Right side)                              | =                       |   |  |  |  | 0.00     | m                |                              |                        |  |
| Skew Angle   | =                       |   |  |  |  | 0.0      | °                |                              |                        |  |
| 1.2 <u>Superstructure Details</u>                        |                         |   |  |  |  |          |                  |                              |                        |  |
| Depth of superstructure                                  | =                       |   |  |  |  | 2.403    | m                |                              |                        |  |
| Depth of Girder  | =                       |   |  |  |  | 2.183    | m                |                              |                        |  |
| Thickness of Deck Slab                                   | =                       |   |  |  |  | 0.220    | m                |                              |                        |  |
| Thickness of wearing coat                                | =                       |   |  |  |  | 0.065    | m                |                              |                        |  |
| No. of Girders   | =                       |   |  |  |  | 4        |                  |                              |                        |  |
| No. of Corss Girders                                     | =                       |   |  |  |  | 0        |                  |                              |                        |  |
| Distance of FRL from bearing of least height             | =                       |   |  |  |  | 2.47     | m                |                              |                        |  |
| Spacing between girders                                  | =                       |   |  |  |  | 3.0      | m                |                              |                        |  |
| Cross-slope  | =                       |   |  |  |  | 2.50%    |                  |                              |                        |  |
| Thickness of bearing (assumed)                           | =                       |   |  |  |  | 0.150    | m                |                              |                        |  |
| Type of Bearing  | =                       |   |  |  |  | Pot ptfe |                  | } assumed for design purpose |                        |  |
| Thickness of pedestal (minimum)                          | =                       |   |  |  |  | 0.350    | m                |                              |                        |  |
| Thickness of nearest bearing+pedestal                    | =                       |   |  |  |  | 0.500    | m                |                              |                        |  |
| 1.3 <u>Material Data</u>                                 |                         |   |  |  |  |          |                  |                              |                        |  |
| Grade of concrete  | $f_{ck}$                | = |  |  |  | M45      |                  |                              |                        |  |
| Grade of steel   | $f_{yk}$                | = |  |  |  | Fe500    |                  |                              |                        |  |
| Density of Steel   |                         | = |  |  |  | 7.85     | t/m <sup>3</sup> |                              |                        |  |
| Density of wearing course                                |                         | = |  |  |  | 2.2      | t/m <sup>3</sup> |                              |                        |  |
| Coefficient of Thermal Expansion of concrete             |                         | = |  |  |  | 1.20E-05 | /°C              |                              | (Cl.215.4, IRC 6 2014) |  |
| Shrinkage strain   |                         | = |  |  |  | 2.0E-04  |                  |                              | (Cl.217.3, IRC 6 2014) |  |
| Modulus of Elasticity of steel                           | $E_s$                   | = |  |  |  | 2.0E+05  | MPa              |                              |                        |  |
| Modulus of Elasticity of concrete                        | $E_c$                   | = |  |  |  | 3.2E+04  | MPa              |                              |                        |  |
| Mean axial tensile strength of concrete                  | $f_{ctm}$               | = |  |  |  | 2.8      | MPa              |                              |                        |  |
| Relative humidity  |                         | = |  |  |  | 70       |                  |                              |                        |  |
| Exposure condition                                       |                         | = |  |  |  | Moderate |                  |                              |                        |  |
| 1.4 <u>Typical Levels</u>                                |                         |   |  |  |  |          |                  |                              |                        |  |
| Formation Level "FRL"                                    | For design purpose only | = |  |  |  | 303.50   | m                |                              |                        |  |
| Dirt wall level  |                         | = |  |  |  | 303.50   | m                |                              |                        |  |
| Max. Abutment cap level "CTL"                            |                         | = |  |  |  | 300.88   | m                |                              |                        |  |
| Front Ground level "GL" / Scour Level                    |                         | = |  |  |  | 286.75   | m                |                              |                        |  |
| Lower water Level  |                         | = |  |  |  | 286.75   | m                |                              |                        |  |
| Highest flood level "HFL"                                |                         | = |  |  |  | 286.75   | m                |                              | 17.00                  |  |
| Foundation Level   |                         | = |  |  |  | 286.50   | m                |                              | 13.75                  |  |
| 1.5 <u>Soil Parameters</u>                               |                         |   |  |  |  |          |                  |                              |                        |  |
| Angle of internal friction,                              | $\phi$                  | = |  |  |  | 30       | °                |                              |                        |  |
| Angle of friction between soil and concrete              | $\delta$                | = |  |  |  | 20       | °                |                              |                        |  |
| 1/2 $d_{dry}$  | $\delta_{submerged}$    | = |  |  |  | 10       | °                |                              |                        |  |
| Surcharge angle  | $\iota$                 | = |  |  |  | 0        | °                |                              |                        |  |
| Dry density of earth                                     | $\gamma_{dry}$          | = |  |  |  | 2.0      | t/m <sup>3</sup> |                              |                        |  |
| Saturated density of earth                               | $\gamma_{sat}$          | = |  |  |  | 2.0      | t/m <sup>3</sup> |                              |                        |  |
| water density  | $\gamma_{water}$        | = |  |  |  | 1.0      | t/m <sup>3</sup> |                              |                        |  |
| Submerged density of earth                               | $\gamma_{sub}$          | = |  |  |  | 1.0      | t/m <sup>3</sup> |                              |                        |  |
| coeff. Of friction b/w footing base & earth              | $\mu$                   | = |  |  |  | 0.80     |                  |                              |                        |  |
| Live load surcharge                                      |                         | = |  |  |  | 1.20     |                  |                              |                        |  |
| Type of soil   |                         | = |  |  |  | Rock     |                  |                              |                        |  |
| Coefficient of friction between (Soil/Rock and concrete) |                         | = |  |  |  | 0.80     |                  |                              |                        |  |
| 1.6 <u>Abutment Dimensions</u>                           |                         |   |  |  |  |          |                  |                              |                        |  |
| Length of abutment cap in L-L direction at top           | =                       |   |  |  |  | 1.43     | m                |                              |                        |  |

|  |   |         |
|--|---|---------|
| Length of footing                        | = | 10.70 m |
| Length of heel                           | = | 6.10 m  |
| Thickness of base slab                   | = | 0.60 m  |
| Heel thickness at root                   | = | 1.20 m  |
| Toe thickness at root                    | = | 1.20 m  |
| Length of heel                           | = | 3.00 m  |
| Stem top thickness                       | = | 1.20 m  |
| Stem bottom thickness                    | = | 1.60 m  |
| Dirtwall thickness                       | = | 0.35 m  |
| Depth of abutment cap (Constant portion) | = | 0.75 m  |
| Depth of abutment cap (Varying portion)  | = | 0.75 m  |
| Thickness of return wall (Avg.)          | = | 0.65 m  |
| No. of return wall                       | = | 2       |
| Provision of weep holes in abutment wall | = | Yes     |

#### 1.7 Partial Safety Factors

(As per Annex B of IRC:6-2014)

**Also refer latest amendment, notification no 78, dated october 2014**

Partial safety factor for relevant loads are presented here

#### For Loads

#### Ultimate Limit State (For Verification of Equilibrium)

(Table 3.1, Annex B, IRC:6-2020)

| Load  | Basic Comb             |           | Seismic Comb           |           |
|---|------------------------|-----------|------------------------|-----------|
|   | Overturning or Sliding | Resisting | Overturning or Sliding | Resisting |
| Dead Load                                     | 1                      | 1         | 1.00                   | 1.00      |
| SIDL (except surfacing)                       | 1                      | 1         | 1.00                   | 1.00      |
| SIDL (surfacing)                              | 1                      | 1         | 1.00                   | 1.0       |
| Live load and associated loads (Leading)      | 1                      | 0         | -                      | -         |
| Live load and associated loads (Accompanying) | 1                      | 0         | 0.2                    | 0         |
| Water Current                                 | 1.0                    | 0         | 1.0                    | -         |
| Buoyancy                                      | 1.0                    | -         | 1.0                    | -         |
| Earth Pressure                                | 1                      | -         | 1.0                    | -         |
| Live Load Surcharge                           | 1                      | 0         | -                      | -         |
| Thermal Load (Leading)                        | 1                      | 0         | -                      | -         |
| Thermal Load (Accompanying)                   | 1                      | 0         | 0.5                    | -         |
| Seismic Effect (During service)               | -                      | -         | 1.0                    | -         |
| Seismic Effect (During construction)          | -                      | -         | 0.5                    | -         |

**Ultimate Limit State (For Verification of Structural Strength)**

(Table 3.2, Annex B, IRC:6-2020)

| Load  | Basic Comb | Seismic Comb |
|---|------------|--------------|
| Dead Load                                     | 1.35       | 1.35         |
| SIDL (except surfacing)                       | 1.35       | 1.35         |
| SIDL (surfacing)                              | 1.75       | 1.75         |
| Live load and associated loads (Leading)      | 1.5        | 0            |
| Live load and associated loads (Accompanying) | 1.15       | 0.2          |
| Water Current                                 | 1          | 1            |
| Buoyancy                                      | 0.15       | 1            |
| Earth Pressure                                | 1.5        | 1.5          |
| Live Load Surcharge                           | 1.2        | 0.2          |
| Seismic Effect (During service)               | -          | 1.5          |
| Seismic Effect (During construction)          | -          | 0.75         |

**Serviceability Limit State**

| Load  | Rare Comb | Quasi-permanent Comb |
|---|-----------|----------------------|
| Dead Load                                     | 1         | 1                    |
| SIDL (except surfacing)                       | 1         | 1                    |
| SIDL (surfacing)                              | 1.2       | 1.2                  |
| Live load and associated loads (Leading)      | 1         | 0                    |
| Live load and associated loads (Accompanying) | 0.75      | 0                    |
| Earth Pressure                                | 1.0       | 1.0                  |
| Live Load Surcharge                           | 0.8       | 0                    |
| Water Current                                 | 1         | -                    |
| Buoyancy                                      | 0.15      | 0.15                 |
| Thermal Load (Leading)                        | 1.0       | -                    |
| Thermal Load (Accompanying)                   | 0.6       | 0.5                  |

**Combination for Base Pressure and Design of Foundation**

(Table 3.4, Annex B, IRC:6-2014)

| Load  | Comb 1 | Comb 2 | Seismic Comb |
|---|--------|--------|--------------|
| Dead Load                                     | 1.35   | 1      | 1.35         |
| SIDL (except surfacing)                       | 1.35   | 1      | 1.35         |
| SIDL (surfacing)                              | 1.75   | 1      | 1.75         |
| Live load and associated loads (Leading)      | 1.5    | 1.3    | 0            |
| Live load and associated loads (Accompanying) | 1.15   | 1      | 0.2          |
| Water Current                                 | 1      | 1      | 1            |
| Buoyancy (Base Pressure)                      | 1      | 1      | 1            |
| Buoyancy (Structural Design)                  | 0.15   | 0.15   | 0.15         |
| Earth Pressure                                | 1.5    | 1.3    | 0            |
| Live Load Surcharge                           | 1.2    | 1      | 0.2          |
| Thermal load                                  | 0.9    | 0.8    | 0.5          |
| Seismic Effect (During service)               | -      | -      | 1.5          |
| Seismic Effect (During construction)          | -      | -      | 0.75         |

**For Materials**

| Material          | Basic Comb | Seismic Comb |
|-------------------|------------|--------------|
| Concrete          | 1.5        | 1.5          |
| Reinforcing steel | 1.15       | 1.15         |

**1.80 Clear Cover**

|               |   |       |
|---------------|---|-------|
| Dirt Wall     | = | 50 mm |
| Abutment Cap  | = | 50 mm |
| Abutment Stem | = | 50 mm |
| Footing       | = | 75 mm |

**1.9**

|  |   |        |
|--|---|--------|
| Seismic Zone                           | = | V      |
| Type of soil                           | = | medium |
| Zone factor                            | = | 0.36   |
| Importance factor                      | = | 1.2    |
| Response Reduction Factor, $R_{long}$  | = | 3      |
| Response Reduction Factor, $R_{trans}$ | = | 1      |
| Response Reduction Factor, $R_{vert}$  | = | 3      |

## INDEX

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| 3.0     | Load Calculations                             | 9        |
| 4.0     | Check for Overturning & Sliding (Equilibrium) | 24       |
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### SALIENT FEATURES OF THE BRIDGE :

|                                       |   |         |
|---------------------------------------|---|---------|
| Span c/c of brg.                      | = | 50.3 m  |
| c/L of brg. c/L of exp. J             | = | 0.6 m   |
| Exp. Gap                              | = | 50 mm   |
| Overall span                          | = | 51.45 m |
| Depth of super-structure              | = | 2.403 m |
| Wearing Coat thickness                | = | 65 mm   |
| Depth of Bearing + Pedestal (minimum) | = | 0.5 mm  |
| Overall Deck width                    | = | 12.00 m |
| Clear carriageway width               | = | 7.50 m  |
| Cross Camber                          | = | 2.50%   |

### MATERIAL USED & THERE PROPERTIES :

#### CONCRETE

|   |      |   |            |
|---|------|---|------------|
| Grade of Concrete                           | fck  | = | M 45 Mpa   |
| Mean value of concrete compressive strength | fcm  | = | M 55 Mpa   |
| Design Concrete compressive strength        | fcd  | = | 0.447 *fck |
|   |      | = | 20.100 MPa |
| Secant Modulus of Elasticity                | Ecm  | = | 34313 MPa  |
| Mean axial tensile strength                 | fctm | = | 3.28 Mpa   |

#### REINFORCING STEEL

|  |     |   |            |
|--|-----|---|------------|
| Grade of Reinforcement                 | fyk | = | Fe 500 Mpa |
| Design yield strength of reinforcement | fyd | = | 0.870 *fyk |
|  |     | = | 435 Mpa    |
| Modulus of Elasticity                  | Es  | = | 200000 Mpa |

|               |   |                       |
|---------------|---|-----------------------|
| Steel Density | = | 7.85 t/m <sup>3</sup> |
| Steel Density | = | 2.5 t/m <sup>4</sup>  |

### ANALYSES ASSUMPTION

#### Enviromental parameters

|                    |   |          |
|--------------------|---|----------|
| Relative humidity  | = | 70 %     |
| Exposure condition | = | Moderate |

|                                    |            |   |                  |
|------------------------------------|------------|---|------------------|
| Modulus of Elasticity for Concrete |            |   |                  |
| For short Term loading             | <b>Ecm</b> | = | <b>34313 Mpa</b> |
| For long Term loading              | Ecm'       | = | Ecm/ (1+φ)       |
| φ = Creep coefficient              |            |   |                  |

|                                  |             |   |                                  |
|----------------------------------|-------------|---|----------------------------------|
| Creep coefficient for Foundation | φ           | = | 1 ( As ho = ∞ , For foundations) |
|                                  | <b>Ecm'</b> | = | <b>17156.5 Mpa</b>               |

**Creep for abutment shaft**

|   |       |   |   |
|---|-------|---|---|
| Cross-sectional Area  | Ac    | = | 19.20 m <sup>2</sup>                              |
| Perimeter in contact with atmosphere u                              |       | = | 12.00 m   |
| Notational size ho  | 2Ac/u | = | 3200 mm   |
| Age of concrete at the time of loading to t <sub>∞</sub> considered |       | = | 90 days   |
|   |       | = | 36500 days  |
| φ (∞,90)  |       | = | 1.10 (Refer Appendix B)                           |
|   |       | ≡ | 1.21 *(Increased by 10% on the conservative side) |
|   | Ecm'  | = | 15549 N/mm <sup>2</sup>                           |

**SERVICEABILITY LIMIT STATE :**

|  |                    |          |            |
|--|--------------------|----------|------------|
| Max permissible Stress in Concrete     |                    |          |            |
| Rare Combination                       | =                  | 0.48*fck | = 21.6 Mpa |
| Quasi permanent Combination            | =                  | 0.36*fck | = 16.2 Mpa |
| Max permissible Stress in Steel (QLS)  | =                  | 0.8*fyk  | = 400 Mpa  |
| Max permissible Stress in Steel (Rare) | =                  | 0.6*fyk  | = 300 Mpa  |
| Permissible crack width                | w <sub>k,max</sub> | =        | 0.3 mm     |

**Backfill Soil Parameter**

|                        |   |   |   |                    |
|------------------------|---|---|---|--------------------|
| φ                      | = | Angle of internal friction,                 | = | 30 °               |
| δ                      | = | Angle of friction between soil and concrete | = | 20 °               |
| δ <sub>submerged</sub> | = | 1/2 d <sub>dry</sub>                        | = | 10 °               |
| ι                      | = | Surcharge angle                             | = | 0 °                |
| γ <sub>dry</sub>       | = | Dry density of earth                        | = | 2 t/m <sup>3</sup> |
| γ <sub>sat</sub>       | = | Saturated density of earth                  | = | 2 t/m <sup>3</sup> |
| γ <sub>water</sub>     | = | water density                               | = | 1 t/m <sup>3</sup> |
| γ <sub>sub</sub>       | = | Submerged density of earth                  | = | 1 t/m <sup>3</sup> |
| μ                      | = | coeff. Of friction b/w footing base & earth | = | 0.8                |

**Live Load Surcharge :**

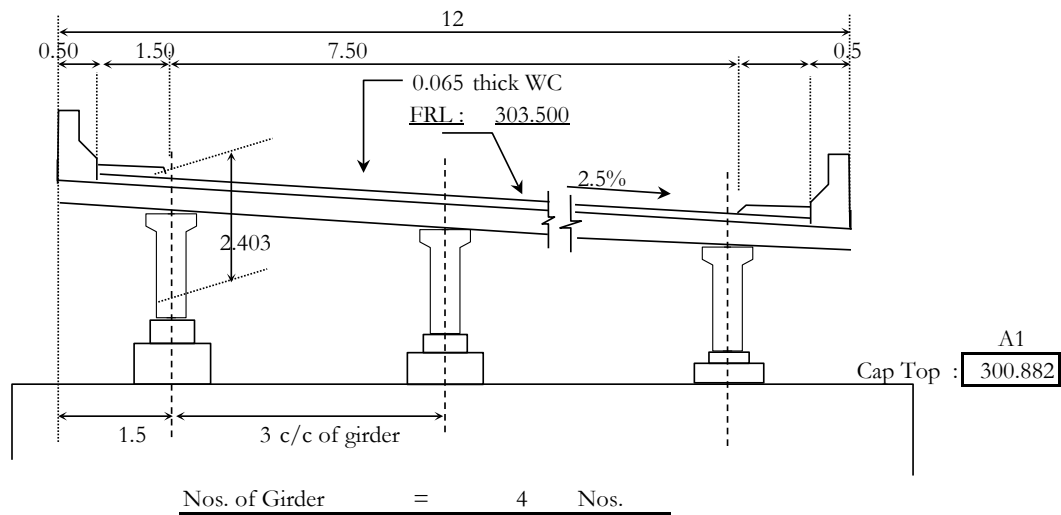
|                                 |      |                      |  |
|---------------------------------|------|----------------------|--|
| Equivelent to                   | 1.20 | m Earth Fill         |  |
| Live Load surcharge intensity q | =    | 2.4 t/m <sup>2</sup> |  |

**SEISMIC PARAMETER**

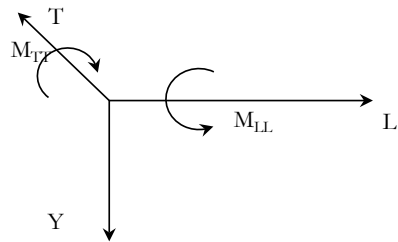
|   |   |   |        |
|---|---|---|--------|
| Seismic Zone                                    |   | = | V      |
| Type of soil                                    |   | = | medium |
| Zone factor                                     | Z | = | 0.36   |
| Importance factor                               | I | = | 1.2    |
| Response Reduction Factor, R <sub>long</sub> .  |   | = | 3      |
| Response Reduction Factor, R <sub>trans</sub> . |   | = | 1      |
| Response Reduction Factor, R <sub>vert</sub> .  |   | = | 3      |

**LEVEL DETAILS :**

|                    |   |                        |                                      |
|--------------------|---|------------------------|--------------------------------------|
| Formation level    | = | 303.500 m              |                                      |
| Lowest water level | = | 286.750 m              |                                      |
| HFL                | = | 286.750                |                                      |
| Ground Level / MSL | = | 286.750 m              |                                      |
| MSL                | = | 286.750 m              |                                      |
| Founding Level     | = | 286.500 m              |                                      |
| Bearing capacity   | = | 60.00 t/m <sup>2</sup> | */( Working State, Non-Seismic case) |
|                    | = | 75.00 t/m <sup>2</sup> | */( Working State, Seismic Case)     |



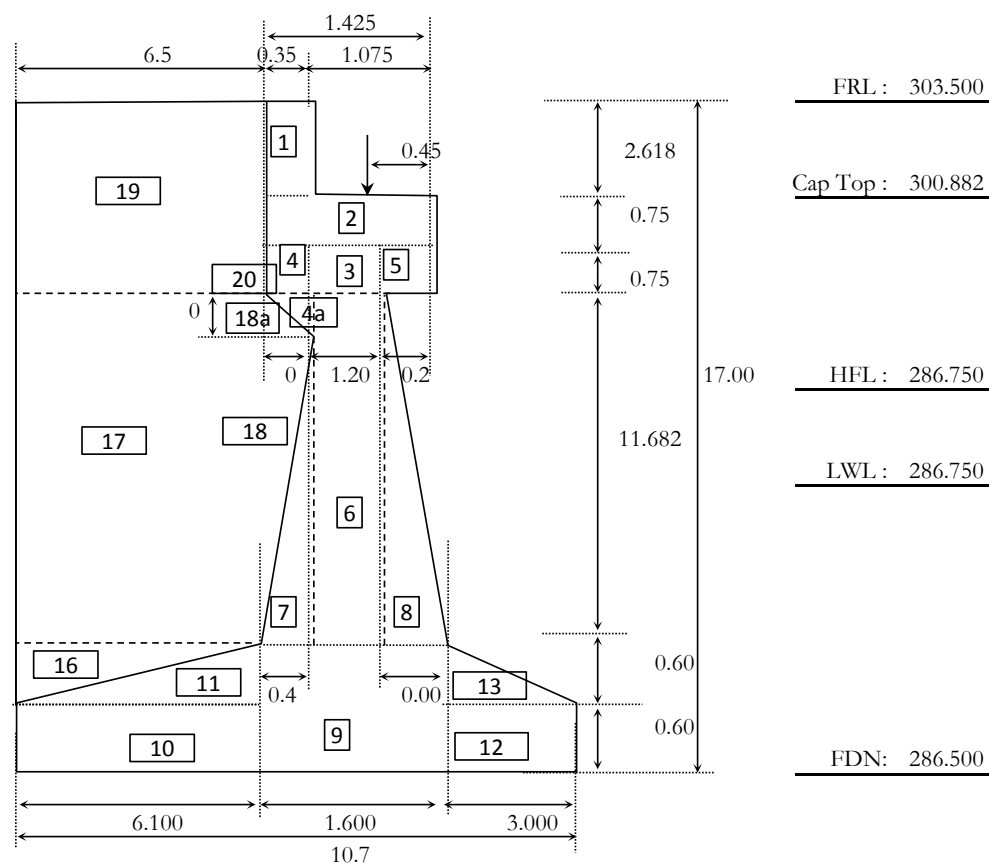
**Sign Convention :**



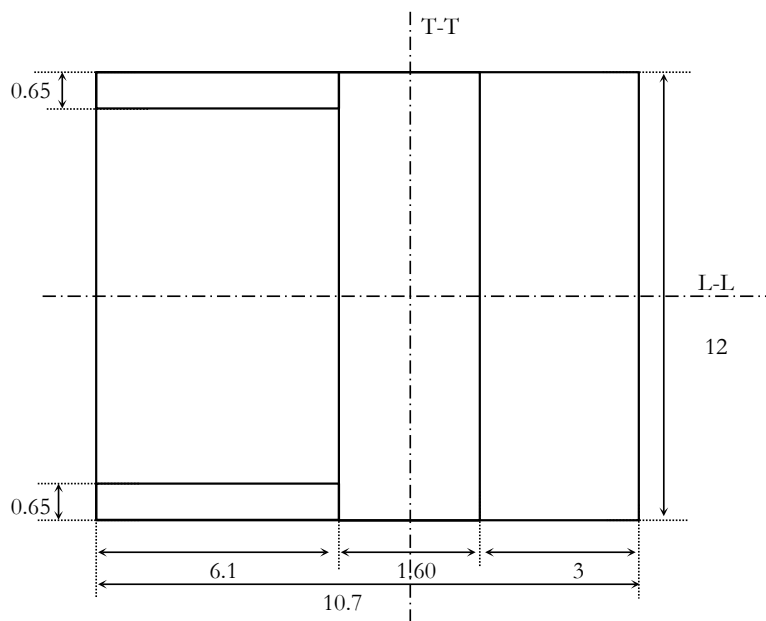
Showing +ve Force & Moment Direction

**ABUTMENT COMPONENT :-**

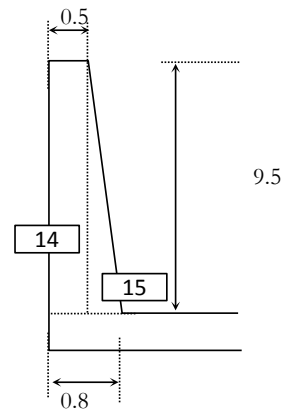
Length of Abutment = 12.00 m



$\alpha$  = Angle of wall face with horizontal = 88.04 °



FOOTING PLAN



RETURN WALL

### FORCES DUE TO SELFWEIGHT OF SUB STRUCTURE & FOUNDATION :

Forces @ Footing Base

$e_L$  = Cg. w.r.t. Toe Edge (along L-L axis)  
 $e_T$  = Cg. Form c/L of base ( along T-T axis)  
 $e_Y$  = Cg. From Footing base

| <b>Calculating Selfweight of Sub-structure :</b>        |             |  |       |    |                |               |              |              |              |
|---|-------------|--|-------|----|----------------|---------------|--------------|--------------|--------------|
| Element   | Area Factor | B  | H     | L  | V              | W             | $e_Y$        | $e_L$        | $e_T$        |
|   |             | m  | m     | m  | m <sup>3</sup> | Tonne         | m            | m            | m            |
| <b>Dirt Wall &amp; Abutment Cap</b>                     |             |  |       |    |                |               |              |              |              |
| 1   | 1           | 0.35   | 2.618 | 12 | 11.00          | 27.49         | 15.69        | -4.025       | 0            |
| 2   | 1           | 1.425  | 0.75  | 12 | 12.825         | 32.06         | 14.01        | -3.49        | 0            |
| 3   | 1           | 1.425  | 0.75  | 12 | 12.825         | 32.0625       | 13.26        | -3.4875      | 0            |
| 4   | 0           | 0  | 0.75  | 12 | 0.00           | 0.00          | 13.38        | -4.2         | 0            |
| 4(a)  | 0           | 0  | 0     | 12 | 0.00           | 0.00          | 12.88        | -4.2         | 0            |
| 5   | 0           | 0.225  | 0.75  | 12 | 0.00           | 0.00          | 13.38        | -2.925       | 0            |
| <b>Total</b>  |             |  |       |    | <b>36.65</b>   | <b>91.62</b>  | <b>14.25</b> | <b>-3.65</b> | <b>0.00</b>  |
| */ Increase Abutment cap weight by                      |             | 0% on account of bearing, bearing pedestal, stopper etc. |       |    |                |               |              |              |              |
| <i>Abutment Cap weight Considered</i>                   |             |  |       |    | <i>36.65</i>   | <i>91.62</i>  | <i>14.25</i> | <i>-3.65</i> | <i>0.00</i>  |
| <b>Abutment Shaft</b>                                   |             |  |       |    |                |               |              |              |              |
| 6   | 1           | 1.2  | 11.68 | 12 | 168.21         | 420.5         | 7.04         | -3.6         | 0            |
| 7   | 0.5         | 0.4  | 11.68 | 12 | 28.04          | 70.1          | 5.09         | -4.33333     | 0            |
| 8   | 0.5         | 0  | 11.68 | 12 | 0.00           | 0.0           | 5.09         | -3.000       | 0            |
| <i>Abutment shaft weight considered.</i>                |             |  |       |    | <i>196.25</i>  | <i>490.62</i> | <i>6.76</i>  | <i>-3.70</i> | <i>0.00</i>  |
| <b>Total Sub-structure self weight at base of shaft</b> |             |  |       |    | <b>232.90</b>  | <b>582.24</b> | <b>7.94</b>  | <b>-3.70</b> | <b>0.000</b> |

### Calculating Selfweight Foundation:

| Element                              | Area Fact | No.s | B   | H   | L   | V              | W              | $e_Y$       | $e_L$        | $e_T$       |
|--------------------------------------|-----------|------|-----|-----|-----|----------------|----------------|-------------|--------------|-------------|
|                                      |           |      | m   | m   | m   | m <sup>3</sup> | Tonne          | m           | m            | m           |
| <b>Footing</b>                       |           |      |     |     |     |                |                |             |              |             |
| 9                                    | 1         | 1    | 1.6 | 1.2 | 12  | 23.04          | 57.60          | 0.60        | -3.8         | 0           |
| 10                                   | 1         | 1    | 6.1 | 0.6 | 12  | 43.92          | 109.80         | 0.30        | -7.65        | 0           |
| 11                                   | 0.5       | 1    | 6.1 | 0.6 | 12  | 21.96          | 54.90          | 0.80        | -6.63        | 0           |
| 12                                   | 1         | 1    | 3   | 0.6 | 12  | 21.60          | 54.00          | 0.30        | -1.5         | 0           |
| 13                                   | 0.5       | 1    | 3   | 0.6 | 12  | 10.80          | 27.00          | 0.80        | -2.000       | 0           |
| <b>Total Footing weight</b>          |           |      |     |     |     | <b>121.32</b>  | <b>303.30</b>  | <b>0.49</b> | <b>-5.14</b> | <b>0.00</b> |
| <b>Return wall</b>                   |           |      |     |     |     |                |                |             |              |             |
| 14                                   | 1         | 2    | 0.5 | 9.5 | 6.1 | 57.95          | 144.88         | 4.75        | -7.65        | 0           |
| 15                                   | 0.5       | 2    | 0.3 | 9.5 | 6.1 | 17.39          | 43.46          | 3.17        | -7.65        | 0           |
| <b>Total Footing weight</b>          |           |      |     |     |     | <b>75.34</b>   | <b>188.34</b>  | <b>4.38</b> | <b>-7.65</b> | <b>0.00</b> |
| <b>Total Sub-structure + Footing</b> |           |      |     |     |     | <b>429.55</b>  | <b>1073.88</b> | <b>5.21</b> | <b>-4.80</b> | <b>0.00</b> |

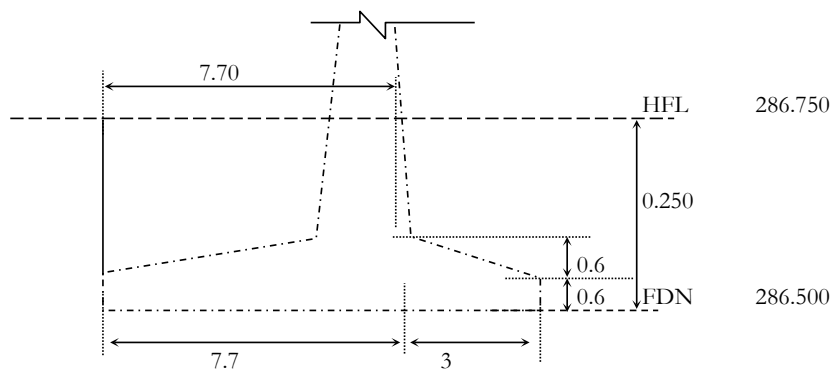
|  |   |             |
|--|---|-------------|
| Total Weight of sub-structure & foundation | = | 1073.88 T   |
| Lever arm about toe (along L-L axis)       | = | -4.80 m     |
| Moment $M_{TT}$                            | = | -5150.75 Tm |
| Lever arm about c/L base (along T-T axis)  | = | 0 m         |
| Moment $M_{LL}$                            | = | 0 Tm        |

#### Calculating Weight of Backfill Dry Condition

| Element           | Area Fact | No.s | B   | H      | L    | V              | W       | $e_Y$ | $e_L$    | $e_T$ |
|-------------------|-----------|------|-----|--------|------|----------------|---------|-------|----------|-------|
|                   |           |      | m   | m      | m    | m <sup>3</sup> | Tonne   | m     | m        | m     |
| Earth Fill Weight |           |      |     |        |      |                |         |       |          |       |
| 16                | 0.5       | 1    | 6.1 | 0.6    | 10.7 | 19.58          | 39.16   | 1.00  | -8.66667 | 0     |
| 17                | 1         | 1    | 6.1 | 15.800 | 10.7 | 1031.27        | 2062.53 | 8.50  | -7.65    | 0     |
| 18                | 0.5       | 1    | 0.4 | 11.682 | 10.7 | 25.00          | 50.00   | 8.99  | -4.33333 | 0     |
| 18a               | 0.5       | 1    | 0   | 0.000  | 10.7 | 0.00           | 0.00    | 12.88 | -4.333   | 0     |
| 19                | 1         | 1    | 4.1 | 0.000  | 10.7 | 0.00           | 0.00    | 17.00 | -8.65    | 0     |
| 20                | 0         | 1    | 0   | 0.75   | 10.7 | 0.00           | 0.00    | 13.13 | -4.200   | 0     |
| Total Earth Fill  |           |      |     |        |      | 1075.85        | 2151.69 | 8.37  | -7.59    | 0.00  |

|   |   |             |
|---|---|-------------|
| Total Weight of backfill                  | = | 2151.69 T   |
| Lever arm about toe (along L-L axis)      | = | -7.59 m     |
| Moment $M_{TT}$                           | = | -16334.4 Tm |
| Lever arm about c/L base (along T-T axis) | = | 0 m         |
| Moment $M_{LL}$                           | = | 0 Tm        |

#### Calculation of Buoyancy



| Element           | Area Fact | No.s | B    | H    | L  | V              | W      | e <sub>Y</sub> | e <sub>L</sub> | e <sub>T</sub> |
|-------------------|-----------|------|------|------|----|----------------|--------|----------------|----------------|----------------|
|                   |           |      | m    | m    | m  | m <sup>3</sup> | Tonne  | m              | m              | m              |
| Earth Fill Weight |           |      |      |      |    |                |        |                |                |                |
| 1                 | 1         | -1   | 7.70 | 0.25 | 12 | -23.10         | -23.10 | 0.13           | -6.85          | 0              |
| 2                 | 0.5       | -1   | 0.00 | 0.25 | 12 | 0.00           | 0.00   | 0.17           | -3.00          | 0              |
| 3                 | 1         | -1   | 3    | 0.6  | 12 | -21.60         | -21.60 | 0.30           | -1.5           | 0              |
| 4                 | 0.5       | -1   | 3    | 0.6  | 12 | -10.80         | -10.80 | 0.80           | 2.00           | 0              |
| Total Earth Fill  |           |      |      |      |    | -55.50         | -55.50 | 0.32           | -3.05          | 0.00           |

|   |   |            |
|---|---|------------|
| Total buoyant weight                      | = | -55.50 T   |
| Lever arm about toe (along L-L axis)      | = | -3.05 m    |
| Moment M <sub>TT</sub>                    | = | 169.035 Tm |
| Lever arm about c/L base (along T-T axis) | = | 0.00 m     |
| Moment M <sub>LL</sub>                    | = | 0 Tm       |

### Finding Creep Coefficient

$$f_{ck} = 45 \text{ Mpa} \quad (\text{Considering Precast Beam material})$$

$$f_{cm} = 55 \text{ Mpa}$$

$$t = 36500 \text{ days}$$

$$t_o = 90 \text{ days}$$

$$\phi(t, t_o) = \phi_o \beta_c(t, t_o)$$

$$\phi_o = \phi_{RH} \beta(f_{cm}) \beta(t_o)$$

$$\phi_{RH} = \begin{cases} 1 + \frac{1 - RH/100}{0.1 (h_o)^{1/3}} & \text{for } f_{cm} \leq 45 \text{ Mpa} \\ \left[ 1 + \frac{1 - RH/100}{0.1 (h_o)^{1/3}} \alpha_1 \right] * \alpha_2 & \text{for } f_{cm} > 45 \text{ Mpa} \end{cases}$$

$$RH = \text{Relative humidity}$$

$$= 70 \%$$

$$h_o = 3200 \text{ mm}$$

$$\alpha_1 = [43.75 / f_{cm}]^{0.7} = 0.85198$$

$$\alpha_2 = [43.75 / f_{cm}]^{0.2} = 0.95526$$

$$\phi_{RH} = 1.12095$$

$$\beta(f_{cm}) = 18.78 / \sqrt{f_{cm}}$$

$$= 2.53229$$

$$\beta(t_o) = 1 / (0.1 + t_o^{0.2})$$

$$= 0.3907$$

$$\phi_o = 1.10903$$

$$\beta_c(t, t_o) = [(t - t_o) / (\beta_H + t - t_o)]^{0.3}$$

$$\beta_H = \begin{cases} \text{Min} \begin{cases} 1.5 [1 + (0.012 RH)^{18}] h_o + 250 \\ 1500 \end{cases} & \text{for } f_{cm} \leq 35 \text{ Mpa} \\ \text{Min} \begin{cases} 1.5 [1 + (0.012 RH)^{18}] h_o + 250 \alpha_3 \\ 1500 * \alpha_3 \end{cases} & \text{for } f_{cm} > 35 \text{ Mpa} \end{cases}$$

$$\alpha_2 = [43.75 / f_{cm}]^{0.5} = 0.892$$

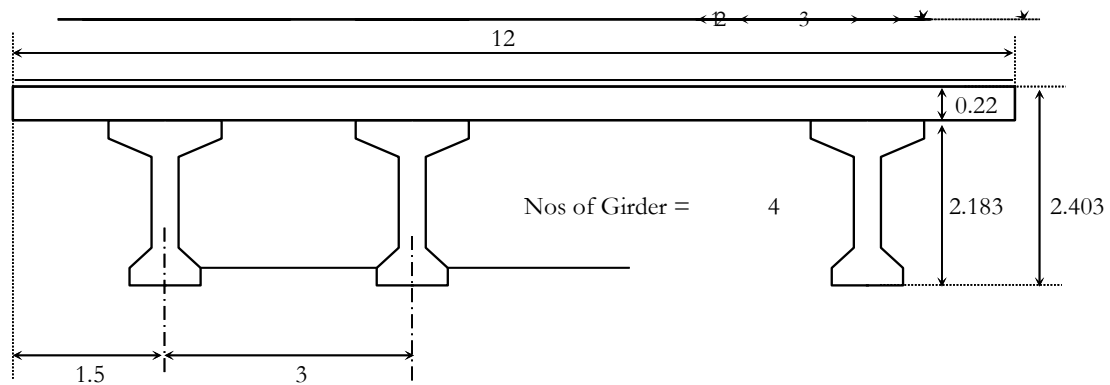
$$\beta_H = 1337.82$$

|                     |       |
|---------------------|-------|
| $\beta_c(t, t_o) =$ | 0.989 |
| $\phi(t, t_o) =$    | 1.10  |



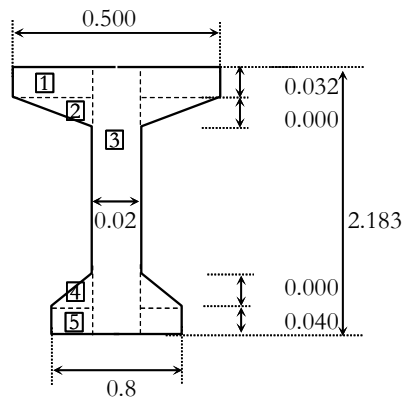
### DEAD LOAD CALCULATION OF SUPER-STRUCTURE :

|                                |   |          |
|--------------------------------|---|----------|
| Overall Span                   | = | 51.45 m  |
| C/c of Bearing                 | = | 50.3 m   |
| Total Deck Width               | = | 12 m     |
| Thickness of Deck width        | = | 0.22 m   |
| Total depth of super-structure | = | 2.403 m  |
| Nos. of Girder                 | = | 4 Nos.   |
| Depth of girder                | = | 2.183 m  |
| c/c of Girders                 | = | 3 m      |
| Nos. of Cross Girder           | = | 0        |
| Density of Steel               | = | 7.85 T/m |

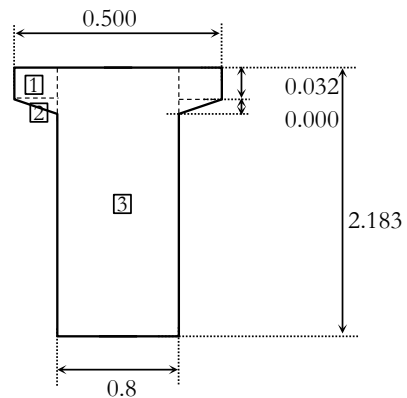


Super-Structure Cross-section

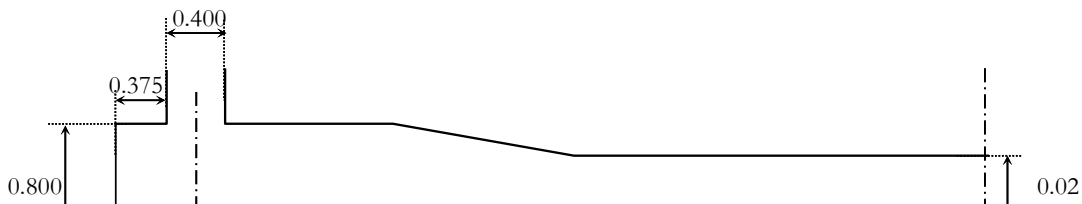
### Girder Cross-Section :

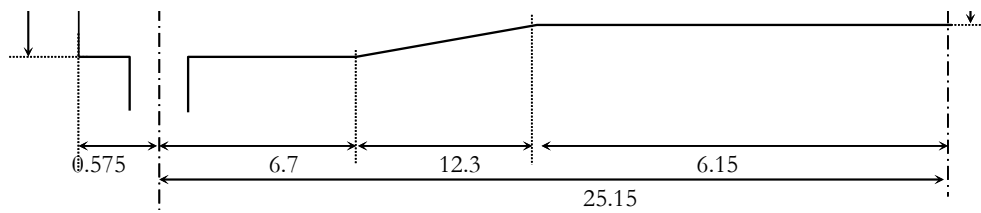


Section at Mid Span



Section at Support

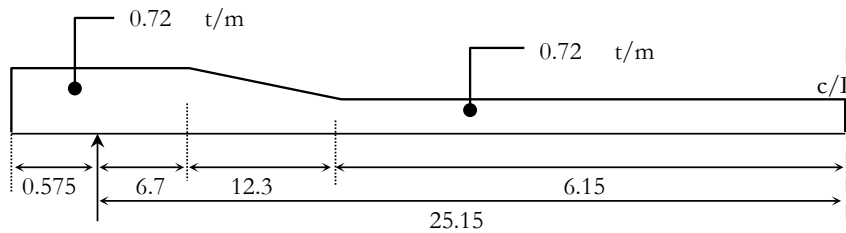




| Section Property of Girder At Mid Span |        |       |       |      |                |                  |
|--|--------|-------|-------|------|----------------|------------------|
| Element No.                            | Factor | B     | D     | Nos. | A              | cg <sub>y'</sub> |
|  |        | m     | m     |      | m <sup>2</sup> | m                |
| 1                                      | 1      | 0.500 | 0.032 | 1    | 0.016          | 0.016            |
| 2                                      | 0.5    | 0.500 | 0     | 2    | 0.0000         | 0.032            |
| 3                                      | 1      | 0.02  | 2.183 | 1    | 0.044          | 1.0915           |
| 4                                      | 0.5    | 0.8   | 0     | 2    | 0.000          | 2.14             |
| 5                                      | 1      | 0.8   | 0.04  | 1    | 0.032          | 2.16             |
|  |        |       |       |      |                |                  |
| <b>Total</b>                           |        |       |       |      | <b>0.09166</b> | <b>1.278</b>     |

| Section Property of Girder At Support Section |        |       |       |      |                |                  |
|---|--------|-------|-------|------|----------------|------------------|
| Element No.                                   | Factor | B     | D     | Nos. | A              | cg <sub>y'</sub> |
|   |        | m     | m     |      | m <sup>2</sup> | m                |
| 1   | 1      | 0.500 | 0.032 | 1    | 0.016          | 0.016            |
| 2   | 1      | 0.02  | 2.183 | 1    | 0.044          | 1.0915           |
| 3   | 1      | 0.8   | 0.040 | 1    | 0.032          | 0.02             |
|   |        |       |       |      |                |                  |
| <b>Total</b>                                  |        |       |       |      | <b>0.09166</b> | <b>0.530</b>     |

Self weight of Precast Beam



| Reaction due to self weight of each girder |             |              |              |  |                   |
|--|-------------|--------------|--------------|--|-------------------|
| Description                                | wt/m<br>T/m | Length<br>m  | weight<br>T  |  | cg. From top<br>m |
| Weight of Support Section                  | 0.72        | 7.275        | 5.23         |  | 0.530             |
| Weight of Transition section               | 0.72        | 12.30        | 8.85         |  | 0.904             |
| Weight of mid span                         | 0.72        | 6.15         | 4.43         |  | 1.278             |
| <b>Total Reaction</b>                      |             |              | <b>18.51</b> |  | <b>0.887</b>      |
|  |             |              |              |  |                   |
| Total weight of one Girder                 | =           | 37.02 Tonne  |              |  |                   |
| Total Nos. of girder                       | =           | 4 Nos.       |              |  |                   |
| Total weight of all girders                | =           | 148.08 Tonne |              |  |                   |



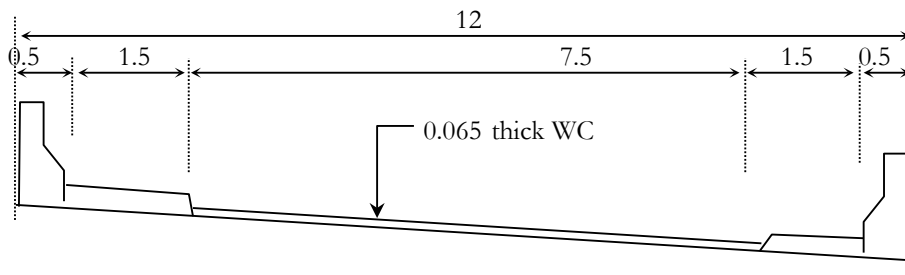
| <u>Calculating weight of superstructure</u> |   | Weight          | Cg. From Deck Top |
|---|---|-----------------|-------------------|
| Weight of all Girder                        | = | 148.08 T        | 1.11 m            |
| Weight of Concrete Deck                     | = | 339.57 T        | 0.11 m            |
| Weight of 12 m solid slab                   | = | 0.00 T          |                   |
| End cross girder Diaphragm                  | = | 46.25 T         | 1.29 m            |
| <b>Total Weight</b>                         | = | <b>533.90 T</b> |                   |
| Increase Concrete weight by 0%              | = | 533.90 T        | 0.489 m           |
| Reaction Over Each End                      | = | 266.95 Tonne    |                   |

|                                       |   |                    |
|---------------------------------------|---|--------------------|
| <b>Total Reaction at Each support</b> | = | <b>266.9 Tonne</b> |
| <b>Cg. From Deck Top</b>              | = | <b>0.489 m</b>     |

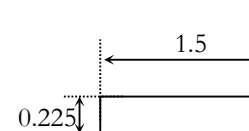
*Forces due to Super-Structure DL about base slab toe :*

|   |   |              |
|---|---|--------------|
| Vertical Load (Sup DL Reaction)           | = | 266.95 Tonne |
| Lever arm about toe (along L-L axis)      | = | -3.2 m       |
| Moment $M_{TT}$                           | = | -860.91 Tm   |
| Lever arm about c/L base (along T-T axis) | = | 0 m          |
| Moment $M_{LL}$                           | = | 0 Tm         |
| Cg. From base slab bottom                 | = | 16.45 m      |

## Calculation of SIDL



|                               |   |                      |
|-------------------------------|---|----------------------|
| Overall span                  | = | 63.45 m              |
| Crash barrier weight          | = | 1 t/m                |
| Cg. From crash barrier bottom | = | 0.476 m              |
| Footpath weight               | = | 0.84375 t/m          |
| Cg. Of Footpath above deck    | = | 0.1125 m             |
| Wearing coat                  | = | 2.2 t/m <sup>2</sup> |



## Forces & Moments @ Foundation base

| Element                     | Description         | wt/m<br>t/m | L<br>m | W<br>Tonne | e <sub>Y</sub><br>m | e <sub>T</sub><br>m |
|-----------------------------|---------------------|-------------|--------|------------|---------------------|---------------------|
| SIDL (excluding surfacing)  |                     |             |        |            |                     |                     |
| 1                           | Crash barrier Left  | 1           | 63.45  | 63.45      | 0.476               | -5.75               |
| 2                           | Crash barrier Right | 1           | 63.45  | 63.45      | 0.476               | 5.75                |
| 3                           | Footpath Left       | 0.84375     | 63.45  | 53.54      | 0.1125              | -4.75               |
| 4                           | Footpath Right      | 0.84375     | 63.45  | 53.54      | 0.1125              | 4.75                |
| <i>Total Load</i>           |                     |             |        | 233.97     | 0.31                | 0.00                |
|                             |                     |             |        |            |                     |                     |
| <i>Reaction per support</i> |                     |             |        | 116.99     | 0.31                | 0.00                |

## Forces due to Super-Structure SIDL about base slab toe :

|   |   |              |
|---|---|--------------|
| Vertical Load (Sup SIDL Reaction)         | = | 116.99 Tonne |
| Lever arm about toe (along L-L axis)      | = | -3.225 m     |
| Moment $M_{TT}$                           | = | -377.28 Tm   |
|   |   |              |
| Lever arm about c/L base (along T-T axis) | = | 0.00 m       |
| Moment $M_{LL}$                           | = | 0.00 Tm      |
|   |   |              |
| Cg. From base Slab bottom                 | = | 17.24 m      |

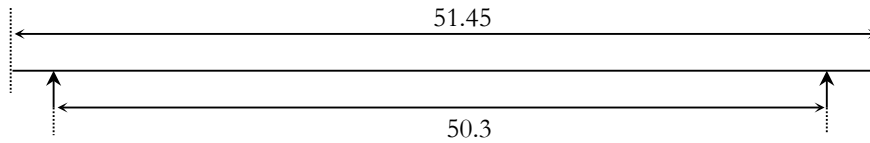
**Selfweight of surfacing**

| Element                     | Description  | wt/m <sup>2</sup> | B   | L     | W     | e <sub>Y</sub> | e <sub>T</sub> |
|-----------------------------|--------------|-------------------|-----|-------|-------|----------------|----------------|
|                             |              | t/m <sup>2</sup>  | m   | m     | Tonne | m              | m              |
| Surfacing<br>1              | Wearing coat | 2.2               | 7.5 | 63.45 | 68.05 | 0.033          | -0.25          |
| <i>Total Load</i>           |              |                   |     |       | 68.05 | 0.033          | -0.25          |
|                             |              |                   |     |       |       |                |                |
| <i>Reaction per support</i> |              |                   |     |       | 34.03 | 0.033          | -0.25          |

***Forces due to Super-Structure Surfacing about base slab toe :***

|   |   |             |
|---|---|-------------|
| Vertical Load (Sup Surfacing Reaction)    | = | 34.03 Tonne |
| Lever arm about toe (along L-L axis)      | = | -3.225 m    |
| Moment $M_{TT}$                           | = | -109.731 Tm |
|   |   |             |
| Lever arm about c/L base (along T-T axis) | = | -0.25 m     |
| Moment $M_{LL}$                           | = | -8.50627 Tm |
|   |   |             |
| Cg. From base Slab bottom                 | = | 16.97 m     |

### FINDING LIVE LOAD REACTIONS OVER ABUTMENT



SPAN\_1                      0.575              50.3              0.575

| CLASS A |   |     |     |     |     |      |      |     |     |
|---------|---|-----|-----|-----|-----|------|------|-----|-----|
| TYPE    | 1 | 6.8 | 6.8 | 6.8 | 6.8 | 11.4 | 11.4 | 2.7 | 2.7 |
| DIST    |   | 3   | 3   | 3   | 4.3 | 1.2  | 3.2  | 1.1 |     |

| CLASS 70R Wheeled |   |      |      |      |      |      |      |    |  |
|-------------------|---|------|------|------|------|------|------|----|--|
| TYPE              | 2 | 8    | 12   | 12   | 17   | 17   | 17   | 17 |  |
| DIST              |   | 3.96 | 1.52 | 2.13 | 1.37 | 3.05 | 1.37 |    |  |

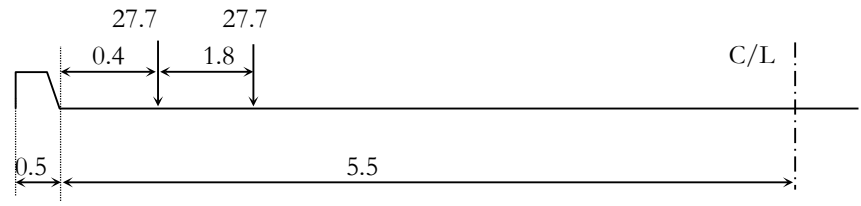
| CLASS 70R Tracked |   |      |      |      |      |      |   |  |  |
|-------------------|---|------|------|------|------|------|---|--|--|
| TYPE              | 3 | 7    | 14   | 14   | 14   | 14   | 7 |  |  |
| DIST              |   | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 |   |  |  |

| Reactions                      | R11<br>Tonne | R12<br>Tonne | Transverse Ecc |
|--------------------------------|--------------|--------------|----------------|
| <b>Maximum Reaction Case :</b> |              |              |                |
| Class A                        | 45.8         | 9.6          | 4.2            |
| Class 70R wheeled              | 90.8         | 9.2          | 2.91           |
| Class 70R tracked              | 67.1         | 2.9          | 3.28           |
| Class A 2Lane                  | 91.6         | 19.2         | 2.45           |
| Class A 3Lane                  | 137.4        | 28.8         | 0.70           |
| Class 1A+70RW                  | 136.6        | 18.8         | 3.20           |
| <b>Governing Case</b>          | <b>137.4</b> | <b>28.8</b>  | <b>2.9</b>     |
|                                |              |              |                |

| <b>Forces due to LL about base slab toe :</b> |   |  |  | <b>Max Reaction</b> | <b>Min Reaction</b> |  |
|---|---|--|--|---------------------|---------------------|--|
| Vertical Load (CW LL Reaction)                | = |  |  | 137.40 Tonne        | 28.80 Tonne         |  |
| Lever arm about toe (along L-L axis)          | = |  |  | -3.225 m            | -3.225 m            |  |
| Moment $M_{TT}$                               | = |  |  | -443.116 Tm         | -92.879 Tm          |  |
| Lever arm about c/L base (along T-T axis)     | = |  |  | 2.91 m              | 2.91 m              |  |
| Moment $M_{LL}$                               | = |  |  | 399.83 Tm           | 83.81 Tm            |  |

Maximum Possible Eccentricity in transverse direction

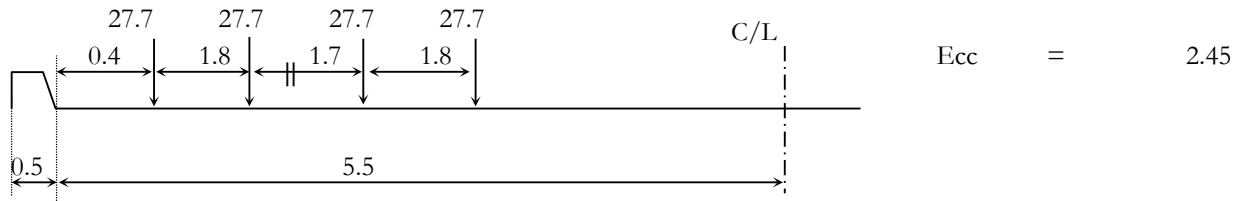
**Class A**



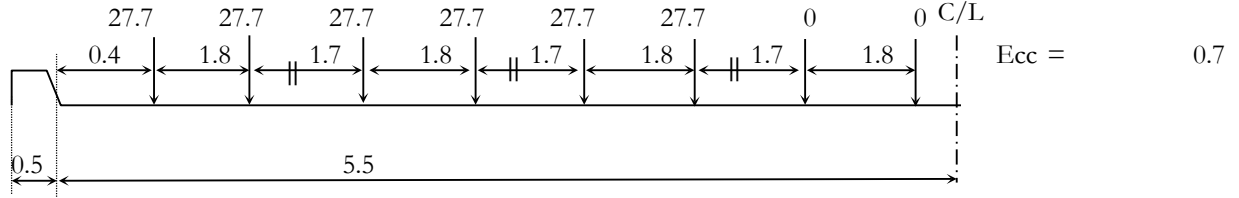
Ecc = 4.2



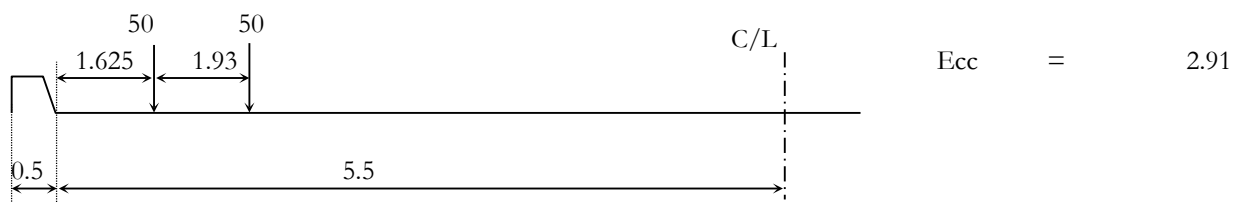
### Class A 2 Lane



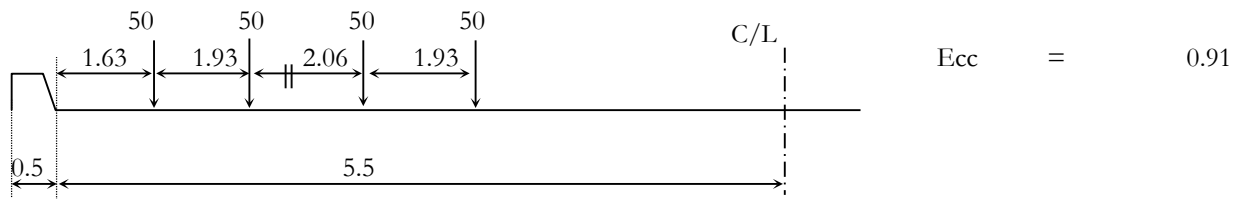
### Class A 3 Lane



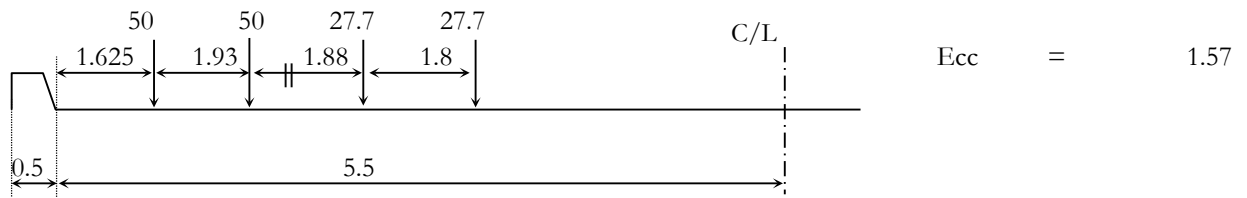
### Class 70R Wheeled



### Class 70R Wheeled 2 Lane



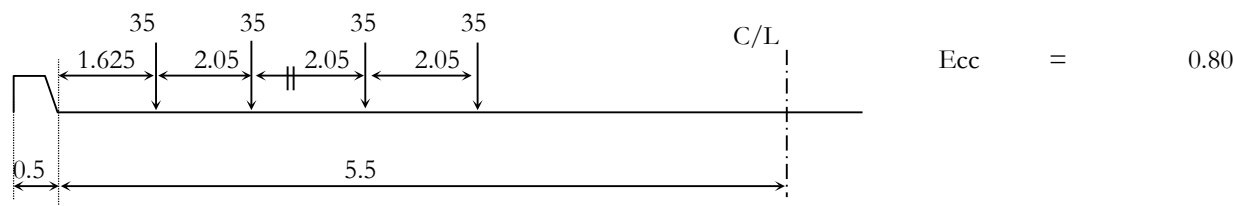
### Class A 1 Lane + Class 70R Wheeled II



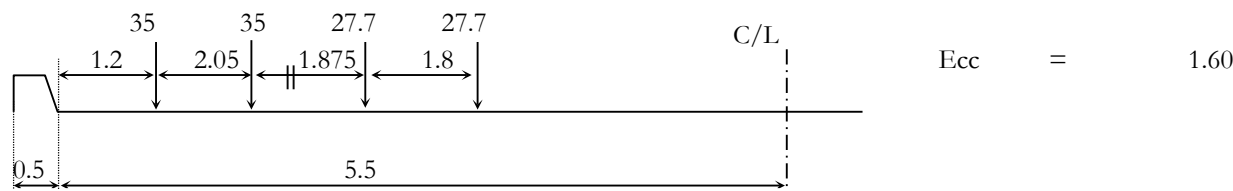
### Class 70R Tracked



**Class 70R Tracked 2 lanes**



**Class A 1 Lane + Class 70R Tracked II**



## Calculation of Longitudinal Forces

### Maximum LL over span :

|            |   |              |
|------------|---|--------------|
| Class A    | = | 137.40 tonne |
| Class 70 R | = | 90.76 tonne  |

$$\begin{aligned} \text{Breaking Force } F_h &= 137.400 \times 0.2 + 0.00 \times 0.05 \\ &= 27.48 \text{ tonne} \end{aligned}$$

$$\text{Coefficient of thermal expansion} = 0.0000117 / ^\circ\text{C}$$

$$\text{Maximum temperature} = 45.2 ^\circ\text{C}$$

$$\text{Minimum temperature} = -2.9 ^\circ\text{C}$$

$$\text{Bridge Temperature} = 31.15 ^\circ\text{C}$$

$$\text{Longitudinal strain} = 0.00036$$

$$\text{Shrinkage coefficient} = 0.0002$$

$$\text{Total strain for longitudinal movement} = 0.00056$$

$$\begin{aligned}
 \text{Horizontal movement} &= \frac{0.00056 \times 50.00 \times 1000}{2} \\
 &= 14.111 \text{ mm} \\
 \text{Size of bearing} &= 500 \times 500 \times 142 \text{ mm} \\
 \text{Strain in bearing} &= \frac{14.111}{142} = 0.09938 \\
 \text{Shear modulus} &= 1 \text{ Mpa} \\
 \text{Shear force per Bearing} &= 0.0994 \times 1.0 \times 500 \times 500 \\
 &= 24844 \text{ N} = 2.533 \text{ t} \\
 \text{Total shear force for 4 bearings ( with 5 \% increase )} &= 2.533 \times 4 \times 1.05 \\
 &= 10.637 \text{ t} \\
 \text{Refer IRC : 6 clause 214.5.1.5;} \\
 &10 \% \text{ increase for variation in movement of span} \\
 \text{Total shear force} &= 1.1 \times 10.637 \\
 &= 11.700 \text{ t}
 \end{aligned}$$

As per clause 214.2 of IRC:6, horizontal braking force  $F_h$ , for each span is:

$$\text{For Class A Single lane} \quad F_h = 0.2 \times 55.40 = 11.08 \text{ t}$$

$$\text{Class A 2 lane} \quad F_h = 0.2 \times 110.80 = 22.16 \text{ t}$$

$$\text{For class 70R wheeled} \quad F_h = 0.2 \times 100.0 = 20 \text{ t}$$

Longitudinal force per support

$$\text{For Class A 2 lane} = \frac{22.160}{2} + 11.700 = 22.78 \text{ t}$$

$$\text{For 70 R} = \frac{20}{2} + 11.700 = 21.70 \text{ t}$$

Horizontal force at Brg. Level

$$\begin{aligned}
 F_{\text{Longitudinal}} &= \text{Max. of } \begin{cases} \text{i)} & = 22.8 \text{ tonne} \\ \text{ii)} & = 21.7 \text{ tonne} \end{cases} \\
 &= \text{MAX}(22.78, 21.7) \\
 &= 22.78 \text{ tonne}
 \end{aligned}$$

$$F_{\text{Longitudinal}} = \underline{\underline{27.48 \text{ tonne}}}$$

| Forces due to LL Longitudinal Forces, about base slab toe : |   |            |
|---|---|------------|
| Longitudinal Force  | = | 27.5 Tonne |
| Lever arm from footing base                                 | = | 14.53 m    |
| Moment in about transverse axis $M_{TT}$                    | = | 399.3 tm   |

### Calculation of Longitudinal Forces

Horizontal force at bearing level in the longitudinal direction at **fixed bearing** (other than elastomeric bearing)

$$= \text{Maximum of } \begin{cases} \text{i) } F_h - \mu (R_g + R_q) \\ \text{ii) } F_h / 2 + \mu (R_g + R_q) \end{cases} \quad \text{Refer Clause 211.5 IRC: 6-2010}$$

Where

$F_h$  = Applied Horizontal force

$R_g$  = Reaction at free end due to dead load and SIDL

$R_q$  = Reaction at free end due to live load load

$\mu$  = Coefficient of Friction at movable bearing = 0.03 or 0.05 which ever govern

\*  $F_h$  (braking force) is considered 20 % of the first train load + 10 % of the load of the succeeding trains or part thereof.

Reaction due to dead load and SIDL

|       |   |              |   |        |   |           |
|-------|---|--------------|---|--------|---|-----------|
|       |   | DL           |   | SIDL   |   | Surfacing |
| $R_g$ | = | 266.95       | + | 116.99 | + | 34.03     |
|       | = | 417.96 tonne |   |        |   |           |

$R_q \text{ max} = 137.40 \text{ tonne}$

Corresponding Live load over Span = 100 tonne of Class 70 R

|               |       |   |             |   |     |   |      |   |      |
|---------------|-------|---|-------------|---|-----|---|------|---|------|
| Braking Force | $F_h$ | = | 100         | x | 0.2 | + | 55.4 | x | 0.05 |
|               |       | = | 22.77 tonne |   |     |   |      |   |      |

$$F_{\text{Longitudinal}} = \text{Max of } \begin{cases} F_h - \mu (R_g + R_q) = 22.77 - 0.03 \times (137.4 + 417.961) \\ F_h / 2 + \mu (R_g + R_q) = 11.385 + 0.05 \times (137.4 + 417.961) \end{cases}$$

$$= \text{Max of } ( 6.109 , 39.153 )$$

$$= \underline{\underline{39.2 \text{ tonne}}}$$

| Forces due to LL Longitudinal Forces, about base slab toe : |   |            |
|---|---|------------|
| Longitudinal Force  | = | 39.2 Tonne |
| Lever arm from footing base                                 | = | 14.53 m    |
| Moment in about transverse axis $M_{TT}$                    | = | 569.0 tm   |

**CALCULATION OF LONGITUDINAL HORIZONTAL FORCES (NORMAL and SEISMIC LONGITUDINAL CASE):**

Maximum LL over span :

Class A = 137.40 tonne  
Class 70 R = 90.76 tonne

Minimum LL over span :

Class A = 9.60 tonne  
Class 70 R = 2.85 tonne

Breaking Force  $F_h$  =  $147.000 \times 0.2 + 0.00 \times 0.05$   
= 29.40 tonne

$\mu R$  =  $0.05 \times \left( \frac{DL}{266.95} + \frac{SIDL}{151.01} \right)$

=  $0.05 \times 417.96$  = 20.90 tonne

$F_h/2$  =  $29.40 / 2.00$  = 14.70 tonne

$F_h/2$  or  $\mu R$  = (whichever is maximum) = 20.90 tonne

**Forces due to LL Longitudinal Forces, about base slab toe :**

Longitudinal Force = **39.2 Tonne**

Lever arm from footing base = 14.53 m

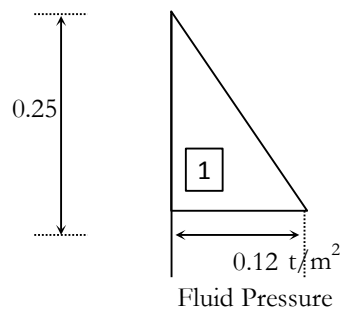
Moment in about transverse axis  $M_{TT}$  = **569.0 tm**

### **FLUID PRESSURE CALCULATION UP TO FOUNDING LEVEL :**

Fluid density = 0.48 t/m<sup>3</sup>  
 Abutment Length L = 12 m  
 Footing Base width B = 10.7 m

GL 286.750

Found.L 286.500



Total Fluid Presure

| Component | Factor | p                | h    | L  | F     | ey    |
|-----------|--------|------------------|------|----|-------|-------|
|           |        | T/m <sup>2</sup> | m    | m  | Tonne | m     |
| 1         | 0.5    | 0.120            | 0.25 | 12 | 0.18  | 0.083 |
| Total     |        |                  |      |    | 0.18  | 0.083 |

**Total fluid Pressure** = **0.18 Tonne**  
**Lever arm** = **0.08**  
**Moment M<sub>TT</sub>** = **0.02 Tm**  
**Net Moment M<sub>TT</sub>** = **0.02 Tm**

### **SUMMARY FLUID PRESSURE :**

| Description      | Fluid Pressure               |                        |
|------------------|------------------------------|------------------------|
|                  | Horizontal (H <sub>L</sub> ) | M <sub>TT</sub> (Dest) |
|                  | Tonne                        | Tm                     |
| 1) LWL Condition | 0.18                         | 0.02                   |

# **CALCULATION OF SEISMIC ACCELERATION SA/G (As per Appendix A1 of IRC SP 114-2018)**

(Notifications of IRC SP 114-2018, Pg 50)

|                           |       |           |        |
|---------------------------|-------|-----------|--------|
| Seismic Zone              |       | Zone      | V      |
| Type of soil              |       | Soil Type | medium |
| Zone factor               |       | Z         | 0.36   |
| Importance Factor         |       | I         | 1.2    |
| Response Reduction Factor | Long  | R.L       | 3.00   |
|                           | Trans | R.T       | 1.00   |

| PARAMETERS   | unit            | Longitudinal | Transverse |
|--|-----------------|--------------|------------|
| Area of Bearing  | mm <sup>2</sup> | 250000       | 250000     |
| Total no. of Bearing   | Nos             | 4            | 4          |
| Total thickness of elastomer   | mm              | 142          | 142        |
| Hardness, IRHD   |                 | 60           | 60         |
| Shear modulus of Elastomer   | Mpa             | 0.9          | 0.9        |
| Stiffness of Elastomer =NAG/t  | N/mm            | 8239         | 8239       |
| Distance of cg of super structure from top of bearing (assuming CG is at centre of superstructure) | m               | 15.048       | 15.048     |
| Force required for 1mm deflection in bearing   | KN              | 8.23943662   | 8.23943662 |
| Corresponding deflection in pier due to force KN for longitudinal direction                        | mm              | 0.229        |            |
| Moment due to force KN in transverse direction   | KN-m            |              | 123.99     |
| Corresponding deflection in pier due to KN and moment KN-m for transverse direction                | mm              |              | 0.02241    |
| Total deflection in( pier and bearing )  | mm              | 1.229        | 1.022      |
| Equivalent stiffness of system   | N/mm            | 6706.19      | 8168.20    |
| Force required for total deflection of 1mm (pier and bearing )(F)                                  | KN              | 6.706        | 8.168      |
| Appropriate Lumped Mass (Total mass)   | KN              | 4454         | 4454       |
| Time Period<br>$\frac{2}{\sqrt{\frac{D}{1000F}}}$  | sec             | 1.630        | 1.477      |
| Avg. response Acc. coeff. for Hard soil sites (Sa/g)   |                 | 0.613        | 0.677      |

Deflection calculations for abutment

For Elastomeric Bearings R =1

1. For Longitudinal direction ,force is acting at top of bearing hence.

$$\text{Deflection} = \frac{PL^3}{3EI}$$

2. For transeverse direction,force is acting at c.g of superstructure hence

$$\text{Deflection} = \frac{PL^3}{3EI} + \frac{ML^2}{2EI}$$

$$\text{Stiffness of Abutment, K2 L} = \frac{3.E.I}{L^3} = 36038 \text{ N/mm}$$

$$\text{Stiffness of Abutment, K2 T} = \frac{3.E.I}{L^3} = 944713 \text{ N/mm}$$

$$\text{Cross Camber} = 749.98\%$$

$$\text{Wearing Coat} = 65 \text{ mm}$$

**Bearing Stiffness has been increased by 30% as per annexure D IRC:83-2018 (part -II)**

$$\text{Depth of superstructure} = 2.403 \text{ m}$$

$$E = 34313 \text{ N/mm}^2 \quad B = 6.40 \text{ m}$$

$$I_L = 1.04167E+12 \text{ mm}^4 \quad D = 1.25 \text{ m}$$

$$I_T = 2.73067E+13 \text{ mm}^4$$

$$L_H = 14383 \text{ mm}$$

$$L_T = 14383 \text{ mm}$$

$$\frac{S_a}{g} = \begin{cases} \text{For rocky or hard soil site} : \begin{cases} 2.5 & 0 < T < 0.40 \text{ s} \\ 1/T & 0.40 \text{ s} < T < 4.00 \text{ s} \\ 0.25 & T > 4.00 \text{ s} \end{cases} \\ \text{For medium stiff soil sites} : \begin{cases} 2.5 & 0 < T < 0.55 \text{ s} \\ 1.36/T & 0.55 \text{ s} < T \leq 4.00 \text{ s} \\ 0.34 & T > 4.00 \text{ s} \end{cases} \\ \text{For soft soil sites} : \begin{cases} 2.5 & 0 \leq T \leq 0.67 \text{ s} \\ 1.67/T & 0.67 \text{ s} \leq T \leq 4.00 \text{ s} \\ 0.42 & T > 4.00 \text{ s} \end{cases} \end{cases}$$



## ACTIVE EARTH PRESSURE CALCULATION FOR OVER-TURNING & SLIDING:

### A) Non-Seismic Case :

Coefficient of Active Earth Pressure

$$K_a = \frac{\sin^2(\alpha + \phi)}{\sin^2 \alpha \cdot \sin(\alpha - \delta) \cdot \left[ 1 + \sqrt{\frac{\sin(\phi + \delta) \cdot \sin(\phi - i)}{\sin(\alpha - \delta) \cdot \sin(\alpha + i)}} \right]^2}$$

Active earth pressure

Backfill Soil Parameter

|                             |   |                    |   |               |
|-----------------------------|---|--------------------|---|---------------|
| $\phi$                      | = | 30 °               | = | 0.524 Radians |
| $\delta$                    | = | 20 °               | = | 0.349 Radians |
| $\delta_{\text{submerged}}$ | = | 10 °               | = | 0.175 Radians |
| $i$                         | = | 0 °                | = | 0 Radians     |
| $\alpha$                    | = | 88.04 °            | = | 1.537 Radians |
| $\gamma_{\text{dry}}$       | = | 2 t/m <sup>3</sup> |   |               |
| $\gamma_{\text{sat}}$       | = | 2 t/m <sup>3</sup> |   |               |
| $\gamma_{\text{sub}}$       | = | 1 t/m <sup>3</sup> |   |               |

LL surcharge intensity      q      =      2.4 t/m<sup>2</sup>

Abutment Length      L      =      12 m

Footing Base width      B      =      10.7 m

---

$K_a \text{ Dry}$       =      0.312

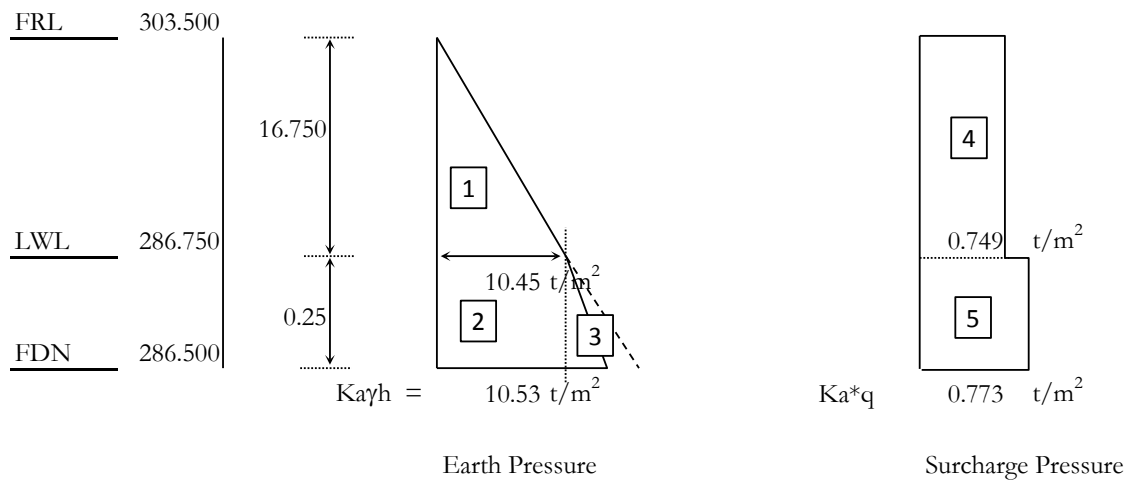
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$K_a' \text{ Submerged}$       =      0.322

---

### 1) LWL CONDITION

|                             |   |                      |
|-----------------------------|---|----------------------|
| $K_a$                       | = | 0.312                |
| $K_a'$                      | = | 0.322                |
| $\gamma_{\text{dry}}$       | = | 2 t/m <sup>3</sup>   |
| $\gamma_{\text{sub}}$       | = | 1 t/m <sup>3</sup>   |
| $\delta$                    | = | 20 °                 |
| $\delta_{\text{submerged}}$ | = | 10 °                 |
| q                           | = | 2.4 t/m <sup>2</sup> |
| L                           | = | 12 m                 |
| B                           | = | 10.7 m               |



#### Total Active Earth Presure

| Component | Factor | p                | h     | L  | F          | $\delta$ | F*Cos $\delta$ | ey    | F*Sin $\delta$ | ex    |
|-----------|--------|------------------|-------|----|------------|----------|----------------|-------|----------------|-------|
|           |        | T/m <sup>2</sup> | m     | m  | Tonne      | deg      | Tonne          | m     | Tonne          | m     |
| 1         | 0.5    | 10.452           | 16.75 | 12 | 1050.43    | 20       | 987.08         | 7.285 | 359.27         | -10.7 |
| 2         | 1      | 10.452           | 0.25  | 12 | 31.36      | 10       | 30.88          | 0.125 | 5.44           | -10.7 |
| 3         | 0.5    | 0.0805           | 0.25  | 12 | 0.12       | 10       | 0.12           | 0.083 | 0.02           | -10.7 |
| Total     |        |                  |       |    | 1081.90275 |          | 1018.08        | 7.067 | 364.7327       | -10.7 |

|                                    |   |                      |
|------------------------------------|---|----------------------|
| <b>Total Active Earth Pressure</b> | = | <b>1081.90 Tonne</b> |
| <b>Horizontal Component</b>        | = | <b>1018.08</b>       |
| <b>Lever arm</b>                   | = | <b>7.07</b>          |
| <b>Moment M<sub>TT</sub></b>       | = | <b>7194.73 Tm</b>    |
| <b>Vertical Component</b>          | = | <b>364.73</b>        |
| <b>Lever arm</b>                   | = | <b>-10.70 m</b>      |
| <b>Moment M<sub>TT</sub></b>       | = | <b>-3902.64 Tm</b>   |
| <b>Net Moment M<sub>TT</sub></b>   | = | <b>3292.09 Tm</b>    |

#### Total Surcharge pressure

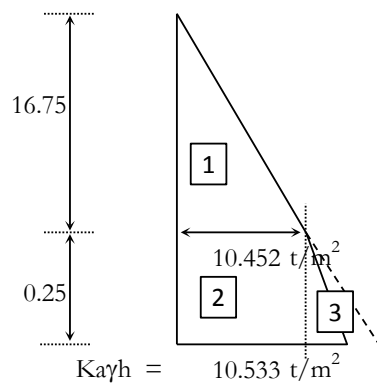
| Component | Factor | p                | h     | L  | F       | ey      |
|-----------|--------|------------------|-------|----|---------|---------|
|           |        | T/m <sup>2</sup> | m     | m  | Tonne   | m       |
| 4         | 1      | 0.7488           | 16.75 | 12 | 150.509 | 8.625   |
| 5         | 1      | 0.7728           | 0.25  | 12 | 2.3184  | 0.125   |
| Total     |        |                  |       |    | 152.827 | 8.49605 |

|                          |   |              |
|--------------------------|---|--------------|
| Total Surcharge Pressure | = | 152.83 Tonne |
| Lever arm above base     | = | 8.50 m       |
| Moment $M_{TT}$          | = | 1298.43 Tm   |

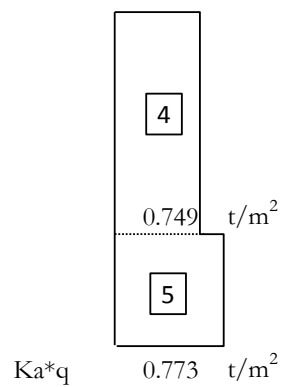
## 2) HFL CONDITION

|                      |   |                      |
|----------------------|---|----------------------|
| $K_a$                | = | 0.312                |
| $K_a'$               | = | 0.322                |
| $\gamma_{dry}$       | = | 2 t/m <sup>3</sup>   |
| $\gamma_{sub}$       | = | 1 t/m <sup>3</sup>   |
| $\delta$             | = | 20 °                 |
| $\delta_{submerged}$ | = | 10 °                 |
| $q$                  | = | 2.4 t/m <sup>2</sup> |
| $L$                  | = | 12 m                 |
| $B$                  | = | 10.7 m               |

|     |         |
|-----|---------|
| FRL | 303.500 |
| HFL | 286.750 |
| FDN | 286.500 |



Earth Pressure



Surcharge Pressure

Total Active Earth Pressure

| Component | Factor | p                | h     | L  | F          | $\delta$ | F*Cos $\delta$ | ey    | F*Sin $\delta$ | ex    |
|-----------|--------|------------------|-------|----|------------|----------|----------------|-------|----------------|-------|
|           |        | T/m <sup>2</sup> | m     | m  | Tonne      | deg      | Tonne          | m     | Tonne          | m     |
| 1         | 0.5    | 10.452           | 16.75 | 12 | 1050.43    | 20       | 987.08         | 7.285 | 359.27         | -10.7 |
| 2         | 1      | 10.452           | 0.25  | 12 | 31.36      | 10       | 30.88          | 0.125 | 5.44           | -10.7 |
| 3         | 0.5    | 0.0805           | 0.25  | 12 | 0.12       | 10       | 0.12           | 0.083 | 0.02           | -10.7 |
| Total     |        |                  |       |    | 1081.90275 |          | 1018.08        | 7.067 | 364.7327       | -10.7 |

|                                    |   |                      |
|------------------------------------|---|----------------------|
| <b>Total Active Earth Pressure</b> | = | <b>1081.90 Tonne</b> |
| <b>Horizontal Component</b>        | = | <b>1018.08</b>       |
| <b>Lever arm</b>                   | = | <b>7.07</b>          |
| <b>Moment M<sub>TT</sub></b>       | = | <b>7194.73 Tm</b>    |
| <b>Vertical Component</b>          | = | <b>364.73</b>        |
| <b>Lever arm</b>                   | = | <b>-10.70 m</b>      |
| <b>Moment M<sub>TT</sub></b>       | = | <b>-3902.64 Tm</b>   |
| <b>Net Moment M<sub>TT</sub></b>   | = | <b>3292.09 Tm</b>    |

Total Surcharge pressure

| Component | Factor | p                | h     | L  | F       | ey      |
|-----------|--------|------------------|-------|----|---------|---------|
|           |        | T/m <sup>2</sup> | m     | m  | Tonne   | m       |
| 4         | 1      | 0.7488           | 16.75 | 12 | 150.509 | 8.625   |
| 5         | 1      | 0.7728           | 0.25  | 12 | 2.3184  | 0.125   |
| Total     |        |                  |       |    | 152.827 | 8.49605 |

|                                 |   |                     |
|---------------------------------|---|---------------------|
| <b>Total Surcharge Pressure</b> | = | <b>152.83 Tonne</b> |
| <b>Lever arm above base</b>     | = | <b>8.50 m</b>       |
| <b>Moment M<sub>TT</sub></b>    | = | <b>1298.43 Tm</b>   |

**SUMMARY OF FORCES FOR OVERTURNING AND SLIDING****SUMMARY ACTIVE EARTH PRESSURE :**

| Description      | Earth Pressure       |                 |                |                 |
|------------------|----------------------|-----------------|----------------|-----------------|
|                  | Horizontal ( $H_L$ ) | $M_{TT}$ (Dest) | Vertical ( V ) | $M_{TT}$ (Steb) |
|                  | Tonne                | Tm              | Tonne          | Tm              |
| 1) LWL Condition | 1018.08              | 7194.73         | 364.73         | -3902.6         |
| 1) HFL Condition | 1018.08              | 7194.73         | 364.73         | -3902.6         |

**SUMMARY SURCHARGE PRESSURE :**

| Description      | Surcharge Pressure   |                 |
|------------------|----------------------|-----------------|
|                  | Horizontal ( $H_L$ ) | $M_{TT}$ (Dest) |
|                  | Tonne                | Tm              |
| 1) LWL Condition | 152.83               | 1298.43         |
| 2) HFL Condition | 152.83               | 1298.43         |

**SUMMARY OF FORCES FOR BASE PRESSURE**

*Total base width* = 10.7 m  
*Distance from toe to shaft back* = 4.6 m

**SUMMARY ACTIVE EARTH PRESSURE :**

| Description      | Earth Pressure       |                 |                |                 |
|------------------|----------------------|-----------------|----------------|-----------------|
|                  | Horizontal ( $H_L$ ) | $M_{TT}$ (Dest) | Vertical ( V ) | $M_{TT}$ (Steb) |
|                  | Tonne                | Tm              | Tonne          | Tm              |
| 1) LWL Condition | 1018.08              | 7194.73         | 364.73         | -1677.77        |
| 1) HFL Condition | 1018.08              | 7194.73         | 364.73         | -1677.77        |

**SUMMARY SURCHARGE PRESSURE :**

| Description      | Surcharge Pressure   |                 |
|------------------|----------------------|-----------------|
|                  | Horizontal ( $H_L$ ) | $M_{TT}$ (Dest) |
|                  | Tonne                | Tm              |
| 1) LWL Condition | 152.83               | 1298.43         |
| 2) HFL Condition | 152.83               | 1298.43         |

### SEISMIC FORCE CALCULATION :

$$\text{Time Period Calculation} \quad T = 2 \sqrt{\frac{D}{1000 F}}$$

$$\begin{aligned} D &= \text{Approximate DL of super-structure \& LL in Tonne (DL+20\% LL)} \\ &= 417.96 + 27 \text{ t} \\ &= 445.441 \text{ Tonne} \end{aligned}$$

$$F = \text{Horizontal force in Tonne required to be applied at center of mass of super-structure for 1 mm deflection at the top of pier / abutment along the considered direction of horizontal force.}$$

$$F = \frac{6 E I}{x^2(3L-x)} \quad \text{for 1 mm deflection at } x$$

$$E = 34313 \text{ N/mm}^2$$

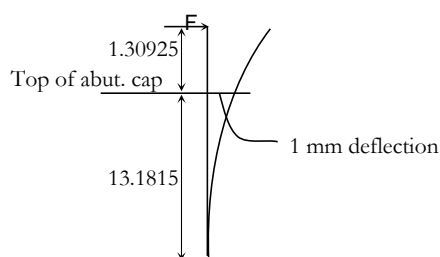
Column Cross-Section

$$B = 12 \text{ m}$$

$$D = 1.4 \text{ m (Average)}$$

$$I_L = 2.744\text{E}+12 \text{ m}^4$$

$$I_T = 2.016\text{E}+14 \text{ m}^4$$



$$\text{Force required in Long. Dir. } F_L = 10.7 \text{ tonne}$$

$$\text{Force required in Long. Dir. } F_T = 788.6 \text{ tonne}$$

$$\text{Time Period -Longitudinal Seismic Case} = 0.407$$

$$\text{Time Period -Transverse Seismic Case} = 0.05$$

$$\text{Sa/g -Longitudinal Seismic Case} = 0.61 \quad (\text{Amendment no. 1/ August 2013/}$$

$$\text{Sa/g -Transverse Seismic Case} = 0.68 \quad \text{IRC:6-2010 clause}$$

$$\text{Sa/g -Vertical Seismic Case} = 0.68 \quad 219.5)$$

$$\text{Seismic Zone} = V$$

$$\text{Type of soil} = \text{medium}$$

$$\text{Zone factor } Z = 0.36$$

$$\text{Importance factor } I = 1.2$$

$$\text{Horizontal seismic coeff. -Long., } A_{hL} = (Z/2)*(I)*(Sa/g)_{(Long.)} = 0.13$$

$$\text{Horizontal seismic coeff. -Trans., } A_{hT} = (Z/2)*(I)*(Sa/g)_{(Trans.)} = 0.15$$

$$\text{Vertical seismic coeff. } A_v = 2/3 A_h = 0.10$$

$$\text{Response Reduction Factor, } R_{long.} = 3$$

$$\text{Response Reduction Factor, } R_{trans.} = 1$$

$$\text{Response Reduction Factor, } R_{vert.} = 3$$

$$\text{Design Horizontal Longitudinal seismic coeff., } A_{hL} = A_h'/R_{(Long.)} = 0.04417$$

$$\text{Design Horizontal Transverse seismic coeff., } A_{hT} = A_h'/R_{(Trans.)} = 0.14625$$

$$\text{Design Vertical Seismic Coefficient - } A_v = A_v'/R_{(vert.)} = 0.0325$$

## DYNAMIC EARTH PRESSURE CALCULATION FOR OVER-TURNING & SLIDING :

### A) Non-Seismic Case :

Coefficient of Active Earth Pressure

$$K_a \text{ Dry} = 0.312$$

$$K_a' \text{ Submerged} = 0.322$$

Backfill Soil Parameter

|                             |   |                   |   |               |
|-----------------------------|---|-------------------|---|---------------|
| $\phi$                      | = | $30^\circ$        | = | 0.524 Radians |
| $\delta$                    | = | $20^\circ$        | = | 0.349 Radians |
| $\delta_{\text{submerged}}$ | = | $10^\circ$        | = | 0.175 Radians |
| $i$                         | = | $0^\circ$         | = | 0.000 Radians |
| $\alpha$                    | = | $90^\circ$        | = | 1.571 Radians |
| $\gamma_{\text{dry}}$       | = | $2 \text{ t/m}^3$ |   |               |
| $\gamma_{\text{sat}}$       | = | $2 \text{ t/m}^3$ |   |               |
| $\gamma_{\text{sub}}$       | = | $1 \text{ t/m}^3$ |   |               |

$$\text{LL surcharge intensity } q = 2.4 \text{ t/m}^2$$

$$\text{Abutment Length } L = 12 \text{ m}$$

$$\text{Footing Base width } B = 10.7 \text{ m}$$

$$C_a = \frac{(1 \pm \alpha_v) * \sin^2(\alpha + \phi - \lambda)}{\cos \lambda * \sin^2 \alpha \cdot \sin(\alpha - \delta - \lambda) \cdot \left[ 1 + \sqrt{\frac{\sin(\phi + \delta) \cdot \sin(\phi - i - \lambda)}{\sin(\alpha - \delta - \lambda) \cdot \sin(\alpha + i)}} \right]^2}$$

$$\alpha_h = 0.04417$$

$$\alpha_v = 0.0325$$

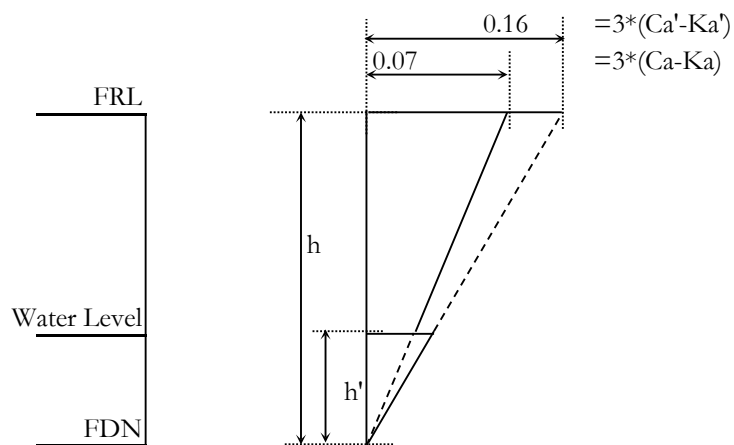
| $\lambda$                    | Formula used  | For | $+\alpha_v$ | $-\alpha_v$ |     |
|------------------------------|---|-----|-------------|-------------|-----|
| $\lambda_{\text{dry}}$       | $= \tan^{-1} \frac{\alpha_h}{1 \pm \alpha_v}$   |     | 2.45        | 2.61        | deg |
| $\lambda_{\text{submerged}}$ | $= \tan^{-1} \frac{\gamma_{\text{sat}} * \alpha_h}{(\gamma_{\text{sat}} - 1) (1 \pm \alpha_v)}$ |     | 4.89        | 5.22        | deg |

| $+\alpha_v$ | $-\alpha_v$ |         |
|-------------|-------------|---------|
| 0.04        | 0.05        | Radians |
| 0.09        | 0.09        | Radians |

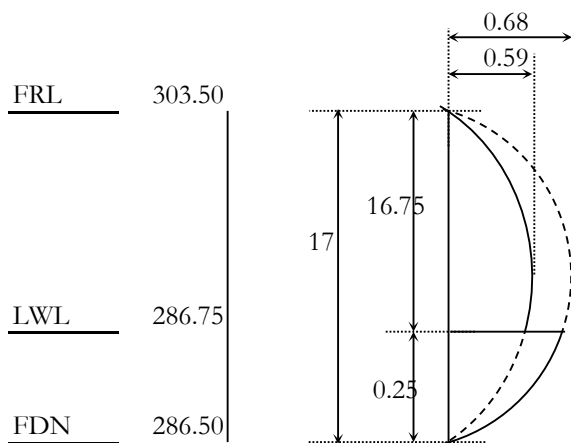
| Seismic case (Coefficient of Earth Pressure) |         |       |
|--|---------|-------|
| For Seismic downward dry condition           | $C_a$   | 0.335 |
| For Seismic downward submerged condition     | $C_a'$  | 0.375 |
| For Seismic upward dry condition             | $C_a-$  | 0.316 |
| For Seismic upward submerged condition       | $C_a-'$ | 0.355 |

### 1) LWL Seismic Downward

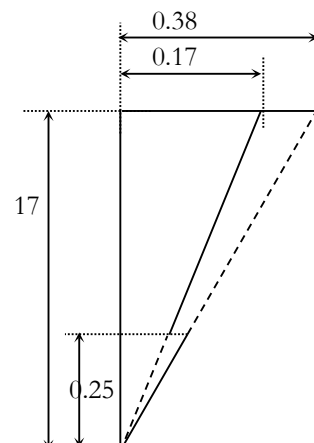
|                             |   |                      |
|-----------------------------|---|----------------------|
| $K_a$                       | = | 0.312                |
| $K_a'$                      | = | 0.322                |
| $C_a$                       | = | 0.335                |
| $C_a'$                      | = | 0.375                |
| $\gamma_{\text{dry}}$       | = | 2 t/m <sup>3</sup>   |
| $\gamma_{\text{sat}}$       | = | 2 t/m <sup>3</sup>   |
| $\gamma_{\text{sub}}$       | = | 1 t/m <sup>3</sup>   |
| $\delta$                    | = | 20 deg               |
| $\delta_{\text{submerged}}$ | = | 10 deg               |
| $q$                         | = | 2.4 t/m <sup>2</sup> |
| $L$                         | = | 12 m                 |
| $B$                         | = | 10.7 m               |



Dynamic Earth Pressure Coeff. Variation



Dynamic Earth Pressure



Dynamic Surcharge Pressure



#### Dyanmic Earth Pressure Calculation

Parabola above Water Level

|                         |   |                       |
|-------------------------|---|-----------------------|
| p <sub>mid_height</sub> | = | 0.59 t/m <sup>2</sup> |
| h                       | = | 17 m                  |
| y                       | = | 8.25 m                |
| L                       | = | 12 m                  |

Parabola below Water Level

|                         |   |                       |
|-------------------------|---|-----------------------|
| p <sub>mid_height</sub> | = | 0.68 t/m <sup>2</sup> |
| h                       | = | 17 m                  |
| y                       | = | -8.25 m               |
| L                       | = | 12 m                  |

| Dyanmic Earth Pressure              | Pa          | δ    | Pa*Cosδ     | ey         | Pa*Sinδ     | ex           |
|-------------------------------------|-------------|------|-------------|------------|-------------|--------------|
|                                     | T           | deg. | T           | m          | T           | m            |
| Parabola above Water Level          | 80.6        | 20   | 75.8        | 8.5        | 27.6        | -10.7        |
| Parabola below Water Level          | 0.1         | 10   | 0.1         | 0.2        | 0.0         | -10.7        |
| <b>Total Dynamic Earth Pressure</b> | <b>80.7</b> |      | <b>75.8</b> | <b>8.5</b> | <b>27.6</b> | <b>-10.7</b> |

|                                     |   |                    |
|-------------------------------------|---|--------------------|
| <b>Total Dynamic Earth Pressure</b> | = | <b>80.70 Tonne</b> |
| <b>Horizontal Component</b>         | = | <b>75.83</b>       |
| <b>Lever arm</b>                    | = | <b>8.50</b>        |
| <b>Moment M<sub>TT</sub></b>        | = | <b>644.49 Tm</b>   |
| <b>Vertical Component</b>           | = | <b>27.59</b>       |
| <b>Lever arm</b>                    | = | <b>-10.70 m</b>    |
| <b>Moment M<sub>TT</sub></b>        | = | <b>-295.208 Tm</b> |
| <b>Net Moment M<sub>TT</sub></b>    | = | <b>349.28 Tm</b>   |

#### Dyanmic Surcharge Pressure Calculation

Pressure Distribution above water level

|                          |   |                       |
|--------------------------|---|-----------------------|
| Intensity at top         | = | 0.17 t/m <sup>2</sup> |
| Intensity at water Level | = | 0.00 t/m <sup>2</sup> |
| h-h'                     | = | 16.75 m               |
| L                        | = | 12 m                  |

Pressure Distribution below water level

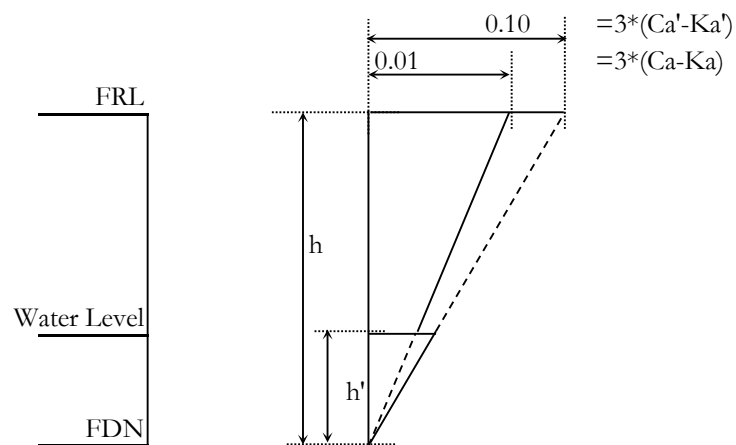
|                          |   |                       |
|--------------------------|---|-----------------------|
| Intensity at water Level | = | 0.01 t/m <sup>2</sup> |
| Intensity at base        | = | 0 t/m <sup>2</sup>    |
| h                        | = | 0.25 m                |
| L                        | = | 12 m                  |

| Dyanmic Surcharge Pressure              | Pa           | Lever arm above Base |
|---|--------------|----------------------|
|   | T/m          | m                    |
| Trapezodial Portion above water Level   | 17.08        | 11.34                |
| Traingular Portion below water Level    | 0.01         | 0.17                 |
| <b>Total Dynamic Surcharge Pressure</b> | <b>17.09</b> | <b>11.33</b>         |

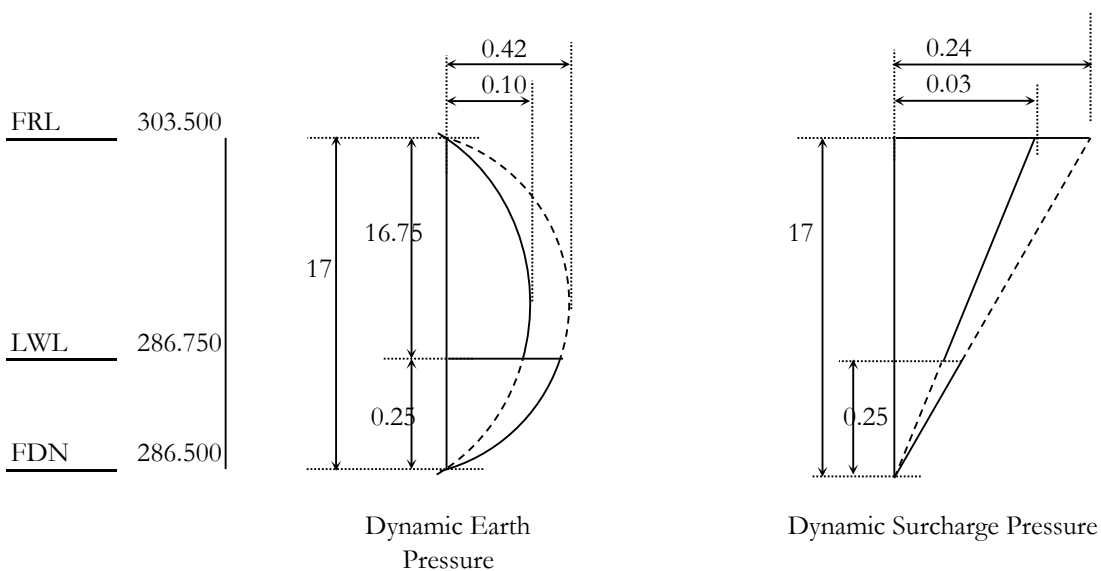
|                                 |   |                    |
|---------------------------------|---|--------------------|
| <b>Total Surcharge Pressure</b> | = | <b>17.09 Tonne</b> |
| <b>Levera arm above base</b>    | = | <b>11.33 m</b>     |
| <b>Moment M<sub>TT</sub></b>    | = | <b>193.65 Tm</b>   |

## 2) LWL Seismic Upward

|                             |   |                      |
|-----------------------------|---|----------------------|
| $K_a$                       | = | 0.312                |
| $K_a'$                      | = | 0.322                |
| $C_a$                       | = | 0.316                |
| $C_a'$                      | = | 0.355                |
| $\gamma_{\text{dry}}$       | = | 2 t/m <sup>3</sup>   |
| $\gamma_{\text{sat}}$       | = | 2 t/m <sup>3</sup>   |
| $\gamma_{\text{sub}}$       | = | 1 t/m <sup>3</sup>   |
| $\delta$                    | = | 20 deg               |
| $\delta_{\text{submerged}}$ | = | 10 deg               |
| $q$                         | = | 2.4 t/m <sup>2</sup> |
| $L$                         | = | 12 m                 |
| $B$                         | = | 10.7 m               |



Dynamic Earth Pressure Coeff. Variation



Dynamic Earth Pressure

Dynamic Surcharge Pressure

### Dyanmic Earth Pressure Calculation

#### Parabola above Water Level

|              |   |                       |
|--------------|---|-----------------------|
| p_mid_height | = | 0.10 t/m <sup>2</sup> |
| h            | = | 17 m                  |
| y            | = | 8.25 m                |
| L            | = | 12 m                  |

#### Parabola below Water Level

|              |   |                       |
|--------------|---|-----------------------|
| p_mid_height | = | 0.42 t/m <sup>2</sup> |
| h            | = | 17 m                  |
| y            | = | -8.25 m               |
| L            | = | 12 m                  |

| Dyanmic Earth Pressure              | Pa          | δ    | Pa*Cosδ     | ey         | Pa*Sinδ    | ex           |
|-------------------------------------|-------------|------|-------------|------------|------------|--------------|
|                                     | T           | deg. | T           | m          | T          | m            |
| Parabola above Water Level          | 14.0        | 20   | 13.1        | 8.5        | 4.8        | -10.7        |
| Parabola below Water Level          | 0.0         | 10   | 0.0         | 0.2        | 0.0        | -10.7        |
| <b>Total Dynamic Earth Pressure</b> | <b>14.0</b> |      | <b>13.2</b> | <b>8.5</b> | <b>4.8</b> | <b>-10.7</b> |

|                                     |   |                    |
|-------------------------------------|---|--------------------|
| <b>Total Dynamic Earth Pressure</b> | = | <b>14.03 Tonne</b> |
| <b>Horizontal Component</b>         | = | <b>13.18</b>       |
| <b>Lever arm</b>                    | = | <b>8.48</b>        |
| <b>Moment M<sub>TT</sub></b>        | = | <b>111.81 Tm</b>   |
| <b>Vertical Component</b>           | = | <b>4.79</b>        |
| <b>Lever arm</b>                    | = | <b>-10.70 m</b>    |
| <b>Moment M<sub>TT</sub></b>        | = | <b>-51.2617 Tm</b> |
| <b>Net Moment M<sub>TT</sub></b>    | = | <b>60.55 Tm</b>    |

### Dyanmic Surcharge Pressure Calculation

#### Pressure Distribution above water level

|                          |   |                        |
|--------------------------|---|------------------------|
| Intensity at top         | = | 0.03 t/m <sup>2</sup>  |
| Intensity at water Level | = | 0.000 t/m <sup>2</sup> |
| h-h'                     | = | 16.75 m                |
| L                        | = | 12 m                   |

#### Pressure Distribution below water level

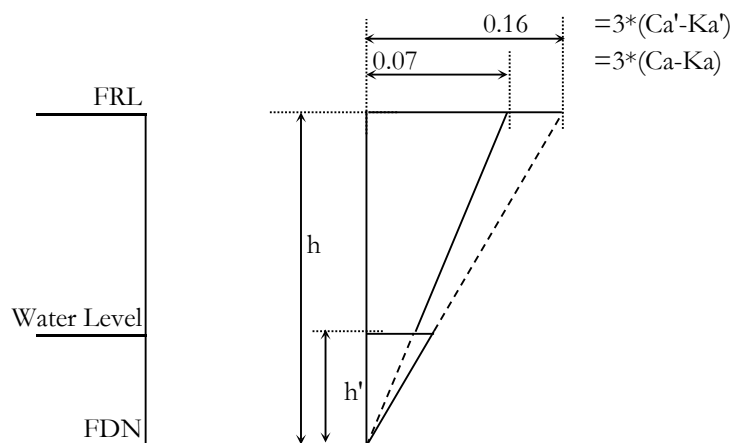
|                          |   |                       |
|--------------------------|---|-----------------------|
| Intensity at water Level | = | 0.00 t/m <sup>2</sup> |
| Intensity at base        | = | 0 t/m <sup>2</sup>    |
| h                        | = | 0.25 m                |
| L                        | = | 12 m                  |

| Dyanmic Surcharge Pressure              | Pa          | Lever arm above Base |
|---|-------------|----------------------|
|   | T/m         | m                    |
| Trapezoidal Portion above water Level   | 2.96        | 11.34                |
| Triangular Portion below water Level    | 0.01        | 0.17                 |
| <b>Total Dynamic Surcharge Pressure</b> | <b>2.97</b> | <b>11.32</b>         |

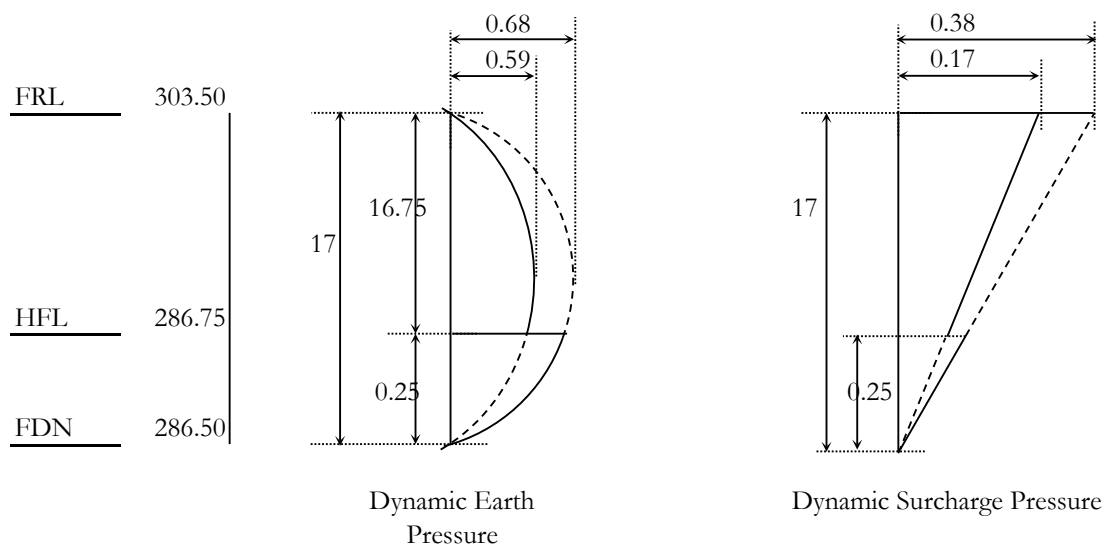
|                                 |   |                   |
|---------------------------------|---|-------------------|
| <b>Total Surcharge Pressure</b> | = | <b>2.97 Tonne</b> |
| <b>Lever arm above base</b>     | = | <b>11.32 m</b>    |
| <b>Moment M<sub>TT</sub></b>    | = | <b>33.59 Tm</b>   |

### 3) HFL Seismic Downward

|                             |   |                      |
|-----------------------------|---|----------------------|
| $K_a$                       | = | 0.312                |
| $K_a'$                      | = | 0.322                |
| $C_a$                       | = | 0.335                |
| $C_a'$                      | = | 0.375                |
| $\gamma_{\text{dry}}$       | = | 2 t/m <sup>3</sup>   |
| $\gamma_{\text{sat}}$       | = | 2 t/m <sup>3</sup>   |
| $\gamma_{\text{sub}}$       | = | 1 t/m <sup>3</sup>   |
| $\delta$                    | = | 20 deg               |
| $\delta_{\text{submerged}}$ | = | 10 deg               |
| $q$                         | = | 2.4 t/m <sup>2</sup> |
| $L$                         | = | 12 m                 |
| $B$                         | = | 10.7 m               |



Dynamic Earth Pressure Coeff. Variation



#### Dyanmic Earth Pressure Calculation

Parabola above Water Level

|                         |   |                       |
|-------------------------|---|-----------------------|
| p <sub>mid_height</sub> | = | 0.59 t/m <sup>2</sup> |
| h                       | = | 17 m                  |
| y                       | = | 8.25 m                |
| L                       | = | 12 m                  |

Parabola below Water Level

|                         |   |                       |
|-------------------------|---|-----------------------|
| p <sub>mid_height</sub> | = | 0.68 t/m <sup>2</sup> |
| h                       | = | 17 m                  |
| y                       | = | -8.25 m               |
| L                       | = | 12 m                  |

| Dyanmic Earth Pressure              | Pa          | δ    | Pa*Cosδ     | ey         | Pa*Sinδ     | ex           |
|-------------------------------------|-------------|------|-------------|------------|-------------|--------------|
|                                     | T           | deg. | T           | m          | T           | m            |
| Parabola above Water Level          | 80.6        | 20   | 75.8        | 8.5        | 27.6        | -10.7        |
| Parabola below Water Level          | 0.1         | 10   | 0.1         | 0.2        | 0.0         | -10.7        |
| <b>Total Dynamic Earth Pressure</b> | <b>80.7</b> |      | <b>75.8</b> | <b>8.5</b> | <b>27.6</b> | <b>-10.7</b> |

|                                     |   |                    |
|-------------------------------------|---|--------------------|
| <b>Total Dynamic Earth Pressure</b> | = | <b>80.70 Tonne</b> |
| <b>Horizontal Component</b>         | = | <b>75.83</b>       |
| <b>Lever arm</b>                    | = | <b>8.50</b>        |
| <b>Moment M<sub>TT</sub></b>        | = | <b>644.49 Tm</b>   |
| <b>Vertical Component</b>           | = | <b>27.59</b>       |
| <b>Lever arm</b>                    | = | <b>-10.70 m</b>    |
| <b>Moment M<sub>TT</sub></b>        | = | <b>-295.208 Tm</b> |
| <b>Net Moment M<sub>TT</sub></b>    | = | <b>349.28 Tm</b>   |

#### Dyanmic Surcharge Pressure Calculation

Pressure Distribution above water level

|                          |   |                        |
|--------------------------|---|------------------------|
| Intensity at top         | = | 0.17 t/m <sup>2</sup>  |
| Intensity at water Level | = | 0.002 t/m <sup>2</sup> |
| h-h'                     | = | 16.75 m                |
| L                        | = | 12 m                   |

Pressure Distribution below water level

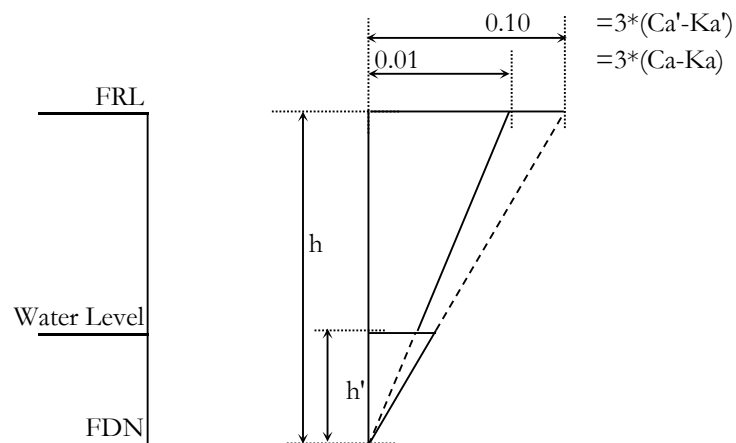
|                          |   |                       |
|--------------------------|---|-----------------------|
| Intensity at water Level | = | 0.01 t/m <sup>2</sup> |
| Intensity at base        | = | 0 t/m <sup>2</sup>    |
| h                        | = | 0.25 m                |
| L                        | = | 12 m                  |

| Dyanmic Surcharge Pressure              | Pa           | Lever arm above Base |
|---|--------------|----------------------|
|   | T/m          | m                    |
| Trapezoidal Portion above water Level   | 17.08        | 11.34                |
| Triangular Portion below water Level    | 0.01         | 0.17                 |
| <b>Total Dynamic Surcharge Pressure</b> | <b>17.09</b> | <b>11.33</b>         |

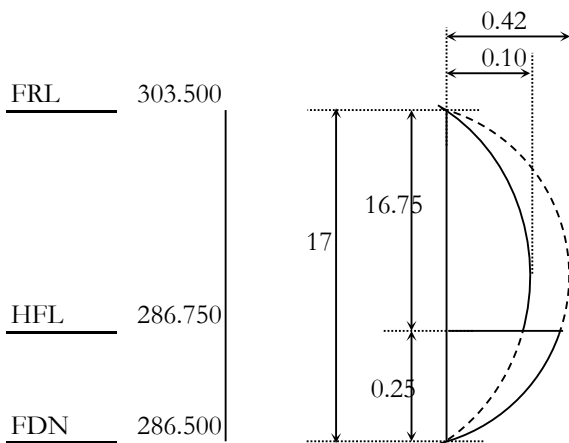
|                                 |   |                    |
|---------------------------------|---|--------------------|
| <b>Total Surcharge Pressure</b> | = | <b>17.09 Tonne</b> |
| <b>Lever arm above base</b>     | = | <b>11.33 m</b>     |
| <b>Moment M<sub>TT</sub></b>    | = | <b>193.65 Tm</b>   |

#### 4) HFL Seismic Upward

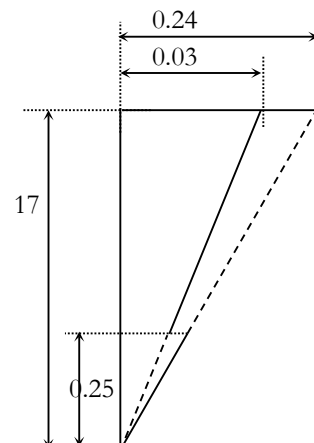
|                             |   |                      |
|-----------------------------|---|----------------------|
| $K_a$                       | = | 0.312                |
| $K_a'$                      | = | 0.322                |
| $C_a$                       | = | 0.316                |
| $C_a'$                      | = | 0.355                |
| $\gamma_{\text{dry}}$       | = | 2 t/m <sup>3</sup>   |
| $\gamma_{\text{sat}}$       | = | 2 t/m <sup>3</sup>   |
| $\gamma_{\text{sub}}$       | = | 1 t/m <sup>3</sup>   |
| $\delta$                    | = | 20 deg               |
| $\delta_{\text{submerged}}$ | = | 10 deg               |
| $q$                         | = | 2.4 t/m <sup>2</sup> |
| $L$                         | = | 12 m                 |
| $B$                         | = | 10.7 m               |



Dynamic Earth Pressure Coeff. Variation



Dynamic Earth Pressure



Dynamic Surcharge Pressure

### Dyanmic Earth Pressure Calculation

#### Parabola above Water Level

|                         |   |                       |
|-------------------------|---|-----------------------|
| p <sub>mid_height</sub> | = | 0.10 t/m <sup>2</sup> |
| h                       | = | 17 m                  |
| y                       | = | 8.25 m                |
| L                       | = | 12 m                  |

#### Parabola below Water Level

|                         |   |                       |
|-------------------------|---|-----------------------|
| p <sub>mid_height</sub> | = | 0.42 t/m <sup>2</sup> |
| h                       | = | 17 m                  |
| y                       | = | -8.25 m               |
| L                       | = | 12 m                  |

| Dyanmic Earth Pressure              | Pa          | δ    | Pa*cosδ     | ey         | Pa*sinδ    | ex           |
|-------------------------------------|-------------|------|-------------|------------|------------|--------------|
|                                     | T           | deg. | T           | m          | T          | m            |
| Parabola above Water Level          | 14.0        | 20   | 13.1        | 8.5        | 4.8        | -10.7        |
| Parabola below Water Level          | 0.0         | 10   | 0.0         | 0.2        | 0.0        | -10.7        |
| <b>Total Dynamic Earth Pressure</b> | <b>14.0</b> |      | <b>13.2</b> | <b>8.5</b> | <b>4.8</b> | <b>-10.7</b> |

|                                     |   |                    |
|-------------------------------------|---|--------------------|
| <b>Total Dynamic Earth Pressure</b> | = | <b>14.03 Tonne</b> |
| <b>Horizontal Component</b>         | = | <b>13.18</b>       |
| <b>Lever arm</b>                    | = | <b>8.48</b>        |
| <b>Moment M<sub>TT</sub></b>        | = | <b>111.81 Tm</b>   |
| <b>Vertical Component</b>           | = | <b>4.79</b>        |
| <b>Lever arm</b>                    | = | <b>-10.70 m</b>    |
| <b>Moment M<sub>TT</sub></b>        | = | <b>-51.2617 Tm</b> |
| <b>Net Moment M<sub>TT</sub></b>    | = | <b>60.55 Tm</b>    |

### Dyanmic Surcharge Pressure Calculation

#### Pressure Distribution above water level

|                          |   |                        |
|--------------------------|---|------------------------|
| Intensity at top         | = | 0.03 t/m <sup>2</sup>  |
| Intensity at water Level | = | 0.000 t/m <sup>2</sup> |
| h-h'                     | = | 16.75 m                |
| L                        | = | 12 m                   |

#### Pressure Distribution below water level

|                          |   |                       |
|--------------------------|---|-----------------------|
| Intensity at water Level | = | 0.00 t/m <sup>2</sup> |
| Intensity at base        | = | 0 t/m <sup>2</sup>    |
| h                        | = | 0.25 m                |
| L                        | = | 12 m                  |

| Dyanmic Surcharge Pressure              | Pa          | Lever arm above Base |
|---|-------------|----------------------|
|   | T/m         | m                    |
| Trapezoidal Portion above water Level   | 2.96        | 11.34                |
| Triangular Portion below water Level    | 0.01        | 0.17                 |
| <b>Total Dynamic Surcharge Pressure</b> | <b>2.97</b> | <b>11.32</b>         |

|                                 |   |                   |
|---------------------------------|---|-------------------|
| <b>Total Surcharge Pressure</b> | = | <b>2.97 Tonne</b> |
| <b>Lever arm above base</b>     | = | <b>11.32 m</b>    |
| <b>Moment M<sub>TT</sub></b>    | = | <b>33.59 Tm</b>   |

**1) SUMMARY DYNAMIC PRESSURE FOR OVERTURNING & SLIDING:**

**a) EARTH PRESSURE FOR OVERTURNING & SLIDING:**

| Description             | Dynamic Earth Pressure       |                        |              |                        |
|-------------------------|------------------------------|------------------------|--------------|------------------------|
|                         | Horizontal (H <sub>L</sub> ) | M <sub>TT</sub> (Dest) | Vertical (V) | M <sub>TT</sub> (Steb) |
|                         | Tonne                        | Tm                     | Tonne        | Tm                     |
| 1) LWL Seismic Downward |                              |                        |              |                        |
| Horizontal Component    | 75.83                        | 644.49                 |              |                        |
| Vertical Component      |                              |                        | 27.59        | -295.21                |
| 2) LWL Seismic Upward   |                              |                        |              |                        |
| Horizontal Component    | 13.18                        | 111.81                 |              |                        |
| Vertical Component      |                              |                        | 4.79         | -51.26                 |
| 3) HFL Seismic Downward |                              |                        |              |                        |
| Horizontal Component    | 75.83                        | 644.49                 |              |                        |
| Vertical Component      |                              |                        | 27.59        | -295.21                |
| 4) HFL Seismic Upward   |                              |                        |              |                        |
| Horizontal Component    | 13.18                        | 111.81                 |              |                        |
| Vertical Component      |                              |                        | 4.79         | -51.26                 |

**b) SURCHARGE PRESSURE FOR OVERTURNING & SLIDING:**

| Description             | Dynamic Surcharge Pressure   |                        |
|-------------------------|------------------------------|------------------------|
|                         | Horizontal (H <sub>L</sub> ) | M <sub>TT</sub> (Dest) |
|                         | Tonne                        | Tm                     |
| 1) LWL Seismic Downward | 17.09                        | 193.65                 |
| 2) LWL Seismic Upward   | 2.97                         | 33.59                  |
| 3) HFL Seismic Downward | 17.09                        | 193.65                 |
| 4) HFL Seismic Upward   | 2.97                         | 33.59                  |

**2) SUMMARY DYNAMIC PRESSURE FOR BASE PRESSURE:**

Total base width = 10.7 m  
Distance from toe to shaft back = 4.6 m



| <b>a) EARTH PRESSURE FOR BASE PRESSURE:</b>                           |                              |                        |              |                        |
|---|------------------------------|------------------------|--------------|------------------------|
| Description   | Dynamic Earth Pressure       |                        |              |                        |
|   | Horizontal (H <sub>L</sub> ) | M <sub>TT (Dest)</sub> | Vertical (V) | M <sub>TT (Steb)</sub> |
|   | Tonne                        | Tm                     | Tonne        | Tm                     |
| 1) LWL Seismic Downward<br>Horizontal Component<br>Vertical Component | 75.83                        | 644.49                 | 27.59        | -126.91                |
| 2) LWL Seismic Upward<br>Horizontal Component<br>Vertical Component   | 13.18                        | 111.81                 | 4.79         | -22.04                 |
| 3) HFL Seismic Downward<br>Horizontal Component<br>Vertical Component | 75.83                        | 644.49                 | 27.59        | -126.91                |
| 4) HFL Seismic Upward<br>Horizontal Component<br>Vertical Component   | 13.18                        | 111.81                 | 4.79         | -22.04                 |

**b) SURCHARGE PRESSURE FOR BASE PRESSURE:**

| Description             | Dynamic Surcharge Pressure   |                        |
|-------------------------|------------------------------|------------------------|
|                         | Horizontal (H <sub>L</sub> ) | M <sub>TT (Dest)</sub> |
|                         | Tonne                        | Tm                     |
| 1) LWL Seismic Downward | 17.09                        | 193.65                 |
| 2) LWL Seismic Upward   | 2.97                         | 33.59                  |
| 3) HFL Seismic Downward | 17.09                        | 193.65                 |
| 4) HFL Seismic Upward   | 2.97                         | 33.59                  |

**SEISMIC COMPONENT OF SUPER-STRUCTURE DL & SIDL :**

|   |          |   |         |
|---|----------|---|---------|
| Longitudinal Horizontal seismic coefficient | $A_{hL}$ | = | 0.04417 |
| Transverse Horizontal seismic coefficient   | $A_{hT}$ | = | 0.14625 |
| Vertical seismic coefficient                | $A_V$    | = | 0.0325  |

Loads & Their Lever arm from base slab bottom

| Description                |   | W     | ey    |
|----------------------------|---|-------|-------|
|                            |   | Tonne | m     |
| Total Super-Structure DL   | = | 533.9 | 16.45 |
| Total Super-Structure SIDL | = | 234.0 | 17.24 |
| Total Surfacing weight     | = | 68.1  | 16.97 |
| Total                      |   | 835.9 | 16.7  |

W = Weight of super-structure

ey = Cg. above base slab in vertical direction

Distance From base slab bottom to bearing top = 14.532 m

Distance from toe tip to c/L of brg = -3.225 m

**SEISMIC LONGITUDINAL :**

|  |          |   |             |
|--|----------|---|-------------|
| Longitudinal seismic coefficient         | $A_{hL}$ | = | 0.04417     |
| Total weight of sup DL, SIDL & surfacing |          | = | 835.9 Tonne |

***Forces at fixed end***

|                                |  |   |            |
|--------------------------------|--|---|------------|
| Seismic Component              |  | = | 36.9 Tonne |
| Lever arm above base slab      |  | = | 14.5 m     |
| Moment about T-T axis $M_{TT}$ |  | = | 536.6 Tm   |

***Forces at free end***

|                                |  |   |           |
|--------------------------------|--|---|-----------|
| Seismic Component              |  | = | 0.0 Tonne |
| Lever arm above base slab      |  | = | 0.0 m     |
| Moment about T-T axis $M_{TT}$ |  | = | 0.0 Tm    |

**SEISMIC TRANSVERSE :**

|  |          |   |             |
|--|----------|---|-------------|
| Horizontal seismic coefficient           | $A_{hT}$ | = | 0.14625     |
| Total weight of sup DL, SIDL & surfacing |          | = | 835.9 Tonne |

***Forces at fixed end***

|                               |  |   |            |
|-------------------------------|--|---|------------|
| Seismic Component             |  | = | 61.1 Tonne |
| Lever arm above base slab     |  | = | 16.7 m     |
| Moment about LL axis $M_{LL}$ |  | = | 1021.5 Tm  |

***Forces at free end***

|                               |  |   |            |
|-------------------------------|--|---|------------|
| Seismic Component             |  | = | 61.1 Tonne |
| Lever arm above base slab     |  | = | 16.7 m     |
| Moment about LL axis $M_{LL}$ |  | = | 1021.5 Tm  |

**SEISMIC VERTICAL :**

|  |       |   |             |
|--|-------|---|-------------|
| Horizontal seismic coefficient           | $A_v$ | = | 0.0325      |
| Total weight of sup DL, SIDL & surfacing |       | = | 835.9 Tonne |

***Forces at fixed end***

|                                |  |   |            |
|--------------------------------|--|---|------------|
| Seismic Component              |  | = | 13.6 Tonne |
| Lever arm from toe             |  | = | -3.2 m     |
| Moment about T-T axis $M_{TT}$ |  | = | -43.8 Tm   |

***Forces at free end***

|                                |  |   |            |
|--------------------------------|--|---|------------|
| Seismic Component              |  | = | 13.6 Tonne |
| Lever arm from toe             |  | = | -3.2 m     |
| Moment about T-T axis $M_{TT}$ |  | = | -43.8 Tm   |

**Summary of Permanent Load (DL+SIDL+SURFACING) seismic Component :**

| At Fixed End, Force about toe | V<br>T | $H_L$<br>T | $H_T$<br>T | ey<br>m | $e_L$<br>m | $M_{LL}$<br>Tm | $M_{TT}$<br>Tm |
|-------------------------------|--------|------------|------------|---------|------------|----------------|----------------|
| Seismic Longitudinal          |        | 36.9       |            | 14.5    |            | 536.6          |                |
| Seismic Transverse            |        |            | 61.1       | 16.7    |            | 1021.5         |                |
| Seismic Vertical              | 13.6   |            |            |         | -3.2       |                | -43.8          |

**SEISMIC COMPONENT OF LIVE LOAD :**

|   |          |   |         |
|---|----------|---|---------|
| Longitudinal Horizontal seismic coefficient | $A_{hL}$ | = | 0.04417 |
| Transverse Horizontal seismic coefficient   | $A_{hT}$ | = | 0.14625 |
| Vertical seismic coefficient                | $A_v$    | = | 0.0325  |

Loads & Their Lever arm from base slab bottom

| Description         | W     | ey   |
|---------------------|-------|------|
|                     | Tonne | m    |
| Maximum Live Load = | 137.4 | 18.2 |
| Minimum Live Load   | 28.8  | 18.2 |

W = Live Load Reaction

ey = Cg. above base slab in vertical direction

Distance From base slab bottom to bearing top = 14.597 m

Distance from toe tip to c/L of brg. = -3.225 m

**SEISMIC LONGITUDINAL :**

No Live Load seismic component is considered in longitudinal direction

**SEISMIC TRANSVERSE :**

Horizontal seismic coefficient  $A_{hT}$  = 0.14625

**Max Live Load Reaction Case :**

|                               |   |              |
|-------------------------------|---|--------------|
| Maximum Live Load reaction    | = | 137.40 Tonne |
| Seismic Component             | = | 20.09 Tonne  |
| Lever arm above base slab     | = | 18.20 m      |
| Moment about LL axis $M_{LL}$ | = | 365.72 Tm    |

**Min Live Load Reaction Case :**

|                               |   |             |
|-------------------------------|---|-------------|
| Minimum Live Load reaction    | = | 28.80 Tonne |
| Seismic Component             | = | 4.21 Tonne  |
| Lever arm above base slab     | = | 18.20 m     |
| Moment about LL axis $M_{LL}$ | = | 76.66 Tm    |

**SEISMIC VERTICAL :**

Vertical seismic coefficient  $A_{hT}$  = 0.0325

**Max Live Load Reaction Case :**

Maximum Live Load reaction = 137.40 Tonne  
 Seismic Component = 4.47 Tonne  
 Lever arm from toe = -3.23 m  
 Moment about LL axis  $M_{LL}$  = -14.40 Tm

**Min Live Load Reaction Case :**

Minimum Live Load reaction = 28.80 Tonne  
 Seismic Component = 0.94 Tonne  
 Lever arm from toe = -3.23 m  
 Moment about LL axis  $M_{LL}$  = -3.02 Tm

**Summary of LL seismic component transferred from super-structure :****Max Live Load Reaction Case :**

| At Fixed/ Free End   | V<br>T | $H_L$<br>T | $H_T$<br>T | $e_y$<br>m | $e_L$<br>m | $M_{LL}$<br>Tm | $M_{TT}$<br>Tm |
|----------------------|--------|------------|------------|------------|------------|----------------|----------------|
| Seismic Longitudinal |        | 0.0        |            | 0.0        |            |                | 0.0            |
| Seismic Transverse   |        |            | 20.1       | 18.20      |            | 365.7          |                |
| Seismic Vertical     | 4.5    |            |            | -3.23      |            |                | -14.4          |

**Min Live Load Reaction Case :**

| At Fixed/ Free End   | V<br>T | $H_L$<br>T | $H_T$<br>T | $e_y$<br>m | $e_L$<br>m | $M_{LL}$<br>Tm | $M_{TT}$<br>Tm |
|----------------------|--------|------------|------------|------------|------------|----------------|----------------|
| Seismic Longitudinal |        | 0.0        |            | 0.0        |            |                | 0.0            |
| Seismic Transverse   |        |            | 4.2        | 18.20      |            | 76.7           |                |
| Seismic Vertical     | 0.9    |            |            | -3.23      |            |                | -3.0           |

**SEISMIC COMPONENT OF SUB-STRUCTURE & BACKFILL :**

|   |          |   |         |
|---|----------|---|---------|
| Longitudinal Horizontal seismic coefficient | $A_{hL}$ | = | 0.04417 |
| Transverse Horizontal seismic coefficient   | $A_{hT}$ | = | 0.14625 |
| Vertical seismic coefficient                | $A_v$    | = | 0.0325  |

**Sub-structure Vertical load**

| Description     | W     | ey  | ex   |
|-----------------|-------|-----|------|
|                 | Tonne | m   | m    |
| Sub-structure = | 582.2 | 7.9 | -3.7 |
| Return wall =   | 188.3 | 4.4 | -7.7 |
| Total           | 770.6 | 7.1 | -4.7 |

W = Weight of super-structure

ey = Cg. above base slab in vertical direction

**Backfill Vertical load**

| Description       | W      | ey  | ex   |
|-------------------|--------|-----|------|
|                   | Tonne  | m   | m    |
| Backfill Weight = | 2151.7 | 8.4 | -7.6 |
| Total             | 2151.7 | 8.4 | -7.6 |

**SEISMIC LONGITUDINAL :**

|                                  |          |   |               |
|----------------------------------|----------|---|---------------|
|                                  |          |   | Sub-Structure |
| Longitudinal seismic coefficient | $A_{hL}$ | = | 0.04417       |
| Total weight of Sub-structure    |          | = | 770.6 Tonne   |
| Seismic Component                |          | = | 34.0 Tonne    |
| Lever arm above base slab        |          | = | 7.1 m         |
| Moment about T-T axis $M_{TT}$   |          | = | 240.7 Tm      |

**SEISMIC TRANSVERSE :**

|                                |          |   |             |
|--------------------------------|----------|---|-------------|
| Horizontal seismic coefficient | $A_{hT}$ | = | 0.14625     |
| Total weight of Sub-structure  |          | = | 770.6 Tonne |
| Seismic Component              |          | = | 112.7 Tonne |
| Lever arm above base slab      |          | = | 7.1 m       |
| Moment about LL axis $M_{LL}$  |          | = | 796.9 Tm    |

**SEISMIC VERTICAL :**

|                                |       |   |             |
|--------------------------------|-------|---|-------------|
| Horizontal seismic coefficient | $A_v$ | = | 0.0325      |
| Total weight of Sub-structure  |       | = | 770.6 Tonne |
| Seismic Component              |       | = | 25.0 Tonne  |
| Lever arm from toe             |       | = | -4.7 m      |
| Moment about T-T axis $M_{TT}$ |       | = | -116.8 Tm   |

**Summary of Sub-structure seismic component :**

| At Fixed End         | V<br>T | $H_L$<br>T | $H_T$<br>T | $M_{LL}$<br>Tm | $M_{TT}$<br>Tm |
|----------------------|--------|------------|------------|----------------|----------------|
| Seismic Longitudinal |        | 34.0       |            |                | 240.7          |
| Seismic Transverse   |        |            | 112.7      | 796.9          |                |
| Seismic Vertical     | 25.0   |            |            |                | -116.8         |

**SEISMIC COMPONENT OF BACK FILL :****SEISMIC LONGITUDINAL :**

Earth Fill

|                                  |          |   |              |
|----------------------------------|----------|---|--------------|
| Longitudinal seismic coefficient | $A_{hL}$ | = | 0.04417      |
| Total weight of Sub-structure    |          | = | 2151.7 Tonne |
| Seismic Component                |          | = | 95.0 Tonne   |
| Lever arm above base slab        |          | = | 8.4 m        |
| Moment about T-T axis $M_{TT}$   |          | = | 796.0 Tm     |

**SEISMIC TRANSVERSE :**

|                                |          |   |              |
|--------------------------------|----------|---|--------------|
| Horizontal seismic coefficient | $A_{hT}$ | = | 0.14625      |
| Total weight of Sub-structure  |          | = | 2151.7 Tonne |
| Seismic Component              |          | = | 314.7 Tonne  |
| Lever arm above base slab      |          | = | 8.4 m        |
| Moment about LL axis $M_{LL}$  |          | = | 2635.4 Tm    |

**SEISMIC VERTICAL :**

|                                |       |   |              |
|--------------------------------|-------|---|--------------|
| Horizontal seismic coefficient | $A_v$ | = | 0.0325       |
| Total weight of Sub-structure  |       | = | 2151.7 Tonne |
| Seismic Component              |       | = | 69.9 Tonne   |
| Lever arm from toe             |       | = | -7.6 m       |
| Moment about T-T axis $M_{TT}$ |       | = | -530.9 Tm    |

***Summery of Earthfill seismic component :***

| At Fixed End         | V    | H <sub>L</sub> | H <sub>T</sub> | M <sub>LL</sub> | M <sub>TT</sub> |
|----------------------|------|----------------|----------------|-----------------|-----------------|
|                      | T    | T              | T              | Tm              | Tm              |
| Seismic Longitudinal |      | 95.0           |                |                 | 796.0           |
| Seismic Transverse   |      |                | 314.7          | 2635.4          |                 |
| Seismic Vertical     | 69.9 |                |                |                 | -530.9          |







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LOAD COMBINATION  
FOR BASE PRESSURE CHECK

| LC-1  | NS, LWL, Span dislodge, FP  | Forces about toe |                |                |                 |                 |  | LC-1 |
|-------|-----------------------------|------------------|----------------|----------------|-----------------|-----------------|--|------|
| S.N.  | Description                 | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |  |      |
|       |                             | Tonne            | Tonne          | Tonne          | Tm              | Tm              |  |      |
| 1)    | Sub-structure & Foundation  | 1073.9           |                |                | -5150.7         | 0.0             |  | 0.95 |
| 2)    | Backfill                    | 2151.7           |                |                | -16334.4        | 0.0             |  | 0.95 |
| 9)    | Fluid Pressure              |                  | 0.18           |                | 0.02            |                 |  | 1.5  |
| 10.1) | Surcharge Pressure LWL(O/S) |                  | 152.8          |                | 1298.4          |                 |  | 1.2  |

| S.N. | Description                | Forces about toe |                |                |                       |                       |                       |                       |
|------|----------------------------|------------------|----------------|----------------|-----------------------|-----------------------|-----------------------|-----------------------|
|      |                            | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT(Dest)</sub> | M <sub>TT(Steb)</sub> | M <sub>LL(Dest)</sub> | M <sub>LL(Steb)</sub> |
|      |                            | Tonne            | Tonne          | Tonne          | Tm                    | Tm                    | Tm                    | Tm                    |
| LC-1 | NS, LWL, Span dislodge, FP | 3064.29          | 183.663        | 0              | 1558.14               | -20410.9              | 0                     | 0                     |

| LC-2  | NS, LWL, Span dislodge, EP  | Forces about toe |                |                |                 |                 |  | LC-2 |
|-------|-----------------------------|------------------|----------------|----------------|-----------------|-----------------|--|------|
| S.N.  | Description                 | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |  |      |
|       |                             | Tonne            | Tonne          | Tonne          | Tm              | Tm              |  |      |
| 1)    | Sub-structure & Foundation  | 1073.9           |                |                | -5150.7         | 0.0             |  | 0.95 |
| 2)    | Backfill                    | 2151.7           |                |                | -16334.4        | 0.0             |  | 0.95 |
| 9.1)  | Earth Pressure LWL (O/S)    |                  |                |                |                 |                 |  | 1.5  |
|       | Horizontal Component        |                  | 1018.1         |                | 7194.7          |                 |  | 1.5  |
|       | Vertical Component          | 364.7            |                |                | -3902.6         |                 |  | 1.5  |
| 10.1) | Surcharge Pressure LWL(O/S) |                  | 152.8          |                | 1298.4          |                 |  | 1.2  |

| S.N. | Description                | Forces about toe |                |                |                       |                       |                       |                       |
|------|----------------------------|------------------|----------------|----------------|-----------------------|-----------------------|-----------------------|-----------------------|
|      |                            | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT(Dest)</sub> | M <sub>TT(Steb)</sub> | M <sub>LL(Dest)</sub> | M <sub>LL(Steb)</sub> |
|      |                            | Tonne            | Tonne          | Tonne          | Tm                    | Tm                    | Tm                    | Tm                    |
| LC-2 | NS, LWL, Span dislodge, EP | 3611.39          | 1710.51        | 0              | 12350.2               | -26264.9              | 0                     | 0                     |

| LC-3 | NS, LWL, Min LL Lead, FP             | Forces about toe |                |                |                 |                 |  | LC-3 |
|------|--------------------------------------|------------------|----------------|----------------|-----------------|-----------------|--|------|
| S.N. | Description                          | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |  |      |
|      |                                      | Tonne            | Tonne          | Tonne          | Tm              | Tm              |  |      |
| 1)   | Sub-structure & Foundation           | 1073.9           |                |                | -5150.7         | 0.0             |  | 0.95 |
| 2)   | Backfill                             | 2151.7           |                |                | -16334.4        | 0.0             |  | 0.95 |
| 3)   | Super-structure DL                   | 266.9            |                |                | -860.9          | 0.0             |  | 0.95 |
| 4)   | SIDL (excluding surfacing)           | 117.0            |                |                | -377.3          | 0.0             |  | 0.95 |
| 5)   | Surfacing                            | 34.0             |                |                | -109.7          | -8.5            |  | 1    |
| 6.2) | Live Load Vertical Load Min Reaction | 28.8             |                |                | -92.9           | 83.8            |  | 1.5  |
| 7)   | Live Load Horizontal Forces          |                  | 39.2           |                | 569.0           |                 |  | 1.5  |
| 9)   | Fluid Pressure                       |                  | 0.18           |                | 0.02            |                 |  | 1.5  |

|       |                             |  |       |  |        |  |  |     |
|-------|-----------------------------|--|-------|--|--------|--|--|-----|
| 10.1) | Surcharge Pressure LWL(O/S) |  | 152.8 |  | 1298.4 |  |  | 1.2 |
|-------|-----------------------------|--|-------|--|--------|--|--|-----|

| S.N. | Description              | Forces about toe |                |                |                       |                       |                       |                       |
|------|--------------------------|------------------|----------------|----------------|-----------------------|-----------------------|-----------------------|-----------------------|
|      |                          | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT(Dest)</sub> | M <sub>TT(Steb)</sub> | M <sub>LL(Dest)</sub> | M <sub>LL(Steb)</sub> |
|      |                          | Tonne            | Tonne          | Tonne          | Tm                    | Tm                    | Tm                    | Tm                    |
| LC-3 | NS, LWL, Min LL Lead, FP | 3506.26          | 242.392        | 0              | 2411.59               | -21836.2              | 125.711               | -8.50627              |

| S.N.  | Description                          | Forces about toe |                |                |                 |                 | LC-4 |
|-------|--------------------------------------|------------------|----------------|----------------|-----------------|-----------------|------|
|       |                                      | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |      |
|       |                                      | Tonne            | Tonne          | Tonne          | Tm              | Tm              |      |
| 1)    | Sub-structure & Foundation           | 1073.9           |                |                | -5150.7         | 0.0             | 0.95 |
| 2)    | Backfill                             | 2151.7           |                |                | -16334.4        | 0.0             | 0.95 |
| 3)    | Super-structure DL                   | 266.9            |                |                | -860.9          | 0.0             | 0.95 |
| 4)    | SIDL (excluding surfacing)           | 117.0            |                |                | -377.3          | 0.0             | 0.95 |
| 5)    | Surfacing                            | 34.0             |                |                | -109.7          | -8.5            | 1    |
| 6.2)  | Live Load Vertical Load Min Reaction | 28.8             |                |                | -92.9           | 83.8            | 1.5  |
| 7)    | Live Load Horizontal Forces          |                  | 39.2           |                | 569.0           |                 | 1.5  |
| 9.1)  | Earth Pressure LWL (O/S)             |                  |                |                |                 |                 | 1.5  |
|       | Horizontal Component                 |                  | 1018.1         |                | 7194.7          |                 | 1.5  |
|       | Vertical Component                   | 364.7            |                |                | -3902.6         |                 | 1.5  |
| 10.1) | Surcharge Pressure LWL(O/S)          |                  | 152.8          |                | 1298.4          |                 | 1.2  |

| S.N. | Description              | Forces about toe |                |                |                       |                       |                       |                       |
|------|--------------------------|------------------|----------------|----------------|-----------------------|-----------------------|-----------------------|-----------------------|
|      |                          | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT(Dest)</sub> | M <sub>TT(Steb)</sub> | M <sub>LL(Dest)</sub> | M <sub>LL(Steb)</sub> |
|      |                          | Tonne            | Tonne          | Tonne          | Tm                    | Tm                    | Tm                    | Tm                    |
| LC-4 | NS, LWL, Min LL Lead, EP | 4053.36          | 1769.24        | 0              | 13203.7               | -27690.2              | 125.711               | -8.50627              |

| S.N.                        | Description                                     | Forces about toe |                |                |                 |                 | LC-5  |
|-----------------------------|---|------------------|----------------|----------------|-----------------|-----------------|-------|
|                             |   | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |       |
|                             |   | Tonne            | Tonne          | Tonne          | Tm              | Tm              |       |
| 1)                          | Sub-structure & Foundation                      | 1073.9           |                |                | -5150.7         | 0.0             | 0.95  |
| 2)                          | Backfill  | 2151.7           |                |                | -16334.4        | 0.0             | 0.95  |
| 9.1)                        | Earth Pressure LWL (O/S)                        |                  |                |                |                 |                 | 1     |
|                             | Horizontal Component                            |                  | 1018.1         |                | 7194.7          |                 | 1     |
|                             | Vertical Component                              | 364.7            |                |                | -3902.6         |                 | 1     |
| <b>Seismic Longitudinal</b> |   |                  |                |                |                 |                 | 0.75  |
| 11)                         | Sub-structure Component                         |                  | 34.0           |                | 240.7           |                 | 0.75  |
| 12)                         | Earth fill component                            |                  | 95.0           |                | 796.0           |                 | 0.75  |
| 12)                         | Super-Structure DL, SIDL, & Surfacing Component |                  | 36.9           |                | 536.6           |                 | 0.75  |
| 13)                         | Dynamic Earth Pressure LWL                      |                  |                |                |                 |                 | 0.75  |
| 13.1)                       | LWL Seismic Downward_O/S                        |                  |                |                |                 |                 | 0.75  |
|                             | Horizontal Component                            |                  | 75.8           |                | 644.5           |                 | 0.75  |
|                             | Vertical Component                              | 27.6             |                |                | -295.2          |                 | 0.75  |
| <b>Seismic Transverses</b>  |   |                  |                |                |                 |                 | 0.225 |
| 15)                         | Sub-structure Component                         |                  |                | 112.7          |                 | 796.9           | 0.225 |
| 17)                         | Super-Structure DL, SIDL, & Surfacing Component |                  |                | 61.1           |                 | 1021.5          | 0.225 |

|                                  |                                       |         |  |     |          |      |  |       |
|----------------------------------|---------------------------------------|---------|--|-----|----------|------|--|-------|
| 18.2)                            | Live Load Component (Min. Reaction)   |         |  | 4.2 |          | 76.7 |  | 0.045 |
| <b>Seismic Vertical Downward</b> |                                       |         |  |     |          |      |  | 0.225 |
| 19)                              | Sub-structure Component               | 25.0436 |  |     | -116.763 |      |  | 0.225 |
| 20)                              | Earthfill component                   | 69.9    |  |     | -530.9   |      |  | 0.225 |
| 21)                              | Super-Structure DL, SIDL, & Surfacing | 13.5836 |  |     | -43.8071 |      |  | 0.225 |
| 22.2)                            | Live Load Component (Min. Reaction)   | 0.93598 |  |     | -3.01854 |      |  | 0.045 |

| S.N. | Description                            | Forces about toe |                |                |                       |                       |                       |                       |
|------|--|------------------|----------------|----------------|-----------------------|-----------------------|-----------------------|-----------------------|
|      |  | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT(Dest)</sub> | M <sub>TT(Steb)</sub> | M <sub>LL(Dest)</sub> | M <sub>LL(Steb)</sub> |
|      |  | Tonne            | Tonne          | Tonne          | Tm                    | Tm                    | Tm                    | Tm                    |
| LC-5 | SIS,LWL, Span dislodge ,Seismic Sx=1,S | 3474.19          | 1199.45        | 39.2996        | 8858.04               | -24690.7              | 412.608               | 0                     |

| LC-6                             | SIS, LWL,Span dislodge ,Seismic Sx=1,S          | Forces about toe |                |                |                 |                 |  | LC-6   |
|----------------------------------|---|------------------|----------------|----------------|-----------------|-----------------|--|--------|
| S.N.                             | Description                                     | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |  |        |
|                                  |   | Tonne            | Tonne          | Tonne          | Tm              | Tm              |  |        |
| 1)                               | Sub-structure & Foundation                      | 1073.9           |                |                | -5150.7         | 0.0             |  | 0.95   |
| 2)                               | Backfill  | 2151.7           |                |                | -16334.4        | 0.0             |  | 0.95   |
| 9.1)                             | Earth Pressure LWL (O/S)                        |                  |                |                |                 |                 |  | 1      |
|                                  | Horizontal Component                            |                  | 1018.1         |                | 7194.7          |                 |  | 1      |
|                                  | Vertical Component                              | 364.7            |                |                | -3902.6         |                 |  | 1      |
| <b>Seismic Longitudinal</b>      |   |                  |                |                |                 |                 |  | 0.75   |
| 11)                              | Sub-structure Component                         |                  | 34.0           |                | 240.7           |                 |  | 0.75   |
| 12)                              | Earth fill component                            |                  | 95.0           |                | 796.0           |                 |  | 0.75   |
| 12)                              | Super-Structure DL, SIDL, & Surfacing Component |                  | 36.9           |                | 536.6           |                 |  | 0.75   |
| 13)                              | Dynamic Earth Pressure LWL                      |                  |                |                |                 |                 |  | 0.75   |
| 13.2)                            | LWL Seismic Upward_O/S                          |                  |                |                |                 |                 |  | 0.75   |
|                                  | Horizontal Component                            |                  | 13.2           |                | 111.8           |                 |  | 0.75   |
|                                  | Vertical Component                              | 4.8              |                |                | -51.3           |                 |  | 0.75   |
| <b>Seismic Transveres</b>        |   |                  |                |                |                 |                 |  | 0.225  |
| 15)                              | Sub-structure Component                         |                  |                | 112.7          |                 | 796.9           |  | 0.225  |
| 17)                              | Super-Structure DL, SIDL, & Surfacing Component |                  |                | 61.1           |                 | 1021.5          |  | 0.225  |
| 18.2)                            | Live Load Component (Min. Reaction)             |                  |                | 4.2            |                 | 76.7            |  | 0.045  |
| <b>Seismic Vertical Downward</b> |   |                  |                |                |                 |                 |  | 0.225  |
| 19)                              | Sub-structure Component                         | 25.0436          |                |                | -116.763        |                 |  | -0.225 |
| 21)                              | Super-Structure DL, SIDL, & Surfacing           | 13.5836          |                |                | -43.8071        |                 |  | -0.225 |
| 22.2)                            | Live Load Component (Min. Reaction)             | 0.93598          |                |                | -3.01854        |                 |  | -0.045 |

| S.N. | Description                            | Forces about toe |                |                |                       |                       |                       |                       |
|------|--|------------------|----------------|----------------|-----------------------|-----------------------|-----------------------|-----------------------|
|      |  | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT(Dest)</sub> | M <sub>TT(Steb)</sub> | M <sub>LL(Dest)</sub> | M <sub>LL(Steb)</sub> |
|      |  | Tonne            | Tonne          | Tonne          | Tm                    | Tm                    | Tm                    | Tm                    |
| LC-6 | SIS, LWL,Span dislodge ,Seismic Sx=1,S | 3423.89          | 1152.47        | 39.2996        | 8494.8                | -24352                | 412.608               | 0                     |

| LC-7 | SIS,LWL,Min LL Acc,Seismic Sx=1,Sz= | Forces about toe |                |                |                 |                 |  | LC-7 |
|------|-------------------------------------|------------------|----------------|----------------|-----------------|-----------------|--|------|
| S.N. | Description                         | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |  |      |
|      |                                     | Tonne            | Tonne          | Tonne          | Tm              | Tm              |  |      |
| 1)   | Sub-structure & Foundation          | 1073.9           |                |                | -5150.7         | 0.0             |  | 0.95 |

|                                  |   |         |        |       |          |        |      |
|----------------------------------|---|---------|--------|-------|----------|--------|------|
| 2)                               | Backfill  | 2151.7  |        |       | -16334.4 | 0.0    | 0.95 |
| 3)                               | Super-structure DL                              | 266.9   |        |       | -860.9   | 0.0    | 0.95 |
| 4)                               | SIDL (excluding surfacing)                      | 117.0   |        |       | -377.3   | 0.0    | 0.95 |
| 5)                               | Surfacing                                       | 34.0    |        |       | -109.7   | -8.5   | 1    |
| 6.2)                             | Live Load Vertical Load Min Reaction            | 28.8    |        |       | -92.9    | 83.8   | 0.2  |
| 7)                               | Live Load Horizontal Forces                     |         | 39.2   |       | 569.0    |        | 0.2  |
| 9.1)                             | Earth Pressure LWL (O/S)                        |         |        |       |          |        | 1    |
|                                  | Horizontal Component                            |         | 1018.1 |       | 7194.7   |        | 1    |
|                                  | Vertical Component                              | 364.7   |        |       | -3902.6  |        | 1    |
| <b>Seismic Longitudinal</b>      |   |         |        |       |          |        | 1.5  |
| 11)                              | Sub-structure Component                         |         | 34.0   |       | 240.7    |        | 1.5  |
| 12)                              | Earth fill component                            |         | 95.0   |       | 796.0    |        | 1.5  |
| 12)                              | Super-Structure DL, SIDL, & Surfacing Component |         | 36.9   |       | 536.6    |        | 1.5  |
| 13)                              | Dynamic Earth Pressure LWL                      |         |        |       |          |        | 1.5  |
| 13.1)                            | LWL Seismic Downward_O/S                        |         |        |       |          |        | 1.5  |
|                                  | Horizontal Component                            |         | 75.8   |       | 644.5    |        | 1.5  |
|                                  | Vertical Component                              | 27.6    |        |       | -295.2   |        | 1.5  |
| <b>Seismic Transverses</b>       |   |         |        |       |          |        | 0.45 |
| 15)                              | Sub-structure Component                         |         |        | 112.7 |          | 796.9  | 0.45 |
| 17)                              | Super-Structure DL, SIDL, & Surfacing Component |         |        | 61.1  |          | 1021.5 | 0.45 |
| 18.2)                            | Live Load Component (Min. Reaction)             |         |        | 4.2   |          | 76.7   | 0.09 |
| <b>Seismic Vertical Downward</b> |   |         |        |       |          |        | 0.45 |
| 19)                              | Sub-structure Component                         | 25.0436 |        |       | -116.763 |        | 0.45 |
| 20)                              | Earthfill component                             | 69.9    |        |       | -530.9   |        | 0.45 |
| 21)                              | Super-Structure DL, SIDL, & Surfacing           | 13.5836 |        |       | -43.8071 |        | 0.45 |
| 22.2)                            | Live Load Component (Min. Reaction)             | 0.93598 |        |       | -3.01854 |        | 0.09 |

| S.N. | Description                         | Forces about toe |                |                |                       |                       |                       |                       |
|------|-------------------------------------|------------------|----------------|----------------|-----------------------|-----------------------|-----------------------|-----------------------|
|      |                                     | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT(Dest)</sub> | M <sub>TT(Steb)</sub> | M <sub>LL(Dest)</sub> | M <sub>LL(Steb)</sub> |
|      |                                     | Tonne            | Tonne          | Tonne          | Tm                    | Tm                    | Tm                    | Tm                    |
| LC-7 | SIS,LWL,Min LL Acc,Seismic Sx=1,Sz= | 3923.87          | 1388.66        | 78.5992        | 10635.2               | -26372.4              | 841.978               | -8.50627              |

| S.N.                        | Description                                     | Forces about toe |                |                |                 |                 | LC-8 |
|-----------------------------|---|------------------|----------------|----------------|-----------------|-----------------|------|
|                             |   | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |      |
|                             |   | Tonne            | Tonne          | Tonne          | Tm              | Tm              |      |
| 1)                          | Sub-structure & Foundation                      | 1073.9           |                |                | -5150.7         | 0.0             | 0.95 |
| 2)                          | Backfill  | 2151.7           |                |                | -16334.4        | 0.0             | 0.95 |
| 3)                          | Super-structure DL                              | 266.9            |                |                | -860.9          | 0.0             | 0.95 |
| 4)                          | SIDL (excluding surfacing)                      | 117.0            |                |                | -377.3          | 0.0             | 0.95 |
| 5)                          | Surfacing                                       | 34.0             |                |                | -109.7          | -8.5            | 1    |
| 6.2)                        | Live Load Vertical Load Min Reaction            | 28.8             |                |                | -92.9           | 83.8            | 0.2  |
| 7)                          | Live Load Horizontal Forces                     |                  | 39.2           |                | 569.0           |                 | 0.2  |
| 9.1)                        | Earth Pressure LWL (O/S)                        |                  |                |                |                 |                 | 1    |
|                             | Horizontal Component                            |                  | 1018.1         |                | 7194.7          |                 | 1    |
|                             | Vertical Component                              | 364.7            |                |                | -3902.6         |                 | 1    |
| <b>Seismic Longitudinal</b> |   |                  |                |                |                 |                 | 1.5  |
| 11)                         | Sub-structure Component                         |                  | 34.0           |                | 240.7           |                 | 1.5  |
| 12)                         | Earth fill component                            |                  | 95.0           |                | 796.0           |                 | 1.5  |
| 12)                         | Super-Structure DL, SIDL, & Surfacing Component |                  | 36.9           |                | 536.6           |                 | 1.5  |
| 13)                         | Dynamic Earth Pressure LWL                      |                  |                |                |                 |                 | 1.5  |

|   |         |      |       |          |        |  |       |
|---|---------|------|-------|----------|--------|--|-------|
| 13.2) LWL Seismic Upward_O/S                        |         |      |       |          |        |  | 1.5   |
| Horizontal Component                                |         | 13.2 |       | 111.8    |        |  | 1.5   |
| Vertical Component                                  | 4.8     |      |       | -51.3    |        |  | 1.5   |
| <b>Seismic Transverses</b>                          |         |      |       |          |        |  |       |
| 15) Sub-structure Component                         |         |      | 112.7 |          | 796.9  |  | 0.45  |
| 17) Super-Structure DL, SIDL, & Surfacing Component |         |      | 61.1  |          | 1021.5 |  | 0.45  |
| 18.2) Live Load Component (Min. Reaction)           |         |      | 4.2   |          | 76.7   |  | 0.09  |
| <b>Seismic Vertical Downward</b>                    |         |      |       |          |        |  |       |
| 19) Sub-structure Component                         | 25.0436 |      |       | -116.763 |        |  | -0.45 |
| 21) Super-Structure DL, SIDL, & Surfacing           | 13.5836 |      |       | -43.8071 |        |  | -0.45 |
| 22.2) Live Load Component (Min. Reaction)           | 0.93598 |      |       | -3.01854 |        |  | -0.09 |

| S.N. | Description                             | Forces about toe |                |                |                        |                        |                        |                        |
|------|---|------------------|----------------|----------------|------------------------|------------------------|------------------------|------------------------|
|      |   | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> (Dest) | M <sub>TT</sub> (Steb) | M <sub>LL</sub> (Dest) | M <sub>LL</sub> (Steb) |
|      |   | Tonne            | Tonne          | Tonne          | Tm                     | Tm                     | Tm                     | Tm                     |
| LC-8 | SIS, LWL, Min LL Acc, Seismic Sx=1, Sz= | 3823.27          | 1294.69        | 78.5992        | 9908.66                | -25695                 | 841.978                | -8.50627               |

| S.N.  | Description                 | Forces about toe |                |                |                 |                 | LC-9 |
|-------|-----------------------------|------------------|----------------|----------------|-----------------|-----------------|------|
|       |                             | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |      |
|       |                             | Tonne            | Tonne          | Tonne          | Tm              | Tm              |      |
| 1)    | Sub-structure & Foundation  | 1073.9           |                |                | -5150.7         | 0.0             | 0.95 |
| 2)    | Backfill                    | 2151.7           |                |                | -16334.4        | 0.0             | 0.95 |
| 8)    | Buoyancy                    | -55.5            |                |                | 169.0           | 0.0             | 1    |
| 9.1)  | Earth Pressure HFL (O/S)    |                  |                |                |                 |                 | 1.5  |
|       | Horizontal Component        |                  | 1018.1         |                | 7194.7          |                 | 1.5  |
|       | Vertical Component          | 364.7            |                |                | -3902.6         |                 | 1.5  |
| 10.1) | Surcharge Pressure HFL(O/S) |                  | 152.8          |                | 1298.4          |                 | 1.2  |

| S.N. | Description                | Forces about toe |                |                |                        |                        |                        |                        |
|------|----------------------------|------------------|----------------|----------------|------------------------|------------------------|------------------------|------------------------|
|      |                            | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> (Dest) | M <sub>TT</sub> (Steb) | M <sub>LL</sub> (Dest) | M <sub>LL</sub> (Steb) |
|      |                            | Tonne            | Tonne          | Tonne          | Tm                     | Tm                     | Tm                     | Tm                     |
| LC-9 | NS, HFL, Span dislodge, EP | 3555.89          | 1710.51        | 0              | 12519.2                | -26264.9               | 0                      | 0                      |

| S.N. | Description                          | Forces about toe |                |                |                 |                 | LC-10 |
|------|--------------------------------------|------------------|----------------|----------------|-----------------|-----------------|-------|
|      |                                      | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |       |
|      |                                      | Tonne            | Tonne          | Tonne          | Tm              | Tm              |       |
| 1)   | Sub-structure & Foundation           | 1073.9           |                |                | -5150.7         | 0.0             | 0.95  |
| 2)   | Backfill                             | 2151.7           |                |                | -16334.4        | 0.0             | 0.95  |
| 3)   | Super-structure DL                   | 266.9            |                |                | -860.9          | 0.0             | 0.95  |
| 4)   | SIDL (excluding surfacing)           | 117.0            |                |                | -377.3          | 0.0             | 0.95  |
| 5)   | Surfacing                            | 34.0             |                |                | -109.7          | -8.5            | 1     |
| 6.2) | Live Load Vertical Load Min Reaction | 28.8             |                |                | -92.9           | 83.8            | 1.5   |
| 7)   | Live Load Horizontal Forces          |                  | 39.2           |                | 569.0           |                 | 1.5   |
| 8)   | Buoyancy                             | -55.5            |                |                | 169.0           | 0.0             | 1     |
| 9.1) | Earth Pressure HFL (O/S)             |                  |                |                |                 |                 | 1.5   |
|      | Horizontal Component                 |                  | 1018.1         |                | 7194.7          |                 | 1.5   |

|       |                             |       |       |  |         |  |  |     |
|-------|-----------------------------|-------|-------|--|---------|--|--|-----|
| 10.1) | Vertical Component          | 364.7 |       |  | -3902.6 |  |  | 1.5 |
|       | Surcharge Pressure HFL(O/S) |       | 152.8 |  | 1298.4  |  |  | 1.2 |

| S.N.  | Description              | Forces about toe |                |                |                       |                       |                       |                       |
|-------|--------------------------|------------------|----------------|----------------|-----------------------|-----------------------|-----------------------|-----------------------|
|       |                          | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT(Dest)</sub> | M <sub>TT(Steb)</sub> | M <sub>LL(Dest)</sub> | M <sub>LL(Steb)</sub> |
|       |                          | Tonne            | Tonne          | Tonne          | Tm                    | Tm                    | Tm                    | Tm                    |
| LC-10 | NS, HFL, Min LL Lead, EP | 3997.86          | 1769.24        | 0              | 13372.7               | -27690.2              | 125.711               | -8.50627              |

| S.N.                             | Description                                     | Forces about toe |                |                |                 |                 | LC-11 |
|----------------------------------|---|------------------|----------------|----------------|-----------------|-----------------|-------|
|                                  |   | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |       |
|                                  |   | Tonne            | Tonne          | Tonne          | Tm              | Tm              |       |
| 1)                               | Sub-structure & Foundation                      | 1073.9           |                |                | -5150.7         | 0.0             | 0.95  |
| 2)                               | Backfill  | 2151.7           |                |                | -16334.4        | 0.0             | 0.95  |
| 8)                               | Buoyancy  | -55.5            |                |                | 169.0           | 0.0             | 1     |
| 9.1)                             | Earth Pressure HFL (O/S)                        |                  |                |                |                 |                 | 1     |
|                                  | Horizontal Component                            |                  | 1018.1         |                | 7194.7          |                 | 1     |
|                                  | Vertical Component                              | 364.7            |                |                | -3902.6         |                 | 1     |
| <b>Seismic Longitudinal</b>      |   |                  |                |                |                 |                 | 0.75  |
| 11)                              | Sub-structure Component                         |                  | 34.0           |                | 240.7           |                 | 0.75  |
| 12)                              | Earth fill component                            |                  | 95.0           |                | 796.0           |                 | 0.75  |
| 12)                              | Super-Structure DL, SIDL, & Surfacing Component |                  | 36.9           |                | 536.6           |                 | 0.75  |
| 13)                              | Dynamic Earth Pressure HFL                      |                  |                |                |                 |                 | 0.75  |
| 13.1)                            | HFL Seismic Downward_O/S                        |                  |                |                |                 |                 | 0.75  |
|                                  | Horizontal Component                            |                  | 75.8           |                | 644.5           |                 | 0.75  |
|                                  | Vertical Component                              | 27.6             |                |                | -295.2          |                 | 0.75  |
| <b>Seismic Transveres</b>        |   |                  |                |                |                 |                 | 0.225 |
| 15)                              | Sub-structure Component                         |                  |                | 112.7          |                 | 796.9           | 0.225 |
| 17)                              | Super-Structure DL, SIDL, & Surfacing Component |                  |                | 61.1           |                 | 1021.5          | 0.225 |
| 18.2)                            | Live Load Component (Min. Reaction)             |                  |                | 4.2            |                 | 76.7            | 0.045 |
| <b>Seismic Vertical Downward</b> |   |                  |                |                |                 |                 | 0.225 |
| 19)                              | Sub-structure Component                         | 25.0436          |                |                | -116.763        |                 | 0.225 |
| 20)                              | Earthfill component                             | 69.9             |                |                | -530.9          |                 | 0.225 |
| 21)                              | Super-Structure DL, SIDL, & Surfacing           | 13.5836          |                |                | -43.8071        |                 | 0.225 |
| 22.2)                            | Live Load Component (Min. Reaction)             | 0.93598          |                |                | -3.01854        |                 | 0.045 |

| S.N.  | Description                            | Forces about toe |                |                |                       |                       |                       |                       |
|-------|--|------------------|----------------|----------------|-----------------------|-----------------------|-----------------------|-----------------------|
|       |  | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT(Dest)</sub> | M <sub>TT(Steb)</sub> | M <sub>LL(Dest)</sub> | M <sub>LL(Steb)</sub> |
|       |  | Tonne            | Tonne          | Tonne          | Tm                    | Tm                    | Tm                    | Tm                    |
| LC-11 | SIS,HFL, Span dislodge ,Seismic Sx=1,S | 3418.69          | 1199.45        | 39.2996        | 9027.08               | -24690.7              | 412.608               | 0                     |

| S.N. | Description                | Forces about toe |                |                |                 |                 | LC-12 |
|------|----------------------------|------------------|----------------|----------------|-----------------|-----------------|-------|
|      |                            | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |       |
|      |                            | Tonne            | Tonne          | Tonne          | Tm              | Tm              |       |
| 1)   | Sub-structure & Foundation | 1073.9           |                |                | -5150.7         | 0.0             | 0.95  |
| 2)   | Backfill                   | 2151.7           |                |                | -16334.4        | 0.0             | 0.95  |
| 8)   | Buoyancy                   | -55.5            |                |                | 169.0           | 0.0             | 1     |



|                                  |   |         |        |       |          |        |        |
|----------------------------------|---|---------|--------|-------|----------|--------|--------|
| 9.1)                             | Earth Pressure HFL (O/S)                        |         |        |       |          |        | 1      |
|                                  | Horizontal Component                            |         | 1018.1 |       | 7194.7   |        | 1      |
|                                  | Vertical Component                              | 364.7   |        |       | -3902.6  |        | 1      |
| <b>Seismic Longitudinal</b>      |   |         |        |       |          |        | 0.75   |
| 11)                              | Sub-structure Component                         |         | 34.0   |       | 240.7    |        | 0.75   |
| 12)                              | Earth fill component                            |         | 95.0   |       | 796.0    |        | 0.75   |
| 12)                              | Super-Structure DL, SIDL, & Surfacing Component |         | 36.9   |       | 536.6    |        | 0.75   |
| 13)                              | Dynamic Earth Pressure HFL                      |         |        |       |          |        | 0.75   |
|                                  | 13.2) HFL Seismic Upward_O/S                    |         |        |       |          |        | 0.75   |
|                                  | Horizontal Component                            |         | 13.2   |       | 111.8    |        | 0.75   |
|                                  | Vertical Component                              | 4.8     |        |       | -51.3    |        | 0.75   |
| <b>Seismic Transverses</b>       |   |         |        |       |          |        | 0.225  |
| 15)                              | Sub-structure Component                         |         |        | 112.7 |          | 796.9  | 0.225  |
| 17)                              | Super-Structure DL, SIDL, & Surfacing Component |         |        | 61.1  |          | 1021.5 | 0.225  |
| 18.2)                            | Live Load Component (Min. Reaction)             |         |        | 4.2   |          | 76.7   | 0.045  |
| <b>Seismic Vertical Downward</b> |   |         |        |       |          |        | 0.225  |
| 19)                              | Sub-structure Component                         | 25.0436 |        |       | -116.763 |        | -0.225 |
| 21)                              | Super-Structure DL, SIDL, & Surfacing           | 13.5836 |        |       | -43.8071 |        | -0.225 |
| 22.2)                            | Live Load Component (Min. Reaction)             | 0.93598 |        |       | -3.01854 |        | -0.045 |

| S.N.  | Description                               | Forces about toe |                         |                         |                             |                             |                             |                             |
|-------|---|------------------|-------------------------|-------------------------|-----------------------------|-----------------------------|-----------------------------|-----------------------------|
|       |   | V<br>Tonne       | H <sub>L</sub><br>Tonne | H <sub>T</sub><br>Tonne | M <sub>TT(Dest)</sub><br>Tm | M <sub>TT(Steb)</sub><br>Tm | M <sub>LL(Dest)</sub><br>Tm | M <sub>LL(Steb)</sub><br>Tm |
| LC-12 | SIS, HFL, Span dislodge ,Seismic Sx=1,Sz= | 3368.39          | 1152.47                 | 39.2996                 | 8663.83                     | -24352                      | 412.608                     | 0                           |

| LC-13                       | S.N. | Description                                     | Forces about toe |                |                |                 |                 | LC-13 |
|-----------------------------|------|---|------------------|----------------|----------------|-----------------|-----------------|-------|
|                             |      |   | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |       |
|                             |      |   | Tonne            | Tonne          | Tonne          | Tm              | Tm              |       |
|                             | 1)   | Sub-structure & Foundation                      | 1073.9           |                |                | -5150.7         | 0.0             | 0.95  |
|                             | 2)   | Backfill  | 2151.7           |                |                | -16334.4        | 0.0             | 0.95  |
|                             | 3)   | Super-structure DL                              | 266.9            |                |                | -860.9          | 0.0             | 0.95  |
|                             | 4)   | SIDL (excluding surfacing)                      | 117.0            |                |                | -377.3          | 0.0             | 0.95  |
|                             | 5)   | Surfacing                                       | 34.0             |                |                | -109.7          | -8.5            | 1     |
|                             | 6.2) | Live Load Vertical Load Min Reaction            | 28.8             |                |                | -92.9           | 83.8            | 0.2   |
|                             | 7)   | Live Load Horizontal Forces                     |                  | 39.2           |                | 569.0           |                 | 0.2   |
|                             | 8)   | Buoyancy  | -55.5            |                |                | 169.0           | 0.0             | 1     |
|                             | 9.1) | Earth Pressure HFL (O/S)                        |                  |                |                |                 |                 | 1     |
|                             |      | Horizontal Component                            |                  | 1018.1         |                | 7194.7          |                 | 1     |
|                             |      | Vertical Component                              | 364.7            |                |                | -3902.6         |                 | 1     |
| <b>Seismic Longitudinal</b> |      |   |                  |                |                |                 |                 | 1.5   |
|                             | 11)  | Sub-structure Component                         |                  | 34.0           |                | 240.7           |                 | 1.5   |
|                             | 12)  | Earth fill component                            |                  | 95.0           |                | 796.0           |                 | 1.5   |
|                             | 12)  | Super-Structure DL, SIDL, & Surfacing Component |                  | 36.9           |                | 536.6           |                 | 1.5   |
|                             | 13)  | Dynamic Earth Pressure HFL                      |                  |                |                |                 |                 | 1.5   |
|                             |      | 13.1) HFL Seismic Downward_O/S                  |                  |                |                |                 |                 | 1.5   |
|                             |      | Horizontal Component                            |                  | 75.8           |                | 644.5           |                 | 1.5   |
|                             |      | Vertical Component                              | 27.6             |                |                | -295.2          |                 | 1.5   |
| <b>Seismic Transverses</b>  |      |   |                  |                |                |                 |                 | 0.45  |
|                             | 15)  | Sub-structure Component                         |                  |                | 112.7          |                 | 796.9           | 0.45  |
|                             | 17)  | Super-Structure DL, SIDL, & Surfacing Component |                  |                | 61.1           |                 | 1021.5          | 0.45  |

|                                  |                                       |         |  |     |          |      |  |      |
|----------------------------------|---------------------------------------|---------|--|-----|----------|------|--|------|
| 18.2)                            | Live Load Component (Min. Reaction)   |         |  | 4.2 |          | 76.7 |  | 0.09 |
| <b>Seismic Vertical Downward</b> |                                       |         |  |     |          |      |  | 0.45 |
| 19)                              | Sub-structure Component               | 25.0436 |  |     | -116.763 |      |  | 0.45 |
| 20)                              | Earthfill component                   | 69.9    |  |     | -530.9   |      |  | 0.45 |
| 21)                              | Super-Structure DL, SIDL, & Surfacing | 13.5836 |  |     | -43.8071 |      |  | 0.45 |
| 22.2)                            | Live Load Component (Min. Reaction)   | 0.93598 |  |     | -3.01854 |      |  | 0.09 |

| S.N.  | Description                         | Forces about toe |                |                |                       |                       |                       |                       |
|-------|-------------------------------------|------------------|----------------|----------------|-----------------------|-----------------------|-----------------------|-----------------------|
|       |                                     | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>IT(Dest)</sub> | M <sub>IT(Steb)</sub> | M <sub>LL(Dest)</sub> | M <sub>LL(Steb)</sub> |
|       |                                     | Tonne            | Tonne          | Tonne          | Tm                    | Tm                    | Tm                    | Tm                    |
| LC-13 | SIS,HFL,Min LL Acc,Seismic Sx=1,Sz= | 3868.37          | 1388.66        | 78.5992        | 10804.2               | -26372.4              | 841.978               | -8.50627              |

| LC-14                            | SIS, HFL,Min LL Acc,Seismic Sx=1,Sz=            | Forces about toe |                |                |                 |                 |  | LC-14 |
|----------------------------------|---|------------------|----------------|----------------|-----------------|-----------------|--|-------|
| S.N.                             | Description                                     | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>IT</sub> | M <sub>LL</sub> |  |       |
|                                  |   | Tonne            | Tonne          | Tonne          | Tm              | Tm              |  |       |
| 1)                               | Sub-structure & Foundation                      | 1073.9           |                |                | -5150.7         | 0.0             |  | 0.95  |
| 2)                               | Backfill  | 2151.7           |                |                | -16334.4        | 0.0             |  | 0.95  |
| 3)                               | Super-structure DL                              | 266.9            |                |                | -860.9          | 0.0             |  | 0.95  |
| 4)                               | SIDL (excluding surfacing)                      | 117.0            |                |                | -377.3          | 0.0             |  | 0.95  |
| 5)                               | Surfacing                                       | 34.0             |                |                | -109.7          | -8.5            |  | 1     |
| 6.2)                             | Live Load Vertical Load Min Reaction            | 28.8             |                |                | -92.9           | 83.8            |  | 0.2   |
| 7)                               | Live Load Horizontal Forces                     |                  | 39.2           |                | 569.0           |                 |  | 0.2   |
| 8)                               | Buoyancy  | -55.5            |                |                | 169.0           | 0.0             |  | 1     |
| 9.1)                             | Earth Pressure HFL (O/S)                        |                  |                |                |                 |                 |  | 1     |
|                                  | Horizontal Component                            |                  | 1018.1         |                | 7194.7          |                 |  | 1     |
|                                  | Vertical Component                              | 364.7            |                |                | -3902.6         |                 |  | 1     |
| <b>Seismic Longitudinal</b>      |   |                  |                |                |                 |                 |  | 1.5   |
| 11)                              | Sub-structure Component                         |                  | 34.0           |                | 240.7           |                 |  | 1.5   |
| 12)                              | Earth fill component                            |                  | 95.0           |                | 796.0           |                 |  | 1.5   |
| 12)                              | Super-Structure DL, SIDL, & Surfacing Component |                  | 36.9           |                | 536.6           |                 |  | 1.5   |
| 13)                              | Dynamic Earth Pressure HFL                      |                  |                |                |                 |                 |  | 1.5   |
| 13.2)                            | HFL Seismic Upward_O/S                          |                  |                |                |                 |                 |  | 1.5   |
|                                  | Horizontal Component                            |                  | 13.2           |                | 111.8           |                 |  | 1.5   |
|                                  | Vertical Component                              | 4.8              |                |                | -51.3           |                 |  | 1.5   |
| <b>Seismic Transverses</b>       |   |                  |                |                |                 |                 |  | 0.45  |
| 15)                              | Sub-structure Component                         |                  |                | 112.7          |                 | 796.9           |  | 0.45  |
| 17)                              | Super-Structure DL, SIDL, & Surfacing Component |                  |                | 61.1           |                 | 1021.5          |  | 0.45  |
| 18.2)                            | Live Load Component (Min. Reaction)             |                  |                | 4.2            |                 | 76.7            |  | 0.09  |
| <b>Seismic Vertical Downward</b> |   |                  |                |                |                 |                 |  | 0.45  |
| 19)                              | Sub-structure Component                         | 25.0436          |                |                | -116.763        |                 |  | -0.45 |
| 21)                              | Super-Structure DL, SIDL, & Surfacing           | 13.5836          |                |                | -43.8071        |                 |  | -0.45 |
| 22.2)                            | Live Load Component (Min. Reaction)             | 0.93598          |                |                | -3.01854        |                 |  | -0.09 |

| S.N.  | Description                          | Forces about toe |                |                |                       |                       |                       |                       |
|-------|--------------------------------------|------------------|----------------|----------------|-----------------------|-----------------------|-----------------------|-----------------------|
|       |                                      | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>IT(Dest)</sub> | M <sub>IT(Steb)</sub> | M <sub>LL(Dest)</sub> | M <sub>LL(Steb)</sub> |
|       |                                      | Tonne            | Tonne          | Tonne          | Tm                    | Tm                    | Tm                    | Tm                    |
| LC-14 | SIS, HFL,Min LL Acc,Seismic Sx=1,Sz= | 3767.77          | 1294.69        | 78.5992        | 10077.7               | -25695                | 841.978               | -8.50627              |

**VERIFICATION of EQUILIBRIUM (OVERTURNING & SLIDING):**

$$FOS|_{\text{sliding}} = \frac{(\mu \cdot \Sigma V + \Sigma H_{\text{restoring}})}{\Sigma H_{\text{sliding}}} \geq 1$$

$$\mu = 0.80$$

$$|FOS|_{\text{overturning}} = \Sigma M_{\text{restoring}} / \Sigma M_{\text{overturning}} \geq 1$$

**SUMMARY OF FORCES:**

| S.N.  | Description                            | Forces about toe |                |                |                       |                       |                       |                       |
|-------|--|------------------|----------------|----------------|-----------------------|-----------------------|-----------------------|-----------------------|
|       |  | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT(Dest)</sub> | M <sub>TT(Steb)</sub> | M <sub>LL(Dest)</sub> | M <sub>LL(Steb)</sub> |
|       |  | Tonne            | Tonne          | Tonne          | Tm                    | Tm                    | Tm                    | Tm                    |
| LC-1  | NS, LWL, Span dislodge, FP             | 3064.29          | 183.663        | 0              | 1558.14               | -20410.9              | 0                     | 0                     |
| LC-2  | NS, LWL, Span dislodge, EP             | 3611.39          | 1710.51        | 0              | 12350.2               | -26264.9              | 0                     | 0                     |
| LC-3  | NS, LWL, Min LL Lead, FP               | 3506.26          | 242.392        | 0              | 2411.59               | -21836.2              | 125.711               | -8.50627              |
| LC-4  | NS, LWL, Min LL Lead, EP               | 4053.36          | 1769.24        | 0              | 13203.7               | -27690.2              | 125.711               | -8.50627              |
|       |  |                  |                |                |                       |                       |                       |                       |
| LC-5  | SIS,LWL, Span dislodge ,Seismic Sx=1,S | 3474.19          | 1199.45        | 39.2996        | 8858.04               | -24690.7              | 412.608               | 0                     |
| LC-6  | SIS, LWL,Span dislodge ,Seismic Sx=1,S | 3423.89          | 1152.47        | 39.2996        | 8494.8                | -24352                | 412.608               | 0                     |
| LC-7  | SIS,LWL,Min LL Acc,Seismic Sx=1,Sz=    | 3923.87          | 1388.66        | 78.5992        | 10635.2               | -26372.4              | 841.978               | -8.50627              |
| LC-8  | SIS, LWL,Min LL Acc,Seismic Sx=1,Sz=   | 3823.27          | 1294.69        | 78.5992        | 9908.66               | -25695                | 841.978               | -8.50627              |
|       |  |                  |                |                |                       |                       |                       |                       |
| LC-9  | NS, HFL, Span dislodge, EP             | 3555.89          | 1710.51        | 0              | 12519.2               | -26264.9              | 0                     | 0                     |
| LC-10 | NS, HFL, Min LL Lead, EP               | 3997.86          | 1769.24        | 0              | 13372.7               | -27690.2              | 125.711               | -8.50627              |
|       |  |                  |                |                |                       |                       |                       |                       |
| LC-11 | SIS,HFL, Span dislodge ,Seismic Sx=1,S | 3418.69          | 1199.45        | 39.2996        | 9027.08               | -24690.7              | 412.608               | 0                     |
| LC-12 | SIS, HFL,Span dislodge ,Seismic Sx=1,S | 3368.39          | 1152.47        | 39.2996        | 8663.83               | -24352                | 412.608               | 0                     |
| LC-13 | SIS,HFL,Min LL Acc,Seismic Sx=1,Sz=    | 3868.37          | 1388.66        | 78.5992        | 10804.2               | -26372.4              | 841.978               | -8.50627              |
| LC-14 | SIS, HFL,Min LL Acc,Seismic Sx=1,Sz=   | 3767.77          | 1294.69        | 78.5992        | 10077.7               | -25695                | 841.978               | -8.50627              |
|       |  |                  |                |                |                       |                       |                       |                       |

| Along Long. Dir <sup>n</sup> |       |
|------------------------------|-------|
| FOS<br> <br>sliding          | Check |
| 13.35                        | OK    |
| 1.69                         | OK    |
| 11.57                        | OK    |
| 1.83                         | OK    |
|                              |       |
| 2.32                         | OK    |
| 2.38                         | OK    |
| 2.26                         | OK    |
| 2.36                         | OK    |
|                              |       |
| 1.66                         | OK    |
| 1.81                         | OK    |
|                              |       |
| 2.28                         | OK    |
| 2.34                         | OK    |
| 2.23                         | OK    |
| 2.33                         | OK    |



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LOAD COMBINATION  
FOR FOOTING DESIGN

| LC-1  | NS, LWL, Span dislodge, FP     | Forces about toe |                |                |                 |                 |  | LC-1 |
|-------|--------------------------------|------------------|----------------|----------------|-----------------|-----------------|--|------|
| S.N.  | Description                    | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |  |      |
|       |                                | Tonne            | Tonne          | Tonne          | Tm              | Tm              |  |      |
| 1)    | Sub-structure & Foundation     | 1073.9           |                |                | -5150.7         | 0.0             |  | 1    |
| 2)    | Backfill                       | 2151.7           |                |                | -16334.4        | 0.0             |  | 1    |
| 9)    | Fluid Pressure                 |                  | 0.18           |                | 0.02            |                 |  | 1    |
| 10.3) | Surcharge Pressure LWL(BP, SD) |                  | 152.8          |                | 1298.4          |                 |  | 1    |

| S.N. | Description                | Forces about toe |                |                |                 |                 |
|------|----------------------------|------------------|----------------|----------------|-----------------|-----------------|
|      |                            | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|      |                            | Tonne            | Tonne          | Tonne          | Tm              | Tm              |
| LC-1 | NS, LWL, Span dislodge, FP | 3225.57          | 153.01         | 0              | -20186.7        | 0               |

| LC-2  | NS, LWL, Span dislodge, EP     | Forces about toe |                |                |                 |                 |  | LC-2 |
|-------|--------------------------------|------------------|----------------|----------------|-----------------|-----------------|--|------|
| S.N.  | Description                    | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |  |      |
|       |                                | Tonne            | Tonne          | Tonne          | Tm              | Tm              |  |      |
| 1)    | Sub-structure & Foundation     | 1073.9           |                |                | -5150.7         | 0.0             |  | 1    |
| 2)    | Backfill                       | 2151.7           |                |                | -16334.4        | 0.0             |  | 1    |
| 9.3)  | Earth Pressure LWL (BP, SD)    |                  |                |                |                 |                 |  | 1    |
|       | Horizontal Component           |                  | 1018.1         |                | 7194.7          |                 |  | 1    |
|       | Vertical Component             | 364.7            |                |                | -1677.8         |                 |  | 1    |
| 10.3) | Surcharge Pressure LWL(BP, SD) |                  | 152.8          |                | 1298.4          |                 |  | 1    |

| S.N. | Description                | Forces about toe |                |                |                 |                 |
|------|----------------------------|------------------|----------------|----------------|-----------------|-----------------|
|      |                            | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|      |                            | Tonne            | Tonne          | Tonne          | Tm              | Tm              |
| LC-2 | NS, LWL, Span dislodge, EP | 3590.3           | 1170.90        | 0              | -14669.8        | 0               |

| LC-3 | NS, LWL, Max LL, FP                  | Forces about toe |                |                |                 |                 |  | LC-3 |
|------|--------------------------------------|------------------|----------------|----------------|-----------------|-----------------|--|------|
| S.N. | Description                          | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |  |      |
|      |                                      | Tonne            | Tonne          | Tonne          | Tm              | Tm              |  |      |
| 1)   | Sub-structure & Foundation           | 1073.9           |                |                | -5150.7         | 0.0             |  | 1    |
| 2)   | Backfill                             | 2151.7           |                |                | -16334.4        | 0.0             |  | 1    |
| 3)   | Super-structure DL                   | 266.9            |                |                | -860.9          | 0.0             |  | 1    |
| 4)   | SIDL (excluding surfacing)           | 117.0            |                |                | -377.3          | 0.0             |  | 1    |
| 5)   | Surfacing                            | 34.0             |                |                | -109.7          | -8.5            |  | 1    |
| 6.1) | Live Load Vertical Load Max Reaction | 137.4            |                |                | -443.1          | 399.8           |  | 1    |

|       |                                |  |       |  |        |  |  |   |
|-------|--------------------------------|--|-------|--|--------|--|--|---|
| 7)    | Live Load Horizontal Forces    |  | 39.2  |  | 569.0  |  |  | 1 |
| 9)    | Fluid Pressure                 |  | 0.18  |  | 0.02   |  |  | 1 |
| 10.3) | Surcharge Pressure LWL(BP, SD) |  | 152.8 |  | 1298.4 |  |  | 1 |

| S.N. | Description         | Forces about toe |                |                |                 |                 |
|------|---------------------|------------------|----------------|----------------|-----------------|-----------------|
|      |                     | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|      |                     | Tonne            | Tonne          | Tonne          | Tm              | Tm              |
| LC-3 | NS, LWL, Max LL, FP | 3780.93          | 192.16         | 0              | -21408.8        | 391.329         |

| LC-4  | NS, LWL, Max LL, EP                  | Forces about toe |                |                |                 |                 |  | LC-4 |
|-------|--------------------------------------|------------------|----------------|----------------|-----------------|-----------------|--|------|
| S.N.  | Description                          | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |  |      |
|       |                                      | Tonne            | Tonne          | Tonne          | Tm              | Tm              |  |      |
| 1)    | Sub-structure & Foundation           | 1073.9           |                |                | -5150.7         | 0.0             |  | 1    |
| 2)    | Backfill                             | 2151.7           |                |                | -16334.4        | 0.0             |  | 1    |
| 3)    | Super-structure DL                   | 266.9            |                |                | -860.9          | 0.0             |  | 1    |
| 4)    | SIDL (excluding surfacing)           | 117.0            |                |                | -377.3          | 0.0             |  | 1    |
| 5)    | Surfacing                            | 34.0             |                |                | -109.7          | -8.5            |  | 1    |
| 6.1)  | Live Load Vertical Load Max Reaction | 137.4            |                |                | -443.1          | 399.8           |  | 1    |
| 7)    | Live Load Horizontal Forces          |                  | 39.2           |                | 569.0           |                 |  | 1    |
| 9.3)  | Earth Pressure LWL (BP, SD)          |                  |                |                |                 |                 |  | 1    |
|       | Horizontal Component                 |                  | 1018.1         |                | 7194.7          |                 |  | 1    |
|       | Vertical Component                   | 364.7            |                |                | -1677.8         |                 |  | 1    |
| 10.3) | Surcharge Pressure LWL(BP, SD)       |                  | 152.8          |                | 1298.4          |                 |  | 1    |

| S.N. | Description         | Forces about toe |                |                |                 |                 |
|------|---------------------|------------------|----------------|----------------|-----------------|-----------------|
|      |                     | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|      |                     | Tonne            | Tonne          | Tonne          | Tm              | Tm              |
| LC-4 | NS, LWL, Max LL, EP | 4145.67          | 1210.06        | 0              | -15891.9        | 391.329         |

| LC-5                        | SIS,LWL, Span dislodge ,Seismic Sx=1.5        | Forces about toe |                |                |                 |                 |  | LC-5 |
|-----------------------------|---|------------------|----------------|----------------|-----------------|-----------------|--|------|
| S.N.                        | Description                                   | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |  |      |
|                             |   | Tonne            | Tonne          | Tonne          | Tm              | Tm              |  |      |
| 1)                          | Sub-structure & Foundation                    | 1073.9           |                |                | -5150.7         | 0.0             |  | 1    |
| 2)                          | Backfill                                      | 2151.7           |                |                | -16334.4        | 0.0             |  | 1    |
| 9.3)                        | Earth Pressure LWL (BP, SD)                   |                  |                |                |                 |                 |  | 1    |
|                             | Horizontal Component                          |                  | 1018.1         |                | 7194.7          |                 |  | 1    |
|                             | Vertical Component                            | 364.7            |                |                | -1677.8         |                 |  | 1    |
| 10.3)                       | Surcharge Pressure LWL(BP, SD)                |                  | 152.8          |                | 1298.4          |                 |  | 0.2  |
| <b>Seismic Longitudinal</b> |   |                  |                |                |                 |                 |  | 0.5  |
| 11)                         | Sub-structure Component                       |                  | 34.0           |                | 240.7           |                 |  | 0.5  |
| 12)                         | Earth fill component                          |                  | 95.0           |                | 796.0           |                 |  | 0.5  |
| 12)                         | Super-Structure DL, SIDL, & Surfacing Compone |                  | 36.9           |                | 536.6           |                 |  | 0.5  |
| 13)                         | Dynamic Earth Pressure LWL                    |                  |                |                |                 |                 |  | 0.5  |

|                                  |   |         |      |       |          |        |      |
|----------------------------------|---|---------|------|-------|----------|--------|------|
| 13)                              | 13.5)LWL Seismic Downward_BP/SD                 |         |      |       |          |        | 0.5  |
|                                  | Horizontal Component                            |         | 75.8 |       | 644.5    |        | 0.5  |
|                                  | Vertical Component                              | 27.6    |      |       | -126.9   |        | 0.5  |
| 14)                              | 14.2) Dynamic Surcharge Pressure BP/SD          |         |      |       |          |        | 0.2  |
|                                  | LWL Seismic Downward                            |         | 17.1 |       | 193.7    |        | 0.2  |
| <b>Seismic Transverses</b>       |   |         |      |       |          |        | 0.15 |
| 15)                              | Sub-structure Component                         |         |      | 112.7 |          | 796.9  | 0.15 |
| 17)                              | Super-Structure DL, SIDL, & Surfacing Component |         |      | 61.1  |          | 1021.5 | 0.15 |
| <b>Seismic Vertical Downward</b> |   |         |      |       |          |        | 0.15 |
| 19)                              | Sub-structure Component                         | 25.0436 |      |       | -116.763 |        | 0.15 |
| 20)                              | Earth fill                                      | 69.9    |      |       | -530.9   |        | 0.15 |
| 21)                              | Super-Structure DL, SIDL, & Surfacing           | 13.5836 |      |       | -43.8071 |        | 0.15 |

| S.N. | Description                             | Forces about toe |                |                |                 |                 |
|------|---|------------------|----------------|----------------|-----------------|-----------------|
|      |   | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|      |   | Tonne            | Tonne          | Tonne          | Tm              | Tm              |
| LC-5 | SIS,LWL, Span dislodge ,Seismic Sx=1,\$ | 3620.38          | 1172.98        | 26.0734        | -14728.1        | 272.772         |

| LC-6                             | SIS, LWL,Span dislodge ,Seismic Sx=1,\$         | Forces about toe |                |                |                 |                 | LC-6  |
|----------------------------------|---|------------------|----------------|----------------|-----------------|-----------------|-------|
| S.N.                             | Description                                     | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |       |
|                                  |   | Tonne            | Tonne          | Tonne          | Tm              | Tm              |       |
| 1)                               | Sub-structure & Foundation                      | 1073.9           |                |                | -5150.7         | 0.0             | 1     |
| 2)                               | Backfill  | 2151.7           |                |                | -16334.4        | 0.0             | 1     |
| 9.3)                             | Earth Pressure LWL (BP, SD)                     |                  |                |                |                 |                 | 1     |
|                                  | Horizontal Component                            |                  | 1018.1         |                | 7194.7          |                 | 1     |
|                                  | Vertical Component                              | 364.7            |                |                | -1677.8         |                 | 1     |
| 10.3)                            | Surcharge Pressure LWL(BP, SD)                  |                  | 152.8          |                | 1298.4          |                 | 0.2   |
| <b>Seismic Longitudinal</b>      |   |                  |                |                |                 |                 | 0.5   |
| 11)                              | Sub-structure Component                         |                  | 34.0           |                | 240.7           |                 | 0.5   |
| 12)                              | Earth fill component                            |                  | 95.0           |                | 796.0           |                 | 0.5   |
| 12)                              | Super-Structure DL, SIDL, & Surfacing Compone   |                  | 36.9           |                | 536.6           |                 | 0.5   |
| 13)                              | Dynamic Earth Pressure LWL                      |                  |                |                |                 |                 | 0.5   |
|                                  | 13.6) LWL Seismic Upward_BP/SD                  |                  |                |                |                 |                 | 0.5   |
|                                  | Horizontal Component                            |                  | 13.2           |                | 111.8           |                 | 0.5   |
|                                  | Vertical Component                              | 4.8              |                |                | -22.0           |                 | 0.5   |
| 14)                              | 14.2) Dynamic Surcharge Pressure BP/SD          |                  |                |                |                 |                 | 0.2   |
|                                  | LWL Seismic Upward                              |                  | 3.0            |                | 33.6            |                 | 0.2   |
| <b>Seismic Transverses</b>       |   |                  |                |                |                 |                 | 0.15  |
| 15)                              | Sub-structure Component                         |                  |                | 112.7          |                 | 796.9           | 0.15  |
| 17)                              | Super-Structure DL, SIDL, & Surfacing Component |                  |                | 61.1           |                 | 1021.5          | 0.15  |
| <b>Seismic Vertical Downward</b> |   |                  |                |                |                 |                 | 0.15  |
| 19)                              | Sub-structure Component                         | 25.0436          |                |                | -116.763        |                 | -0.15 |
| 21)                              | Super-Structure DL, SIDL, & Surfacing           | 13.5836          |                |                | -43.8071        |                 | -0.15 |

| S.N. | Description | Forces about toe |                |                |                 |                 |
|------|-------------|------------------|----------------|----------------|-----------------|-----------------|
|      |             | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |

|      |   | Tonne   | Tonne   | Tonne   | Tm       | Tm      |
|------|---|---------|---------|---------|----------|---------|
| LC-6 | SIS, LWL, Span dislodge ,Seismic Sx=1,Sz=0.3, | 3586.91 | 1138.83 | 26.0734 | -14846.2 | 272.772 |

| LC-7                             | SIS,LWL,Max LL,Seismic Sx=1,Sz=0.3,             | Forces about toe |                |                |                 |                 | LC-7 |
|----------------------------------|---|------------------|----------------|----------------|-----------------|-----------------|------|
| S.N.                             | Description                                     | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |      |
|                                  |   | Tonne            | Tonne          | Tonne          | Tm              | Tm              |      |
| 1)                               | Sub-structure & Foundation                      | 1073.9           |                |                | -5150.7         | 0.0             | 1    |
| 2)                               | Backfill  | 2151.7           |                |                | -16334.4        | 0.0             | 1    |
| 3)                               | Super-structure DL                              | 266.9            |                |                | -860.9          | 0.0             | 1    |
| 4)                               | SIDL (excluding surfacing)                      | 117.0            |                |                | -377.3          | 0.0             | 1    |
| 5)                               | Surfacing                                       | 34.0             |                |                | -109.7          | -8.5            | 1    |
| 6.1)                             | Live Load Vertical Load Max Reaction            | 137.4            |                |                | -443.1          | 399.8           | 0.2  |
| 7)                               | Live Load Horizontal Forces                     |                  | 39.2           |                | 569.0           |                 | 0.2  |
| 9.3)                             | Earth Pressure LWL (BP, SD)                     |                  |                |                |                 |                 | 1    |
|                                  | Horizontal Component                            |                  | 1018.1         |                | 7194.7          |                 | 1    |
|                                  | Vertical Component                              | 364.7            |                |                | -1677.8         |                 | 1    |
| 10.3)                            | Surcharge Pressure LWL(BP, SD)                  |                  | 152.8          |                | 1298.4          |                 | 0.2  |
| <b>Seismic Longitudinal</b>      |   |                  |                |                |                 |                 | 1    |
| 11)                              | Sub-structure Component                         |                  | 34.0           |                | 240.7           |                 | 1    |
| 12)                              | Earth fill component                            |                  | 95.0           |                | 796.0           |                 | 1    |
| 12)                              | Super-Structure DL, SIDL, & Surfacing Component |                  | 36.9           |                | 536.6           |                 | 1    |
| 13)                              | Dynamic Earth Pressure LWL                      |                  |                |                |                 |                 | 1    |
| 13)                              | 13.5)LWL Seismic Downward_BP/SD                 |                  |                |                |                 |                 | 1    |
|                                  | Horizontal Component                            |                  | 75.8           |                | 644.5           |                 | 1    |
|                                  | Vertical Component                              | 27.6             |                |                | -126.9          |                 | 1    |
| 14)                              | 14.2) Dynamic Surcharge Pressure BP/SD          |                  |                |                |                 |                 | 0.2  |
|                                  | LWL Seismic Downward                            |                  | 17.1           |                | 193.7           |                 | 0.2  |
| <b>Seismic Transveres</b>        |   |                  |                |                |                 |                 | 0.3  |
| 15)                              | Sub-structure Component                         |                  |                | 112.7          |                 | 796.9           | 0.3  |
| 17)                              | Super-Structure DL, SIDL, & Surfacing Component |                  |                | 61.1           |                 | 1021.5          | 0.3  |
| 18.1)                            | Live Load Component (Max. Reaction)             |                  |                | 20.095         |                 | 365.722         | 0.06 |
| <b>Seismic Vertical Downward</b> |   |                  |                |                |                 |                 | 0.3  |
| 19)                              | Sub-structure Component                         | 25.0436          |                |                | -116.763        |                 | 0.3  |
| 20)                              | Earth fill                                      | 69.9             |                |                | -530.9          |                 | 0.3  |
| 21)                              | Super-Structure DL, SIDL, & Surfacing           | 13.5836          |                |                | -43.8071        |                 | 0.3  |
| 22.1)                            | Live Load Component (Max. Reaction)             | 4.5              |                |                | -14.4           |                 | 0.06 |

| S.N. | Description                         | Forces about toe |                |                |                 |                 |
|------|-------------------------------------|------------------|----------------|----------------|-----------------|-----------------|
|      |                                     | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|      |                                     | Tonne            | Tonne          | Tonne          | Tm              | Tm              |
| LC-7 | SIS,LWL,Max LL,Seismic Sx=1,Sz=0.3, | 4096.17          | 1301.73        | 53.3524        | -15110          | 638.949         |

| LC-8 | SIS, LWL,Max LL,Seismic Sx=1,Sz=0.3, | Forces about toe |                |                |                 |                 | LC-8 |
|------|--------------------------------------|------------------|----------------|----------------|-----------------|-----------------|------|
| S.N. | Description                          | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |      |



|                                  |   | Tonne   | Tonne   | Tonne  | Tm       | Tm      |  |       |
|----------------------------------|---|---------|---------|--------|----------|---------|--|-------|
| 1)                               | Sub-structure & Foundation                      | 1073.9  |         |        | -5150.7  | 0.0     |  | 1     |
| 2)                               | Backfill  | 2151.7  |         |        | -16334.4 | 0.0     |  | 1     |
| 3)                               | Super-structure DL                              | 266.9   |         |        | -860.9   | 0.0     |  | 1     |
| 4)                               | SIDL (excluding surfacing)                      | 117.0   |         |        | -377.3   | 0.0     |  | 1     |
| 5)                               | Surfacing                                       | 34.0    |         |        | -109.7   | -8.5    |  | 1     |
| 6.1)                             | Live Load Vertical Load Max Reaction            | 137.4   |         |        | -443.1   | 399.8   |  | 0.2   |
| 7)                               | Live Load Horizontal Forces                     |         | 39.2    |        | 569.0    |         |  | 0.2   |
| 10.1)                            | Surcharge Pressure LWL(O/S)                     |         | 152.827 |        | 1298.428 |         |  | 0.2   |
| 9.3)                             | Earth Pressure LWL (BP, SD)                     |         |         |        |          |         |  | 1     |
|                                  | Horizontal Component                            |         | 1018.1  |        | 7194.7   |         |  | 1     |
|                                  | Vertical Component                              | 364.7   |         |        | -1677.8  |         |  | 1     |
| 10.3)                            | Surcharge Pressure LWL(BP, SD)                  |         | 152.8   |        | 1298.4   |         |  | 0.2   |
| <b>Seismic Longitudinal</b>      |   |         |         |        |          |         |  | 1     |
| 11)                              | Sub-structure Component                         |         | 34.0    |        | 240.7    |         |  | 1     |
| 12)                              | Earth fill component                            |         | 95.0    |        | 796.0    |         |  | 1     |
| 12)                              | Super-Structure DL, SIDL, & Surfacing Component |         | 36.9    |        | 536.6    |         |  | 1     |
| 13)                              | Dynamic Earth Pressure LWL                      |         |         |        |          |         |  | 1     |
|                                  | 13.6) LWL Seismic Upward_BP/SD                  |         |         |        |          |         |  | 1     |
|                                  | Horizontal Component                            |         | 13.2    |        | 111.8    |         |  | 1     |
|                                  | Vertical Component                              | 4.8     |         |        | -22.0    |         |  | 1     |
| 14)                              | 14.2) Dynamic Surcharge Pressure BP/SD          |         |         |        |          |         |  | 0.2   |
|                                  | LWL Seismic Upward                              |         | 3.0     |        | 33.6     |         |  | 0.2   |
| <b>Seismic Transverses</b>       |   |         |         |        |          |         |  | 0.3   |
| 15)                              | Sub-structure Component                         |         |         | 112.7  |          | 796.9   |  | 0.3   |
| 17)                              | Super-Structure DL, SIDL, & Surfacing Component |         |         | 61.1   |          | 1021.5  |  | 0.3   |
| 18.1)                            | Live Load Component (Max. Reaction)             |         |         | 20.095 |          | 365.722 |  | 0.06  |
| <b>Seismic Vertical Downward</b> |   |         |         |        |          |         |  | 0.3   |
| 19)                              | Sub-structure Component                         | 25.0436 |         |        | -116.763 |         |  | -0.3  |
| 21)                              | Super-Structure DL, SIDL, & Surfacing           | 13.5836 |         |        | -43.8071 |         |  | -0.3  |
| 22.1)                            | Live Load Component (Max. Reaction)             | 4.5     |         |        | -14.4    |         |  | -0.06 |

| S.N. | Description                         | Forces about toe |                |                |                 |                 |
|------|-------------------------------------|------------------|----------------|----------------|-----------------|-----------------|
|      |                                     | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|      |                                     | Tonne            | Tonne          | Tonne          | Tm              | Tm              |
| LC-8 | SIS, LWL,Max LL,Seismic Sx=1,Sz=0.3 | 4028.68          | 1266.82        | 53.3524        | -15052.8        | 638.949         |

| S.N.  | Description                    | Forces about toe |                |                |                 |                 | LC-9 |
|-------|--------------------------------|------------------|----------------|----------------|-----------------|-----------------|------|
|       |                                | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |      |
|       |                                | Tonne            | Tonne          | Tonne          | Tm              | Tm              |      |
| 1)    | Sub-structure & Foundation     | 1073.9           |                |                | -5150.7         | 0.0             | 1    |
| 2)    | Backfill                       | 2151.7           |                |                | -16334.4        | 0.0             | 1    |
| 8)    | Buoyancy                       | -55.5            |                |                | 169.0           | 0.0             | 1    |
| 9.3)  | Earth Pressure HFL (BP, SD)    |                  |                |                |                 |                 | 1    |
|       | Horizontal Component           |                  | 1018.1         |                | 7194.7          |                 | 1    |
|       | Vertical Component             | 364.7            |                |                | -1677.8         |                 | 1    |
| 10.3) | Surcharge Pressure HFL(BP, SD) |                  | 152.8          |                | 1298.4          |                 | 1    |

| S.N. | Description                | Forces about toe |                |                |                 |                 |
|------|----------------------------|------------------|----------------|----------------|-----------------|-----------------|
|      |                            | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|      |                            | Tonne            | Tonne          | Tonne          | Tm              | Tm              |
| LC-9 | NS, HFL, Span dislodge, EP | 3534.8           | 1170.90        | 0              | -14500.8        | 0               |

| S.N.  | Description                          | Forces about toe |                |                |                 |                 | LC-10 |
|-------|--------------------------------------|------------------|----------------|----------------|-----------------|-----------------|-------|
|       |                                      | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |       |
|       |                                      | Tonne            | Tonne          | Tonne          | Tm              | Tm              |       |
| 1)    | Sub-structure & Foundation           | 1073.9           |                |                | -5150.7         | 0.0             | 1     |
| 2)    | Backfill                             | 2151.7           |                |                | -16334.4        | 0.0             | 1     |
| 3)    | Super-structure DL                   | 266.9            |                |                | -860.9          | 0.0             | 1     |
| 4)    | SIDL (excluding surfacing)           | 117.0            |                |                | -377.3          | 0.0             | 1     |
| 5)    | Surfacing                            | 34.0             |                |                | -109.7          | -8.5            | 1     |
| 6.1)  | Live Load Vertical Load Max Reaction | 137.4            |                |                | -443.1          | 399.8           | 1     |
| 7)    | Live Load Horizontal Forces          |                  | 39.2           |                | 569.0           |                 | 1     |
| 8)    | Buoyancy                             | -55.5            |                |                | 169.0           | 0.0             | 1     |
| 9.3)  | Earth Pressure HFL (BP, SD)          |                  |                |                |                 |                 | 1     |
|       | Horizontal Component                 |                  | 1018.1         |                | 7194.7          |                 | 1     |
|       | Vertical Component                   | 364.7            |                |                | -1677.8         |                 | 1     |
| 10.3) | Surcharge Pressure HFL(BP, SD)       |                  | 152.8          |                | 1298.4          |                 | 1     |

| S.N.  | Description         | Forces about toe |                |                |                 |                 |
|-------|---------------------|------------------|----------------|----------------|-----------------|-----------------|
|       |                     | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|       |                     | Tonne            | Tonne          | Tonne          | Tm              | Tm              |
| LC-10 | NS, HFL, Max LL, EP | 4090.17          | 1210.06        | 0              | -15722.8        | 391.329         |

| S.N.                        | Description                                     | Forces about toe |                |                |                 |                 | LC-11 |
|-----------------------------|---|------------------|----------------|----------------|-----------------|-----------------|-------|
|                             |   | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |       |
|                             |   | Tonne            | Tonne          | Tonne          | Tm              | Tm              |       |
| 1)                          | Sub-structure & Foundation                      | 1073.9           |                |                | -5150.7         | 0.0             | 1     |
| 2)                          | Backfill  | 2151.7           |                |                | -16334.4        | 0.0             | 1     |
| 8)                          | Buoyancy  | -55.5            |                |                | 169.0           | 0.0             | 1     |
| 9.3)                        | Earth Pressure HFL (BP, SD)                     |                  |                |                |                 |                 | 1     |
|                             | Horizontal Component                            |                  | 1018.1         |                | 7194.7          |                 | 1     |
|                             | Vertical Component                              | 364.7            |                |                | -1677.8         |                 | 1     |
| 10.3)                       | Surcharge Pressure HFL(BP, SD)                  |                  | 152.8          |                | 1298.4          |                 | 0.2   |
| <b>Seismic Longitudinal</b> |   |                  |                |                |                 |                 | 0.5   |
| 11)                         | Sub-structure Component                         |                  | 34.0           |                | 240.7           |                 | 0.5   |
| 12)                         | Earth fill component                            |                  | 95.0           |                | 796.0           |                 | 0.5   |
| 12)                         | Super-Structure DL, SIDL, & Surfacing Component |                  | 36.9           |                | 536.6           |                 | 0.5   |
| 13)                         | Dynamic Earth Pressure HFL                      |                  |                |                |                 |                 | 0.5   |
| 13)                         | 13.5)HFL Seismic Downward_BP/SD                 |                  |                |                |                 |                 | 0.5   |
|                             | Horizontal Component                            |                  | 75.8           |                | 644.5           |                 | 0.5   |

|                                  |   |         |      |       |          |        |      |
|----------------------------------|---|---------|------|-------|----------|--------|------|
|                                  | Vertical Component                              | 27.6    |      |       | -126.9   |        | 0.5  |
| 14)                              | 14.2) Dynamic Surcharge Pressure BP/SD          |         |      |       |          |        | 0.2  |
|                                  | HFL Seismic Downward                            |         | 17.1 |       | 193.7    |        | 0.2  |
| <b>Seismic Transverses</b>       |   |         |      |       |          |        | 0.15 |
| 15)                              | Sub-structure Component                         |         |      | 112.7 |          | 796.9  | 0.15 |
| 17)                              | Super-Structure DL, SIDL, & Surfacing Component |         |      | 61.1  |          | 1021.5 | 0.15 |
| <b>Seismic Vertical Downward</b> |   |         |      |       |          |        | 0.15 |
| 19)                              | Sub-structure Component                         | 25.0436 |      |       | -116.763 |        | 0.15 |
| 20)                              | Earth fill                                      | 69.9    |      |       | -530.9   |        | 0.15 |
| 21)                              | Super-Structure DL, SIDL, & Surfacing           | 13.5836 |      |       | -43.8071 |        | 0.15 |

| S.N.  | Description                            | Forces about toe |                |                |                 |                 |
|-------|--|------------------|----------------|----------------|-----------------|-----------------|
|       |  | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|       |  | Tonne            | Tonne          | Tonne          | Tm              | Tm              |
| LC-11 | SIS,HFL, Span dislodge ,Seismic Sx=1,S | 3564.88          | 1172.98        | 26.0734        | -14559.1        | 272.772         |

| LC-12                            | SIS, HFL,Span dislodge ,Seismic Sx=1,S          | Forces about toe |                |                |                 |                 |  | LC-12 |
|----------------------------------|---|------------------|----------------|----------------|-----------------|-----------------|--|-------|
| S.N.                             | Description                                     | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |  |       |
|                                  |   | Tonne            | Tonne          | Tonne          | Tm              | Tm              |  |       |
| 1)                               | Sub-structure & Foundation                      | 1073.9           |                |                | -5150.7         | 0.0             |  | 1     |
| 2)                               | Backfill  | 2151.7           |                |                | -16334.4        | 0.0             |  | 1     |
| 8)                               | Buoyancy  | -55.5            |                |                | 169.0           | 0.0             |  | 1     |
| 9.3)                             | Earth Pressure HFL (BP, SD)                     |                  |                |                |                 |                 |  | 1     |
|                                  | Horizontal Component                            |                  | 1018.1         |                | 7194.7          |                 |  | 1     |
|                                  | Vertical Component                              | 364.7            |                |                | -1677.8         |                 |  | 1     |
| 10.3)                            | Surcharge Pressure HFL(BP, SD)                  |                  | 152.8          |                | 1298.4          |                 |  | 0.2   |
| <b>Seismic Longitudinal</b>      |   |                  |                |                |                 |                 |  | 0.5   |
| 11)                              | Sub-structure Component                         |                  | 34.0           |                | 240.7           |                 |  | 0.5   |
| 12)                              | Earth fill component                            |                  | 95.0           |                | 796.0           |                 |  | 0.5   |
| 12)                              | Super-Structure DL, SIDL, & Surfacing Compone   |                  | 36.9           |                | 536.6           |                 |  | 0.5   |
| 13)                              | Dynamic Earth Pressure HFL                      |                  |                |                |                 |                 |  | 0.5   |
|                                  | 13.6) HFL Seismic Upward_BP/SD                  |                  |                |                |                 |                 |  | 0.5   |
|                                  | Horizontal Component                            |                  | 13.2           |                | 111.8           |                 |  | 0.5   |
|                                  | Vertical Component                              | 4.8              |                |                | -22.0           |                 |  | 0.5   |
| 14)                              | 14.2) Dynamic Surcharge Pressure BP/SD          |                  |                |                |                 |                 |  | 0.2   |
|                                  | HFL Seismic Upward                              |                  | 3.0            |                | 33.6            |                 |  | 0.2   |
| <b>Seismic Transverses</b>       |   |                  |                |                |                 |                 |  | 0.15  |
| 15)                              | Sub-structure Component                         |                  |                | 112.7          |                 | 796.9           |  | 0.15  |
| 17)                              | Super-Structure DL, SIDL, & Surfacing Component |                  |                | 61.1           |                 | 1021.5          |  | 0.15  |
| <b>Seismic Vertical Downward</b> |   |                  |                |                |                 |                 |  | 0.15  |
| 19)                              | Sub-structure Component                         | 25.0436          |                |                | -116.763        |                 |  | -0.15 |
| 21)                              | Super-Structure DL, SIDL, & Surfacing           | 13.5836          |                |                | -43.8071        |                 |  | -0.15 |

| S.N. | Description | Forces about toe |                |                |                 |                 |
|------|-------------|------------------|----------------|----------------|-----------------|-----------------|
|      |             | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|      |             | Tonne            | Tonne          | Tonne          | Tm              | Tm              |

|       |  |         |         |         |          |         |
|-------|--|---------|---------|---------|----------|---------|
| LC-12 | SIS, HFL,Span dislodge ,Seismic Sx=1,Sz=0.3,Sy=0.3 | 3531.41 | 1138.83 | 26.0734 | -14677.2 | 272.772 |
|-------|--|---------|---------|---------|----------|---------|

| LC-13                            | SIS,HFL,Max LL,Seismic Sx=1,Sz=0.3,Sy=0.3       | Forces about toe |                |                |                 |                 | LC-13 |
|----------------------------------|---|------------------|----------------|----------------|-----------------|-----------------|-------|
| S.N.                             | Description                                     | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |       |
|                                  |   | Tonne            | Tonne          | Tonne          | Tm              | Tm              |       |
| 1)                               | Sub-structure & Foundation                      | 1073.9           |                |                | -5150.7         | 0.0             | 1     |
| 2)                               | Backfill  | 2151.7           |                |                | -16334.4        | 0.0             | 1     |
| 3)                               | Super-structure DL                              | 266.9            |                |                | -860.9          | 0.0             | 1     |
| 4)                               | SIDL (excluding surfacing)                      | 117.0            |                |                | -377.3          | 0.0             | 1     |
| 5)                               | Surfacing                                       | 34.0             |                |                | -109.7          | -8.5            | 1     |
| 6.1)                             | Live Load Vertical Load Max Reaction            | 137.4            |                |                | -443.1          | 399.8           | 0.2   |
| 7)                               | Live Load Horizontal Forces                     |                  | 39.2           |                | 569.0           |                 | 0.2   |
| 8)                               | Buoyancy  | -55.5            |                |                | 169.0           | 0.0             | 1     |
| 9.3)                             | Earth Pressure HFL (BP, SD)                     |                  |                |                |                 |                 | 1     |
|                                  | Horizontal Component                            |                  | 1018.1         |                | 7194.7          |                 | 1     |
|                                  | Vertical Component                              | 364.7            |                |                | -1677.8         |                 | 1     |
| 10.3)                            | Surcharge Pressure HFL(BP, SD)                  |                  | 152.8          |                | 1298.4          |                 | 0.2   |
| <b>Seismic Longitudinal</b>      |   |                  |                |                |                 |                 | 1     |
| 11)                              | Sub-structure Component                         |                  | 34.0           |                | 240.7           |                 | 1     |
| 12)                              | Earth fill component                            |                  | 95.0           |                | 796.0           |                 | 1     |
| 12)                              | Super-Structure DL, SIDL, & Surfacing Component |                  | 36.9           |                | 536.6           |                 | 1     |
| 13)                              | Dynamic Earth Pressure HFL                      |                  |                |                |                 |                 | 1     |
| 13)                              | 13.5)HFL Seismic Downward_BP/SD                 |                  |                |                |                 |                 | 1     |
|                                  | Horizontal Component                            |                  | 75.8           |                | 644.5           |                 | 1     |
|                                  | Vertical Component                              | 27.6             |                |                | -126.9          |                 | 1     |
| 14)                              | 14.2) Dynamic Surcharge Pressure BP/SD          |                  |                |                |                 |                 | 0.2   |
|                                  | HFL Seismic Downward                            |                  | 17.1           |                | 193.7           |                 | 0.2   |
| <b>Seismic Transveres</b>        |   |                  |                |                |                 |                 | 0.3   |
| 15)                              | Sub-structure Component                         |                  |                | 112.7          |                 | 796.9           | 0.3   |
| 17)                              | Super-Structure DL, SIDL, & Surfacing Component |                  |                | 61.1           |                 | 1021.5          | 0.3   |
| 18.1)                            | Live Load Component (Max. Reaction)             |                  |                | 20.095         |                 | 365.722         | 0.06  |
| <b>Seismic Vertical Downward</b> |   |                  |                |                |                 |                 | 0.3   |
| 19)                              | Sub-structure Component                         | 25.0436          |                |                | -116.763        |                 | 0.3   |
| 20)                              | Earth fill                                      | 69.9             |                |                | -530.9          |                 | 0.3   |
| 21)                              | Super-Structure DL, SIDL, & Surfacing           | 13.5836          |                |                | -43.8071        |                 | 0.3   |
| 22.1)                            | Live Load Component (Max. Reaction)             | 4.5              |                |                | -14.4           |                 | 0.06  |

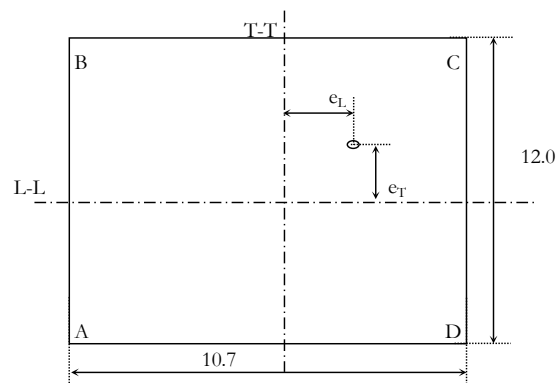
| S.N.  | Description                               | Forces about toe |                |                |                 |                 |
|-------|---|------------------|----------------|----------------|-----------------|-----------------|
|       |   | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|       |   | Tonne            | Tonne          | Tonne          | Tm              | Tm              |
| LC-13 | SIS,HFL,Max LL,Seismic Sx=1,Sz=0.3,Sy=0.3 | 4040.67          | 1301.73        | 53.3524        | -14941          | 638.949         |

| LC-14 | SIS, HFL,Max LL,Seismic Sx=1,Sz=0.3,Sy=0.3 | Forces about toe |                |                |                 |                 | LC-14 |
|-------|--|------------------|----------------|----------------|-----------------|-----------------|-------|
| S.N.  | Description                                | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |       |

|                                  |   | Tonne   | Tonne  | Tonne  | Tm       | Tm      |  |       |
|----------------------------------|---|---------|--------|--------|----------|---------|--|-------|
| 1)                               | Sub-structure & Foundation                      | 1073.9  |        |        | -5150.7  | 0.0     |  | 1     |
| 2)                               | Backfill  | 2151.7  |        |        | -16334.4 | 0.0     |  | 1     |
| 3)                               | Super-structure DL                              | 266.9   |        |        | -860.9   | 0.0     |  | 1     |
| 4)                               | SIDL (excluding surfacing)                      | 117.0   |        |        | -377.3   | 0.0     |  | 1     |
| 5)                               | Surfacing                                       | 34.0    |        |        | -109.7   | -8.5    |  | 1     |
| 6.1)                             | Live Load Vertical Load Max Reaction            | 137.4   |        |        | -443.1   | 399.8   |  | 0.2   |
| 7)                               | Live Load Horizontal Forces                     |         | 39.2   |        | 569.0    |         |  | 0.2   |
| 8)                               | Buoyancy  | -55.5   |        |        | 169.0    | 0.0     |  | 1     |
| 10.1)                            | Surcharge Pressure HFL(O/S)                     |         | 152.8  |        | 1298.4   |         |  | 0.2   |
| 9.3)                             | Earth Pressure HFL (BP, SD)                     |         |        |        |          |         |  | 1     |
|                                  | Horizontal Component                            |         | 1018.1 |        | 7194.7   |         |  | 1     |
|                                  | Vertical Component                              | 364.7   |        |        | -1677.8  |         |  | 1     |
| 10.3)                            | Surcharge Pressure HFL(BP, SD)                  |         | 152.8  |        | 1298.4   |         |  | 0.2   |
| <b>Seismic Longitudinal</b>      |   |         |        |        |          |         |  | 1     |
| 11)                              | Sub-structure Component                         |         | 34.0   |        | 240.7    |         |  | 1     |
| 12)                              | Earth fill component                            |         | 95.0   |        | 796.0    |         |  | 1     |
| 12)                              | Super-Structure DL, SIDL, & Surfacing Component |         | 36.9   |        | 536.6    |         |  | 1     |
| 13)                              | Dynamic Earth Pressure HFL                      |         |        |        |          |         |  | 1     |
|                                  | 13.6) HFL Seismic Upward_BP/SD                  |         |        |        |          |         |  | 1     |
|                                  | Horizontal Component                            |         | 13.2   |        | 111.8    |         |  | 1     |
|                                  | Vertical Component                              | 4.8     |        |        | -22.0    |         |  | 1     |
| 14)                              | 14.2) Dynamic Surcharge Pressure BP/SD          |         |        |        |          |         |  | 0.2   |
|                                  | HFL Seismic Upward                              |         | 3.0    |        | 33.6     |         |  | 0.2   |
| <b>Seismic Transverses</b>       |   |         |        |        |          |         |  | 0.3   |
| 15)                              | Sub-structure Component                         |         |        | 112.7  |          | 796.9   |  | 0.3   |
| 17)                              | Super-Structure DL, SIDL, & Surfacing Component |         |        | 61.1   |          | 1021.5  |  | 0.3   |
| 18.1)                            | Live Load Component (Max. Reaction)             |         |        | 20.095 |          | 365.722 |  | 0.06  |
| <b>Seismic Vertical Downward</b> |   |         |        |        |          |         |  | 0.3   |
| 19)                              | Sub-structure Component                         | 25.0436 |        |        | -116.763 |         |  | -0.3  |
| 21)                              | Super-Structure DL, SIDL, & Surfacing           | 13.5836 |        |        | -43.8071 |         |  | -0.3  |
| 22.1)                            | Live Load Component (Max. Reaction)             | 4.5     |        |        | -14.4    |         |  | -0.06 |

| S.N.  | Description                         | Forces about toe |                |                |                 |                 |
|-------|-------------------------------------|------------------|----------------|----------------|-----------------|-----------------|
|       |                                     | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|       |                                     | Tonne            | Tonne          | Tonne          | Tm              | Tm              |
| LC-14 | SIS, HFL,Max LL,Seismic Sx=1,Sz=0.3 | 3973.18          | 1266.82        | 53.3524        | -14883.8        | 638.949         |

**CHECK FOR MAXIMUM BASE PRESSRE**  
**LOAD COMBINATION FOR MAXIMUM BASE PRESSURE**



| Coordinates of basecorner |        |        |
|---------------------------|--------|--------|
| Edges                     | x (m)  | z (m)  |
| A                         | -5.350 | 6.000  |
| B                         | -5.350 | -6.000 |
| C                         | 5.350  | -6.000 |
| D                         | 5.350  | 6.000  |

| Properties of Base |                          |   |                        |
|--------------------|--------------------------|---|------------------------|
| Area               | 10.7x12                  | = | 128.4 m <sup>2</sup>   |
| I <sub>TT</sub>    | 12x10.7 <sup>3</sup> /12 | = | 1225.04 m <sup>4</sup> |
| I <sub>LL</sub>    | 10.7x12 <sup>3</sup> /12 | = | 1540.8 m <sup>4</sup>  |

| Maximum Base Pressure |               | Heel side |     | Toe Side |       | Bearing Capacity | Check  |
|-----------------------|---------------|-----------|-----|----------|-------|------------------|--------|
| Non-Seismic case      | LWL Condition | 8.1       | 8.1 | 47.8     | 47.78 | 60.0             | OK     |
| Seismic Case          | LWL Condition | 10.0      | 3.3 | 61.3     | 45.8  | 75.0             | OK     |
| Non-Seismic case      | HFL Condition | 5.5       | 0.5 | 62.3     | 57.3  | 60.0             | REVISE |
| Seismic Case          | HFL Condition | 10.2      | 3.4 | 60.3     | 44.9  | 75.0             | OK     |

**CHECK FOR MAXIMUM BASE PRESSRE**

**SUMMARY OF FORCES :**

|       |  |                  |                |                |                 |                 | <i>Eccentricity of Vertical load from toe point</i> |                     | <i>Eccentricity of Vertical load wrt cg of base</i> |                 | <i>Moment and forces at cg of base</i> |                  | <i>Base Pressure = <math>P/A \pm M_{TT} * x / I_{TT} \pm M_{LL} * z / I_{LL}</math></i> |                  |                  |                  |
|-------|--|------------------|----------------|----------------|-----------------|-----------------|---|---------------------|---|-----------------|--|------------------|---|------------------|------------------|------------------|
| S.N.  | Description                            | Forces about toe |                |                |                 |                 | e <sub>L1</sub>                                     | e <sub>T1</sub>     | e <sub>L</sub>                                      | e <sub>T</sub>  | M <sub>TT</sub>                        | M <sub>LL</sub>  | <i>base pressure at footing corners</i>   |                  |                  |                  |
|       |  | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> | M <sub>TT</sub> / V                                 | M <sub>LL</sub> / V | B/2-e <sub>L1</sub>                                 | e <sub>T1</sub> | V*e <sub>L</sub>                       | V*e <sub>T</sub> | A   | B                | C                | D                |
|       |  | Tonne            | Tonne          | Tonne          | Tm              | Tm              | m   | m                   | m   | m               | Tm                                     | Tm               | T/m <sup>2</sup>  | T/m <sup>2</sup> | T/m <sup>2</sup> | T/m <sup>2</sup> |
| LC-2  | NS, LWL, Span dislodge, EP             | 3590.3           | 1170.9         | 0              | -14669.8        | 0               | -4.09   | 0.00                | 1.26  | 0.00            | 4538.3                                 | 0.0              | 8.1   | 8.1              | 47.8             | 47.8             |
| LC-3  | NS, LWL, Max LL, FP                    | 3780.93          | 192.16         | 0              | -21408.8        | 391.329         | -5.66   | 0.10                | -0.31   | 0.10            | -1180.8                                | 391.3            | 36.1  | 33.1             | 22.8             | 25.8             |
| LC-4  | NS, LWL, Max LL, EP                    | 4145.67          | 1210.06        | 0              | -15891.9        | 391.329         | -3.83   | 0.09                | 1.52  | 0.09            | 6287.5                                 | 391.3            | 6.4   | 3.3              | 58.2             | 61.3             |
| LC-5  | SIS,LWL, Span dislodge ,Seismic Sx=1,S | 3620.38          | 1172.98        | 26.0734        | -14728.1        | 272.772         | -4.07   | 0.08                | 1.28  | 0.08            | 4641.0                                 | 272.8            | 9.0   | 6.9              | 47.4             | 49.5             |
| LC-6  | SIS, LWL,Span dislodge ,Seismic Sx=1,S | 3586.91          | 1138.83        | 26.0734        | -14846.2        | 272.772         | -4.14   | 0.08                | 1.21  | 0.08            | 4343.7                                 | 272.8            | 10.0  | 7.9              | 45.8             | 48.0             |
| LC-7  | SIS,LWL,Max LL,Seismic Sx=1,Sz=0.3,S   | 4096.17          | 1301.73        | 53.3524        | -15110          | 638.949         | -3.69   | 0.16                | 1.66  | 0.16            | 6804.5                                 | 638.9            | 4.7   | -0.3             | 59.1             | 64.1             |
| LC-8  | SIS, LWL,Max LL,Seismic Sx=1,Sz=0.3,S  | 4028.68          | 1266.82        | 53.3524        | -15052.8        | 638.949         | -3.74   | 0.16                | 1.61  | 0.16            | 6500.6                                 | 638.9            | 5.5   | 0.5              | 57.3             | 62.3             |
| LC-9  | NS, HFL, Span dislodge, EP             | 3534.8           | 1170.9         | 0              | -14500.8        | 0               | -4.10   | 0.00                | 1.25  | 0.00            | 4410.5                                 | 0.0              | 8.3   | 8.3              | 46.8             | 46.8             |
| LC-10 | NS, HFL, Max LL, EP                    | 4090.17          | 1210.06        | 0              | -15722.8        | 391.329         | -3.84   | 0.10                | 1.51  | 0.10            | 6159.6                                 | 391.3            | 6.5   | 3.4              | 57.2             | 60.3             |
| LC-11 | SIS,HFL, Span dislodge ,Seismic Sx=1,S | 3564.88          | 1172.98        | 26.0734        | -14559.1        | 272.772         | -4.08   | 0.08                | 1.27  | 0.08            | 4513.1                                 | 272.8            | 9.1   | 7.0              | 46.4             | 48.5             |
| LC-12 | SIS, HFL,Span dislodge ,Seismic Sx=1,S | 3531.41          | 1138.83        | 26.0734        | -14677.2        | 272.772         | -4.16   | 0.08                | 1.19  | 0.08            | 4215.8                                 | 272.8            | 10.2  | 8.0              | 44.9             | 47.0             |
| LC-13 | SIS,HFL,Max LL,Seismic Sx=1,Sz=0.3,S   | 4040.67          | 1301.73        | 53.3524        | -14941          | 638.949         | -3.70   | 0.16                | 1.65  | 0.16            | 6676.6                                 | 638.9            | 4.8   | -0.2             | 58.1             | 63.1             |
| LC-14 | SIS, HFL,Max LL,Seismic Sx=1,Sz=0.3,S  | 3973.18          | 1266.82        | 53.3524        | -14883.8        | 638.949         | -3.75   | 0.16                | 1.60  | 0.16            | 6372.7                                 | 638.9            | 5.6   | 0.6              | 56.3             | 61.3             |



DESIGN OF FOUNDATION  
ULS LOAD COMBINATION

| LC-2        | NS(1), LWL, Span dislodge, EP  | Forces about toe |                |                |                 |                 |  | LC-2 |
|-------------|--------------------------------|------------------|----------------|----------------|-----------------|-----------------|--|------|
| S.N.        | Description                    | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |  |      |
|             |                                | Tonne            | Tonne          | Tonne          | Tm              | Tm              |  |      |
| 1)          | Sub-structure & Foundation     | 1073.9           |                |                | -5150.75        | 0               |  | 1.35 |
| 2)          | Backfill                       | 2151.7           |                |                | -16334.4        | 0               |  | 1.35 |
| <b>9.3)</b> | Earth Pressure LWL (BP, SD)    |                  |                |                |                 |                 |  | 1.5  |
|             | Horizontal Component           |                  | 1018.08        |                | 7194.73         |                 |  | 1.5  |
|             | Vertical Component             | 364.73           |                |                | -1677.77        |                 |  | 1.5  |
| 10.3)       | Surcharge Pressure LWL(BP, SD) |                  | 152.83         |                | 1298.43         |                 |  | 1.2  |

| S.N. | Description                   | Forces about toe |                |                |                 |                 |
|------|-------------------------------|------------------|----------------|----------------|-----------------|-----------------|
|      |                               | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|      |                               | Tonne            | Tonne          | Tonne          | Tm              | Tm              |
| LC-2 | NS(1), LWL, Span dislodge, EP | 4901.62          | 1710.51        | 0              | -19171.4        | 0               |

| LC-4        | NS(1), LWL, Min LL acomp, EP         | Forces about toe |                |                |                 |                 |  | LC-4 |
|-------------|--------------------------------------|------------------|----------------|----------------|-----------------|-----------------|--|------|
| S.N.        | Description                          | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |  |      |
|             |                                      | Tonne            | Tonne          | Tonne          | Tm              | Tm              |  |      |
| 1)          | Sub-structure & Foundation           | 1073.9           |                |                | -5150.75        | 0               |  | 1.35 |
| 2)          | Backfill                             | 2151.7           |                |                | -16334.4        | 0               |  | 1.35 |
| 3)          | Super-structure DL                   | 266.9            |                |                | -860.913        | 0               |  | 1.35 |
| 4)          | SIDL (excluding surfacing)           | 117.0            |                |                | -377.28         | 0               |  | 1.35 |
| 5)          | Surfacing                            | 34.0             |                |                | -109.731        | -8.50627        |  | 1.75 |
| 6.2)        | Live Load Vertical Load Min Reaction | 28.8             |                |                | -92.88          | 83.81           |  | 1.15 |
| 7)          | Live Load Horizontal Forces          |                  | 39.2           |                | 568.97          |                 |  | 1.15 |
| <b>9.3)</b> | Earth Pressure LWL (BP, SD)          |                  |                |                |                 |                 |  | 1.5  |
|             | Horizontal Component                 |                  | 1018.08        |                | 7194.73         |                 |  | 1.5  |
|             | Vertical Component                   | 364.73           |                |                | -1677.77        |                 |  | 1.5  |
| 10.3)       | Surcharge Pressure LWL(BP, SD)       |                  | 152.83         |                | 1298.43         |                 |  | 1.2  |

| S.N. | Description                  | Forces about toe |                |                |                 |                 |
|------|------------------------------|------------------|----------------|----------------|-----------------|-----------------|
|      |                              | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|      |                              | Tonne            | Tonne          | Tonne          | Tm              | Tm              |
| LC-4 | NS(1), LWL, Min LL acomp, EP | 5512.6           | 1755.53        | 0              | -20487.5        | 81.4922         |



| LC-6        | NS(1), LWL, Max LL Lead, EP          | Forces about toe |                |                |                 |                 |  | LC-6 |
|-------------|--------------------------------------|------------------|----------------|----------------|-----------------|-----------------|--|------|
| S.N.        | Description                          | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |  |      |
|             |                                      | Tonne            | Tonne          | Tonne          | Tm              | Tm              |  |      |
| 1)          | Sub-structure & Foundation           | 1073.9           |                |                | -5150.75        | 0               |  | 1.35 |
| 2)          | Backfill                             | 2151.7           |                |                | -16334.4        | 0               |  | 1.35 |
| 3)          | Super-structure DL                   | 266.9            |                |                | -860.913        | 0               |  | 1.35 |
| 4)          | SIDL (excluding surfacing)           | 117.0            |                |                | -377.28         | 0               |  | 1.35 |
| 5)          | Surfacing                            | 34.0             |                |                | -109.731        | -8.50627        |  | 1.75 |
| 6.1)        | Live Load Vertical Load Max Reaction | 137.4            |                |                | -443.12         | 399.83          |  | 1.5  |
| 7)          | Live Load Horizontal Forces          |                  | 39.2           |                | 568.97          |                 |  | 1.5  |
| <b>9.3)</b> | Earth Pressure LWL (BP, SD)          |                  |                |                |                 |                 |  | 1    |
|             | Horizontal Component                 |                  | 1018.08        |                | 7194.73         |                 |  | 1    |
|             | Vertical Component                   | 364.73           |                |                | -1677.77        |                 |  | 1    |
| 10.3)       | Surcharge Pressure LWL(BP, SD)       |                  | 152.83         |                | 1298.43         |                 |  | 1.2  |

| S.N. | Description                 | Forces about toe |                |                |                 |                 |
|------|-----------------------------|------------------|----------------|----------------|-----------------|-----------------|
|      |                             | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|      |                             | Tonne            | Tonne          | Tonne          | Tm              | Tm              |
| LC-6 | NS(1), LWL, Max LL Lead, EP | 5503.21          | 1260.2         | 0              | -23604.7        | 584.866         |

| LC-8        | NS(2), LWL, Span dislodge, EP  | Forces about toe |                |                |                 |                 |  | LC-8 |
|-------------|--------------------------------|------------------|----------------|----------------|-----------------|-----------------|--|------|
| S.N.        | Description                    | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |  |      |
|             |                                | Tonne            | Tonne          | Tonne          | Tm              | Tm              |  |      |
| 1)          | Sub-structure & Foundation     | 1073.9           |                |                | -5150.75        | 0               |  | 1    |
| 2)          | Backfill                       | 2151.7           |                |                | -16334.4        | 0               |  | 1    |
| <b>9.3)</b> | Earth Pressure LWL (BP, SD)    |                  |                |                |                 |                 |  | 1.3  |
|             | Horizontal Component           |                  | 1018.08        |                | 7194.73         |                 |  | 1.3  |
|             | Vertical Component             | 364.73           |                |                | -1677.77        |                 |  | 1.3  |
| 10.3)       | Surcharge Pressure LWL(BP, SD) |                  | 152.83         |                | 1298.43         |                 |  | 1    |

| S.N. | Description                   | Forces about toe |                |                |                 |                 |
|------|-------------------------------|------------------|----------------|----------------|-----------------|-----------------|
|      |                               | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|      |                               | Tonne            | Tonne          | Tonne          | Tm              | Tm              |
| LC-8 | NS(2), LWL, Span dislodge, EP | 3699.72          | 1476.33        | 0              | -13014.7        | 0               |

| LC-10       | NS(2), LWL, Min LL acom, EP          | Forces about toe |                |                |                 |                 |  | LC-10 |
|-------------|--------------------------------------|------------------|----------------|----------------|-----------------|-----------------|--|-------|
| S.N.        | Description                          | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |  |       |
|             |                                      | Tonne            | Tonne          | Tonne          | Tm              | Tm              |  |       |
| 1)          | Sub-structure & Foundation           | 1073.9           |                |                | -5150.75        | 0               |  | 1     |
| 2)          | Backfill                             | 2151.7           |                |                | -16334.4        | 0               |  | 1     |
| 3)          | Super-structure DL                   | 266.9            |                |                | -860.913        | 0               |  | 1     |
| 4)          | SIDL (excluding surfacing)           | 117.0            |                |                | -377.28         | 0               |  | 1     |
| 5)          | Surfacing                            | 34.0             |                |                | -109.731        | -8.50627        |  | 1     |
| 6.2)        | Live Load Vertical Load Min Reaction | 28.8             |                |                | -92.88          | 83.81           |  | 1     |
| 7)          | Live Load Horizontal Forces          |                  | 39.2           |                | 568.97          |                 |  | 1     |
| <b>9.3)</b> | Earth Pressure LWL (BP, SD)          |                  |                |                |                 |                 |  | 1.3   |
|             | Horizontal Component                 |                  | 1018.08        |                | 7194.73         |                 |  | 1.3   |
|             | Vertical Component                   | 364.73           |                |                | -1677.77        |                 |  | 1.3   |
| 10.3)       | Surcharge Pressure LWL(BP, SD)       |                  | 152.83         |                | 1298.43         |                 |  | 1     |

| S.N.  | Description                 | Forces about toe |                |                |                 |                 |
|-------|-----------------------------|------------------|----------------|----------------|-----------------|-----------------|
|       |                             | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|       |                             | Tonne            | Tonne          | Tonne          | Tm              | Tm              |
| LC-10 | NS(2), LWL, Min LL acom, EP | 4146.48          | 1515.48        | 0              | -13886.5        | 75.3009         |

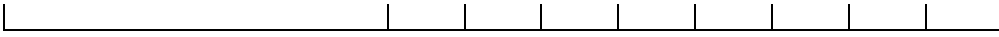
| S.N.  | Description                          | Forces about toe |                |                |                 |                 | LC-12 |
|-------|--------------------------------------|------------------|----------------|----------------|-----------------|-----------------|-------|
|       |                                      | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |       |
|       |                                      | Tonne            | Tonne          | Tonne          | Tm              | Tm              |       |
| 1)    | Sub-structure & Foundation           | 1073.9           |                |                | -5150.75        | 0               | 1     |
| 2)    | Backfill                             | 2151.7           |                |                | -16334.4        | 0               | 1     |
| 3)    | Super-structure DL                   | 266.9            |                |                | -860.913        | 0               | 1     |
| 4)    | SIDL (excluding surfacing)           | 117.0            |                |                | -377.28         | 0               | 1     |
| 5)    | Surfacing                            | 34.0             |                |                | -109.731        | -8.50627        | 1     |
| 6.1)  | Live Load Vertical Load Max Reaction | 137.4            |                |                | -443.12         | 399.83          | 1.3   |
| 7)    | Live Load Horizontal Forces          |                  | 39.2           |                | 568.97          |                 | 1.3   |
| 9.3)  | Earth Pressure LWL (BP, SD)          |                  |                |                |                 |                 | 0.85  |
|       | Horizontal Component                 |                  | 1018.08        |                | 7194.73         |                 | 0.85  |
|       | Vertical Component                   | 364.73           |                |                | -1677.77        |                 | 0.85  |
| 10.3) | Surcharge Pressure LWL(BP, SD)       |                  | 152.83         |                | 1298.43         |                 | 1     |

| S.N.  | Description                 | Forces about toe |                |                |                 |                 |
|-------|-----------------------------|------------------|----------------|----------------|-----------------|-----------------|
|       |                             | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|       |                             | Tonne            | Tonne          | Tonne          | Tm              | Tm              |
| LC-12 | NS(2), LWL, Max LL Lead, EP | 4132.18          | 1069.09        | 0              | -16681.6        | 511.279         |

| S.N.  | Description                    | Forces about toe |                |                |                 |                 | LC-19 |
|-------|--------------------------------|------------------|----------------|----------------|-----------------|-----------------|-------|
|       |                                | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |       |
|       |                                | Tonne            | Tonne          | Tonne          | Tm              | Tm              |       |
| 1)    | Sub-structure & Foundation     | 1073.9           |                |                | -5150.75        | 0               | 1.35  |
| 2)    | Backfill                       | 2151.7           |                |                | -16334.4        | 0               | 1.35  |
| 8)    | Buoyancy                       | -55.5            |                |                | 169.0           | 0.0             | 0.15  |
| 9.3)  | Earth Pressure HFL (BP, SD)    |                  |                |                |                 |                 | 1.5   |
|       | Horizontal Component           |                  | 1018.1         |                | 7194.7          |                 | 1.5   |
|       | Vertical Component             | 364.7            |                |                | -1677.8         |                 | 1.5   |
| 10.3) | Surcharge Pressure HFL(BP, SD) |                  | 152.8          |                | 1298.4          |                 | 1.2   |

| S.N.  | Description                   | Forces about toe |                |                |                 |                 |
|-------|-------------------------------|------------------|----------------|----------------|-----------------|-----------------|
|       |                               | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|       |                               | Tonne            | Tonne          | Tonne          | Tm              | Tm              |
| LC-19 | NS(1), HFL, Span dislodge, EP | 4893.3           | 1710.51        | 0              | -19146.1        | 0               |

| S.N.  | Description                          | Forces about toe |                |                |                 |                 | LC-20 |
|-------|--------------------------------------|------------------|----------------|----------------|-----------------|-----------------|-------|
|       |                                      | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |       |
|       |                                      | Tonne            | Tonne          | Tonne          | Tm              | Tm              |       |
| 1)    | Sub-structure & Foundation           | 1073.9           |                |                | -5150.75        | 0               | 1.35  |
| 2)    | Backfill                             | 2151.7           |                |                | -16334.4        | 0               | 1.35  |
| 3)    | Super-structure DL                   | 266.9            |                |                | -860.913        | 0               | 1.35  |
| 4)    | SIDL (excluding surfacing)           | 117.0            |                |                | -377.28         | 0               | 1.35  |
| 5)    | Surfacing                            | 34.0             |                |                | -109.731        | -8.50627        | 1.75  |
| 6.2)  | Live Load Vertical Load Min Reaction | 28.8             |                |                | -92.88          | 83.81           | 1.15  |
| 7)    | Live Load Horizontal Forces          |                  | 39.2           |                | 568.97          |                 | 1.15  |
| 8)    | Buoyancy                             | -55.5            |                |                | 169.0           | 0.0             | 0.15  |
| 9.3)  | Earth Pressure HFL (BP, SD)          |                  |                |                |                 |                 | 1.5   |
|       | Horizontal Component                 |                  | 1018.1         |                | 7194.7          |                 | 1.5   |
|       | Vertical Component                   | 364.7            |                |                | -1677.8         |                 | 1.5   |
| 10.3) | Surcharge Pressure HFL(BP, SD)       |                  | 152.8          |                | 1298.4          |                 | 1.2   |



| S.N.  | Description                  | Forces about toe |                |                |                 |                 |
|-------|------------------------------|------------------|----------------|----------------|-----------------|-----------------|
|       |                              | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|       |                              | Tonne            | Tonne          | Tonne          | Tm              | Tm              |
| LC-20 | NS(1), HFL, Min LL acomp, EP | 5504.27          | 1755.53        | 0              | -20462.2        | 81.4922         |

| S.N.  | Description                          | Forces about toe |                |                |                 |                 |  | LC-21 |
|-------|--------------------------------------|------------------|----------------|----------------|-----------------|-----------------|--|-------|
|       |                                      | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |  |       |
|       |                                      | Tonne            | Tonne          | Tonne          | Tm              | Tm              |  |       |
| 1)    | Sub-structure & Foundation           | 1073.9           |                |                | -5150.75        | 0               |  | 1.35  |
| 2)    | Backfill                             | 2151.7           |                |                | -16334.4        | 0               |  | 1.35  |
| 3)    | Super-structure DL                   | 266.9            |                |                | -860.913        | 0               |  | 1.35  |
| 4)    | SIDL (excluding surfacing)           | 117.0            |                |                | -377.28         | 0               |  | 1.35  |
| 5)    | Surfacing                            | 34.0             |                |                | -109.731        | -8.50627        |  | 1.75  |
| 6.1)  | Live Load Vertical Load Max Reaction | 137.4            |                |                | -443.12         | 399.83          |  | 1.5   |
| 7)    | Live Load Horizontal Forces          |                  | 39.2           |                | 568.97          |                 |  | 1.5   |
| 8)    | Buoyancy                             | -55.5            |                |                | 169.0           | 0.0             |  | 0.15  |
| 9.3)  | Earth Pressure HFL (BP, SD)          |                  |                |                |                 |                 |  | 1     |
|       | Horizontal Component                 |                  | 1018.1         |                | 7194.7          |                 |  | 1     |
|       | Vertical Component                   | 364.7            |                |                | -1677.8         |                 |  | 1     |
| 10.3) | Surcharge Pressure HFL(BP, SD)       |                  | 152.8          |                | 1298.4          |                 |  | 1.2   |

| S.N.  | Description                 | Forces about toe |                |                |                 |                 |
|-------|-----------------------------|------------------|----------------|----------------|-----------------|-----------------|
|       |                             | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|       |                             | Tonne            | Tonne          | Tonne          | Tm              | Tm              |
| LC-21 | NS(1), HFL, Max LL Lead, EP | 5494.89          | 1260.2         | 0              | -23579.4        | 584.866         |

| S.N.  | Description                    | Forces about toe |                |                |                 |                 |  | LC-22 |
|-------|--------------------------------|------------------|----------------|----------------|-----------------|-----------------|--|-------|
|       |                                | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |  |       |
|       |                                | Tonne            | Tonne          | Tonne          | Tm              | Tm              |  |       |
| 1)    | Sub-structure & Foundation     | 1073.9           |                |                | -5150.75        | 0               |  | 1     |
| 2)    | Backfill                       | 2151.7           |                |                | -16334.4        | 0               |  | 1     |
| 8)    | Buoyancy                       | -55.5            |                |                | 169.0           | 0.0             |  | 0.15  |
| 9.3)  | Earth Pressure HFL (BP, SD)    |                  |                |                |                 |                 |  | 1.3   |
|       | Horizontal Component           |                  | 1018.1         |                | 7194.7          |                 |  | 1.3   |
|       | Vertical Component             | 364.7            |                |                | -1677.8         |                 |  | 1.3   |
| 10.3) | Surcharge Pressure HFL(BP, SD) |                  | 152.8          |                | 1298.4          |                 |  | 1     |

| S.N.  | Description                   | Forces about toe |                |                |                 |                 |
|-------|-------------------------------|------------------|----------------|----------------|-----------------|-----------------|
|       |                               | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|       |                               | Tonne            | Tonne          | Tonne          | Tm              | Tm              |
| LC-22 | NS(2), HFL, Span dislodge, EP | 3691.4           | 1476.33        | 0              | -12989.3        | 0               |

| S.N. | Description                          | Forces about toe |                |                |                 |                 |  | LC-23 |
|------|--------------------------------------|------------------|----------------|----------------|-----------------|-----------------|--|-------|
|      |                                      | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |  |       |
|      |                                      | Tonne            | Tonne          | Tonne          | Tm              | Tm              |  |       |
| 1)   | Sub-structure & Foundation           | 1073.9           |                |                | -5150.75        | 0               |  | 1     |
| 2)   | Backfill                             | 2151.7           |                |                | -16334.4        | 0               |  | 1     |
| 3)   | Super-structure DL                   | 266.9            |                |                | -860.913        | 0               |  | 1     |
| 4)   | SIDL (excluding surfacing)           | 117.0            |                |                | -377.28         | 0               |  | 1     |
| 5)   | Surfacing                            | 34.0             |                |                | -109.731        | -8.50627        |  | 1     |
| 6.2) | Live Load Vertical Load Min Reaction | 28.8             |                |                | -92.88          | 83.81           |  | 1     |
| 7)   | Live Load Horizontal Forces          |                  | 39.2           |                | 568.97          |                 |  | 1     |
| 8)   | Buoyancy                             | -55.5            |                |                | 169.0           | 0.0             |  | 0.15  |
| 9.3) | Earth Pressure HFL (BP, SD)          |                  |                |                |                 |                 |  | 1.3   |
|      | Horizontal Component                 |                  | 1018.1         |                | 7194.7          |                 |  | 1.3   |
|      | Vertical Component                   | 364.7            |                |                | -1677.8         |                 |  | 1.3   |

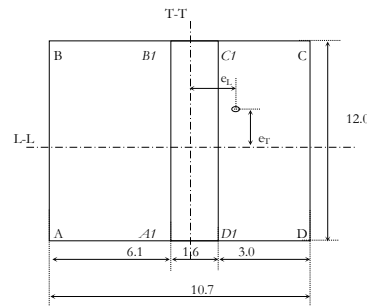
|       |                                |  |       |  |        |  |  |   |
|-------|--------------------------------|--|-------|--|--------|--|--|---|
| 10.3) | Surcharge Pressure HFL(BP, SD) |  | 152.8 |  | 1298.4 |  |  | 1 |
|-------|--------------------------------|--|-------|--|--------|--|--|---|

| S.N.  | Description                 | Forces about toe |                |                |                 |                 |
|-------|-----------------------------|------------------|----------------|----------------|-----------------|-----------------|
|       |                             | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|       |                             | Tonne            | Tonne          | Tonne          | Tm              | Tm              |
| LC-23 | NS(2), HFL, Min LL acom, EP | 4138.16          | 1515.48        | 0              | -13861.2        | 75.3009         |

| S.N.  | Description                          | Forces about toe |                |                |                 |                 | LC-24 |
|-------|--------------------------------------|------------------|----------------|----------------|-----------------|-----------------|-------|
|       |                                      | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |       |
|       |                                      | Tonne            | Tonne          | Tonne          | Tm              | Tm              |       |
| 1)    | Sub-structure & Foundation           | 1073.9           |                |                | -5150.75        | 0               | 1     |
| 2)    | Backfill                             | 2151.7           |                |                | -16334.4        | 0               | 1     |
| 3)    | Super-structure DL                   | 266.9            |                |                | -860.913        | 0               | 1     |
| 4)    | SIDL (excluding surfacing)           | 117.0            |                |                | -377.28         | 0               | 1     |
| 5)    | Surfacing                            | 34.0             |                |                | -109.731        | -8.50627        | 1     |
| 6.1)  | Live Load Vertical Load Max Reaction | 137.4            |                |                | -443.12         | 399.83          | 1.3   |
| 7)    | Live Load Horizontal Forces          |                  | 39.2           |                | 568.97          |                 | 1.3   |
| 8)    | Buoyancy                             | -55.5            |                |                | 169.0           | 0.0             | 0.15  |
| 9.3)  | Earth Pressure HFL (BP, SD)          |                  |                |                |                 |                 | 0.85  |
|       | Horizontal Component                 |                  | 1018.1         |                | 7194.7          |                 | 0.85  |
|       | Vertical Component                   | 364.7            |                |                | -1677.8         |                 | 0.85  |
| 10.3) | Surcharge Pressure HFL(BP, SD)       |                  | 152.8          |                | 1298.4          |                 | 1     |

| S.N.  | Description                 | Forces about toe |                |                |                 |                 |
|-------|-----------------------------|------------------|----------------|----------------|-----------------|-----------------|
|       |                             | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|       |                             | Tonne            | Tonne          | Tonne          | Tm              | Tm              |
| LC-24 | NS(2), HFL, Max LL Lead, EP | 4123.85          | 1069.09        | 0              | -16656.3        | 511.279         |

**BASE PRESSRE CALCULATION**  
**ULS LOAD COMBINATIONS**



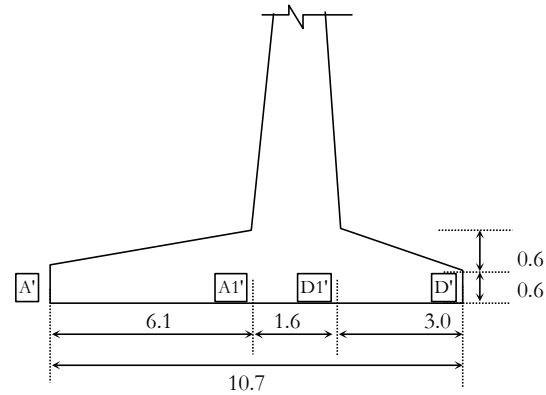
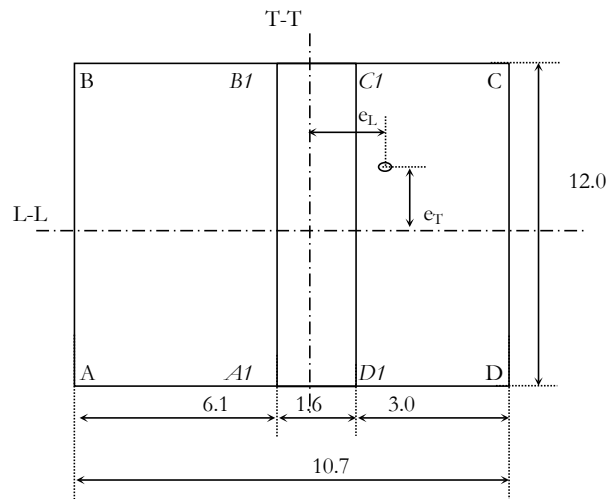
| Coordinates of basecorner |        |        |
|---------------------------|--------|--------|
| Edges                     | x (m)  | z (m)  |
| A                         | -5.350 | 6.000  |
| B                         | -5.350 | -6.000 |
| C                         | 5.350  | -6.000 |
| D                         | 5.350  | 6.000  |

| Properties of Base |                          |   |                        |
|--------------------|--------------------------|---|------------------------|
| Area               | 10.7x12                  | = | 128.4 m <sup>2</sup>   |
| I <sub>TT</sub>    | 12x10.7 <sup>3</sup> /12 | = | 1225.04 m <sup>4</sup> |
| I <sub>LL</sub>    | 10.7x12 <sup>3</sup> /12 | = | 1540.8 m <sup>4</sup>  |

**CHECK FOR MAXIMUM BASE PRESSRE**

| SUMMARY OF FORCES : |  |                  |                |                |                 | Eccentricity of Vertical load from toe point |                     | Eccentricity of Vertical load wrt cg of base |                    | Moment and forces at cg of base |                  | Gross Base Pressure = $P/A \pm M_{TT} * x / I_{TT} \pm M_{LL} * z / I_{LL}$ |                                  |                  |                  |                  |
|---------------------|--|------------------|----------------|----------------|-----------------|--|---------------------|--|--------------------|---------------------------------|------------------|---|----------------------------------|------------------|------------------|------------------|
| S.N.                | Description                              | Forces about toe |                |                |                 |  | e <sub>L</sub>      | e <sub>T</sub>                               | e <sub>L</sub>     | e <sub>T</sub>                  | M <sub>TT</sub>  | M <sub>LL</sub>   | base pressure at footing corners |                  |                  |                  |
|                     |  | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub>                              | M <sub>TT</sub> / V | M <sub>LL</sub> / V                          | B/2-e <sub>L</sub> | e <sub>T</sub>                  | V*e <sub>L</sub> | V*e <sub>T</sub>  | A                                | B                | C                | D                |
|                     |  | Tonne            | Tonne          | Tonne          | Tm              | Tm   | m                   | m  | m                  | m                               | Tm               | Tm  | T/m <sup>2</sup>                 | T/m <sup>2</sup> | T/m <sup>2</sup> | T/m <sup>2</sup> |
| LC-1                | NS(1), LWL, Span dislodge, FP            | 4354.52          |                |                |                 |  |                     |  |                    |                                 |                  |   |                                  |                  |                  |                  |
| LC-2                | NS(1), LWL, Span dislodge, EP            | 4901.62          | 1710.51        | 0              | -19171          | 0  | -3.91               | 0.00   | 1.44               | 0.00                            | 7052.2           | 0.0   | 7.4                              | 7.4              | 69.0             | 69.0             |
| LC-3                | NS(1), LWL, Min LL acomp, FP             |                  |                |                |                 |  |                     |  |                    |                                 |                  |   |                                  |                  |                  |                  |
| LC-4                | NS(1), LWL, Min LL acomp, EP             | 5512.6           | 1755.53        | 0              | -20488          | 81.4922                                      | -3.72               | 0.01   | 1.63               | 0.01                            | 9004.9           | 81.5  | 3.9                              | 3.3              | 81.9             | 82.6             |
| LC-5                | NS(1), LWL, Max LL Lead, FP              |                  |                |                |                 |  |                     |  |                    |                                 |                  |   |                                  |                  |                  |                  |
| LC-6                | NS(1), LWL, Max LL Lead, EP              | 5503.21          | 1260.2         | 0              | -23605          | 584.866                                      | -4.29               | 0.11   | 1.06               | 0.11                            | 5837.5           | 584.9   | 19.6                             | 15.1             | 66.1             | 70.6             |
| LC-7                | NS(2), LWL, Span dislodge, FP            |                  |                |                |                 |  |                     |  |                    |                                 |                  |   |                                  |                  |                  |                  |
| LC-8                | NS(2), LWL, Span dislodge, EP            | 3699.72          | 1476.33        | 0              | -13015          | 0  | -3.52               | 0.00   | 1.83               | 0.00                            | 6778.8           | 0.0   | -0.8                             | -0.8             | 58.4             | 58.4             |
| LC-9                | NS(2), LWL, Min LL acomp, FP             |                  |                |                |                 |  |                     |  |                    |                                 |                  |   |                                  |                  |                  |                  |
| LC-10               | NS(2), LWL, Min LL acomp, EP             | 4146.48          | 1515.48        | 0              | -13887          | 75.3009                                      | -3.35               | 0.02   | 2.00               | 0.02                            | 8297.2           | 75.3  | -3.6                             | -4.2             | 68.2             | 68.8             |
| LC-11               | NS(2), LWL, Max LL Lead, FP              |                  |                |                |                 |  |                     |  |                    |                                 |                  |   |                                  |                  |                  |                  |
| LC-12               | NS(2), LWL, Max LL Lead, EP              | 4132.18          | 1069.09        | 0              | -16682          | 511.279                                      | -4.04               | 0.12   | 1.31               | 0.12                            | 5425.5           | 511.3   | 10.5                             | 6.5              | 53.9             | 57.9             |
| LC-13               | SIS,LWL, Span dislodge ,Seismic Sx=1,Sz= | 4777.68          | 1298.12        | 53.0545        | -21257          | 557.021                                      | -4.45               | 0.12   | 0.90               | 0.12                            | 4303.1           | 557.0   | 20.6                             | 16.2             | 53.8             | 58.2             |
| LC-14               | SIS, LWL,Span dislodge ,Seismic Sx=1,Sz= | 4712.32          | 1230.87        | 53.0545        | -21486          | 557.021                                      | -4.56               | 0.12   | 0.79               | 0.12                            | 3724.4           | 557.0   | 22.6                             | 18.3             | 50.8             | 55.1             |
| LC-15               | SIS,LWL,Min LL Acc,Seismic Sx=1,Sz=      | 5424.8           | 1550.81        | 106.109        | -21131          | 1115.92                                      | -3.90               | 0.21   | 1.45               | 0.21                            | 7891.8           | 1115.9  | 12.1                             | 3.4              | 72.4             | 81.1             |
| LC-16               | SIS, LWL,Min LL Acc,Seismic Sx=1,Sz=     | 5288.99          | 1420.13        | 106.109        | -21522          | 1115.92                                      | -4.07               | 0.21   | 1.28               | 0.21                            | 6774.0           | 1115.9  | 16.0                             | 7.3              | 66.4             | 75.1             |
| LC-17               | SIS,LWL,Max LL Acc,Seismic Sx=1,Sz=      | 5446.95          | 1550.81        | 108.039        | -21202          | 1214.24                                      | -3.89               | 0.22   | 1.46               | 0.22                            | 7938.9           | 1214.2  | 12.5                             | 3.0              | 72.4             | 81.8             |
| LC-18               | SIS, LWL,Max LL Acc,Seismic Sx=1,Sz=     | 5310.28          | 1420.13        | 108.039        | -21591          | 1214.24                                      | -4.07               | 0.23   | 1.28               | 0.23                            | 6819.3           | 1214.2  | 16.3                             | 6.8              | 66.4             | 75.9             |
| LC-19               | NS(1), HFL, Span dislodge, EP            | 4893.3           | 1710.51        | 0              | -19146          | 0  | -3.91               | 0.00   | 1.44               | 0.00                            | 7033.1           | 0.0   | 7.4                              | 7.4              | 68.8             | 68.8             |
| LC-20               | NS(1), HFL, Min LL acomp, EP             | 5504.27          | 1755.53        | 0              | -20462          | 81.4922                                      | -3.72               | 0.01   | 1.63               | 0.01                            | 8985.7           | 81.5  | 3.9                              | 3.3              | 81.8             | 82.4             |
| LC-21               | NS(1), HFL, Max LL Lead, EP              | 5494.89          | 1260.2         | 0              | -23579          | 584.866                                      | -4.29               | 0.11   | 1.06               | 0.11                            | 5818.3           | 584.9   | 19.7                             | 15.1             | 65.9             | 70.5             |
| LC-22               | NS(2), HFL, Span dislodge, EP            | 3691.4           | 1476.33        | 0              | -12989          | 0  | -3.52               | 0.00   | 1.83               | 0.00                            | 6759.6           | 0.0   | -0.8                             | -0.8             | 58.3             | 58.3             |
| LC-23               | NS(2), HFL, Min LL acomp, EP             | 4138.16          | 1515.48        | 0              | -13861          | 75.3009                                      | -3.35               | 0.02   | 2.00               | 0.02                            | 8278.0           | 75.3  | -3.6                             | -4.2             | 68.1             | 68.7             |
| LC-24               | NS(2), HFL, Max LL Lead, EP              | 4123.85          | 1069.09        | 0              | -16656          | 511.279                                      | -4.04               | 0.12   | 1.31               | 0.12                            | 5406.3           | 511.3   | 10.5                             | 6.5              | 53.7             | 57.7             |
| LC-25               | SIS,HFL, Span dislodge ,Seismic Sx=1,Sz= | 4769.36          | 1298.12        | 53.0545        | -21232          | 557.021                                      | -4.45               | 0.12   | 0.90               | 0.12                            | 4284.0           | 557.0   | 20.6                             | 16.3             | 53.7             | 58.0             |
| LC-26               | SIS, HFL,Span dislodge ,Seismic Sx=1,Sz= | 4703.99          | 1230.87        | 53.0545        | -21461          | 557.021                                      | -4.56               | 0.12   | 0.79               | 0.12                            | 3705.2           | 557.0   | 22.6                             | 18.3             | 50.6             | 55.0             |
| LC-27               | SIS,HFL,Min LL Acc,Seismic Sx=1,Sz=      | 5416.48          | 1550.81        | 106.109        | -21106          | 1115.92                                      | -3.90               | 0.21   | 1.45               | 0.21                            | 7872.6           | 1115.9  | 12.1                             | 3.5              | 72.2             | 80.9             |
| LC-28               | SIS, HFL,Min LL Acc,Seismic Sx=1,Sz=     | 5280.67          | 1420.13        | 106.109        | -21497          | 1115.92                                      | -4.07               | 0.21   | 1.28               | 0.21                            | 6754.8           | 1115.9  | 16.0                             | 7.3              | 66.3             | 75.0             |
| LC-29               | SIS,HFL,Max LL Acc,Seismic Sx=1,Sz=      | 5438.63          | 1550.81        | 108.039        | -21177          | 1214.24                                      | -3.89               | 0.22   | 1.46               | 0.22                            | 7919.7           | 1214.2  | 12.5                             | 3.0              | 72.2             | 81.7             |
| LC-30               | SIS, HFL,Max LL Acc,Seismic Sx=1,Sz=     | 5301.96          | 1420.13        | 108.039        | -21565          | 1214.24                                      | -4.07               | 0.23   | 1.28               | 0.23                            | 6800.1           | 1214.2  | 16.3                             | 6.9              | 66.3             | 75.7             |

**NET BASE PRESSRE CALCULATION**  
**ULS LOAD COMBINATIONS**



**Deduction due to overburden pressure LWL:**

| LWL           | A'           | A1'          | D'          | D1'         | Comb-1 | Comb-2 | Comb-3 |
|---------------|--------------|--------------|-------------|-------------|--------|--------|--------|
| Earth fill    | 32.8         | 31.6         | 0           | 0           | 1.35   | 1      | 1.35   |
| footing       | 1.5          | 3            | 1.5         | 3           | 1.35   | 1      | 1.35   |
| <b>Comb-1</b> | <b>46.31</b> | <b>46.71</b> | <b>2.03</b> | <b>4.05</b> |        |        |        |
| <b>Comb-2</b> | <b>34.30</b> | <b>34.60</b> | <b>1.50</b> | <b>3.00</b> |        |        |        |
| <b>Comb-3</b> | <b>46.31</b> | <b>46.71</b> | <b>2.03</b> | <b>4.05</b> |        |        |        |

**Deduction due to overburden pressure HFL:**

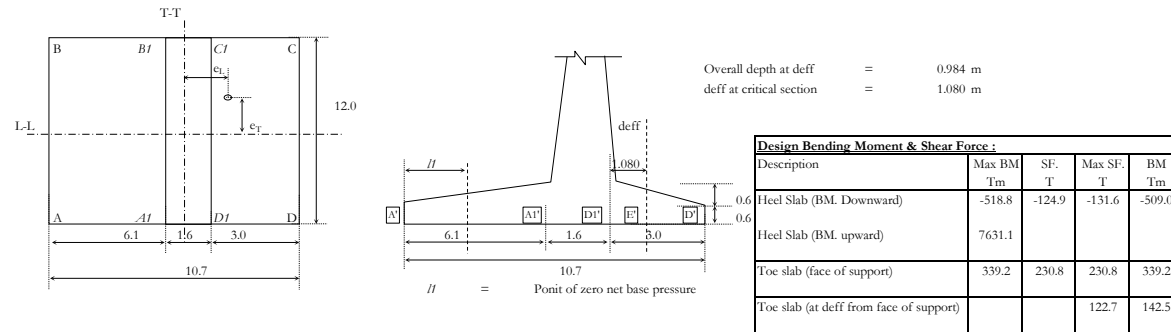
| LWL           | A'           | A1'          | D'          | D1'         | Comb-1 | Comb-2 | Comb-3 |
|---------------|--------------|--------------|-------------|-------------|--------|--------|--------|
| Earth fill    | 32.8         | 31.6         | 0           | 0           | 1.35   | 1      | 1.35   |
| footing       | 1.5          | 3            | 1.5         | 3           | 1.35   | 1      | 1.35   |
| Bouency       | -0.25        | -0.25        | -0.6        | -1.2        | 0.15   | 0.15   | 0.15   |
| <b>Comb-1</b> | <b>46.27</b> | <b>46.67</b> | <b>1.94</b> | <b>3.87</b> |        |        |        |
| <b>Comb-2</b> | <b>34.26</b> | <b>34.56</b> | <b>1.41</b> | <b>2.82</b> |        |        |        |
| <b>Comb-3</b> | <b>46.27</b> | <b>46.67</b> | <b>1.94</b> | <b>3.87</b> |        |        |        |

**DESIGN OF HEEL SLAB**

| <b>SUMMARY OF FORCES :</b> |  | <b>Gross Base Pressure = <math>P/A \pm M_{TT} * x / I_{TT} \pm M_{LL} * z / I_{LL}</math></b> |                        |                        |                        | <b>Average Gross Base Pressure at Critical points</b> |                        |                        |                        | <b>NET BASE PRESSURE</b>                |                        |                        |                        |
|----------------------------|--|---|------------------------|------------------------|------------------------|---|------------------------|------------------------|------------------------|---|------------------------|------------------------|------------------------|
| <b>S.No.</b>               | <b>Description</b>                     | <b>base pressure at footing corners</b>   |                        |                        |                        | <b>base pressure at footing corners</b>               |                        |                        |                        | <b>base pressure at footing corners</b> |                        |                        |                        |
|                            |  | <b>A</b>  | <b>B</b>               | <b>C</b>               | <b>D</b>               | <b>A'</b>   | <b>A1'</b>             | <b>D'</b>              | <b>D1'</b>             | <b>A'</b>                               | <b>A1'</b>             | <b>D'</b>              | <b>D1'</b>             |
|                            |  | <b>T/m<sup>2</sup></b>  | <b>T/m<sup>2</sup></b> | <b>T/m<sup>2</sup></b> | <b>T/m<sup>2</sup></b> | <b>T/m<sup>2</sup></b>                                | <b>T/m<sup>2</sup></b> | <b>T/m<sup>2</sup></b> | <b>T/m<sup>2</sup></b> | <b>T/m<sup>2</sup></b>                  | <b>T/m<sup>2</sup></b> | <b>T/m<sup>2</sup></b> | <b>T/m<sup>2</sup></b> |
| LC-1                       | NS(1), LWL, Span dislodge, FP          | 0.0   | 0.0                    | 0.0                    | 0.0                    | 0.0   | 0.0                    | 0.0                    | 0.0                    |   |                        |                        |                        |
| LC-2                       | NS(1), LWL, Span dislodge, EP          | 7.4   | 7.4                    | 69.0                   | 69.0                   | 7.4   | 42.5                   | 69.0                   | 51.7                   | -38.9                                   | -4.2                   | 66.9                   | 47.7                   |
| LC-3                       | NS(1), LWL, Min LL acomp, FP           | 0.0   | 0.0                    | 0.0                    | 0.0                    | 0.0   | 0.0                    | 0.0                    | 0.0                    |   |                        |                        |                        |
| LC-4                       | NS(1), LWL, Min LL acomp, EP           | 3.9   | 3.3                    | 81.9                   | 82.6                   | 3.6   | 48.4                   | 82.3                   | 60.2                   | -42.7                                   | 1.7                    | 80.2                   | 56.2                   |
| LC-5                       | NS(1), LWL, Max LL Lead, FP            | 0.0   | 0.0                    | 0.0                    | 0.0                    | 0.0   | 0.0                    | 0.0                    | 0.0                    | -46.3                                   | -46.7                  | -2.0                   | -4.1                   |
| LC-6                       | NS(1), LWL, Max LL Lead, EP            | 19.6  | 15.1                   | 66.1                   | 70.6                   | 17.4  | 46.4                   | 68.4                   | 54.1                   | -28.9                                   | -0.3                   | 66.3                   | 50.0                   |
| LC-7                       | NS(2), LWL, Span dislodge, FP          | 0.0   | 0.0                    | 0.0                    | 0.0                    | 0.0   | 0.0                    | 0.0                    | 0.0                    | -34.3                                   | -34.6                  | -1.5                   | -3.0                   |
| LC-8                       | NS(2), LWL, Span dislodge, EP          | -0.8  | -0.8                   | 58.4                   | 58.4                   | -0.8  | 33.0                   | 58.4                   | 41.8                   | -35.1                                   | -1.6                   | 56.9                   | 38.8                   |
| LC-9                       | NS(2), LWL, Min LL acomp, FP           | 0.0   | 0.0                    | 0.0                    | 0.0                    | 0.0   | 0.0                    | 0.0                    | 0.0                    | -34.3                                   | -34.6                  | -1.5                   | -3.0                   |
| LC-10                      | NS(2), LWL, Min LL acom, EP            | -3.6  | -4.2                   | 68.2                   | 68.8                   | -3.9  | 37.4                   | 68.5                   | 48.2                   | -38.2                                   | 2.8                    | 67.0                   | 45.2                   |
| LC-11                      | NS(2), LWL, Max LL Lead, FP            | 0.0   | 0.0                    | 0.0                    | 0.0                    | 0.0   | 0.0                    | 0.0                    | 0.0                    | -34.3                                   | -34.6                  | -1.5                   | -3.0                   |
| LC-12                      | NS(2), LWL, Max LL Lead, EP            | 10.5  | 6.5                    | 53.9                   | 57.9                   | 8.5   | 35.5                   | 55.9                   | 42.6                   | -25.8                                   | 0.9                    | 54.4                   | 39.6                   |
| LC-13                      | SIS,LWL, Span dislodge ,Seismic Sx=1,S | 20.6  | 16.2                   | 53.8                   | 58.2                   | 18.4  | 39.8                   | 56.0                   | 45.5                   | -15.9                                   | 5.2                    | 54.5                   | 42.5                   |
| LC-14                      | SIS, LWL,Span dislodge ,Seismic Sx=1,S | 22.6  | 18.3                   | 50.8                   | 55.1                   | 20.4  | 39.0                   | 53.0                   | 43.8                   | -13.9                                   | 4.4                    | 51.5                   | 40.8                   |
| LC-15                      | SIS,LWL,Min LL Acc,Seismic Sx=1,Sz=    | 12.1  | 3.4                    | 72.4                   | 81.1                   | 7.8   | 47.1                   | 76.7                   | 57.4                   | -26.5                                   | 12.5                   | 75.2                   | 54.4                   |
| LC-16                      | SIS, LWL,Min LL Acc,Seismic Sx=1,Sz=   | 16.0  | 7.3                    | 66.4                   | 75.1                   | 11.6  | 45.3                   | 70.8                   | 54.2                   | -22.7                                   | 10.7                   | 69.3                   | 51.2                   |
| LC-17                      | SIS,LWL,Max LL Acc,Seismic Sx=1,Sz=    | 12.5  | 3.0                    | 72.4                   | 81.8                   | 7.8   | 47.3                   | 77.1                   | 57.7                   | -26.5                                   | 12.7                   | 75.6                   | 54.7                   |
| LC-18                      | SIS, LWL,Max LL Acc,Seismic Sx=1,Sz=   | 16.3  | 6.8                    | 66.4                   | 75.9                   | 11.6  | 45.5                   | 71.1                   | 54.4                   | -22.7                                   | 10.9                   | 69.6                   | 51.4                   |
| LC-19                      | NS(1), HFL, Span dislodge, EP          | 7.4   | 7.4                    | 68.8                   | 68.8                   | 7.4   | 42.4                   | 68.8                   | 51.6                   | -38.9                                   | -4.3                   | 66.9                   | 47.7                   |
| LC-20                      | NS(1), HFL, Min LL acomp, EP           | 3.9   | 3.3                    | 81.8                   | 82.4                   | 3.6   | 48.4                   | 82.1                   | 60.1                   | -42.6                                   | 1.7                    | 80.2                   | 56.2                   |
| LC-21                      | NS(1), HFL, Max LL Lead, EP            | 19.7  | 15.1                   | 65.9                   | 70.5                   | 17.4  | 46.4                   | 68.2                   | 54.0                   | -28.9                                   | -0.3                   | 66.3                   | 50.1                   |
| LC-22                      | NS(2), HFL, Span dislodge, EP          | -0.8  | -0.8                   | 58.3                   | 58.3                   | -0.8  | 32.9                   | 58.3                   | 41.7                   | -35.0                                   | -1.7                   | 56.9                   | 38.9                   |
| LC-23                      | NS(2), HFL, Min LL acom, EP            | -3.6  | -4.2                   | 68.1                   | 68.7                   | -3.9  | 37.3                   | 68.4                   | 48.1                   | -38.2                                   | 2.7                    | 67.0                   | 45.3                   |
| LC-24                      | NS(2), HFL, Max LL Lead, EP            | 10.5  | 6.5                    | 53.7                   | 57.7                   | 8.5   | 35.4                   | 55.7                   | 42.5                   | -25.8                                   | 0.9                    | 54.3                   | 39.7                   |
| LC-25                      | SIS,HFL, Span dislodge ,Seismic Sx=1,S | 20.6  | 16.3                   | 53.7                   | 58.0                   | 18.4  | 39.8                   | 55.9                   | 45.4                   | -15.9                                   | 5.2                    | 54.4                   | 42.4                   |
| LC-26                      | SIS, HFL,Span dislodge ,Seismic Sx=1,S | 22.6  | 18.3                   | 50.6                   | 55.0                   | 20.5  | 38.9                   | 52.8                   | 43.7                   | -13.8                                   | 4.3                    | 51.3                   | 40.7                   |
| LC-27                      | SIS,HFL,Min LL Acc,Seismic Sx=1,Sz=    | 12.1  | 3.5                    | 72.2                   | 80.9                   | 7.8   | 47.0                   | 76.6                   | 57.3                   | -26.5                                   | 12.4                   | 75.1                   | 54.3                   |
| LC-28                      | SIS, HFL,Min LL Acc,Seismic Sx=1,Sz=   | 16.0  | 7.3                    | 66.3                   | 75.0                   | 11.6  | 45.3                   | 70.6                   | 54.1                   | -22.7                                   | 10.7                   | 69.1                   | 51.1                   |
| LC-29                      | SIS,HFL,Max LL Acc,Seismic Sx=1,Sz=    | 12.5  | 3.0                    | 72.2                   | 81.7                   | 7.8   | 47.2                   | 76.9                   | 57.5                   | -26.5                                   | 12.6                   | 75.4                   | 54.5                   |
| LC-30                      | SIS, HFL,Max LL Acc,Seismic Sx=1,Sz=   | 16.3  | 6.9                    | 66.3                   | 75.7                   | 11.6  | 45.5                   | 71.0                   | 54.3                   | -22.7                                   | 10.9                   | 69.5                   | 51.3                   |



**FINDING BENDING MOMENT & SHEAR FORCE AT CRITICAL SECTION  
ULS LOAD COMBINATIONS**



**DESIGN OF HEEL SLAB**

**SUMMARY OF FORCES :**

| SUMMARY OF FORCES: |  | NET BASE PRESSURE                |                  |                  |                  |                  | Point of zero net base pressure | BM at Point of zero base pressure | BENDING MOMENT & SHEAR FORCE |        |           |           |           |           |  |
|--------------------|--|----------------------------------|------------------|------------------|------------------|------------------|---------------------------------|-----------------------------------|------------------------------|--------|-----------|-----------|-----------|-----------|--|
| S.N.               | Description                              | base pressure at footing corners |                  |                  |                  |                  |                                 |                                   | Heel Slab                    |        | Toe Slab  |           |           |           |  |
|                    |  | A'                               | A1'              | D'               | D1'              | E1'              |                                 |                                   | BM                           | SF     | BM   face | SF   face | SF   deff | BM   deff |  |
|                    |  | T/m <sup>2</sup>                 | T/m <sup>2</sup> | T/m <sup>2</sup> | T/m <sup>2</sup> | T/m <sup>2</sup> |                                 |                                   | Tm                           | T      | Tm        | T         | T         | Tm        |  |
| LC-1               | NS(1), LWL, Span dislodge, FP            |                                  |                  |                  |                  |                  |                                 |                                   |                              |        |           |           |           |           |  |
| LC-2               | NS(1), LWL, Span dislodge, EP            | -38.9                            | -4.2             | 66.9             | 47.7             | 60.0             | 0.00                            | 0.00                              | -509.0                       | -131.6 | 272.3     | 171.9     | 103.3     | 119.1     |  |
| LC-3               | NS(1), LWL, Min LL accomp, FP            |                                  |                  |                  |                  |                  |                                 |                                   |                              |        |           |           |           |           |  |
| LC-4               | NS(1), LWL, Min LL accomp, EP            | -42.7                            | 1.7              | 80.2             | 56.2             | 71.6             | 0.00                            | 0.00                              | -518.8                       | -124.9 | 324.9     | 204.6     | 122.6     | 142.6     |  |
| LC-5               | NS(1), LWL, Max LL Lead, FP              |                                  |                  |                  |                  |                  |                                 |                                   |                              |        |           |           |           |           |  |
| LC-6               | NS(1), LWL, Max LL Lead, EP              | -28.9                            | -0.3             | 66.3             | 50.0             | 60.5             | 0.00                            | 0.00                              | -360.6                       | -89.1  | 274.0     | 174.5     | 106.0     | 118.6     |  |
| LC-7               | NS(2), LWL, Span dislodge, FP            |                                  |                  |                  |                  |                  |                                 |                                   |                              |        |           |           |           |           |  |
| LC-8               | NS(2), LWL, Span dislodge, EP            | -35.1                            | -1.6             | 56.9             | 38.8             | 50.4             | 0.00                            | 0.00                              | -445.4                       | -112.0 | 229.0     | 143.6     | 85.7      | 100.9     |  |
| LC-9               | NS(2), LWL, Min LL accomp, FP            |                                  |                  |                  |                  |                  |                                 |                                   |                              |        |           |           |           |           |  |
| LC-10              | NS(2), LWL, Min LL accomp, EP            | -38.2                            | 2.8              | 67.0             | 45.2             | 59.2             | 0.00                            | 0.00                              | -457.1                       | -108.2 | 268.9     | 168.4     | 100.2     | 118.7     |  |
| LC-11              | NS(2), LWL, Max LL Lead, FP              |                                  |                  |                  |                  |                  |                                 |                                   |                              |        |           |           |           |           |  |
| LC-12              | NS(2), LWL, Max LL Lead, EP              | -25.8                            | 0.9              | 54.4             | 39.6             | 49.1             | 0.00                            | 0.00                              | -314.6                       | -76.0  | 222.5     | 140.9     | 85.1      | 97.0      |  |
| LC-13              | SIS,LWL, Span dislodge ,Seismic Sx=1,Sz= | -15.9                            | 5.2              | 54.5             | 42.5             | 50.2             | 0                               | 0                                 | -164.5                       | -32.5  | 227.2     | 145.4     | 88.9      | 97.8      |  |
| LC-14              | SIS, LWL,Span dislodge ,Seismic Sx=1,Sz= | -13.9                            | 4.4              | 51.5             | 40.8             | 47.6             | 0                               | 0                                 | -144.8                       | -28.9  | 215.7     | 138.5     | 84.9      | 92.5      |  |
| LC-15              | SIS,LWL,Min LL Acc,Seismic Sx=1,Sz=      | -26.5                            | 12.5             | 75.2             | 54.4             | 67.7             | 0                               | 0                                 | -251.5                       | -42.8  | 307.2     | 194.4     | 117.2     | 134.0     |  |
| LC-16              | SIS, LWL,Min LL Acc,Seismic Sx=1,Sz=     | -22.7                            | 10.7             | 69.3             | 51.2             | 62.8             | 0                               | 0                                 | -214.9                       | -36.5  | 284.6     | 180.7     | 109.4     | 123.7     |  |
| LC-17              | SIS,LWL,Max LL Acc,Seismic Sx=1,Sz=      | -26.5                            | 12.7             | 75.6             | 54.7             | 68.1             | 0                               | 0                                 | -250.6                       | -42.3  | 308.8     | 195.4     | 117.8     | 134.7     |  |
| LC-18              | SIS, LWL,Max LL Acc,Seismic Sx=1,Sz=     | -22.7                            | 10.9             | 69.6             | 51.4             | 63.1             | 0                               | 0                                 | -214.1                       | -36.0  | 286.1     | 181.6     | 109.9     | 124.3     |  |
| LC-19              | NS(1), HFL, Span dislodge, EP            | -38.9                            | -4.3             | 66.9             | 47.7             | 60.0             | 0.00                            | 0.00                              | -508.5                       | -131.5 | 272.3     | 171.9     | 103.4     | 119.1     |  |
| LC-20              | NS(1), HFL, Min LL accomp, EP            | -42.6                            | 1.7              | 80.2             | 56.2             | 71.6             | 0.00                            | 0.00                              | -518.4                       | -124.9 | 324.9     | 204.6     | 122.7     | 142.5     |  |
| LC-21              | NS(1), HFL, Max LL Lead, EP              | -28.9                            | -0.3             | 66.3             | 50.1             | 60.4             | 0.00                            | 0.00                              | -360.2                       | -89.1  | 273.9     | 174.5     | 106.1     | 118.6     |  |
| LC-22              | NS(2), HFL, Span dislodge, EP            | -35.0                            | -1.7             | 56.9             | 38.9             | 50.4             | 0.00                            | 0.00                              | -444.9                       | -112.0 | 228.9     | 143.6     | 85.7      | 100.8     |  |
| LC-23              | NS(2), HFL, Min LL accomp, EP            | -38.2                            | 2.7              | 67.0             | 45.3             | 59.2             | 0.00                            | 0.00                              | -456.7                       | -108.1 | 268.8     | 168.4     | 100.3     | 118.6     |  |
| LC-24              | NS(2), HFL, Max LL Lead, EP              | -25.8                            | 0.9              | 54.3             | 39.7             | 49.0             | 0.00                            | 0.00                              | -314.1                       | -75.9  | 222.5     | 141.0     | 85.2      | 96.9      |  |
| LC-25              | SIS,HFL, Span dislodge ,Seismic Sx=1,Sz= | 20.6                             | 16.3             | 53.7             | 58.0             | 18.4             | 28.97                           | 5765.35                           | 356.4                        | 112.5  | 248.1     | 167.6     | 73.4      | 77.3      |  |
| LC-26              | SIS, HFL,Span dislodge ,Seismic Sx=1,Sz= | 22.6                             | 18.3             | 50.6             | 55.0             | 20.5             | 31.81                           | 7631.05                           | 394.0                        | 124.8  | 234.4     | 158.5     | 72.4      | 74.8      |  |
| LC-27              | SIS,HFL,Min LL Acc,Seismic Sx=1,Sz=      | 12.1                             | 3.5              | 72.2             | 80.9             | 7.8              | 8.53                            | 294.43                            | 172.1                        | 47.6   | 338.0     | 229.7     | 85.2      | 93.5      |  |
| LC-28              | SIS, HFL,Min LL Acc,Seismic Sx=1,Sz=     | 16.0                             | 7.3              | 66.3             | 75.0             | 11.6             | 11.21                           | 669.14                            | 243.3                        | 70.9   | 311.3     | 211.9     | 83.1      | 88.6      |  |
| LC-29              | SIS,HFL,Max LL Acc,Seismic Sx=1,Sz=      | 12.5                             | 3.0              | 72.2             | 81.7             | 7.8              | 8.06                            | 270.79                            | 173.9                        | 47.4   | 339.2     | 230.8     | 85.9      | 93.5      |  |
| LC-30              | SIS, HFL,Max LL Acc,Seismic Sx=1,Sz=     | 16.3                             | 6.9              | 66.3             | 75.7             | 11.6             | 10.53                           | 603.26                            | 245.1                        | 70.7   | 312.4     | 213.0     | 83.8      | 88.5      |  |

## DESIGN OF TOE SLAB :

### (ULS) CHECK FOR BENDING MOMENT

Design Bending Moment  $M_{ED} = 339.2 \text{ Tm}$

$a_l = d$  (shifting moment curve by a distance  $a_l$ )

$D = 1.2 \text{ m}$  \*/ overall depth at face of support

$d = 1.109 \text{ m}$  \*/ deff at face of support

$D' = 0.978 \text{ m}$  \*/ overall depth at  $d$  from face of support

$d' = 0.887 \text{ m}$  \*/ deff at  $d$  from face of support

Clear Cover = 75 mm

Ast Provided = 32  $\phi$  @ 120 c/c  
+ 32  $\phi$  @ 120 c/c  
= 10053 mm<sup>2</sup>/m

Grade of Concrete  $f_{ck} = 45 \text{ Mpa}$

Grade of steel  $f_{yk} = 500 \text{ Mpa}$

$x_u = 0.87 f_{yk} A_{st} / 0.362 f_{ck} b$   
= 268 mm

$x_{u_{max}} = 0.456 d'$   
= 405 mm UNDER REINFORCED

Ast calculated =  $M / 0.87 f_{yk} (d' - 0.416 x_u)$

= 10053 mm<sup>2</sup>/m

Ast minimum = 0.15% \*  $b * d$

= 1664 mm<sup>2</sup>/m

Ast required = Max( 10053 , 1664 )

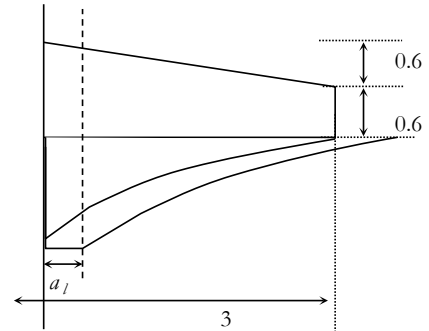
= 10053 mm<sup>2</sup>/m > 10053 mm<sup>2</sup>/m REVISE REINF.

Distribution steel = 20% of Ast.main (Refer clause 16.6.1 of IRC :112-2011)

= 2011 mm<sup>2</sup>/m

Provide distribution steel as 20  $\phi$  @ 150 c/c

2094 mm<sup>2</sup>/m OK



|                  |   |         |
|------------------|---|---------|
| $f_{yk}$         | = | 500 Mpa |
| $\epsilon_{uk}$  | = | 0.0025  |
| $\epsilon_{ud}$  | = | 0.00225 |
| $f_{ck}$         | = | 45 Mpa  |
| $\epsilon_{cu2}$ | = | 0.0035  |
| $x_{u_{max}}/d$  | = | 0.4560  |

**(SLS) CHECK FOR STRESSES (RARE & QUASI PERMANENT LOAD COMBINATIONS)**

$$\begin{aligned}
 \text{Design Bending Moment } M_{\text{RARE}} &= 232.61 \text{ Tm} \\
 M_{\text{QP}} &= 197.44 \text{ Tm} \\
 M_{\text{ST}} &= M_{\text{RARE}} - M_{\text{QP}} \quad (\text{Bending Moment due to short term loading}) \\
 &= 35.17 \text{ Tm}
 \end{aligned}$$

$$\begin{aligned}
 \text{Modulus of Elasticity for Concrete} \\
 \text{For short term loading } E_{\text{cm}} &= 34313 \text{ Mpa} \\
 \text{Creep coefficient } \phi &= 1 \\
 \text{For long term loading } E_{\text{cm}}' &= 17156 \text{ Mpa}
 \end{aligned}$$

$$\text{Reinf. modulus of elasticity } E_s = 200000 \text{ N/mm}^2$$

$$\text{Modular ratio for QP Combination} = E_s / E_{\text{cm}}' = 11.66$$

Equavelent Modulus of Elasticity for Rare Combination :

$$E_{\text{c,eq}} = \frac{E_{\text{cm}} * (M_{\text{QP}} + M_{\text{ST}})}{M_{\text{ST}} + (1 + \phi) * M_{\text{QP}}} = 18560 \text{ MPa}$$

$$\text{Modular ratio for Rare Combination} = E_s / E_{\text{c,eq}} = 10.78$$

| Formula used for calculation of stress    |   |
|---|---|
| dc (depth of neutral axis)                | $= \frac{-m * A_s + \sqrt{(m^2 * A_s^2 + 2 * m * A_s * b * d)}}{b}$ |
| $I_{\text{NA}}$ (Transformed)             | $= b * dc^3 / 3 + m * A_s * (d - dc)^2$                             |
| Compressive stress in concrete $\sigma_c$ | $= M_{\text{RARE}} * dc / I_{\text{NA}}$                            |
| Tensile stress in steel $\sigma_s$        | $= m * M_{\text{RARE}} * (d - dc) / I_{\text{NA}}$                  |

| <i>Description</i>                        | <i>Stress Check For Rare Combination</i> | <i>Stress Check For QP Combination</i> |
|---|--|--|
| Design Moment                             | = 232.61 Tm                              | = 197.44 Tm                            |
| Total Depth at section                    | = 1.2 m                                  | = 1.2 m                                |
| deff                                      | = 1.109 m                                | = 1.109 m                              |
| width b                                   | = 1 m                                    | = 1 m                                  |
| $A_{\text{st, provided}}$                 | = 10053 mm <sup>2</sup> /m               | = 10053 mm <sup>2</sup> /m             |
| Modular ratio                             | = 10.78                                  | = 11.66                                |
| dc (depth of neutral axis)                | = 394 mm                                 | = 406 mm                               |
| $I_{\text{NA}}$ (Transformed)             | = 7.58E+10 mm <sup>4</sup>               | = 8.02E+10 mm <sup>4</sup>             |
| Compressive stress in concrete $\sigma_c$ | = 12.09 N/mm <sup>2</sup>                | = 9.99 N/mm <sup>2</sup>               |
| Permissible Compressive stress            | = 21.6 N/mm <sup>2</sup> OK              | = 16.2 N/mm <sup>2</sup> OK            |
| Tensile stress in steel $\sigma_s$        | = 237 N/mm <sup>2</sup>                  | = 202 N/mm <sup>2</sup>                |
| Permissible tensile stress                | = 300 N/mm <sup>2</sup> OK               | = 400 N/mm <sup>2</sup> OK             |

**(SLS) CHECK FOR CRACK WIDTH (QUASI PERMANENT LOAD COMBINATIONS)**

Minimum Reinforcement for crack control :

$$A_{s,min} = k_c k f_{ct,eff} A_{ct} / \sigma_s \quad (IRC 112 / clause 12.3.3 (2))$$

For Web

$$k_c = 0.4 \text{ For Bending member}$$

$$h = 1.2 \text{ m}, \quad b = 1 \text{ m}$$

$$k = 0.65$$

$$f_{ct,eff} = f_{ctm} = 3.28 \text{ Mpa}$$

$A_{ct}$  = Area of concrete within tensile zone just before the first crack form, section behaves elastically until the tensile fiber stress reaches  $f_{ctm}$ . hence Neutral axis depth will be considered for gross section

$$A_{ct} = b * h/2 = 0.6 \text{ m}^2$$

$$\sigma_s = \text{Maximum stress permitted in reinf. Immediately after formation of crack} = f_{yk} = 500 \text{ Mpa}$$

$$A_{s,min} = 1022 \text{ mm}^2/\text{m} < 10053 \text{ mm}^2/\text{m} \quad \text{OK}$$

Calculation of crack width : (IRC 112 / clause 12.3.4)

$$w_{k,max} = 0.3 \text{ mm}$$

$$\text{Clear cover } c = 75 \text{ mm}$$

$$\text{Bar dia } \phi_{eq} = 32.00 \text{ mm}$$

$$5(c + \phi_{eq}/2) = 455 \text{ mm}$$

$$\text{Spacing b/w bars} = 60 \text{ mm} < 455 \text{ mm}$$

$$s_{rmax} = \text{Maximum crack spacing} = 3.4c + 0.17 \phi / \rho_{Peff} = 378.106 \text{ mm}$$

The Following formula can be used for calculation of maximum crack spacing.

$$h_{c,eff} = \text{Min} \begin{cases} 2.5 (h - d) \\ (h - x)/3 \\ h/2 \end{cases} = 0.2275 \text{ m}$$

|     |     |              |
|-----|-----|--------------|
| $h$ | $=$ | 1.2 m        |
| $d$ | $=$ | 1.109 m      |
| $x$ | $=$ | 0.40594002 m |

\*/ (for Quasi Permanent Load combination)

$$\text{width } b = 1 \text{ m}$$

$$A_{c,eff} = h_{c,eff} * b = 0.2275 \text{ m}^2$$

$$\begin{aligned}
 \rho_{p,eff} &= A_s / A_{c,eff} \\
 &= 10053 / 227500 \\
 &= 0.0442 \\
 \sigma_{sc} &= \text{Stress in tension Reinforcement assuming cracked section} \\
 &= 201.70 \text{ Mpa} \quad */ \text{ (for Quasi Permanent Load combination)} \\
 E_s &= 200000 \text{ Mpa} \\
 E_{cm}' &= 17156 \text{ Mpa} \quad */ \text{ (for Long term loading)} \\
 \alpha_e &= E_s / E_{cm} \\
 \alpha_e &= 11.66 \\
 k_t &= 0.5 \quad (\text{factor dependent on duration of load}) \\
 \epsilon_{sm} - \epsilon_{cm} &= \text{Max} \left\{ \begin{array}{l} \frac{\sigma_{sc} - k_t f_{ct,eff} (1 + \alpha_e \rho_{p,eff})}{E_s} \\ 0.6 \sigma_{sc} / E_s \end{array} \right. \\
 &= 0.00073 \\
 w_k &= s_{rmax} (\epsilon_{sm} - \epsilon_{cm}) \\
 &= 0.275 \text{ mm} < 0.300 \text{ mm} \quad \text{OK}
 \end{aligned}$$

**(ULS) CHECK FOR SHEAR FORCE** (Section At deff from face of Support)

$$\begin{aligned}
 \text{Factored Shear Force } V_{ED} &= 122.68 \text{ T} \\
 \text{Corresponding BM } M_{ED} &= 142.48 \text{ Tm}
 \end{aligned}$$

$$\begin{aligned}
 V_{CCD} &= \text{Reductin in Shear force due to inclined compression chord} \\
 &= M_{ED} / d * \sin \beta
 \end{aligned}$$

$$\beta = 11.310 \text{ deg} \quad */ \text{Inclination angle of compression chord.}$$

$$V_{CCD} = 31.496 \text{ T}$$

$$\begin{aligned}
 \text{Design Shear Force } V_{NS} &= V_{ED} - V_{CCD} \\
 &= 91.18 \text{ Tonne}
 \end{aligned}$$

Reduction in Design Shear For Within Zone (  $a_v = 0.5d$  to  $2d$ )

$$a_v = 1.109 \text{ m}$$

$$\begin{aligned}
 \text{Reduction factor } \beta_1 &= a_v / 2d \\
 &= 0.5
 \end{aligned}$$

$$\begin{aligned}
 \text{Design Shear Force } V_{NS}' &= \beta_1 * V_{NS} \\
 &= 45.59 \text{ Tonne}
 \end{aligned}$$

**Max Shear Capacity of section**

$$v = 0.6 * (1 - f_{ck} / 310) \quad \text{*/ } f_{ck} \text{ in Mpa}$$

$$= 0.5129$$

$$f_{cd} = 0.447 * f_{ck}$$

$$= 20.10 \text{ Mpa}$$

$$V_{RDC, \max} = 0.5 b_w d v f_{cd}$$

$$= 457 \text{ 'Tonne} > 45.59 \text{ 'Tonne OK}$$

$$D' = 0.978 \text{ m} \quad \text{*/ overall depth at face of support}$$

$$d' = 0.887 \text{ m} \quad \text{*/ deff at face of support}$$

**Check for Design Shear Reinforcement :**

$$k = \text{Min} \left\{ \begin{array}{l} 1 + \sqrt{200/d} \\ 2 \end{array} \right. \quad \text{d is depth in mm}$$

$$k = 1.475$$

$$\rho_1 = \text{Min} \left\{ \begin{array}{l} A_{sl} / b_w d \\ 0.02 \end{array} \right.$$

$$\rho_1 = 0.01133$$

$$\sigma_{cp} = 0 \text{ Mpa}$$

$$v_{\min} = 0.031 k^{3/2} f_{ck}^{1/2}$$

$$= 0.372$$

$$V_{Rdc} = \text{Max} \left\{ \begin{array}{l} (0.12 k (80 \rho_1 f_{ck})^{0.33} + 0.15 \sigma_{cp}) b_w d \\ (v_{\min} + 0.15 \sigma_{cp}) b_w d \end{array} \right. \quad (IRC 112 / \text{ clause } 10.3.2 (2))$$

$$= 53.39 \text{ 'Tonne} > 45.59 \text{ 'Tonne NO SHEAR REINFORCEMENT REQUIRED}$$

## DESIGN OF HEEL SLAB :

### (ULS) CHECK FOR BENDING MOMENT

Design Bending Moment  $M_{ED}$  = 518.83 Tm

$a_l$  = d (shifting moment curve by a distance  $a_l$ )

D = 1.2 m \*/ overall depth at face of support

d = 1.109 m \*/ deff at face of support

D' = 1.091 m \*/ overall depth at d from face of support

d' = 1.000 m \*/ deff at d from face of support

Clear Cover = 75 mm

Ast Provided = 32  $\phi$  @ 110 c/c  
 + 32  $\phi$  @ 110 c/c  
 = 14623 mm<sup>2</sup>/m

Grade of Concrete fck = 45 Mpa

Grade of steel fyk = 500 Mpa

xu = 0.87 fyk Ast / 0.362 fck b  
 = 390 mm

$x_{u_{max}}$  = 0.609 d  
 = 609 mm UNDER REINFORCED

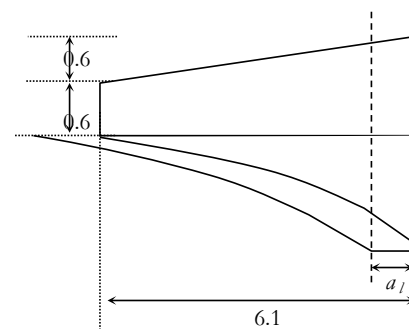
Ast calculated = M / 0.87 fyk (d - 0.416 xu)  
 = 14242 mm<sup>2</sup>/m

Ast minimum = 0.15% \* b \* d  
 = 1664 mm<sup>2</sup>/m

Ast required = Max( 14242 , 1664 )  
 = 14242 mm<sup>2</sup>/m < 14623 mm<sup>2</sup>/m OK

Distribution steel = 20% of Ast.main (Refer clause 16.6.1 of IRC :112-2011)  
 = 2925 mm<sup>2</sup>/m

Provide distribution steel as 20  $\phi$  @ 100 c/c  
 3142 mm<sup>2</sup>/m OK



ALTERNATE

|                  |   |         |
|------------------|---|---------|
| fyk              | = | 500 Mpa |
| $\epsilon_{uk}$  | = | 0.0025  |
| $\epsilon_{ud}$  | = | 0.00225 |
| fck              | = | 45 Mpa  |
| $\epsilon_{cu2}$ | = | 0.0035  |
| $xu_{max}/d$     | = | 0.6087  |

**(ULS) CHECK FOR SHEAR FORCE**

(Section At Face of Support)

$$\text{Factored Shear Force } V_{ED} = 131.60 \text{ T}$$

$$\text{Corresponding BM } M_{ED} = 509.01 \text{ Tm}$$

$$V_{CCD} = \text{Reduction in Shear force due to inclined compression chord}$$

$$= M_{ED} / d * \sin \beta$$

$$\beta = 5.618 \text{ deg} \quad */ \text{Inclination angle of compression chord.}$$

$$V_{CCD} = 44.928 \text{ T}$$

$$\text{Design Shear Force } V_{NS} = V_{ED} - V_{CCD}$$

$$= 86.67 \text{ Tonne}$$

Reduction in Design Shear For Within Zone ( $a_v = 0.5d$  to 0)

$$\text{Reduction factor } \beta_1 = 0.5$$

$$\text{Design Shear Force } V_{NS}' = \beta_1 * V_{NS}$$

$$= 43.33 \text{ Tonne}$$

**Max Shear Capacity of section**

$$v = 0.6 * (1 - f_{ck} / 310) \quad */ f_{ck} \text{ in Mpa}$$

$$= 0.513$$

$$f_{cd} = 0.447 * f_{ck}$$

$$= 20.10 \text{ Mpa}$$

$$V_{RDC, \max} = 0.5 b_w d v f_{cd}$$

$$= 572 \text{ Tonne} > 43.33 \text{ Tonne} \quad \text{OK}$$

$$D = 1.200 \text{ m} \quad */ \text{overall depth at face of support}$$

$$d = 1.109 \text{ m} \quad */ \text{deff at face of support}$$

**Check for Design Shear Reinforcement :**

$$k = \text{Min} \left\{ \begin{array}{l} 1 + \sqrt{200/d} \\ 2 \end{array} \right. \quad d \text{ is depth in mm}$$

$$k = 1.425$$

$$\rho_1 = \text{Min} \left\{ \begin{array}{l} A_{sl} / b_w d \\ 0.02 \end{array} \right.$$

$$\rho_1 = 0.01319$$

$$\sigma_{cp} = 0 \text{ Mpa}$$

$$v_{\min} = 0.031 k^{3/2} f_{ck}^{1/2}$$

$$= 0.354$$

c



$$V_{Rdc} = \text{Max} \left\{ \begin{array}{l} (0.12 k (80 \rho_1 f_{ck})^{0.33} + 0.15 \sigma_{cp}) b w d \\ (v_{min} + 0.15 \sigma_{cp}) b w d \end{array} \right. \quad (\text{IRC 112 / clause 10.3.2 (2)})$$

$$= 68 \text{ Tonne} > 43.3 \text{ Tonne} \quad \text{NO SHEAR REINFORCEMENT REQUIRED}$$

### (SLS) CHECK FOR STRESSES (RARE & QUASI PERMANENT LOAD COMBINATIONS)

Design Bending Moment

$$\begin{aligned} M_{RARE} &= 342.93 \text{ Tm} \\ M_{QP} &= 267.15 \text{ Tm} \\ M_{ST} &= M_{RARE} - M_{QP} \quad (\text{Bending Moment due to short term loading}) \\ &= 75.78 \text{ Tm} \end{aligned}$$

Modulus of Elasticity for Concrete

For short term loading  $E_{cm} = 34313 \text{ Mpa}$

Creep coefficient  $\phi = 1$

For long term loading  $E_{cm}' = 17156 \text{ Mpa}$

Reinf. modulus of elasticity  $E_s = 200000 \text{ N/mm}^2$

Modular ratio for QP Combination  $= E_s / E_{cm} = 5.829$

Equavelent Modulus of Elasticity for Rare Combination :

$$E_{c,eq} = \frac{E_{cm} * (M_{QP} + M_{ST})}{M_{ST} + (1 + \phi) * M_{QP}} = 19288 \text{ MPa}$$

Modular ratio for Rare Combination  $= E_s / E_{c,eq} = 10.37$

| Formula used for calculation of stress    |   |
|---|---|
| dc (depth of neutral axis)                | $= \frac{-m * A_s + \sqrt{(m^2 * A_s^2 + 2 * m * A_s * b * d)}}{b}$ |
| $I_{NA}$ (Transformed)                    | $= b * dc^3 / 3 + m * A_s * (d - dc)^2$                             |
| Compressive stress in concrete $\sigma_c$ | $= M_{RARE} * dc / I_{NA}$  |
| Tensile stress in steel $\sigma_s$        | $= m * M_{RARE} * (d - dc) / I_{NA}$                                |

| Description                               | Stress Check For Rare Combination | Stress Check For QP Combination |
|---|-----------------------------------|---------------------------------|
| Design Moment                             | = 342.93 Tm                       | = 267.15 Tm                     |
| Total Depth at section                    | = 1.2 m                           | = 1.2 m                         |
| deff                                      | = 1.109 m                         | = 1.109 m                       |
| width b                                   | = 1 m                             | = 1 m                           |
| $A_{st, provided}$                        | = 14622.7 mm <sup>2</sup> /m      | = 14622.7 mm <sup>2</sup> /m    |
| Modular ratio                             | = 10.37                           | = 5.83                          |
| dc (depth of neutral axis)                | = 447.79 mm                       | = 357.83 mm                     |
| $I_{NA}$ (Transformed)                    | = 9.62E+10 mm <sup>4</sup>        | = 6.34E+10 mm <sup>4</sup>      |
| Compressive stress in concrete $\sigma_c$ | = 15.96 N/mm <sup>2</sup>         | = 15.09 N/mm <sup>2</sup>       |
| Permissible Compressive stress            | = 21.6 N/mm <sup>2</sup> OK       | = 16.2 N/mm <sup>2</sup> OK     |
| Tensile stress in steel $\sigma_s$        | = 244.36 N/mm <sup>2</sup>        | = 184.60 N/mm <sup>2</sup>      |
| Permissible tensile stress                | = 300 N/mm <sup>2</sup> OK        | = 400 N/mm <sup>2</sup> OK      |



**(SLS) CHECK FOR CRACK WIDTH (QUASI PERMANENT LOAD COMBINATIONS)**

Minimum Reinforcement for crack control:

$$A_{s,min} = k_c k f_{ct,eff} A_{ct} / \sigma_s \quad (IRC 112 / clause 12.3.3 (2))$$

$$k_c = 0.4 \text{ For Bending member}$$

$$h = 1.2 \text{ m}, \quad b = 1 \text{ m}$$

$$k = 0.65$$

$$f_{ct,eff} = f_{ctm} = 3.28 \text{ Mpa}$$

$$A_{ct} = b * h / 2 = 0.6 \text{ m}^2$$

$$\sigma_s = f_{yk} = 500 \text{ Mpa}$$

$$A_{s,min} = 1022 \text{ mm}^2/\text{m} < 14623 \text{ mm}^2/\text{m} \quad \text{OK}$$

Calculation of crack width: (IRC 112 / clause 12.3.4)

$$w_{k,max} = 0.3 \text{ mm}$$

$$\text{Clear cover } c = 75 \text{ mm}$$

$$\text{Bar dia } \phi_{eq} = 32.00 \text{ mm}$$

$$5 (c + \phi_{eq}/2) = 455 \text{ mm}$$

$$\text{Spacing b/w bars} = 55 \text{ mm} < 455 \text{ mm}$$

$$s_{rmax} = \text{Maximum crack spacing}$$

$$= 3.4c + 0.17 \phi / \rho_{Peff}$$

$$= 339.636 \text{ mm}$$

The Following formula can be used for calculation of maximum crack spacing.

$$h_{c,eff} = \text{Min} \begin{cases} 2.5 (h - d) \\ (h - x)/3 \\ h/2 \end{cases}$$

$$= 0.228 \text{ m}$$

|     |     |              |
|-----|-----|--------------|
| $h$ | $=$ | 1.2 m        |
| $d$ | $=$ | 1.109 m      |
| $x$ | $=$ | 0.35783446 m |

\*/ (for Quasi Permanent Load combination)

$$\text{width } b = 1 \text{ m}$$

$$A_{c,eff} = h_{c,eff} * b = 0.2275 \text{ m}^2$$

$$\rho_{P,eff} = A_s / A_{c,eff}$$

$$= 14622.7 / 227500$$

$$= 0.06428$$

$$\sigma_{sc} = \text{Stress in tension Reinforcement assuming cracked section}$$

$$= 184.60 \text{ Mpa} \quad */ \text{ (for Quasi Permanent Load combination)}$$

$$E_s = 200000 \text{ Mpa}$$

$$E_{cm}' = 17156.5 \text{ Mpa} \quad */ \text{ (for Long term loading)}$$

$$\alpha_c = E_s / E_{cm}'$$

$$\alpha_c = 11.6574$$

$$k_t = 0.5 \quad (\text{factor dependent on duration of load})$$

$$\begin{aligned}
 \epsilon_{sm} - \epsilon_{cm} &= \text{Max} \left\{ \frac{(1 + \alpha_e \rho_{P,eff}) / \rho_{P,eff}}{E_s} \right. \\
 &= 0.0007 \\
 w_k &= s_{rmax} (\epsilon_{sm} - \epsilon_{cm}) \\
 &= 0.238 \text{ mm} < 0.300 \text{ mm} \quad \text{OK}
 \end{aligned}$$



'-----

DESIGN OF FOUNDATION  
SLS LOAD COMBINATION

| LC-2        | QP, LWL, EP                 | Forces about toe |                |                |                 |                 |  | LC-2 |
|-------------|-----------------------------|------------------|----------------|----------------|-----------------|-----------------|--|------|
| S.N.        | Description                 | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |  |      |
|             |                             | Tonne            | Tonne          | Tonne          | Tm              | Tm              |  |      |
| 1)          | Sub-structure & Foundation  | 1073.8807        |                |                | -5150.747       | 0               |  | 1    |
| 2)          | Backfill                    | 2151.6908        |                |                | -16334.43       | 0               |  | 1    |
| 3)          | Super-structure DL          | 266.94974        |                |                | -860.9129       | 0               |  | 1    |
| 4)          | SIDL (excluding surfacing)  | 116.98594        |                |                | -377.2796       | 0               |  | 1    |
| 5)          | Surfacing                   | 34.025063        |                |                | -109.7308       | -8.506266       |  | 1    |
| <b>9.3)</b> | Earth Pressure LWL (BP, SD) |                  |                |                |                 |                 |  | 1    |
|             | Horizontal Component        |                  | 1018.08        |                | 7194.73         |                 |  | 1    |
|             | Vertical Component          | 364.73273        |                |                | -1677.77        |                 |  | 1    |

| S.N. | Description | Forces about toe |                |                |                 |                 |
|------|-------------|------------------|----------------|----------------|-----------------|-----------------|
|      |             | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|      |             | Tonne            | Tonne          | Tonne          | Tm              | Tm              |
| LC-2 | QP, LWL, EP | 4008.265         | 1018.0761      | 0              | -17316.14       | -8.506266       |

| LC-4        | RARE, LWL, Span dislodge EP    | Forces about toe |                |                |                 |                 |  | LC-4 |
|-------------|--------------------------------|------------------|----------------|----------------|-----------------|-----------------|--|------|
| S.N.        | Description                    | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |  |      |
|             |                                | Tonne            | Tonne          | Tonne          | Tm              | Tm              |  |      |
| 1)          | Sub-structure & Foundation     | 1073.8807        |                |                | -5150.747       | 0               |  | 1    |
| 2)          | Backfill                       | 2151.6908        |                |                | -16334.43       | 0               |  | 1    |
| <b>9.3)</b> | Earth Pressure LWL (BP, SD)    |                  |                |                |                 |                 |  | 1    |
|             | Horizontal Component           |                  | 1018.08        |                | 7194.73         |                 |  | 1    |
|             | Vertical Component             | 364.73273        |                |                | -1677.77        |                 |  | 1    |
| 10.3)       | Surcharge Pressure LWL(BP, SD) |                  | 152.83         |                | 1298.43         |                 |  | 0.8  |

| S.N. | Description                 | Forces about toe |                |                |                 |                 |
|------|-----------------------------|------------------|----------------|----------------|-----------------|-----------------|
|      |                             | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|      |                             | Tonne            | Tonne          | Tonne          | Tm              | Tm              |
| LC-4 | RARE, LWL, Span dislodge EP | 3590.3042        | 1140.3379      | 0              | -14929.47       | 0               |

| LC-6        | RARE, LWL, Min LL acomp, EP          | Forces about toe |                |                |                 |                 |  | LC-6 |
|-------------|--------------------------------------|------------------|----------------|----------------|-----------------|-----------------|--|------|
| S.N.        | Description                          | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |  |      |
|             |                                      | Tonne            | Tonne          | Tonne          | Tm              | Tm              |  |      |
| 1)          | Sub-structure & Foundation           | 1073.8807        |                |                | -5150.747       | 0               |  | 1    |
| 2)          | Backfill                             | 2151.6908        |                |                | -16334.43       | 0               |  | 1    |
| 3)          | Super-structure DL                   | 266.94974        |                |                | -860.9129       | 0               |  | 1    |
| 4)          | SIDL (excluding surfacing)           | 116.98594        |                |                | -377.2796       | 0               |  | 1    |
| 5)          | Surfacing                            | 34.025063        |                |                | -109.7308       | -8.506266       |  | 1    |
| 6.2)        | Live Load Vertical Load Min Reaction | 28.799702        |                |                | -92.88          | 83.81           |  | 0.75 |
| 7)          | Live Load Horizontal Forces          |                  | 39.153         |                | 568.97215       |                 |  | 0.75 |
| <b>9.3)</b> | Earth Pressure LWL (BP, SD)          |                  |                |                |                 |                 |  | 1    |
|             | Horizontal Component                 |                  | 1018.08        |                | 7194.73         |                 |  | 1    |
|             | Vertical Component                   | 364.73273        |                |                | -1677.77        |                 |  | 1    |
| 10.3)       | Surcharge Pressure LWL(BP, SD)       |                  | 152.83         |                | 1298.43         |                 |  | 0.8  |

|  |  |  |  |  |  |  |  |
|--|--|--|--|--|--|--|--|
|  |  |  |  |  |  |  |  |
|--|--|--|--|--|--|--|--|

| S.N. | Description                 | Forces about toe |                |                |                 |                 |
|------|-----------------------------|------------------|----------------|----------------|-----------------|-----------------|
|      |                             | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|      |                             | Tonne            | Tonne          | Tonne          | Tm              | Tm              |
| LC-6 | RARE, LWL, Min LL acomp, EP | 4029.8647        | 1169.7027      | 0              | -15920.33       | 54.349084       |

| S.N.  | Description                          | Forces about toe |                |                |                 |                 |  | LC-8 |
|-------|--------------------------------------|------------------|----------------|----------------|-----------------|-----------------|--|------|
|       |                                      | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |  |      |
|       |                                      | Tonne            | Tonne          | Tonne          | Tm              | Tm              |  |      |
| LC-8  | RARE, LWL, Max LL lead, EP           |                  |                |                |                 |                 |  |      |
| 1)    | Sub-structure & Foundation           | 1073.8807        |                |                | -5150.747       | 0               |  | 1    |
| 2)    | Backfill                             | 2151.6908        |                |                | -16334.43       | 0               |  | 1    |
| 3)    | Super-structure DL                   | 266.94974        |                |                | -860.9129       | 0               |  | 1    |
| 4)    | SIDL (excluding surfacing)           | 116.98594        |                |                | -377.2796       | 0               |  | 1    |
| 5)    | Surfacing                            | 34.025063        |                |                | -109.7308       | -8.506266       |  | 1    |
| 6.1)  | Live Load Vertical Load Max Reaction | 137.4003         |                |                | -443.12         | 399.83          |  | 1    |
| 7)    | Live Load Horizontal Forces          |                  | 39.153         |                | 568.97215       |                 |  | 1    |
| 9.3)  | Earth Pressure LWL (BP, SD)          |                  |                |                |                 |                 |  | 1    |
|       | Horizontal Component                 |                  | 1018.08        |                | 7194.73         |                 |  | 1    |
|       | Vertical Component                   | 364.73273        |                |                | -1677.77        |                 |  | 1    |
| 10.3) | Surcharge Pressure LWL(BP, SD)       |                  | 152.83         |                | 1298.43         |                 |  | 0.8  |

| S.N. | Description                | Forces about toe |                |                |                 |                 |
|------|----------------------------|------------------|----------------|----------------|-----------------|-----------------|
|      |                            | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|      |                            | Tonne            | Tonne          | Tonne          | Tm              | Tm              |
| LC-8 | RARE, LWL, Max LL lead, EP | 4145.6653        | 1179.4909      | 0              | -16151.54       | 391.3286        |

| S.N. | Description                 | Forces about toe |                |                |                 |                 |  | LC-9 |
|------|-----------------------------|------------------|----------------|----------------|-----------------|-----------------|--|------|
|      |                             | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |  |      |
|      |                             | Tonne            | Tonne          | Tonne          | Tm              | Tm              |  |      |
| LC-9 | QP, HFL, EP                 |                  |                |                |                 |                 |  |      |
| 1)   | Sub-structure & Foundation  | 1073.8807        |                |                | -5150.747       | 0               |  | 1    |
| 2)   | Backfill                    | 2151.6908        |                |                | -16334.43       | 0               |  | 1    |
| 3)   | Super-structure DL          | 266.94974        |                |                | -860.9129       | 0               |  | 1    |
| 4)   | SIDL (excluding surfacing)  | 116.98594        |                |                | -377.2796       | 0               |  | 1    |
| 5)   | Surfacing                   | 34.025063        |                |                | -109.7308       | -8.506266       |  | 1    |
| 8)   | Buoyancy                    | -55.5            |                |                | 169.0           | 0.0             |  | 0.15 |
| 9.3) | Earth Pressure HFL (BP, SD) |                  |                |                |                 |                 |  | 1    |
|      | Horizontal Component        |                  | 1018.1         |                | 7194.7          |                 |  | 1    |
|      | Vertical Component          | 364.7            |                |                | -1677.8         |                 |  | 1    |

| S.N. | Description | Forces about toe |                |                |                 |                 |
|------|-------------|------------------|----------------|----------------|-----------------|-----------------|
|      |             | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|      |             | Tonne            | Tonne          | Tonne          | Tm              | Tm              |
| LC-9 | QP, HFL, EP | 3999.94          | 1018.0761      | 0              | -17290.78       | -8.506266       |

| S.N.  | Description                 | Forces about toe |                |                |                 |                 |  | LC-10 |
|-------|-----------------------------|------------------|----------------|----------------|-----------------|-----------------|--|-------|
|       |                             | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |  |       |
|       |                             | Tonne            | Tonne          | Tonne          | Tm              | Tm              |  |       |
| LC-10 | RARE, HFL, Span dislodge EP |                  |                |                |                 |                 |  |       |
| 1)    | Sub-structure & Foundation  | 1073.8807        |                |                | -5150.747       | 0               |  | 1     |

|       |                                |           |        |  |           |     |  |      |
|-------|--------------------------------|-----------|--------|--|-----------|-----|--|------|
| 2)    | Backfill                       | 2151.6908 |        |  | -16334.43 | 0   |  | 1    |
| 8)    | Buoyancy                       | -55.5     |        |  | 169.0     | 0.0 |  | 0.15 |
| 9.3)  | Earth Pressure HFL (BP, SD)    |           |        |  |           |     |  | 1    |
|       | Horizontal Component           |           | 1018.1 |  | 7194.7    |     |  | 1    |
|       | Vertical Component             | 364.7     |        |  | -1677.8   |     |  | 1    |
| 10.3) | Surcharge Pressure HFL(BP, SD) |           | 152.8  |  | 1298.4    |     |  | 0.8  |

| S.N.  | Description                 | Forces about toe |                |                |                 |                 |
|-------|-----------------------------|------------------|----------------|----------------|-----------------|-----------------|
|       |                             | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|       |                             | Tonne            | Tonne          | Tonne          | Tm              | Tm              |
| LC-10 | RARE, HFL, Span dislodge EP | 3581.9792        | 1140.3379      | 0              | -14904.12       | 0               |

| S.N.  | Description                          | Forces about toe |                |                |                 |                 | LC-11 |
|-------|--------------------------------------|------------------|----------------|----------------|-----------------|-----------------|-------|
|       |                                      | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |       |
|       |                                      | Tonne            | Tonne          | Tonne          | Tm              | Tm              |       |
| LC-11 | RARE, HFL, Min LL acomp, EP          |                  |                |                |                 |                 |       |
| 1)    | Sub-structure & Foundation           | 1073.8807        |                |                | -5150.747       | 0               | 1     |
| 2)    | Backfill                             | 2151.6908        |                |                | -16334.43       | 0               | 1     |
| 3)    | Super-structure DL                   | 266.94974        |                |                | -860.9129       | 0               | 1     |
| 4)    | SIDL (excluding surfacing)           | 116.98594        |                |                | -377.2796       | 0               | 1     |
| 5)    | Surfacing                            | 34.025063        |                |                | -109.7308       | -8.506266       | 1     |
| 6.2)  | Live Load Vertical Load Min Reaction | 28.799702        |                |                | -92.88          | 83.81           | 0.75  |
| 7)    | Live Load Horizontal Forces          |                  | 39.153         |                | 568.97215       |                 | 0.75  |
| 8)    | Buoyancy                             | -55.5            |                |                | 169.0           | 0.0             | 0.15  |
| 9.3)  | Earth Pressure HFL (BP, SD)          |                  |                |                |                 |                 | 1     |
|       | Horizontal Component                 |                  | 1018.1         |                | 7194.7          |                 | 1     |
|       | Vertical Component                   | 364.7            |                |                | -1677.8         |                 | 1     |
| 10.3) | Surcharge Pressure HFL(BP, SD)       |                  | 152.8          |                | 1298.4          |                 | 0.8   |

| S.N.  | Description                 | Forces about toe |                |                |                 |                 |
|-------|-----------------------------|------------------|----------------|----------------|-----------------|-----------------|
|       |                             | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|       |                             | Tonne            | Tonne          | Tonne          | Tm              | Tm              |
| LC-11 | RARE, HFL, Min LL acomp, EP | 4021.5397        | 1169.7027      | 0              | -15894.97       | 54.349084       |

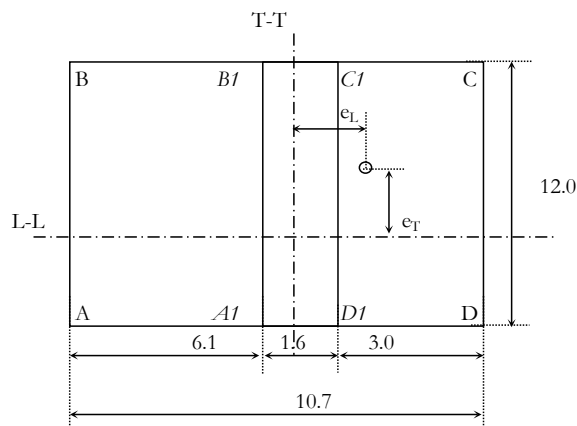
| S.N.  | Description                          | Forces about toe |                |                |                 |                 | LC-12 |
|-------|--------------------------------------|------------------|----------------|----------------|-----------------|-----------------|-------|
|       |                                      | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |       |
|       |                                      | Tonne            | Tonne          | Tonne          | Tm              | Tm              |       |
| LC-12 | RARE, HFL, Max LL lead, EP           |                  |                |                |                 |                 |       |
| 1)    | Sub-structure & Foundation           | 1073.8807        |                |                | -5150.747       | 0               | 1     |
| 2)    | Backfill                             | 2151.6908        |                |                | -16334.43       | 0               | 1     |
| 3)    | Super-structure DL                   | 266.94974        |                |                | -860.9129       | 0               | 1     |
| 4)    | SIDL (excluding surfacing)           | 116.98594        |                |                | -377.2796       | 0               | 1     |
| 5)    | Surfacing                            | 34.025063        |                |                | -109.7308       | -8.506266       | 1     |
| 6.1)  | Live Load Vertical Load Max Reaction | 137.4003         |                |                | -443.12         | 399.83          | 1     |
| 7)    | Live Load Horizontal Forces          |                  | 39.153         |                | 568.97215       |                 | 1     |
| 8)    | Buoyancy                             | -55.5            |                |                | 169.0           | 0.0             | 0.15  |
| 9.3)  | Earth Pressure HFL (BP, SD)          |                  |                |                |                 |                 | 1     |
|       | Horizontal Component                 |                  | 1018.1         |                | 7194.7          |                 | 1     |
|       | Vertical Component                   | 364.7            |                |                | -1677.8         |                 | 1     |
| 10.3) | Surcharge Pressure HFL(BP, SD)       |                  | 152.8          |                | 1298.4          |                 | 0.8   |



| S.N.  | Description                | Forces about toe |                |                |                 |                 |
|-------|----------------------------|------------------|----------------|----------------|-----------------|-----------------|
|       |                            | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|       |                            | Tonne            | Tonne          | Tonne          | Tm              | Tm              |
| LC-12 | RARE, HFL, Max LL lead, EP | 4137.3403        | 1179.4909      | 0              | -16126.18       | 391.3286        |

# BASE PRESSRE CALCULATION

## SLS LOAD COMBINATIONS



| Coordinates of basecorner |        |        |
|---------------------------|--------|--------|
| Edges                     | x (m)  | z (m)  |
| A                         | -5.350 | 6.000  |
| B                         | -5.350 | -6.000 |
| C                         | 5.350  | -6.000 |
| D                         | 5.350  | 6.000  |

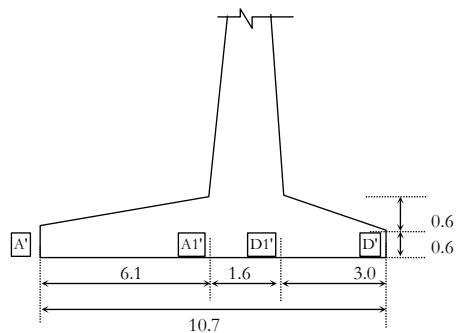
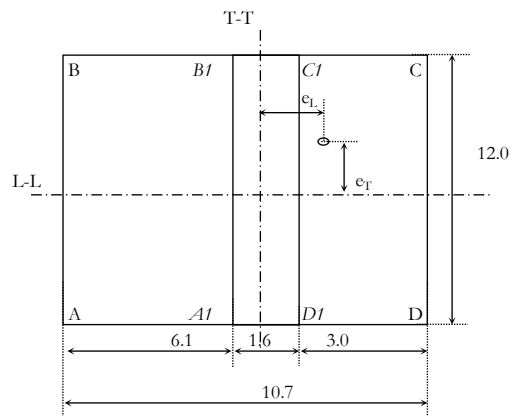
| Properties of Base |                          |   |                        |
|--------------------|--------------------------|---|------------------------|
| Area               | 10.7x12                  | = | 128.4 m <sup>2</sup>   |
| I <sub>TT</sub>    | 12x10.7 <sup>3</sup> /12 | = | 1225.04 m <sup>4</sup> |
| I <sub>LL</sub>    | 10.7x12 <sup>3</sup> /12 | = | 1540.80 m <sup>4</sup> |

## CHECK FOR MAXIMUM BASE PRESSRE

### SUMMARY OF FORCES :

|       |                             |                  |                |                |                 |                 | <i>Eccentricity of Vertical load from toe point</i> |                     | <i>Eccentricity of Vertical load wrt cg of base</i> |                 | <i>Moment and forces at cg of base</i> |                  | <i>Gross Base Pressure = P/ A ± M<sub>TT</sub> *x / I<sub>TT</sub> ± M<sub>LL</sub> *z / I<sub>LL</sub></i> |                  |                  |                  |
|-------|-----------------------------|------------------|----------------|----------------|-----------------|-----------------|---|---------------------|---|-----------------|--|------------------|---|------------------|------------------|------------------|
| S.N.  | Description                 | Forces about toe |                |                |                 |                 | e <sub>L1</sub>                                     | e <sub>T1</sub>     | e <sub>L</sub>                                      | e <sub>T</sub>  | M <sub>TT</sub>                        | M <sub>LL</sub>  | <i>base pressure at footing corners</i>   |                  |                  |                  |
|       |                             | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> | M <sub>TT</sub> / V                                 | M <sub>LL</sub> / V | B/2-e <sub>L1</sub>                                 | e <sub>T1</sub> | V*e <sub>L</sub>                       | V*e <sub>T</sub> | A   | B                | C                | D                |
|       |                             | Tonne            | Tonne          | Tonne          | Tm              | Tm              | m   | m                   | m   | m               | Tm                                     | Tm               | T/m <sup>2</sup>  | T/m <sup>2</sup> | T/m <sup>2</sup> | T/m <sup>2</sup> |
| LC-1  | QP, LWL, FP                 | 3643.53          | 0.18           | 0              | -22833          | -8.5063         |   |                     |   |                 |  |                  |   |                  |                  |                  |
| LC-2  | QP, LWL, EP                 | 4008.26          | 1018.08        | 0              | -17316          | -8.5063         | -4.32   | 0.00                | 1.03  | 0.00            | 4128.1                                 | -8.5             | 13.2  | 13.2             | 49.3             | 49.2             |
| LC-3  | RARE, LWL, Span dislodge FP | 3225.57          | 122.442        | 0              | -20446          | 0               |   |                     |   |                 |  |                  |   |                  |                  |                  |
| LC-4  | RARE, LWL, Span dislodge EP | 3590.3           | 1140.34        | 0              | -14929          | 0               | -4.16   | 0.00                | 1.19  | 0.00            | 4278.7                                 | 0.0              | 9.3   | 9.3              | 46.6             | 46.6             |
| LC-5  | RARE, LWL, Min LL acomp, FP | 3665.13          | 151.807        | 0              | -21437          | 54.3491         |   |                     |   |                 |  |                  |   |                  |                  |                  |
| LC-6  | RARE, LWL, Min LL acomp, EP | 4029.86          | 1169.7         | 0              | -15920          | 54.3491         | -3.95   | 0.01                | 1.40  | 0.01            | 5639.5                                 | 54.3             | 7.0   | 6.5              | 55.8             | 56.2             |
| LC-7  | RARE, LWL, Max LL lead, FP  | 3780.93          | 161.595        | 0              | -21668          | 391.329         |   |                     |   |                 |  |                  |   |                  |                  |                  |
| LC-8  | RARE, LWL, Max LL lead, EP  | 4145.67          | 1179.49        | 0              | -16152          | 391.329         | -3.90   | 0.09                | 1.45  | 0.09            | 6027.8                                 | 391.3            | 7.5   | 4.4              | 57.1             | 60.1             |
| LC-9  | QP, HFL, EP                 | 3999.94          | 1018.08        | 0              | -17291          | -8.5063         | -4.32   | 0.00                | 1.03  | 0.00            | 4108.9                                 | -8.5             | 13.2  | 13.2             | 49.1             | 49.1             |
| LC-10 | RARE, HFL, Span dislodge EP | 3581.98          | 1140.34        | 0              | -14904          | 0               | -4.16   | 0.00                | 1.19  | 0.00            | 4259.5                                 | 0.0              | 9.3   | 9.3              | 46.5             | 46.5             |
| LC-11 | RARE, HFL, Min LL acomp, EP | 4021.54          | 1169.7         | 0              | -15895          | 54.3491         | -3.95   | 0.01                | 1.40  | 0.01            | 5620.3                                 | 54.3             | 7.0   | 6.6              | 55.7             | 56.1             |
| LC-12 | RARE, HFL, Max LL lead, EP  | 4137.34          | 1179.49        | 0              | -16126          | 391.329         | -3.90   | 0.09                | 1.45  | 0.09            | 6008.6                                 | 391.3            | 7.5   | 4.5              | 56.9             | 60.0             |

**NET BASE PRESSRE CALCULATION**  
**SLS LOAD COMBINATIONS**



Deduction due to over burden LWL

| LWL           | A'           | A1'          | D'          | D1'         | Comb-1 |
|---------------|--------------|--------------|-------------|-------------|--------|
| Earth fill    | 32.8         | 31.6         | 0           | 0           | 1      |
| footing       | 1.5          | 3            | 1.5         | 3           | 1      |
| <b>Comb-1</b> | <b>34.30</b> | <b>34.60</b> | <b>1.50</b> | <b>3.00</b> |        |

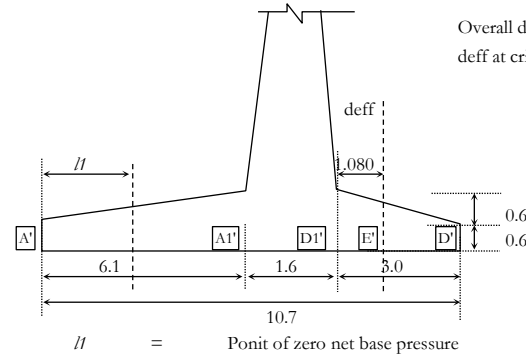
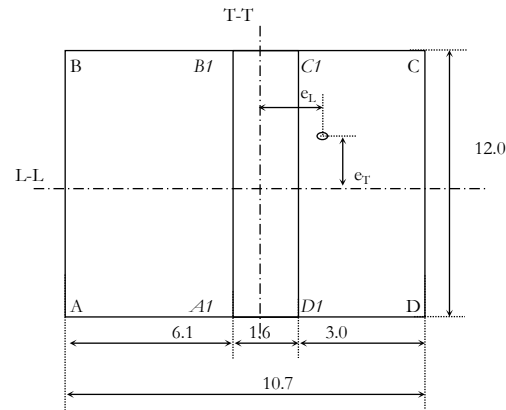
Deduction due to over burden HFL

| LWL           | A'           | A1'          | D'          | D1'         | Comb-1 |
|---------------|--------------|--------------|-------------|-------------|--------|
| Earth fill    | 32.8         | 31.6         | 0           | 0           | 1      |
| footing       | 1.5          | 3            | 1.5         | 3           | 1      |
| Buoyancy      | -0.25        | -0.25        | -0.6        | -1.2        | 0.15   |
| <b>Comb-1</b> | <b>34.26</b> | <b>34.56</b> | <b>1.41</b> | <b>2.82</b> |        |

**DESIGN FORCES FOR BASE SLAB**

| <b>SUMMARY OF FORCES :</b> |                             | <b>Gross Base Pressure = <math>P/A \pm M_{TT} *x / I_{TT} \pm M_{LL} *z / I_{LL}</math></b> |                  |                  |                  | <b>Average Gross Base Pressure at Critical points</b> |                  |                  |                  | <b>NET BASE PRESSURE</b>                |                  |                  |                  |
|----------------------------|-----------------------------|---|------------------|------------------|------------------|---|------------------|------------------|------------------|---|------------------|------------------|------------------|
| S.N.                       | Description                 | <b>base pressure at footing corners</b>   |                  |                  |                  | <b>base pressure at footing corners</b>               |                  |                  |                  | <b>base pressure at footing corners</b> |                  |                  |                  |
|                            |                             | A   | B                | C                | D                | A'  | A1'              | D'               | D1'              | A'                                      | A1'              | D'               | D1'              |
|                            |                             | T/m <sup>2</sup>  | T/m <sup>2</sup> | T/m <sup>2</sup> | T/m <sup>2</sup> | T/m <sup>2</sup>                                      | T/m <sup>2</sup> | T/m <sup>2</sup> | T/m <sup>2</sup> | T/m <sup>2</sup>                        | T/m <sup>2</sup> | T/m <sup>2</sup> | T/m <sup>2</sup> |
| LC-1                       | QP, LWL, FP                 |   |                  |                  |                  |   |                  |                  |                  |   |                  |                  |                  |
| LC-2                       | QP, LWL, EP                 | 13.2  | 13.2             | 49.3             | 49.2             | 13.2  | 33.7             | 49.2             | 39.14            | -21.1                                   | -0.9             | 47.7             | 36.1             |
| LC-3                       | RARE, LWL, Span dislodge FP |   |                  |                  |                  |   |                  |                  |                  |   |                  |                  |                  |
| LC-4                       | RARE, LWL, Span dislodge EP | 9.3   | 9.3              | 46.6             | 46.6             | 9.3   | 30.6             | 46.6             | 36.17            | -25.0                                   | -4.0             | 45.1             | 33.2             |
| LC-5                       | RARE, LWL, Min LL acomp, FP |   |                  |                  |                  |   |                  |                  |                  |   |                  |                  |                  |
| LC-6                       | RARE, LWL, Min LL acomp, EP | 7.0   | 6.5              | 55.8             | 56.2             | 6.8   | 34.8             | 56.0             | 42.20            | -27.5                                   | 0.2              | 54.5             | 39.2             |
| LC-7                       | RARE, LWL, Max LL lead, FP  |   |                  |                  |                  |   |                  |                  |                  |   |                  |                  |                  |
| LC-8                       | RARE, LWL, Max LL lead, EP  | 7.5   | 4.4              | 57.1             | 60.1             | 6.0   | 36.0             | 58.6             | 43.85            | -28.3                                   | 1.4              | 57.1             | 40.9             |
| LC-9                       | QP, HFL, EP                 | 13.2  | 13.2             | 49.1             | 49.1             | 13.2  | 33.7             | 49.1             | 39.03            | -21.1                                   | -0.9             | 47.7             | 36.2             |
| LC-10                      | RARE, HFL, Span dislodge EP | 9.3   | 9.3              | 46.5             | 46.5             | 9.3   | 30.5             | 46.5             | 36.07            | -25.0                                   | -4.1             | 45.1             | 33.2             |
| LC-11                      | RARE, HFL, Min LL acomp, EP | 7.0   | 6.6              | 55.7             | 56.1             | 6.8   | 34.8             | 55.9             | 42.10            | -27.5                                   | 0.2              | 54.5             | 39.3             |
| LC-12                      | RARE, HFL, Max LL lead, EP  | 7.5   | 4.5              | 56.9             | 60.0             | 6.0   | 35.9             | 58.5             | 43.75            | -28.3                                   | 1.3              | 57.1             | 40.9             |

**FINDING BENDING MOMENT & SHEAR FORCE AT CRITICAL SECTION**  
**SLS LOAD COMBINATIONS**



| Design Bending Moment & Shear Force : |      |            |          |
|---------------------------------------|------|------------|----------|
| Description                           |      | Rare<br>Tm | QS<br>Tm |
| Heel Slab (BM. Downward)              | I.WL | -342.9     | -267.2   |
| Toe slab (face of support)            | I.WL | 232.6      | 197.4    |

**DESIGN FORCES FOR BASE SLAB**

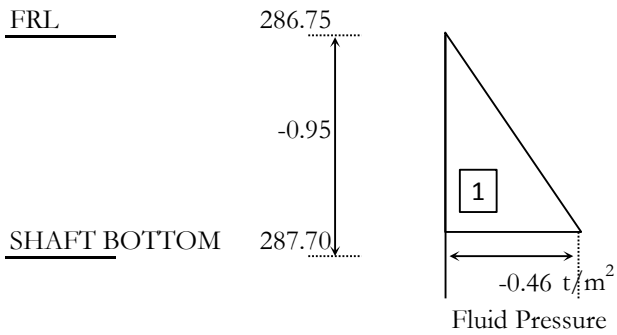
| SUMMARY OF FORCES : |                             | NET BASE PRESSURE                |                  |                  |                  |                  |
|---------------------|-----------------------------|----------------------------------|------------------|------------------|------------------|------------------|
| S.N.                | Description                 | base pressure at footing corners |                  |                  |                  |                  |
|                     |                             | A'                               | A1'              | D'               | D1'              | E1'              |
|                     |                             | T/m <sup>2</sup>                 | T/m <sup>2</sup> | T/m <sup>2</sup> | T/m <sup>2</sup> | T/m <sup>2</sup> |
| LC-1                | QP, LWL, FP                 | 0.0                              | 0.0              | 0.0              | 0.0              | 0                |
| LC-2                | QP, LWL, EP                 | -21.1                            | -0.9             | 47.7             | 36.1             | 43.5658          |
| LC-4                | RARE, LWL, Span dislodge EP | -25.0                            | -4.0             | 45.1             | 33.2             | 40.8355          |
| LC-6                | RARE, LWL, Min LL acomp, EP | -27.5                            | 0.2              | 54.5             | 39.2             | 49.0021          |
| LC-8                | RARE, LWL, Max LL lead, EP  | -28.3                            | 1.4              | 57.1             | 40.9             | 51.2575          |
| LC-9                | QP, HFL, EP                 | -21.1                            | -0.9             | 47.7             | 36.2             | 43.5565          |
| LC-10               | RARE, HFL, Span dislodge EP | -25.0                            | -4.1             | 45.1             | 33.2             | 40.8262          |
| LC-11               | RARE, HFL, Min LL acomp, EP | -27.5                            | 0.2              | 54.5             | 39.3             | 48.9928          |
| LC-12               | RARE, HFL, Max LL lead, EP  | -28.3                            | 1.3              | 57.1             | 40.9             | 51.2482          |

| Point of<br>zero net<br>base<br>pressure | BM at<br>Point of<br>zero base<br>pressure |
|--|--|
| $l$                                      | BM   |
| m  | Tm   |
| 0.00                                     | 0.00                                       |
| 0.00                                     | 0.00                                       |
| 0.00                                     | 0.00                                       |
| 0.00                                     | 0.00                                       |
| 0.00                                     | 0.00                                       |
| 0.00                                     | 0.00                                       |
| 0.00                                     | 0.00                                       |
| 0.00                                     | 0.00                                       |
| 0.00                                     | 0.00                                       |
| 0.00                                     | 0  |

| BENDING MOMENT & SHEAR FORCE |       |          |                      |                      |                      |                      |
|------------------------------|-------|----------|----------------------|----------------------|----------------------|----------------------|
| Heel Slab                    |       | Toe Slab |                      |                      |                      |                      |
| BM                           | SF    |          | BM   <sub>face</sub> | SF   <sub>face</sub> | SF   <sub>deff</sub> | BM   <sub>deff</sub> |
| Tm                           | T     |          | Tm                   | T                    | T                    | Tm                   |
| 0.0                          | 0.0   |          | 0.0                  | 0.0                  | 0.00                 | 0.00                 |
| -267.2                       | -67.0 |          | 197.4                | 125.8                | 76.51                | 85.44                |
| -335.3                       | -88.6 |          | 185.2                | 117.5                | 71.04                | 80.57                |
| -340.2                       | -83.3 |          | 222.3                | 140.6                | 84.68                | 97.09                |
| -342.9                       | -82.2 |          | 232.6                | 146.9                | 88.42                | 101.67               |
| -266.7                       | -66.9 |          | 197.4                | 125.9                | 76.58                | 85.36                |
| -334.8                       | -88.5 |          | 185.1                | 117.5                | 71.11                | 80.49                |
| -339.7                       | -83.2 |          | 222.3                | 140.6                | 84.74                | 97.02                |
| -342.5                       | -82.2 |          | 232.6                | 147.0                | 88.49                | 101.59               |

### **FLUID PRESSURE CALCULATION FOR SHAFT DESIGN :**

Fluid density = 0.48 t/m<sup>3</sup>  
 Abutment Length L = 12 m



Total Fluid Pressure

| Component | Factor | p                | h     | L  | F      | ey       |
|-----------|--------|------------------|-------|----|--------|----------|
|           |        | T/m <sup>2</sup> | m     | m  | Tonne  | m        |
| 1         | 0.5    | -0.456           | -0.95 | 12 | 2.60   | -0.31667 |
| Total     |        |                  |       |    | 2.5992 | -0.317   |

|                                  |   |                   |
|----------------------------------|---|-------------------|
| <b>Total fluid Pressure</b>      | = | <b>2.60 Tonne</b> |
| <b>Lever arm</b>                 | = | <b>-0.32</b>      |
| <b>Moment M<sub>TT</sub></b>     | = | <b>-0.82 Tm</b>   |
| <b>Net Moment M<sub>TT</sub></b> | = | <b>-0.82 Tm</b>   |

### **SUMMARY FLUID PRESSURE :**

| Description      | Fluid Pressure               |                        |
|------------------|------------------------------|------------------------|
|                  | Horizontal (H <sub>L</sub> ) | M <sub>TT</sub> (Dest) |
|                  | Tonne                        | Tm                     |
| 1) LWL Condition | 2.60                         | -0.82                  |

## EARTH PRESSURE CALCULATION FOR SHAFT DESIGN :

### A) Non-Seismic Case :

Coefficient of Active Earth Pressure

$$\text{Active earth pressure } Ka = \frac{\sin^2(\alpha + \phi)}{\sin^2 \alpha \cdot \sin(\alpha - \delta) \cdot \left[ 1 + \sqrt{\frac{\sin(\phi + \delta) \cdot \sin(\phi - i)}{\sin(\alpha - \delta) \cdot \sin(\alpha + i)}} \right]^2}$$

Backfill Soil Parameter

|                             |   |                    |   |               |
|-----------------------------|---|--------------------|---|---------------|
| $\phi$                      | = | 30 °               | = | 0.524 Radians |
| $\delta$                    | = | 20 °               | = | 0.349 Radians |
| $\delta_{\text{submerged}}$ | = | 10 °               | = | 0.175 Radians |
| $i$                         | = | 0 °                | = | 0 Radians     |
| $\alpha$                    | = | 88.04 °            | = | 1.537 Radians |
| $\gamma_{\text{dry}}$       | = | 2 t/m <sup>3</sup> |   |               |
| $\gamma_{\text{sat}}$       | = | 2 t/m <sup>3</sup> |   |               |
| $\gamma_{\text{sub}}$       | = | 1 t/m <sup>3</sup> |   |               |

|                        |   |   |                      |
|------------------------|---|---|----------------------|
| LL surcharge intensity | q | = | 2.4 t/m <sup>2</sup> |
|------------------------|---|---|----------------------|

|                 |   |   |      |
|-----------------|---|---|------|
| Abutment Length | L | = | 12 m |
|-----------------|---|---|------|

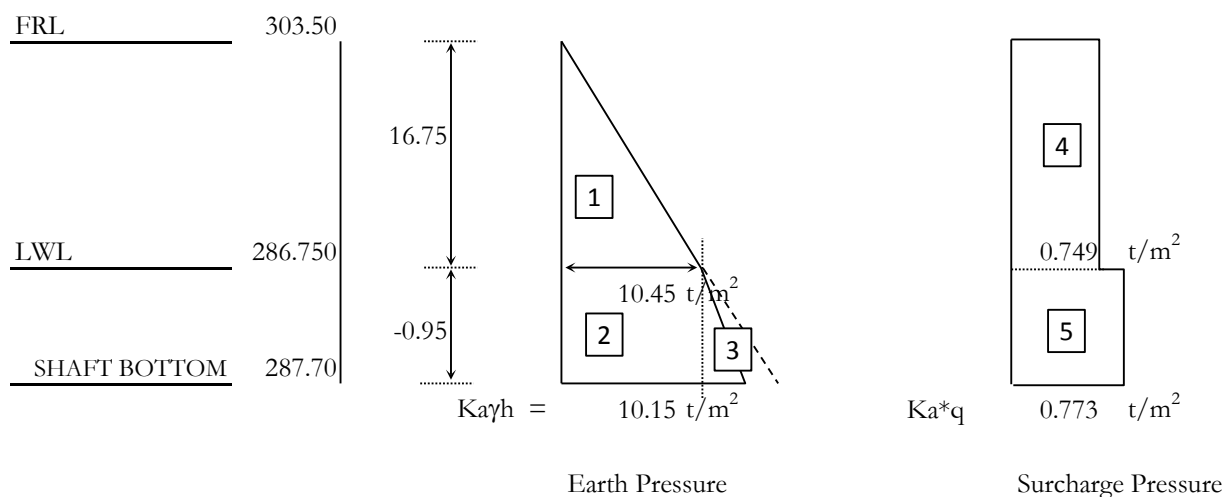
|             |   |   |       |
|-------------|---|---|-------|
| Shaft width | B | = | 1.6 m |
|-------------|---|---|-------|

|                   |   |       |
|-------------------|---|-------|
| $Ka_{\text{Dry}}$ | = | 0.312 |
|-------------------|---|-------|

|                          |   |       |
|--------------------------|---|-------|
| $Ka'_{\text{Submerged}}$ | = | 0.322 |
|--------------------------|---|-------|

### 1) LWL CONDITION

|                             |   |                      |
|-----------------------------|---|----------------------|
| Ka                          | = | 0.312                |
| Ka'                         | = | 0.322                |
| $\gamma_{\text{dry}}$       | = | 2 t/m <sup>3</sup>   |
| $\gamma_{\text{sub}}$       | = | 1 t/m <sup>3</sup>   |
| $\delta$                    | = | 20 °                 |
| $\delta_{\text{submerged}}$ | = | 10 °                 |
| q                           | = | 2.4 t/m <sup>2</sup> |
| L                           | = | 12 m                 |
| B                           | = | 1.6 m                |



Total Earth Pressure at rest

| Component | Factor | p                | h     | L  | F       | $\delta$ | $F \cdot \cos \delta$ | ey     | $F \cdot \sin \delta$ | ex   |
|-----------|--------|------------------|-------|----|---------|----------|-----------------------|--------|-----------------------|------|
|           |        | T/m <sup>2</sup> | m     | m  | Tonne   | deg      | Tonne                 | m      | Tonne                 | m    |
| 1         | 0.5    | 10.452           | 16.75 | 12 | 1050.43 | 20       | 987.08                | 6.085  | 359.27                | -0.8 |
| 2         | 1      | 10.452           | -0.95 | 12 | -119.15 | 10       | -117.34               | -0.475 | -20.69                | -0.8 |
| 3         | 0.5    | -0.3059          | -0.95 | 12 | 1.74    | 10       | 1.72                  | -0.317 | 0.30                  | -0.8 |
| Total     |        |                  |       |    | 933.017 |          | 871.452               | 6.497  | 338.879               | -0.8 |

|                                       |   |                     |
|---------------------------------------|---|---------------------|
| <b>Total Earth Pressure at rest</b>   | = | <b>933.02 Tonne</b> |
| <b>Horizontal Component</b>           | = | <b>871.45</b>       |
| <b>Lever arm</b>                      | = | <b>6.50</b>         |
| <b>Moment <math>M_{TT}</math></b>     | = | <b>5661.59 Tm</b>   |
| <b>Vertical Component</b>             | = | <b>338.88</b>       |
| <b>Lever arm</b>                      | = | <b>-0.80 m</b>      |
| <b>Moment <math>M_{TT}</math></b>     | = | <b>-271.10 Tm</b>   |
| <b>Net Moment <math>M_{TT}</math></b> | = | <b>5390.49 Tm</b>   |

Total Surcharge pressure

| Component | Factor | p                | h     | L  | F        | ey      |
|-----------|--------|------------------|-------|----|----------|---------|
|           |        | T/m <sup>2</sup> | m     | m  | Tonne    | m       |
| 4         | 1      | 0.7488           | 16.75 | 12 | 150.51   | 7.425   |
| 5         | 1      | 0.7728           | -0.95 | 12 | -8.80992 | -0.475  |
| Total     |        |                  |       |    | 141.699  | 7.91617 |



|                                   |          |                     |
|-----------------------------------|----------|---------------------|
| <b>Total Surcharge Pressure</b>   | <b>=</b> | <b>141.70 Tonne</b> |
| <b>Lever arm above base</b>       | <b>=</b> | <b>7.92 m</b>       |
| <b>Moment <math>M_{TT}</math></b> | <b>=</b> | <b>1121.71 Tm</b>   |

**SUMMARY EARTH PRESSURE :**

| Description      | Earth Pressure       |                 |                |                 |
|------------------|----------------------|-----------------|----------------|-----------------|
|                  | Horizontal ( $H_L$ ) | $M_{TT}$ (Dest) | Vertical ( V ) | $M_{TT}$ (Steb) |
|                  | Tonne                | Tm              | Tonne          | Tm              |
| 1) LWL Condition | 871.45               | 5661.59         | 338.88         | -271.1          |

**SUMMARY SURCHARGE PRESSURE :**

| Description      | Surcharge Pressure   |                 |
|------------------|----------------------|-----------------|
|                  | Horizontal ( $H_L$ ) | $M_{TT}$ (Dest) |
|                  | Tonne                | Tm              |
| 1) LWL Condition | 141.70               | 1121.71         |

## DYNAMIC EARTH PRESSURE CALCULATION FOR SHAFT DESIGN :

### A) Non-Seismic Case :

Coefficient of Earth Pressure at rest

$$K_o \text{ Dry} = 0.312$$

$$K_o' \text{ Submerged} = 0.322$$

Backfill Soil Parameter

|                             |   |                   |   |               |
|-----------------------------|---|-------------------|---|---------------|
| $\phi$                      | = | $30^\circ$        | = | 0.524 Radians |
| $\delta$                    | = | $20^\circ$        | = | 0.349 Radians |
| $\delta_{\text{submerged}}$ | = | $10^\circ$        | = | 0.175 Radians |
| $i$                         | = | $0^\circ$         | = | 0 Radians     |
| $\alpha$                    | = | $90^\circ$        | = | 1.571 Radians |
| $\gamma_{\text{dry}}$       | = | $2 \text{ t/m}^3$ |   |               |
| $\gamma_{\text{sat}}$       | = | $2 \text{ t/m}^3$ |   |               |
| $\gamma_{\text{sub}}$       | = | $1 \text{ t/m}^3$ |   |               |

$$\text{LL surcharge intensity } q = 2.4 \text{ t/m}^2$$

$$\text{Abutment Length } (1 \pm \alpha_v) * \sin^2(\alpha + \phi - \lambda) = 12 \text{ m}$$

$$\text{Shaft width } = \frac{B}{\cos \lambda * \sin^2 \alpha \cdot \sin(\alpha - \delta - \lambda) \cdot \left[ 1 + \sqrt{\frac{\sin(\phi + \delta) \cdot \sin(\phi - i - \lambda)}{\sin(\alpha - \delta - \lambda) \cdot \sin(\alpha + i)}} \right]} = 1.6 \text{ m}$$

$$\alpha_h = 0.04417$$

$$\alpha_v = 0.0325$$

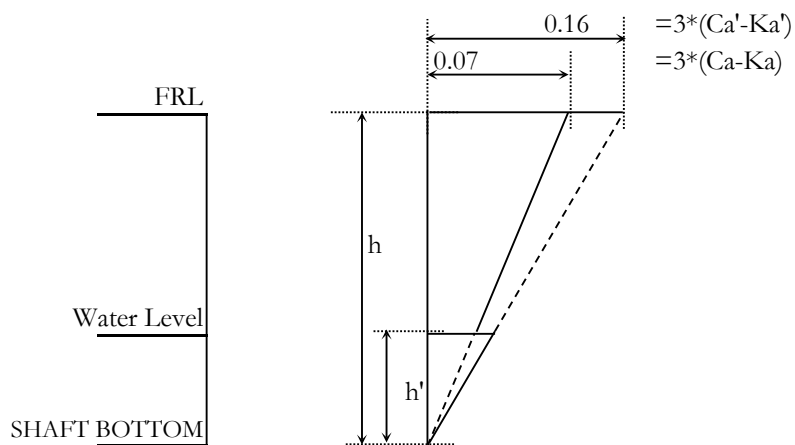
| $\lambda$                    | Formula used  | For | $+\alpha_v$ | $-\alpha_v$ |     |
|------------------------------|---|-----|-------------|-------------|-----|
| $\lambda_{\text{dry}}$       | $= \tan^{-1} \frac{\alpha_h}{1 \pm \alpha_v}$   |     | 2.45        | 2.61        | deg |
| $\lambda_{\text{submerged}}$ | $= \tan^{-1} \frac{\gamma_{\text{sat}} * \alpha_h}{(\gamma_{\text{sat}} - 1) (1 \pm \alpha_v)}$ |     | 4.89        | 5.21728     | deg |

| $+\alpha_v$ | $-\alpha_v$ |         |
|-------------|-------------|---------|
| 0.04        | 0.05        | Radians |
| 0.09        | 0.09        | Radians |

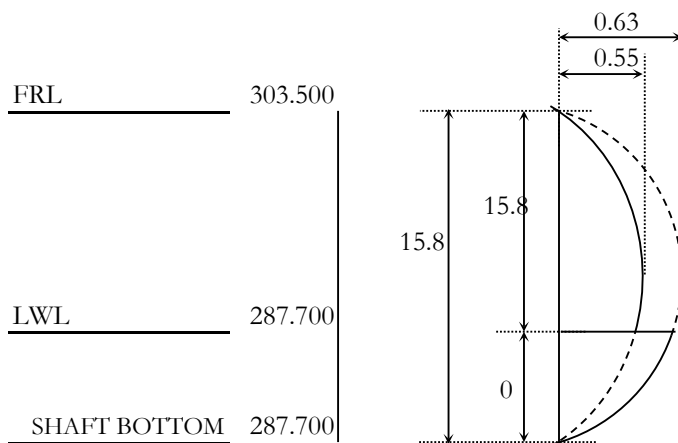
| Seismic case (Coefficient of Earth Pressure) |         |       |
|--|---------|-------|
| For Seismic downward dry condition           | $C_a$   | 0.335 |
| For Seismic downward submerged condition     | $C_a'$  | 0.375 |
| For Seismic upward dry condition             | $C_a-$  | 0.316 |
| For Seismic upward submerged condition       | $C_a-'$ | 0.355 |

### 1) LWL Seismic Downward

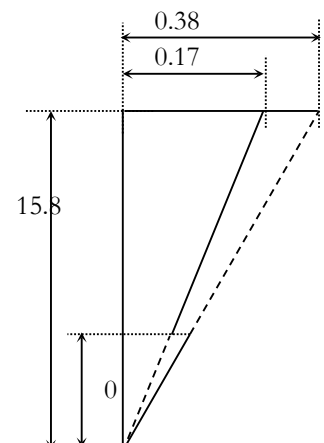
|                             |   |                      |
|-----------------------------|---|----------------------|
| $K_a$                       | = | 0.312                |
| $K_a'$                      | = | 0.322                |
| $C_a$                       | = | 0.335                |
| $C_a'$                      | = | 0.375                |
| $\gamma_{\text{dry}}$       | = | 2 t/m <sup>3</sup>   |
| $\gamma_{\text{sat}}$       | = | 2 t/m <sup>3</sup>   |
| $\gamma_{\text{sub}}$       | = | 1 t/m <sup>3</sup>   |
| $\delta$                    | = | 20 deg               |
| $\delta_{\text{submerged}}$ | = | 10 deg               |
| $q$                         | = | 2.4 t/m <sup>2</sup> |
| $L$                         | = | 12 m                 |
| $B$                         | = | 1.6 m                |



Dynamic Earth Pressure Coeff. Variation



Dynamic Earth Pressure



Dynamic Surcharge Pressure

#### Dyanmic Earth Pressure Calculation

Parabola above Water Level

|                         |   |                       |
|-------------------------|---|-----------------------|
| p <sub>mid_height</sub> | = | 0.55 t/m <sup>2</sup> |
| h                       | = | 15.8 m                |
| y                       | = | 7.9 m                 |
| L                       | = | 12 m                  |

Parabola below Water Level

|                         |   |                       |
|-------------------------|---|-----------------------|
| p <sub>mid_height</sub> | = | 0.63 t/m <sup>2</sup> |
| h                       | = | 15.8 m                |
| y                       | = | -7.9 m                |
| L                       | = | 12 m                  |

| Dyanmic Earth Pressure              | Pa          | δ    | Pa*Cosδ     | ey         | Pa*Sinδ     | ex          |
|-------------------------------------|-------------|------|-------------|------------|-------------|-------------|
|                                     | T           | deg. | T           | m          | T           | m           |
| Parabola above Water Level          | 69.7        | 20   | 65.5        | 7.9        | 23.8        | -0.8        |
| Parabola below Water Level          | 0.0         | 10   | 0.0         | 0.0        | 0.0         | -0.8        |
| <b>Total Dynamic Earth Pressure</b> | <b>69.7</b> |      | <b>65.5</b> | <b>7.9</b> | <b>23.8</b> | <b>-0.8</b> |

|                                     |   |                    |
|-------------------------------------|---|--------------------|
| <b>Total Dynamic Earth Pressure</b> | = | <b>69.70 Tonne</b> |
| <b>Horizontal Component</b>         | = | <b>65.50</b>       |
| <b>Lever arm</b>                    | = | <b>7.90</b>        |
| <b>Moment M<sub>TT</sub></b>        | = | <b>517.42 Tm</b>   |
| <b>Vertical Component</b>           | = | <b>23.84</b>       |
| <b>Lever arm</b>                    | = | <b>-0.80 m</b>     |
| <b>Moment M<sub>TT</sub></b>        | = | <b>-19.0708 Tm</b> |
| <b>Net Moment M<sub>TT</sub></b>    | = | <b>498.35 Tm</b>   |

#### Dyanmic Surcharge Pressure Calculation

Pressure Distribution above water level

|                          |   |                        |
|--------------------------|---|------------------------|
| Intensity at top         | = | 0.17 t/m <sup>2</sup>  |
| Intensity at water Level | = | 0.000 t/m <sup>2</sup> |
| h-h'                     | = | 15.8 m                 |
| L                        | = | 12 m                   |

Pressure Distribution below water level

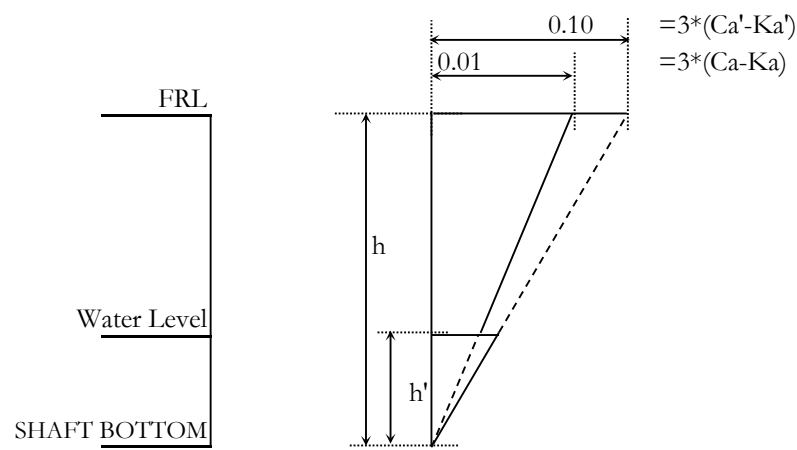
|                          |   |                       |
|--------------------------|---|-----------------------|
| Intensity at water Level | = | 0.00 t/m <sup>2</sup> |
| Intensity at base        | = | 0 t/m <sup>2</sup>    |
| h                        | = | 0 m                   |
| L                        | = | 12 m                  |

| Dyanmic Surcharge Pressure              | Pa           | Lever arm above Base |
|---|--------------|----------------------|
|   | T/m          | m                    |
| Trapezoidal Portion above water Level   | 15.88        | 10.5333              |
| Triangular Portion below water Level    | 0.00         | 0.00                 |
| <b>Total Dynamic Surcharge Pressure</b> | <b>15.88</b> | <b>10.53</b>         |

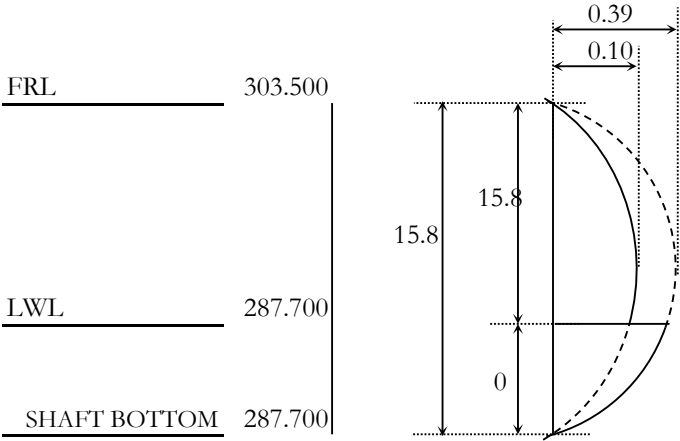
|                                 |   |                    |
|---------------------------------|---|--------------------|
| <b>Total Surcharge Pressure</b> | = | <b>15.88 Tonne</b> |
| <b>Lever arm above base</b>     | = | <b>10.53 m</b>     |
| <b>Moment M<sub>TT</sub></b>    | = | <b>167.28 Tm</b>   |

2) LWL Seismic Upward

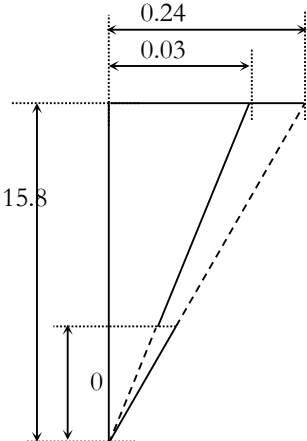
|                             |   |                      |
|-----------------------------|---|----------------------|
| Ka                          | = | 0.312                |
| Ka'                         | = | 0.322                |
| Ca-                         | = | 0.316                |
| Ca-'                        | = | 0.355                |
| $\gamma_{\text{dry}}$       | = | 2 t/m <sup>3</sup>   |
| $\gamma_{\text{sat}}$       | = | 2 t/m <sup>3</sup>   |
| $\gamma_{\text{sub}}$       | = | 1 t/m <sup>3</sup>   |
| $\delta$                    | = | 20 deg               |
| $\delta_{\text{submerged}}$ | = | 10 deg               |
| q                           | = | 2.4 t/m <sup>2</sup> |
| L                           | = | 12 m                 |
| B                           | = | 1.6 m                |



Dynamic Earth Pressure Coeff. Variation



Dynamic Earth Pressure



Dynamic Surcharge Pressure

### Dyanmic Earth Pressure Calculation

Parabola above Water Level

|                         |   |                       |
|-------------------------|---|-----------------------|
| p <sub>mid_height</sub> | = | 0.10 t/m <sup>2</sup> |
| h                       | = | 15.8 m                |
| y                       | = | 7.9 m                 |
| L                       | = | 12 m                  |

Parabola below Water Level

|                         |   |                       |
|-------------------------|---|-----------------------|
| p <sub>mid_height</sub> | = | 0.39 t/m <sup>2</sup> |
| h                       | = | 15.8 m                |
| y                       | = | -7.9 m                |
| L                       | = | 12 m                  |

| Dyanmic Earth Pressure              | Pa          | δ    | Pa*Cosδ     | ey         | Pa*Sinδ    | ex          |
|-------------------------------------|-------------|------|-------------|------------|------------|-------------|
|                                     | T           | deg. | T           | m          | T          | m           |
| Parabola above Water Level          | 12.1        | 20   | 11.4        | 7.9        | 4.1        | -0.8        |
| Parabola below Water Level          | 0.0         | 10   | 0.0         | 0.0        | 0.0        | -0.8        |
| <b>Total Dynamic Earth Pressure</b> | <b>12.1</b> |      | <b>11.4</b> | <b>7.9</b> | <b>4.1</b> | <b>-0.8</b> |

|                                     |   |                    |
|-------------------------------------|---|--------------------|
| <b>Total Dynamic Earth Pressure</b> | = | <b>12.09 Tonne</b> |
| <b>Horizontal Component</b>         | = | <b>11.36</b>       |
| <b>Lever arm</b>                    | = | <b>7.90</b>        |
| <b>Moment M<sub>TT</sub></b>        | = | <b>89.76 Tm</b>    |
| <b>Vertical Component</b>           | = | <b>4.14</b>        |
| <b>Lever arm</b>                    | = | <b>-0.80 m</b>     |
| <b>Moment M<sub>TT</sub></b>        | = | <b>-3.30835 Tm</b> |
| <b>Net Moment M<sub>TT</sub></b>    | = | <b>86.45 Tm</b>    |

### Dyanmic Surcharge Pressure Calculation

Pressure Distribution above water level

|                          |   |                        |
|--------------------------|---|------------------------|
| Intensity at top         | = | 0.03 t/m <sup>2</sup>  |
| Intensity at water Level | = | 0.000 t/m <sup>2</sup> |
| h-h'                     | = | 15.8 m                 |
| L                        | = | 12 m                   |

Pressure Distribution below water level

|                          |   |                       |
|--------------------------|---|-----------------------|
| Intensity at water Level | = | 0.00 t/m <sup>2</sup> |
| Intensity at base        | = | 0 t/m <sup>2</sup>    |
| h                        | = | 0 m                   |
| L                        | = | 12 m                  |

| Dyanmic Surcharge Pressure              | Pa          | Lever arm above Base |
|---|-------------|----------------------|
|   | T/m         | m                    |
| Trapezoidal Portion above water Level   | 2.75        | 10.53                |
| Triangular Portion below water Level    | 0.00        | 0.00                 |
| <b>Total Dynamic Surcharge Pressure</b> | <b>2.75</b> | <b>10.53</b>         |

|                                 |   |                   |
|---------------------------------|---|-------------------|
| <b>Total Surcharge Pressure</b> | = | <b>2.75 Tonne</b> |
| <b>Lever arm above base</b>     | = | <b>10.53 m</b>    |
| <b>Moment M<sub>TT</sub></b>    | = | <b>29.02 Tm</b>   |

***SUMMARY DYNAMIC EARTH PRESSURE :***

| Description   | Dynamic Earth Pressure       |                        |               |                        |
|---|------------------------------|------------------------|---------------|------------------------|
|   | Horizontal (H <sub>L</sub> ) | M <sub>TT</sub> (Dest) | Vertical (V ) | M <sub>TT</sub> (Steb) |
|   | Tonne                        | Tm                     | Tonne         | Tm                     |
| 1) LWL Seismic Downward<br>Horizontal Component<br>Vertical Component | 0.00                         | 0.00                   | 0.00          | 0                      |
| 2) LWL Seismic Upward<br>Horizontal Component<br>Vertical Component   | 0.00                         | 0.00                   | 0.00          | 0.00                   |

***SUMMARY DYNAMIC SURCHARGE PRESSURE :***

| Description             | Dynamic Surcharge Pressure   |                        |
|-------------------------|------------------------------|------------------------|
|                         | Horizontal (H <sub>L</sub> ) | M <sub>TT</sub> (Dest) |
|                         | Tonne                        | Tm                     |
| 1) LWL Seismic Downward | 0.00                         | 0.00                   |
| 2) LWL Seismic Upward   | 0.00                         | 0.00                   |

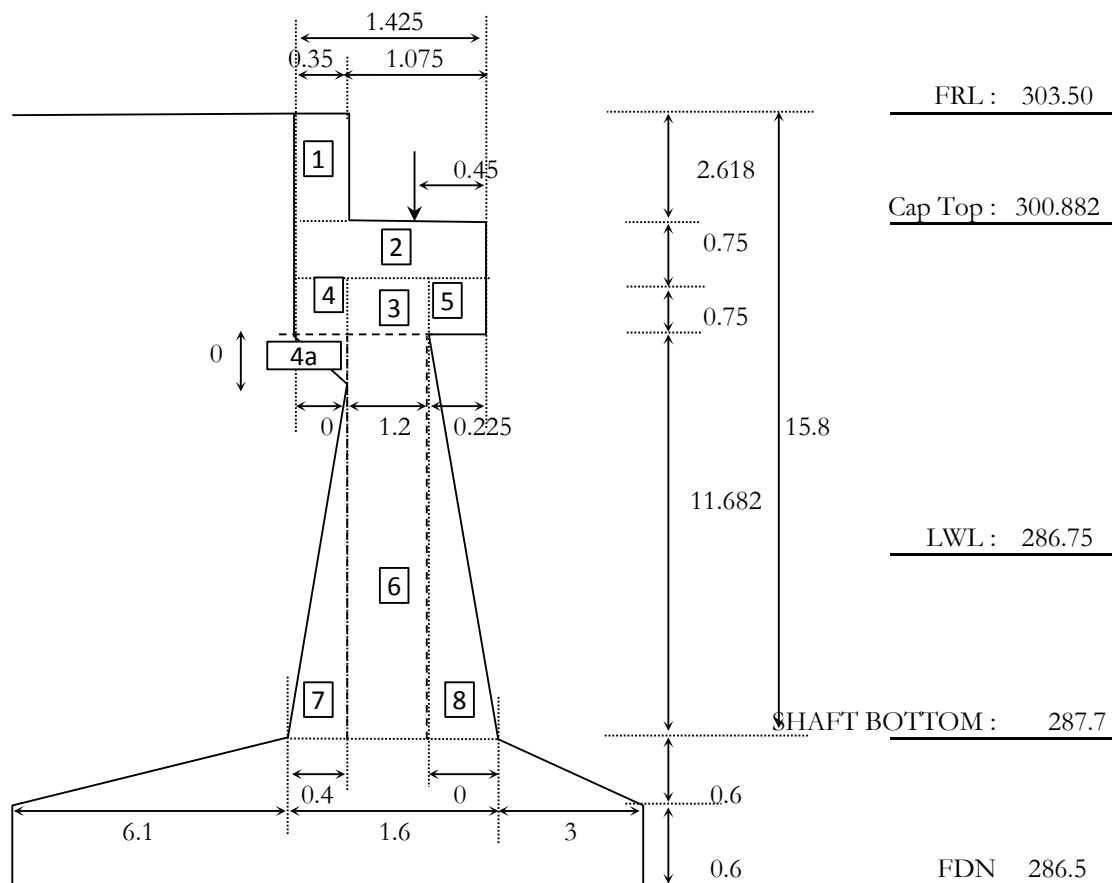
## UNFACTORED FORCES FOR DESIGN OF SHAFT :

### SELFWEIGHT OF ABUTMENT

|                           |                           |       |                  |
|---------------------------|---------------------------|-------|------------------|
| RCC Density               | =                         | 2.5   | t/m <sup>3</sup> |
| water density             | $\gamma_{\text{water}}$ = | 1     | t/m <sup>3</sup> |
| Soil Density              | $\gamma_{\text{soil}}$ =  | 2     | t/m <sup>3</sup> |
| Thickness of wearing coat | =                         | 0.065 | m                |
| Depth of super-structure  | =                         | 2.403 | m                |

### ABUTMENT COMPONENT :-

Length of Abutment = 12 m



### Calculating Selfweight of Sub-structure :

Forces @ Base of abutment shaft

$e_L$  = Cg. w.r.t. c/L of shaft, at bottom of abutment shaft.  
 $e_Y$  = Cg. From base of abutment shaft.



| Element                                  | Area Factor | B     | H   | L  | V              | W      | e <sub>Y</sub> | e <sub>L</sub> |
|--|-------------|-------|---|----|----------------|--------|----------------|----------------|
|  |             | m     | m   | m  | m <sup>3</sup> | Tonne  | m              | m              |
| Dirt Wall & Abutment Cap                 |             |       |   |    |                |        |                |                |
| 1  | 1           | 0.35  | 2.618   | 12 | 11.00          | 27.49  | 14.49          | -0.225         |
| 2  | 1           | 1.425 | 0.75  | 12 | 12.825         | 32.06  | 12.81          | 0.3125         |
| 3  | 1           | 1.425 | 0.75  | 12 | 12.825         | 32.06  | 12.81          | 0.3125         |
| 4  | 0           | 0     | 0.75  | 12 | 0.00           | 0.00   | 12.18          | -0.4           |
| 4a                                       | 0           | 0     | 0   | 12 | 0.00           | 0.00   | 11.68          | -0.4           |
| 5  | 0           | 0.225 | 0.75  | 12 | 0.00           | 0.00   | 12.18          | 0.875          |
|  | Total       |       |   |    | 36.65          | 91.62  | 13.31          | 0.15           |
| */ Increase Abutment cap weight by       |             |       | 20% on account of bearing, bearing pedestal, stopper etc. |    |                |        |                |                |
| <i>Abutment Cap weight Considered</i>    |             |       |   |    | 43.98          | 109.94 | 13.31          | 0.15           |
| Abutment Shaft                           |             |       |   |    |                |        |                |                |
| 6  | 1           | 1.2   | 11.68   | 12 | 168.21         | 420.5  | 5.84           | 0.2            |
| 7  | 0.5         | 0.4   | 11.68   | 12 | 28.04          | 70.1   | 3.89           | -0.53333       |
| 8  | 0.5         | 0     | 11.68   | 12 | 0.00           | 0.0    | 3.89           | 0.800          |
| <i>Abutment shaft weight considered.</i> |             |       |   |    | 196.25         | 490.62 | 5.56           | 0.10           |

|   |               |               |             |             |
|---|---------------|---------------|-------------|-------------|
| <b>Total Sub-structure self weight at base of shaft</b> | <b>240.23</b> | <b>600.57</b> | <b>6.98</b> | <b>0.11</b> |
|---|---------------|---------------|-------------|-------------|

|   |          |                   |
|---|----------|-------------------|
| <b>Total Weight of sub-structure &amp; foundation</b> | <b>=</b> | <b>600.57 T</b>   |
| <b>Lever arm about toe (along L-L axis)</b>           | <b>=</b> | <b>0.11 m</b>     |
| <b>Moment M<sub>TT</sub></b>                          | <b>=</b> | <b>63.3494 Tm</b> |

***Forces due to Super-Structure DL, at Shaft Bottom:***

|   |   |              |
|---|---|--------------|
| Vertical Load (Sup DL Reaction)           | = | 266.95 Tonne |
| Cg. From Deck Top                         | = | 0.49 m       |
| Lever arm about toe (along L-L axis)      | = | 0.575 m      |
| Moment M <sub>TT</sub>                    | = | 153.496 Tm   |
| Lever arm about c/L base (along T-T axis) | = | 0.00 m       |
| Moment M <sub>LL</sub>                    | = | 0 Tm         |
| Cg. From base slab bottom                 | = | 15.246 m     |

***Forces due to Super-Structure SIDL, at Shaft Bottom:***

|   |   |              |
|---|---|--------------|
| Vertical Load (Sup SIDL Reaction)         | = | 116.99 Tonne |
| Cg. above Deck Top                        | = | 0.31 m       |
| Lever arm about toe (along L-L axis)      | = | 0.575 m      |
| Moment $M_{TT}$                           | = | 67.2669 Tm   |
| Lever arm about c/L base (along T-T axis) | = | 0.00 m       |
| Moment $M_{LL}$                           | = | 0.00 Tm      |
| Cg. From base Slab bottom                 | = | 16.045 m     |

***Forces due to Super-Structure Surfacing , at Shaft Bottom:***

|   |   |             |
|---|---|-------------|
| Vertical Load (Sup Surfacing Reaction)    | = | 34.03 Tonne |
| Cg. above Deck Top                        | = | 0.03 m      |
| Lever arm about toe (along L-L axis)      | = | 0.575 m     |
| Moment $M_{TT}$                           | = | 19.5644 Tm  |
| Lever arm about c/L base (along T-T axis) | = | -0.25 m     |
| Moment $M_{LL}$                           | = | -8.51 Tm    |
| Cg. From base Slab bottom                 | = | 15.768 m    |

| <b>Forces due to LL , at Shaft Bottom:</b> |   | <b>Max Reaction</b> | <b>Min Reaction</b> |
|--|---|---------------------|---------------------|
| Vertical Load (CW LL Reaction)             | = | 137.40 Tonne        | 28.80 Tonne         |
| Lever arm about toe (along L-L axis)       | = | 0.575 m             | 0.575 m             |
| Moment $M_{TT}$                            | = | 79.0052 Tm          | 16.5598 Tm          |
| Lever arm about c/L base (along T-T axis)  | = | 2.91 m              | 2.91 m              |
| Moment $M_{LL}$                            | = | 399.83 Tm           | 83.81 Tm            |

| <b>Forces due to LL Longitudinal Forces, at Shaft Bottom:</b> |   |                   |  |
|---|---|-------------------|--|
| Longitudinal Force  | = | <b>39.2 Tonne</b> |  |
| Lever arm from footing base                                   | = | 13.332 m          |  |
| Moment in about transverse axis $M_{TT}$                      | = | <b>522.0 tm</b>   |  |

**Seismic Component of Permanent Load (DL+SIDL+SURFACING), at Shaft Bottom:**

| At Fixed End, Force about toe | V<br>T | $H_L$<br>T | $H_T$<br>T | ey<br>m | $e_L$<br>m | $M_{LL}$<br>Tm | $M_{TT}$<br>Tm |
|-------------------------------|--------|------------|------------|---------|------------|----------------|----------------|
| Seismic Longitudinal          |        | 36.9       |            | 13.332  |            |                | 492.3          |
| Seismic Transverse            |        |            | 61.1       | 15.512  |            | 948.2          |                |
| Seismic Vertical              | 13.6   |            |            |         | 0.575      |                | 7.8            |

**Summery of LL seismic component transferred from super-structure, at Shaft Bottom:**

**Max Live Load Reaction Case :**

| At Fixed/ Free End   | V<br>T | $H_L$<br>T | $H_T$<br>T | ey<br>m | $e_L$<br>m | $M_{LL}$<br>Tm | $M_{TT}$<br>Tm |
|----------------------|--------|------------|------------|---------|------------|----------------|----------------|
| Seismic Longitudinal |        | 0.0        |            | 0.0     |            |                | 0.0            |
| Seismic Transverse   |        |            | 20.1       | 17.000  |            | 341.6          |                |
| Seismic Vertical     | 4.5    |            |            |         | 0.6        |                | 2.6            |

Min Live Load Reaction Case :

| At Fixed/ Free End   | V<br>T | H <sub>L</sub><br>T | H <sub>T</sub><br>T | ey<br>m | e <sub>L</sub><br>m | M <sub>LL</sub><br>Tm | M <sub>TT</sub><br>Tm |
|----------------------|--------|---------------------|---------------------|---------|---------------------|-----------------------|-----------------------|
| Seismic Longitudinal |        | 0.0                 |                     | 0.0     |                     |                       | 0.0                   |
| Seismic Transverse   |        |                     | 4.2                 | 17.000  |                     | 71.6                  |                       |
| Seismic Vertical     | 0.9    |                     |                     | 0.6     |                     |                       | 0.5                   |

**SEISMIC COMPONENT OF SUB-STRUCTURE :**

Longitudinal Horizontal seismic coefficient       $A_{hL}$       =      0.04417

Transverse Horizontal seismic coefficient       $A_{hT}$       =      0.14625

Vertical seismic coefficient       $A_V$       =      0.0325

**Sub-structure seismic component :**

| Description          | W     | ey             | ex             | W   | =              | Weight of sub-structure              |                 |
|----------------------|-------|----------------|----------------|-----|----------------|--------------------------------------|-----------------|
|                      | Tonne | m              | m              | ey  | =              | Cg. above base slab in vertical dir. |                 |
| Sub-structure =      | 600.6 | 7.0            | 0.1            |     |                |                                      |                 |
| Seismic Component    | V     | H <sub>L</sub> | H <sub>T</sub> | ey  | e <sub>L</sub> | M <sub>LL</sub>                      | M <sub>TT</sub> |
|                      | T     | T              | T              | m   | m              | Tm                                   | Tm              |
| Seismic Longitudinal | 26.5  |                |                | 7.0 |                | 185.2                                |                 |
| Seismic Transverse   | 87.8  |                |                | 7.0 |                | 613.2                                |                 |
| Seismic Vertical     | 19.5  |                |                | 0.1 |                | 2.1                                  |                 |

**SUMMARY OF FORCES :**

| S.N.  | Description                          | Forces about toe |                |                |                 |                 |
|-------|--------------------------------------|------------------|----------------|----------------|-----------------|-----------------|
|       |                                      | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|       |                                      | Tonne            | Tonne          | Tonne          | Tm              | Tm              |
| 1)    | Sub-structure                        | 600.6            |                |                | 63.3            | 0.0             |
| 3)    | Super-structure DL                   | 266.9            |                |                | 153.5           | 0.0             |
| 4)    | SIDL (excluding surfacing)           | 117.0            |                |                | 67.3            | 0.0             |
| 5)    | Surfacing                            | 34.0             |                |                | 19.6            | -8.5            |
| 6.1)  | Live Load Vertical Load Max Reaction | 137.4            |                |                | 79.0            | 399.8           |
| 6.2)  | Live Load Vertical Load Min Reaction | 28.8             |                |                | 16.6            | 83.8            |
| 7)    | Live Load Horizontal Forces          |                  | 39.2           |                | 522.0           |                 |
| 9)    | Fluid Pressure                       |                  | 2.5992         |                | -0.8            |                 |
| 9.1)  | Earth Pressure LWL                   |                  |                |                |                 |                 |
|       | Horizontal Component                 |                  | 871.5          |                | 5661.6          |                 |
|       | Vertical Component                   | 338.9            |                |                | -271.1          |                 |
| 10.1) | Surcharge Pressure LWL               |                  | 141.7          |                | 1121.7          |                 |



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LOAD COMBINATION  
FOR DESIGN OF PIER SHAFT

| LC-1  | NS, LWL, Span dislodge, FP | Forces about toe |                |                |                 |                 | LC-1 |
|-------|----------------------------|------------------|----------------|----------------|-----------------|-----------------|------|
| S.N.  | Description                | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |      |
|       |                            | Tonne            | Tonne          | Tonne          | Tm              | Tm              |      |
| 1)    | Sub-structure              | 600.57           |                |                | 63.349          | 0               | 1.35 |
| 9)    | Fluid Pressure             |                  | 2.5992         |                | -0.823          |                 | 1.5  |
| 10.1) | Surcharge Pressure LWL     |                  | 141.7          |                | 1121.7          |                 | 1.2  |

| S.N. | Description                | Forces at bottom of abutment shaft |                |                |                 |                 |
|------|----------------------------|------------------------------------|----------------|----------------|-----------------|-----------------|
|      |                            | V                                  | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|      |                            | Tonne                              | Tonne          | Tonne          | Tm              | Tm              |
| LC-1 | NS, LWL, Span dislodge, FP | 810.76                             | 173.94         | 0              | 1430.3          | 0               |

| LC-2  | NS, LWL, Span dislodge, EP | Forces about toe |                |                |                 |                 | LC-2 |
|-------|----------------------------|------------------|----------------|----------------|-----------------|-----------------|------|
| S.N.  | Description                | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |      |
|       |                            | Tonne            | Tonne          | Tonne          | Tm              | Tm              |      |
| 1)    | Sub-structure              | 600.57           |                |                | 63.349          | 0               | 1.35 |
| 9.1)  | Earth Pressure LWL         |                  |                |                |                 |                 | 1.5  |
|       | Horizontal Component       |                  | 871.45         |                | 5661.6          |                 | 1.5  |
| 10.1) | Surcharge Pressure LWL     |                  | 141.7          |                | 1121.7          |                 | 1.2  |

| S.N. | Description                | Forces at bottom of abutment shaft |                |                |                 |                 |
|------|----------------------------|------------------------------------|----------------|----------------|-----------------|-----------------|
|      |                            | V                                  | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|      |                            | Tonne                              | Tonne          | Tonne          | Tm              | Tm              |
| LC-2 | NS, LWL, Span dislodge, EP | 810.76                             | 1477.2         | 0              | 9924            | 0               |

| LC-3 | NS, LWL, Min LL Lead, FP   | Forces about toe |                |                |                 |                 | LC-3 |
|------|----------------------------|------------------|----------------|----------------|-----------------|-----------------|------|
| S.N. | Description                | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |      |
|      |                            | Tonne            | Tonne          | Tonne          | Tm              | Tm              |      |
| 1)   | Sub-structure              | 600.57           |                |                | 63.349          | 0               | 1.35 |
| 3)   | Super-structure DL         | 266.95           |                |                | 153.5           | 0               | 1.35 |
| 4)   | SIDL (excluding surfacing) | 116.99           |                |                | 67.267          | 0               | 1.35 |
| 5)   | Surfacing                  | 34.025           |                |                | 19.564          | -8.506          | 1.75 |

|       |                                   |      |        |  |        |        |  |      |
|-------|-----------------------------------|------|--------|--|--------|--------|--|------|
| 6.2)  | Live Load Vertical Load Min React | 28.8 |        |  | 16.56  | 83.807 |  | 1.15 |
| 7)    | Live Load Horizontal Forces       |      | 39.153 |  | 521.99 |        |  | 1.15 |
| 9)    | Fluid Pressure                    |      | 2.5992 |  | -0.823 |        |  | 1.5  |
| 10.1) | Surcharge Pressure LWL            |      | 141.7  |  | 1121.7 |        |  | 1.2  |

| S.N. | Description              | Forces at bottom of abutment shaft |                |                |                 |                 |
|------|--------------------------|------------------------------------|----------------|----------------|-----------------|-----------------|
|      |                          | V                                  | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|      |                          | Tonne                              | Tonne          | Tonne          | Tm              | Tm              |
| LC-3 | NS, LWL, Min LL Lead, FP | 1421.7                             | 218.96         | 0              | 2381.9          | 81.492          |

| LC-4  | NS, LWL, Min LL Lead, EP          | Forces about toe |                |                |                 |                 |  | LC-4 |
|-------|-----------------------------------|------------------|----------------|----------------|-----------------|-----------------|--|------|
| S.N.  | Description                       | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |  |      |
|       |                                   | Tonne            | Tonne          | Tonne          | Tm              | Tm              |  |      |
| 1)    | Sub-structure                     | 600.57           |                |                | 63.349          | 0               |  | 1.35 |
| 3)    | Super-structure DL                | 266.95           |                |                | 153.5           | 0               |  | 1.35 |
| 4)    | SIDL (excluding surfacing)        | 116.99           |                |                | 67.267          | 0               |  | 1.35 |
| 5)    | Surfacing                         | 34.025           |                |                | 19.564          | -8.506          |  | 1.75 |
| 6.2)  | Live Load Vertical Load Min React | 28.8             |                |                | 16.56           | 83.807          |  | 1.15 |
| 7)    | Live Load Horizontal Forces       |                  | 39.153         |                | 521.99          |                 |  | 1.15 |
| 9.1)  | Earth Pressure LWL                |                  |                |                |                 |                 |  | 1.5  |
|       | Horizontal Component              |                  | 871.45         |                | 5661.6          |                 |  | 1.5  |
| 10.1) | Surcharge Pressure LWL            |                  | 141.7          |                | 1121.7          |                 |  | 1.2  |

| S.N. | Description              | Forces at bottom of abutment shaft |                |                |                 |                 |
|------|--------------------------|------------------------------------|----------------|----------------|-----------------|-----------------|
|      |                          | V                                  | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|      |                          | Tonne                              | Tonne          | Tonne          | Tm              | Tm              |
| LC-4 | NS, LWL, Min LL Lead, EP | 1421.7                             | 1522.2         | 0              | 10876           | 81.492          |

| LC-5 | NS, LWL, Max LL, FP               | Forces about toe |                |                |                 |                 |  | LC-5 |
|------|-----------------------------------|------------------|----------------|----------------|-----------------|-----------------|--|------|
| S.N. | Description                       | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |  |      |
|      |                                   | Tonne            | Tonne          | Tonne          | Tm              | Tm              |  |      |
| 1)   | Sub-structure                     | 600.57           |                |                | 63.349          | 0               |  | 1.35 |
| 3)   | Super-structure DL                | 266.95           |                |                | 153.5           | 0               |  | 1.35 |
| 4)   | SIDL (excluding surfacing)        | 116.99           |                |                | 67.267          | 0               |  | 1.35 |
| 5)   | Surfacing                         | 34.025           |                |                | 19.564          | -8.506          |  | 1.75 |
| 6.1) | Live Load Vertical Load Max React | 137.4            |                |                | 79.005          | 399.83          |  | 1.5  |
| 7)   | Live Load Horizontal Forces       |                  | 39.153         |                | 521.99          |                 |  | 1.5  |
| 9)   | Fluid Pressure                    |                  | 2.5992         |                | -0.823          |                 |  | 1    |



|       |                        |  |       |  |        |  |     |
|-------|------------------------|--|-------|--|--------|--|-----|
| 10.1) | Surcharge Pressure LWL |  | 141.7 |  | 1121.7 |  | 1.2 |
|-------|------------------------|--|-------|--|--------|--|-----|

| S.N. | Description         | Forces at bottom of abutment shaft |                |                |                 |                 |
|------|---------------------|------------------------------------|----------------|----------------|-----------------|-----------------|
|      |                     | V                                  | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|      |                     | Tonne                              | Tonne          | Tonne          | Tm              | Tm              |
| LC-5 | NS, LWL, Max LL, FP | 1594.7                             | 231.37         | 0              | 2664.5          | 584.87          |

|       |                                  |                  |                |                |                 |                 |      |
|-------|----------------------------------|------------------|----------------|----------------|-----------------|-----------------|------|
| LC-6  | NS, LWL, Max LL, EP              | Forces about toe |                |                |                 |                 | LC-6 |
| S.N.  | Description                      | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |      |
|       |                                  | Tonne            | Tonne          | Tonne          | Tm              | Tm              |      |
| 1)    | Sub-structure                    | 600.57           |                |                | 63.349          | 0               | 1.35 |
| 3)    | Super-structure DL               | 266.95           |                |                | 153.5           | 0               | 1.35 |
| 4)    | SIDL (excluding surfacing)       | 116.99           |                |                | 67.267          | 0               | 1.35 |
| 5)    | Surfacing                        | 34.025           |                |                | 19.564          | -8.506          | 1.75 |
| 6.1)  | Live Load Vertical Load Max Reac | 137.4            |                |                | 79.005          | 399.83          | 1.5  |
| 7)    | Live Load Horizontal Forces      |                  | 39.153         |                | 521.99          |                 | 1.5  |
| 9.1)  | Earth Pressure LWL               |                  |                |                |                 |                 | 1    |
|       | Horizontal Component             |                  | 871.45         |                | 5661.6          |                 | 1    |
| 10.1) | Surcharge Pressure LWL           |                  | 141.7          |                | 1121.7          |                 | 1.2  |

| S.N. | Description         | Forces at bottom of abutment shaft |                |                |                 |                 |
|------|---------------------|------------------------------------|----------------|----------------|-----------------|-----------------|
|      |                     | V                                  | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|      |                     | Tonne                              | Tonne          | Tonne          | Tm              | Tm              |
| LC-6 | NS, LWL, Max LL, EP | 1594.7                             | 1100.2         | 0              | 8326.9          | 584.87          |

|                             |   |                  |                |                |                 |                 |      |
|-----------------------------|---|------------------|----------------|----------------|-----------------|-----------------|------|
| LC-7                        | SIS,LWL, Span dislodge ,Seismic S         | Forces about toe |                |                |                 |                 | LC-7 |
| S.N.                        | Description                               | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |      |
|                             |   | Tonne            | Tonne          | Tonne          | Tm              | Tm              |      |
| 1)                          | Sub-structure                             | 600.57           |                |                | 63.349          | 0               | 1.35 |
| 9.1)                        | Earth Pressure LWL                        |                  |                |                |                 |                 | 1    |
|                             | Horizontal Component                      |                  | 871.45         |                | 5661.6          |                 | 1    |
| 10.1)                       | Surcharge Pressure LWL                    |                  | 141.7          |                | 1121.7          |                 | 0.2  |
| <b>Seismic Longitudinal</b> |   |                  |                |                |                 |                 | 0.75 |
| 11)                         | Sub-structure Component                   |                  | 26.528         |                | 185.2           |                 | 0.75 |
| 12)                         | Backfill                                  |                  | 76.398         |                | 804.72          |                 | 0.75 |
| 12)                         | Super-Structure DL, SIDL, & Surfacing Cor |                  | 36.924         |                | 492.27          |                 | 0.75 |
| 13)                         | Dynamic Earth Pressure                    |                  |                |                |                 |                 | 0.75 |
|                             | Horizontal Component                      |                  | 0              |                | 0               |                 | 0.75 |

|                                  |   |        |   |        |        |        |       |
|----------------------------------|---|--------|---|--------|--------|--------|-------|
| 14)                              | Dynamic Surcharge Pressure                      |        |   |        |        |        | 0.15  |
|                                  | 14.1) LWL Seismic Downward                      |        | 0 |        | 0      |        | 0.15  |
| <b>Seismic Transverses</b>       |   |        |   |        |        |        | 0.225 |
| 15)                              | Sub-structure Component                         |        |   | 87.832 |        | 613.18 | 0.225 |
| 17)                              | Super-Structure DL, SIDL, & Surfacing Component |        |   | 61.126 |        | 948.19 | 0.225 |
| <b>Seismic Vertical Downward</b> |   |        |   |        |        |        | 0.225 |
| 19)                              | Sub-structure Component                         | 19.518 |   |        | 2.0588 |        | 0.225 |
| 21)                              | Super-Structure DL, SIDL, & Surf                | 13.584 |   |        | 7.8106 |        | 0.225 |

| S.N. | Description                       | Forces at bottom of abutment shaft |                |                |                 |                 |
|------|-----------------------------------|------------------------------------|----------------|----------------|-----------------|-----------------|
|      |                                   | V                                  | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|      |                                   | Tonne                              | Tonne          | Tonne          | Tm              | Tm              |
| LC-7 | SIS,LWL, Span dislodge ,Seismic S | 818.21                             | 1004.7         | 33.516         | 7085.3          | 351.31          |

|                                  |   |                  |                |                |                 |                 |        |
|----------------------------------|---|------------------|----------------|----------------|-----------------|-----------------|--------|
| LC-8                             | SIS, LWL,Span dislodge ,Seismic S               | Forces about toe |                |                |                 |                 | LC-8   |
| S.N.                             | Description                                     | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |        |
|                                  |   | Tonne            | Tonne          | Tonne          | Tm              | Tm              |        |
| 1)                               | Sub-structure                                   | 600.57           |                |                | 63.349          | 0               | 1.35   |
| 9.1)                             | Earth Pressure LWL                              |                  |                |                |                 |                 | 1      |
|                                  | Horizontal Component                            |                  | 871.45         |                | 5661.6          |                 | 1      |
| 10.1)                            | Surcharge Pressure LWL                          |                  | 141.7          |                | 1121.7          |                 | 0.2    |
| <b>Seismic Longitudinal</b>      |   |                  |                |                |                 |                 | 0.75   |
| 11)                              | Sub-structure Component                         |                  | 26.528         |                | 185.2           |                 | 0.75   |
| 12)                              | Backfill  |                  | 76.398         |                | 804.72          |                 | 0.75   |
| 12)                              | Super-Structure DL, SIDL, & Surfacing Co        |                  | 36.924         |                | 492.27          |                 | 0.75   |
| 13)                              | Dynamic Earth Pressure                          |                  |                |                |                 |                 | 0.75   |
|                                  | Horizontal Component                            |                  | 0              |                | 0               |                 | 0.75   |
| 14)                              | Dynamic Surcharge Pressure                      |                  |                |                |                 |                 | 0.15   |
|                                  | 14.2) LWL Seismic Upward                        |                  | 0              |                | 0               |                 | 0.15   |
| <b>Seismic Transverses</b>       |   |                  |                |                |                 |                 | 0.225  |
| 15)                              | Sub-structure Component                         |                  |                | 87.832         |                 | 613.18          | 0.225  |
| 17)                              | Super-Structure DL, SIDL, & Surfacing Component |                  |                | 61.126         |                 | 948.19          | 0.225  |
| <b>Seismic Vertical Downward</b> |   |                  |                |                |                 |                 | 0.225  |
| 19)                              | Sub-structure Component                         | 19.518           |                |                | 2.0588          |                 | -0.225 |
| 21)                              | Super-Structure DL, SIDL, & Surf                | 13.584           |                |                | 7.8106          |                 | -0.225 |

| S.N. | Description                       | Forces at bottom of abutment shaft |                |                |                 |                 |
|------|-----------------------------------|------------------------------------|----------------|----------------|-----------------|-----------------|
|      |                                   | V                                  | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|      |                                   | Tonne                              | Tonne          | Tonne          | Tm              | Tm              |
| LC-8 | SIS, LWL,Span dislodge ,Seismic S | 803.32                             | 1004.7         | 33.516         | 7080.9          | 351.31          |

|  |  |  |  |  |  |  |
|--|--|--|--|--|--|--|
|  |  |  |  |  |  |  |
|--|--|--|--|--|--|--|

| LC-9                             | SIS,LWL,Min LL Acc,Seismic Sx=                  | Forces about toe |                |                |                 |                 | LC-9 |
|----------------------------------|---|------------------|----------------|----------------|-----------------|-----------------|------|
| S.N.                             | Description                                     | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |      |
|                                  |   | Tonne            | Tonne          | Tonne          | Tm              | Tm              |      |
| 1)                               | Sub-structure                                   | 600.57           |                |                | 63.349          | 0               | 1.35 |
| 3)                               | Super-structure DL                              | 266.95           |                |                | 153.5           | 0               | 1.35 |
| 4)                               | SIDL (excluding surfacing)                      | 116.99           |                |                | 67.267          | 0               | 1.35 |
| 5)                               | Surfacing                                       | 34.025           |                |                | 19.564          | -8.506          | 1.35 |
| 6.2)                             | Live Load Vertical Load Min React               | 28.8             |                |                | 16.56           | 83.807          | 0.2  |
| 7)                               | Live Load Horizontal Forces                     |                  | 39.153         |                | 521.99          |                 | 0.2  |
| 9.1)                             | Earth Pressure LWL                              |                  |                |                |                 |                 | 1    |
|                                  | Horizontal Component                            |                  | 871.45         |                | 5661.6          |                 | 1    |
| 10.1)                            | Surcharge Pressure LWL                          |                  | 141.7          |                | 1121.7          |                 | 0.2  |
| <b>Seismic Longitudinal</b>      |   |                  |                |                |                 |                 | 1.5  |
| 11)                              | Sub-structure Component                         |                  | 26.528         |                | 185.2           |                 | 1.5  |
| 12)                              | Backfill  |                  | 76.398         |                | 804.72          |                 | 1.5  |
| 12)                              | Super-Structure DL, SIDL, & Surfacing Component |                  | 36.924         |                | 492.27          |                 | 1.5  |
| 13)                              | Dynamic Earth Pressure                          |                  |                |                |                 |                 | 1.5  |
|                                  | Horizontal Component                            |                  | 0              |                | 0               |                 | 1.5  |
| 14)                              | Dynamic Surcharge Pressure                      |                  |                |                |                 |                 | 0.3  |
|                                  | 14.1) LWL Seismic Downward                      |                  | 0              |                | 0               |                 | 0.3  |
| <b>Seismic Transverses</b>       |   |                  |                |                |                 |                 | 0.45 |
| 15)                              | Sub-structure Component                         |                  |                | 87.832         |                 | 613.18          | 0.45 |
| 17)                              | Super-Structure DL, SIDL, & Surfacing Component |                  |                | 61.126         |                 | 948.19          | 0.45 |
| 18.2)                            | Live Load Component (Min. Reaction)             |                  |                | 4.2119         |                 | 71.603          | 0.09 |
| <b>Seismic Vertical Downward</b> |   |                  |                |                |                 |                 | 0.45 |
| 19)                              | Sub-structure Component                         | 19.518           |                |                | 2.0588          |                 | 0.45 |
| 21)                              | Super-Structure DL, SIDL, & Surfacing Component | 13.584           |                |                | 7.8106          |                 | 0.45 |
| 22.2)                            | Live Load Component (Min. Reaction)             | 0.936            |                |                | 0.5382          |                 | 0.09 |

| S.N. | Description                    | Forces at bottom of abutment shaft |                |                |                 |                 |
|------|--------------------------------|------------------------------------|----------------|----------------|-----------------|-----------------|
|      |                                | V                                  | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|      |                                | Tonne                              | Tonne          | Tonne          | Tm              | Tm              |
| LC-9 | SIS,LWL,Min LL Acc,Seismic Sx= | 1395.8                             | 1117.4         | 67.41          | 8631.4          | 714.34          |

| LC-10 | SIS, LWL,Min LL Acc,Seismic Sx= | Forces about toe |                |                |                 |                 | LC-10 |
|-------|---------------------------------|------------------|----------------|----------------|-----------------|-----------------|-------|
| S.N.  | Description                     | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |       |
|       |                                 | Tonne            | Tonne          | Tonne          | Tm              | Tm              |       |
| 1)    | Sub-structure                   | 600.57           |                |                | 63.349          | 0               | 1.35  |
| 3)    | Super-structure DL              | 266.95           |                |                | 153.5           | 0               | 1.35  |
| 4)    | SIDL (excluding surfacing)      | 116.99           |                |                | 67.267          | 0               | 1.35  |

|                                  |   |        |        |        |        |        |  |       |
|----------------------------------|---|--------|--------|--------|--------|--------|--|-------|
| 5)                               | Surfacing                                       | 34.025 |        |        | 19.564 | -8.506 |  | 1.35  |
| 6.2)                             | Live Load Vertical Load Min Reaction            | 28.8   |        |        | 16.56  | 83.807 |  | 0.2   |
| 7)                               | Live Load Horizontal Forces                     |        | 39.153 |        | 521.99 |        |  | 0.2   |
| 9.1)                             | Earth Pressure LWL                              |        |        |        |        |        |  | 1     |
|                                  | Horizontal Component                            |        | 871.45 |        | 5661.6 |        |  | 1     |
| 10.1)                            | Surcharge Pressure LWL                          |        | 141.7  |        | 1121.7 |        |  | 0.2   |
| <b>Seismic Longitudinal</b>      |   |        |        |        |        |        |  | 1.5   |
| 11)                              | Sub-structure Component                         |        | 26.528 |        | 185.2  |        |  | 1.5   |
| 12)                              | Backfill  |        | 76.398 |        | 804.72 |        |  | 1.5   |
| 12)                              | Super-Structure DL, SIDL, & Surfacing Component |        | 36.924 |        | 492.27 |        |  | 1.5   |
| 13)                              | Dynamic Earth Pressure                          |        |        |        |        |        |  | 1.5   |
|                                  | Horizontal Component                            |        | 0      |        | 0      |        |  | 1.5   |
| 14)                              | Dynamic Surcharge Pressure                      |        |        |        |        |        |  | 0.3   |
|                                  | 14.2) LWL Seismic Upward                        |        | 0      |        | 0      |        |  | 0.3   |
| <b>Seismic Transverses</b>       |   |        |        |        |        |        |  | 0.45  |
| 15)                              | Sub-structure Component                         |        |        | 87.832 |        | 613.18 |  | 0.45  |
| 17)                              | Super-Structure DL, SIDL, & Surfacing Component |        |        | 61.126 |        | 948.19 |  | 0.45  |
| 18.2)                            | Live Load Component (Min. Reaction)             |        |        | 4.2119 |        | 71.603 |  | 0.09  |
| <b>Seismic Vertical Downward</b> |   |        |        |        |        |        |  | 0.45  |
| 19)                              | Sub-structure Component                         | 19.518 |        |        | 2.0588 |        |  | -0.45 |
| 21)                              | Super-Structure DL, SIDL, & Surfacing Component | 13.584 |        |        | 7.8106 |        |  | -0.45 |
| 22.2)                            | Live Load Component (Min. Reaction)             | 0.936  |        |        | 0.5382 |        |  | -0.09 |

| S.N.  | Description   | Forces at bottom of abutment shaft |                |                |                 |                 |
|-------|---|------------------------------------|----------------|----------------|-----------------|-----------------|
|       |   | V                                  | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|       |   | Tonne                              | Tonne          | Tonne          | Tm              | Tm              |
| LC-10 | SIS, LWL, Min LL Acc, Seismic S <sub>x</sub> =1, S <sub>z</sub> =0.45 | 1365.8                             | 1117.4         | 67.41          | 8622.4          | 714.34          |

| S.N.                        | Description                          | Forces about toe |                |                |                 |                 | LC-11 |
|-----------------------------|--------------------------------------|------------------|----------------|----------------|-----------------|-----------------|-------|
|                             |                                      | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |       |
|                             |                                      | Tonne            | Tonne          | Tonne          | Tm              | Tm              |       |
| 1)                          | Sub-structure                        | 600.57           |                |                | 63.349          | 0               | 1.35  |
| 3)                          | Super-structure DL                   | 266.95           |                |                | 153.5           | 0               | 1.35  |
| 4)                          | SIDL (excluding surfacing)           | 116.99           |                |                | 67.267          | 0               | 1.35  |
| 5)                          | Surfacing                            | 34.025           |                |                | 19.564          | -8.506          | 1.35  |
| 6.1)                        | Live Load Vertical Load Max Reaction | 137.4            |                |                | 79.005          | 399.83          | 0.2   |
| 7)                          | Live Load Horizontal Forces          |                  | 39.153         |                | 521.99          |                 | 0.2   |
| 9.1)                        | Earth Pressure LWL                   |                  |                |                |                 |                 | 1     |
|                             | Horizontal Component                 |                  | 871.45         |                | 5661.6          |                 | 1     |
| 10.1)                       | Surcharge Pressure LWL               |                  | 141.7          |                | 1121.7          |                 | 0.2   |
| <b>Seismic Longitudinal</b> |                                      |                  |                |                |                 |                 | 1.5   |
| 11)                         | Sub-structure Component              |                  | 26.528         |                | 185.2           |                 | 1.5   |
| 12)                         | Backfill                             |                  | 76.398         |                | 804.72          |                 | 1.5   |

|                                  |   |        |        |        |        |      |
|----------------------------------|---|--------|--------|--------|--------|------|
| 12)                              | Super-Structure DL, SIDL, & Surfacing Component | 36.924 |        | 492.27 |        | 1.5  |
| 13)                              | Dynamic Earth Pressure                          |        |        |        |        | 1.5  |
|                                  | Horizontal Component                            | 0      |        | 0      |        | 1.5  |
| 14)                              | Dynamic Surcharge Pressure                      |        |        |        |        | 0.3  |
|                                  | 14.1) LWL Seismic Downward                      | 0      |        | 0      |        | 0.3  |
| <b>Seismic Transverses</b>       |   |        |        |        |        | 0.45 |
| 15)                              | Sub-structure Component                         |        | 87.832 |        | 613.18 | 0.45 |
| 17)                              | Super-Structure DL, SIDL, & Surfacing Component |        | 61.126 |        | 948.19 | 0.45 |
| 18.1)                            | Live Load Component (Max. Reaction)             |        | 20.095 |        | 341.61 | 0.09 |
| <b>Seismic Vertical Downward</b> |   |        |        |        |        | 0.45 |
| 19)                              | Sub-structure Component                         | 19.518 |        | 2.0588 |        | 0.45 |
| 21)                              | Super-Structure DL, SIDL, & Surfacing Component | 13.584 |        | 7.8106 |        | 0.45 |
| 22.1)                            | Live Load Component (Max. Reaction)             | 4.4655 |        | 2.5676 |        | 0.09 |

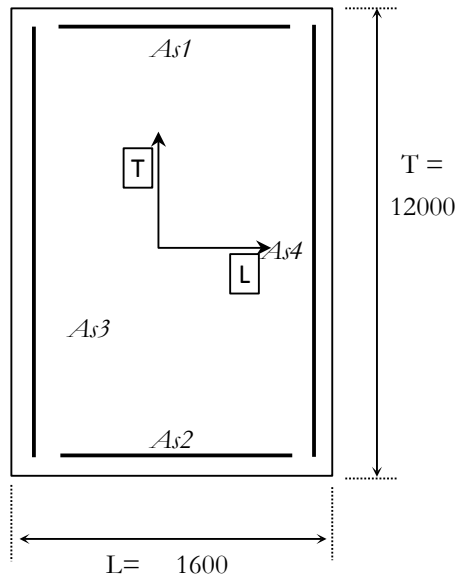
| S.N.  | Description                    | Forces at bottom of abutment shaft |                |                |                 |                 |
|-------|--------------------------------|------------------------------------|----------------|----------------|-----------------|-----------------|
|       |                                | V                                  | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|       |                                | Tonne                              | Tonne          | Tonne          | Tm              | Tm              |
| LC-11 | SIS,LWL,Max LL,Seismic Sx=1,Sz | 1417.8                             | 1117.4         | 68.84          | 8644.1          | 801.84          |

| LC-12                       | SIS, LWL,Max LL,Seismic Sx=1,Sz                 | Forces about toe |                |                |                 |                 | LC-12 |
|-----------------------------|---|------------------|----------------|----------------|-----------------|-----------------|-------|
| S.N.                        | Description                                     | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |       |
|                             |   | Tonne            | Tonne          | Tonne          | Tm              | Tm              |       |
| 1)                          | Sub-structure                                   | 600.57           |                |                | 63.349          | 0               | 1.35  |
| 3)                          | Super-structure DL                              | 266.95           |                |                | 153.5           | 0               | 1.35  |
| 4)                          | SIDL (excluding surfacing)                      | 116.99           |                |                | 67.267          | 0               | 1.35  |
| 5)                          | Surfacing                                       | 34.025           |                |                | 19.564          | -8.506          | 1.35  |
| 6.1)                        | Live Load Vertical Load Max Reaction            | 137.4            |                |                | 79.005          | 399.83          | 0.2   |
| 7)                          | Live Load Horizontal Forces                     |                  | 39.153         |                | 521.99          |                 | 0.2   |
| 9.1)                        | Earth Pressure LWL                              |                  |                |                |                 |                 | 1     |
|                             | Horizontal Component                            |                  | 871.45         |                | 5661.6          |                 | 1     |
| 10.1)                       | Surcharge Pressure LWL                          |                  | 141.7          |                | 1121.7          |                 | 0.2   |
| <b>Seismic Longitudinal</b> |   |                  |                |                |                 |                 | 1.5   |
| 11)                         | Sub-structure Component                         |                  | 26.528         |                | 185.2           |                 | 1.5   |
| 12)                         | Backfill  |                  | 76.398         |                | 804.72          |                 | 1.5   |
| 12)                         | Super-Structure DL, SIDL, & Surfacing Component |                  | 36.924         |                | 492.27          |                 | 1.5   |
| 13)                         | Dynamic Earth Pressure                          |                  |                |                |                 |                 | 1.5   |
|                             | Horizontal Component                            |                  | 0              |                | 0               |                 | 1.5   |
| 14)                         | Dynamic Surcharge Pressure                      |                  |                |                |                 |                 | 0.3   |
|                             | 14.2) LWL Seismic Upward                        |                  | 0              |                | 0               |                 | 0.3   |
| <b>Seismic Transverses</b>  |   |                  |                |                |                 |                 | 0.45  |
| 15)                         | Sub-structure Component                         |                  |                | 87.832         |                 | 613.18          | 0.45  |
| 17)                         | Super-Structure DL, SIDL, & Surfacing Component |                  |                | 61.126         |                 | 948.19          | 0.45  |
| 18.1)                       | Live Load Component (Max. Reaction)             |                  |                | 20.095         |                 | 341.61          | 0.09  |

|                                  |                                  |        |  |  |        |       |
|----------------------------------|----------------------------------|--------|--|--|--------|-------|
| <b>Seismic Vertical Downward</b> |                                  |        |  |  |        | 0.45  |
| 19)                              | Sub-structure Component          | 19.518 |  |  | 2.0588 | -0.45 |
| 21)                              | Super-Structure DL, SIDL, & Surf | 13.584 |  |  | 7.8106 | -0.45 |
| 22.1)                            | Live Load Component (Max. React  | 4.4655 |  |  | 2.5676 | -0.09 |

| S.N.  | Description  | Forces at bottom of abutment shaft |                |                |                 |                 |
|-------|--|------------------------------------|----------------|----------------|-----------------|-----------------|
|       |  | V                                  | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|       |  | Tonne                              | Tonne          | Tonne          | Tm              | Tm              |
| LC-12 | SIS, LWL,Max LL,Seismic S <sub>x</sub> =1,S <sub>y</sub> | 1387.2                             | 1117.4         | 68.84          | 8634.7          | 801.84          |

**ULS CHECK FOR ABUTMENT SHAFT :**



**Check For Biaxial Bending Moment**

$$N_{RD} = A_c f_{cd} + A_s f_{yd}$$

$$= 50480.9 \text{ Tonne}$$

$$\left( \frac{M_{EDT}}{M_{EDT}} \right)^\alpha + \left( \frac{M_{EDL}}{M_{RDL}} \right)^\alpha \leq 1$$

$$f_{ck} = 45 \text{ Mpa}$$

$$f_{cd} = 20.1 \text{ Mpa}$$

$$f_{yd} = 434.8 \text{ Mpa}$$

$$A_c = 19200000 \text{ mm}^2$$

$$A_s = 273444 \text{ mm}^2$$

**ULS CHECK FOR ABUTMENT SHAFT :**

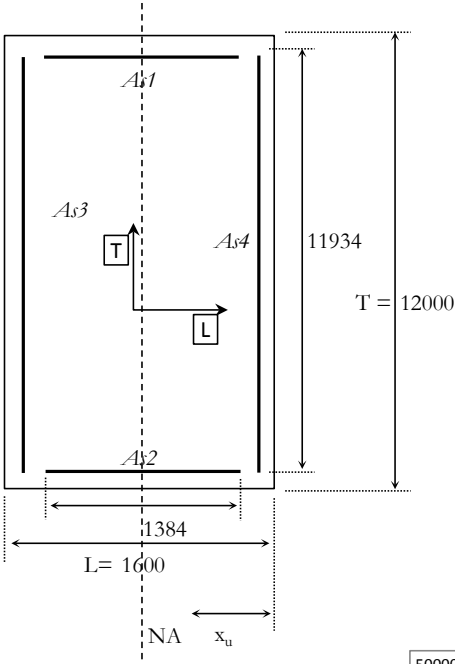
| S.N.  | Description                                      | Forces at bottom of abutment shaft |          |         |           |           | CHECK FOR MOMENT CAPACITY |          |           |           |   |
|-------|--|------------------------------------|----------|---------|-----------|-----------|---------------------------|----------|-----------|-----------|---|
|       |  | $N_{ED}$                           | $H_L$    | $H_T$   | $M_{ETT}$ | $M_{ELL}$ | $N_{ED}/N_{RD}$           | $\alpha$ | $M_{RIT}$ | $M_{RLL}$ | $(M_{EDT}/M_{RDT})^\alpha + (M_{EDL}/M_{RDL})^\alpha$ |
|       |  | Tonne                              | Tonne    | Tonne   | Tm        | Tm        |                           |          | Tm        | Tm        | Check   |
| LC-1  | NS, LWL, Span dislodge, FP                       | 810.764                            | 173.9375 | 0       | 1430.34   | 0         |                           |          |           |           |   |
| LC-2  | NS, LWL, Span dislodge, EP                       | 810.764                            | 1477.217 | 0       | 9923.96   | 0         | 0.0                       | 1        | 11228.4   | 58785.8   | 0.88 OK   |
| LC-4  | NS, LWL, Min LL Lead, EP                         | 1421.74                            | 1522.243 | 0       | 10875.6   | 81.4922   | 0.0                       | 1        | 11656.9   | 60344.5   | 0.93 OK   |
| LC-6  | NS, LWL, Max LL, EP                              | 1594.72                            | 1100.22  | 0       | 8326.93   | 584.866   | 0.0                       | 1        | 11778.2   | 60785.8   | 0.72 OK   |
|       |  |                                    |          |         |           |           |                           |          |           |           |   |
| LC-7  | SIS,LWL, Span dislodge ,Seismic $S_x=1, S_z=0.3$ | 818.212                            | 1004.679 | 33.5156 | 7085.32   | 351.308   | 0.0                       | 1        | 11233.6   | 58804.8   | 0.64 OK   |
| LC-8  | SIS, LWL,Span dislodge ,Seismic $S_x=1, S_z=0.3$ | 803.316                            | 1004.679 | 33.5156 | 7080.88   | 351.308   | 0.0                       | 1        | 11223.1   | 58766.8   | 0.64 OK   |
| LC-9  | SIS,LWL,Min LL Acc,Seismic $S_x=1, S_z=0.3$      | 1395.75                            | 1117.397 | 67.4102 | 8631.39   | 714.337   | 0.0                       | 1        | 11638.6   | 60278.2   | 0.75 OK   |
| LC-10 | SIS, LWL,Min LL Acc,Seismic $S_x=1, S_z=0.3$     | 1365.79                            | 1117.397 | 67.4102 | 8622.41   | 714.337   | 0.0                       | 1        | 11617.6   | 60201.8   | 0.75 OK   |
| LC-11 | SIS,LWL,Max LL,Seismic $S_x=1, S_z=0.3$          | 1417.79                            | 1117.397 | 68.8397 | 8644.06   | 801.843   | 0.0                       | 1        | 11654.1   | 60334.5   | 0.76 OK   |

|       |                                     |         |          |         |         |         |     |   |         |         |      |    |
|-------|-------------------------------------|---------|----------|---------|---------|---------|-----|---|---------|---------|------|----|
| LC-12 | SIS, LWL,Max LL,Seismic Sx=1,Sz=0.3 | 1387.19 | 1117.397 | 68.8397 | 8634.72 | 801.843 | 0.0 | 1 | 11632.6 | 60256.4 | 0.76 | OK |
|-------|-------------------------------------|---------|----------|---------|---------|---------|-----|---|---------|---------|------|----|



INTERACTION DIAGRAM : (P : M<sub>TT</sub>)

SECTION AT SHAFT BOTTOM



| xu/D  | Pu       | Mu      |
|-------|----------|---------|
|       | T        | Tm      |
| 1E-09 | -11894.8 | 2317.67 |
| 0.2   | 1881.9   | 11979.6 |
| 0.4   | 8411.75  | 14553.9 |
| 0.6   | 15930.7  | 14700.6 |
| 0.8   | 27001.5  | 10679.8 |
| 1     | 36118.8  | 6346.63 |
| 1.2   | 40906.1  | 3463.19 |
| 1.4   | 43276.8  | 2019.79 |
| 1.6   | 44657.8  | 1171.51 |
| 1.8   | 45548.6  | 619.51  |
| 2     | 46166    | 234.543 |

Section Dimensions:

|   |   |       |    |
|---|---|-------|----|
| D | = | 1600  | mm |
| B | = | 12000 | mm |

Material Properties:

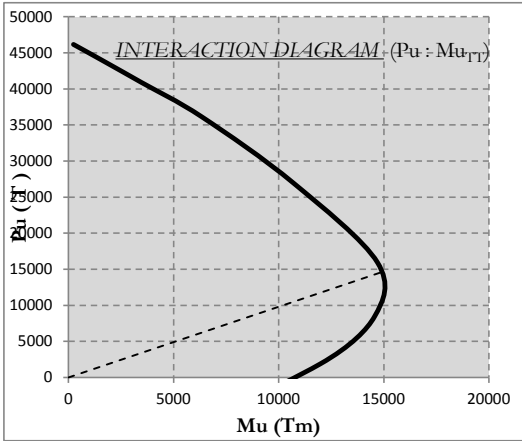
|     |   |        |                   |
|-----|---|--------|-------------------|
| fck | = | 45     | N/mm <sup>2</sup> |
| fyk | = | 500    | N/mm <sup>2</sup> |
| Es  | = | 200000 | N/mm <sup>2</sup> |

Reinforcement Details:

| Reinf.                                | Dia | Spacing | Cover | From | To    | Y_Cg  | Nos. | Spacing | Remark  |
|---------------------------------------|-----|---------|-------|------|-------|-------|------|---------|---------|
|                                       | mm  | mm      | mm    | m    | m     | m     |      |         |         |
| REINFORCEMENT ACROSS AXIS OF BENDING: |     |         |       |      |       |       |      |         |         |
| As1                                   | 32  | 150     | 50    | 305  | 1384  | 5934  | 8    | 154     |         |
| As2                                   | 32  | 150     | 50    | 305  | 1384  | -5934 | 8    | 154     |         |
| REINFORCEMENT ALONG AXIS OF BENDING:  |     |         |       |      |       |       |      |         |         |
| As3                                   | 32  | 110     | 75    | 66   | 11934 | -709  | 108  | 111     | LAYER-2 |
|                                       | 32  | 110     | 139   | 66   | 11934 | -645  | 108  | 111     |         |
| As4                                   | 32  | 110     | 50    | 66   | 11934 | 734   | 108  | 111     |         |

|                              |   |         |                 |
|------------------------------|---|---------|-----------------|
| As tension face (Length)     | = | 173718  | mm <sup>2</sup> |
| As Compression face (Length) | = | 86858.8 | mm <sup>2</sup> |
| As tension face (width)      | = | 6433.98 | mm <sup>2</sup> |
| As Compression face (width)  | = | 6433.98 | mm <sup>2</sup> |
| Total As                     | = | 273444  | mm <sup>2</sup> |
|                              | = | 1.42    | %               |

|                 |            |
|-----------------|------------|
| Balance Failure |            |
| d1              | 1509 mm    |
| xu              | 931.481 mm |
| xu/D            | 0.58218    |
| Pu              | 14781.5 T  |
| Mu              | 15084.6 Tm |



**Formula Used In Construction of Intraction Diagram :**

$$P_u = C_c + C_s$$

$$M_u = M_c + M_s$$

$$C_c = \begin{cases} 0.361 * f_{ck} * x_u * b & x_u \leq D \\ 0.447 * f_{ck} * (1 - 4 * g / 21) * b * D & x_u > D \end{cases}$$

$$g = 16 / (7 x_u / D - 3)^2$$

$$C_s = \Sigma (f_{si} - f_{ci}) A_{si}$$

$$f_{ci} = \begin{cases} 0 & \epsilon_{si} \leq 0 \\ 0.447 f_{ck} & \epsilon_{si} \geq 0.002 \\ 0.447 f_{ck} [2 * (\epsilon_{si} / 0.002) - (\epsilon_{si} / 0.002)^2] & \text{otherwise} \end{cases}$$

$$f_{si} = \begin{cases} -0.87 f_y & \epsilon_{si} \leq -0.00217 \\ \epsilon_{si} * E_s & \epsilon_{si} > -0.00217 \\ 0.87 f_y & \epsilon_{si} > 0.00217 \end{cases} \quad \epsilon_{si} \leq 0.00217$$

$$M_c = C_c * (0.5D - x)$$

$$M_s = \Sigma C_{si} * y_i$$

$$x = \begin{cases} 0.416 x_u & x_u \leq D \\ (0.5 - 8 * g / 49) * \{D / (1 - 4 * g / 21)\} & x_u > D \end{cases}$$

$$x = \text{Centroid of stress blok area from most compressed edge}$$

$$\epsilon_{si} = \begin{cases} 0.0035 * \left[ \frac{x_u - D / 2 + y_i}{x_u} \right] & x_u \leq D \\ 0.002 * \left[ 1 + \frac{y_i - D / 14}{x_u - 3D / 7} \right] & x_u > D \end{cases}$$

| Pu      | Mu      |
|---------|---------|
| T       | Tm      |
| 810.764 | 1430.34 |
| 810.764 | 9923.96 |
| 1421.74 | 2381.94 |
| 1421.74 | 10875.6 |
| 1594.72 | 8326.93 |
| 0       | 0       |
| 818.212 | 7085.32 |
| 803.316 | 7080.88 |

**Reinforcement in Transverse Direction :**

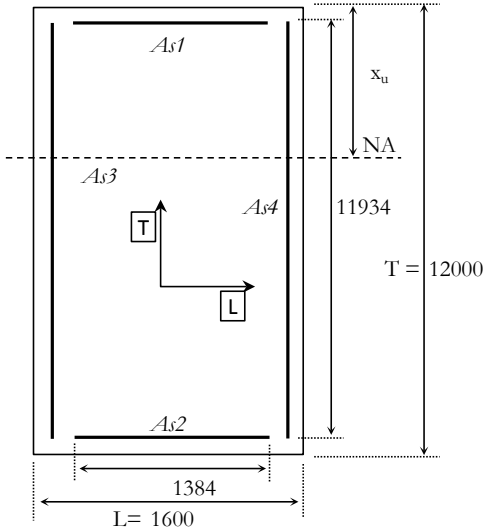
Total vertical reinf. = 273444 mm<sup>2</sup>  
Length of abutment = 12 m  
Reinf. /m length = 22787 mm<sup>2</sup>/m  
Reinforcement in transverse direction = 0.25 times vertical reinf  
= 5697 mm<sup>2</sup>/m ( Total on both face)

Cross -sectional area Ac per meter length/ heighth = 1600000 mm<sup>2</sup> /m  
Minimum reinf. = 0.001 Ac  
= 1600 mm<sup>2</sup>/m

Reinforcement required = 5697 mm<sup>2</sup>/m (Total on both face)

Provide 20  $\phi$  @ 120 c/c on each face  
= 2618 mm<sup>2</sup>/m on each face  
 $\cong$  5236 mm<sup>2</sup>/m (total on both faces ) REVERSE

INTRACTION DIAGRAM : (P : M<sub>LL</sub>)



| xu/D  | Pu       | Mu      |
|-------|----------|---------|
|       | T        | Tm      |
| 1E-09 | -11894.8 | 0.00019 |
| 0.2   | -672.121 | 55002.7 |
| 0.4   | 10023.2  | 82288.4 |
| 0.6   | 20718.6  | 84983.5 |
| 0.8   | 30569.8  | 69359.8 |
| 1     | 38926.9  | 45011.6 |
| 1.2   | 43025.4  | 27747.8 |
| 1.4   | 44978.1  | 19535.7 |
| 1.6   | 46077.3  | 14910.7 |
| 1.8   | 46765.3  | 12008.8 |
| 2     | 47228.2  | 10044.9 |
| 100   | 49001.7  | 120.493 |

SECTION AT SHAFT BOTTOM

Section Dimensions:

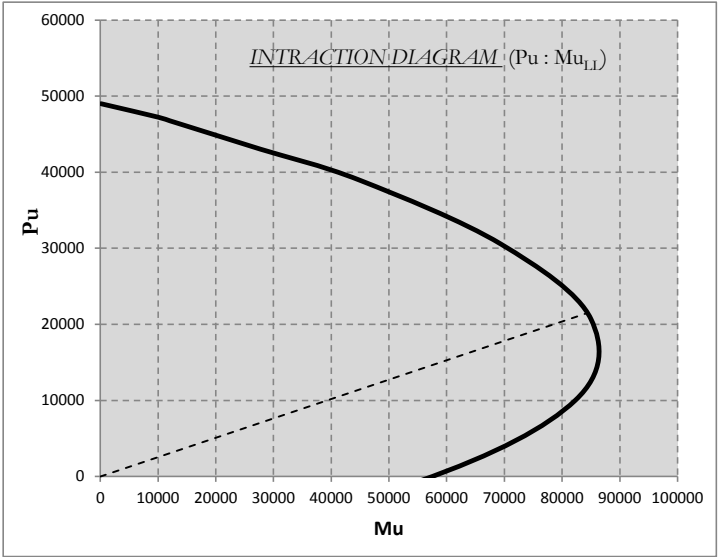
|   |   |       |    |
|---|---|-------|----|
| D | = | 12000 | mm |
| B | = | 1600  | mm |

Material Properties:

|                 |   |        |                   |
|-----------------|---|--------|-------------------|
| f <sub>ck</sub> | = | 45     | N/mm <sup>2</sup> |
| f <sub>yk</sub> | = | 500    | N/mm <sup>2</sup> |
| E <sub>s</sub>  | = | 200000 | N/mm <sup>2</sup> |

Reinforcement Details :

| Reinf.                                | Dia | Spacing | Cover | From | To    | Y_Cg  | Nos. | Spacing | Remark  |
|---------------------------------------|-----|---------|-------|------|-------|-------|------|---------|---------|
|                                       | mm  | mm      | mm    | m    | m     | m     |      |         |         |
| REINFORCEMENT ACROSS AXIS OF BENDING: |     |         |       |      |       |       |      |         |         |
| As3                                   | 32  | 110     | 75    | 66   | 11934 | -709  | 108  | 110.916 | LAYER-2 |
|                                       | 32  | 110     | 139   | 66   | 11934 | -645  | 108  | 110.916 |         |
| As4                                   | 32  | 110     | 50    | 66   | 11934 | 734   | 108  | 110.916 |         |
| REINFORCEMENT ALONG AXIS OF BENDING:  |     |         |       |      |       |       |      |         |         |
| As1                                   | 32  | 150     | 50    | 305  | 1384  | 5934  | 8    | 154.143 |         |
| As2                                   | 32  | 150     | 50    | 305  | 1384  | -5934 | 8    | 154.143 |         |



Balance Failure

|      |              |
|------|--------------|
| d1   | 11934        |
| xu   | 7366.6667 mm |
| xu/D | 0.6138889    |
| Pu   | 21461.494 T  |
| Mu   | 84253.519 Tm |

**Confinement Reinforcement of Abutment:**

|   |    |   |  |
|---|----|---|--|
| Width of abutment shaft                               | b  | = | 1600 mm  |
| Length of abutment shaft                              | L  | = | 12000 mm   |
| Clear cover to earth face                             |    | = | 75 mm  |
| Clear cover to other face                             |    | = | 50 mm  |
| Confined area of concrete                             |    | = | 17552500 mm <sup>2</sup>   |
| $N_{ED}$  |    | = | 1595 Tonne   |
| Ac  |    | = | 19200000 mm <sup>2</sup>   |
| fck   |    | = | 45 Mpa   |
| fcd   |    | = | 20.10 Mpa  |
| fyd   |    | = | 435 Mpa  |
| Normalized axial force                                |    |   |  |
| $\eta_k$  |    | = | Max $N_{ED}/Ac fck$  |
| $\eta_k$  |    | = | 0.018 < 0.08   |
|   |    | = | < 0.3  |
| Extent of confinement                                 |    | = | Depth of section within the plane of bending                               |
|   |    | = | 1.6 m  |
| Required volumetric ratio of transverse reinforcement |    |   |  |
| $\omega_{w,req}$                                      |    | = | 0.37 Ac/ Acc $\eta_k$ +0.13 fyd/fcd ( $\rho_L$ -0.01)                      |
| Ac  |    | = | Area of gross concrete section   |
|   |    | = | 19.20 m <sup>2</sup>   |
| Acc   |    | = | Confined core concrete area of the section within the outside dia of loop. |
|   |    | = | 17.55 m <sup>2</sup>   |
| $\rho_L$  |    | = | Reinforcement ratio of the longitudinal reinforcement                      |
|   |    | = | As/Acc   |
| Area of steel provided                                | As | = | 273444 mm <sup>2</sup>   |
| $\rho_L$  |    | = | 0.01558 mm <sup>2</sup>  |
| $\omega_{w,req}$                                      |    | = | 0.02316  |
| Minimum Confining Reinforcement                       |    |   |  |
| $\omega_{w,d}$  |    | = | Max(1.4* $\omega_{w,req}$ , 0.12)  |
|   |    | = | 0.12   |
| Volumetric ratio of transverse reinforcement          |    |   |  |
| $\rho_w$  |    | = | $\omega_{w,d}fcd/fyd$  |
|   |    | = | 0.00555  |

Volumetric ratio of transverse reinforcement

$$\rho_w = A_{sw} / b S_L$$

Area of the spiral or hoop bar

$$A_{sw} = \rho_w * b * S_L$$

$$b = \text{Dimension of the core perpendicular to the direction of confinement.} \\ = 1475 \text{ mm}$$

$$S_L = \text{Spacing of hoops or ties in longitudinal direction (in vertical direction)} \\ \leq 1/5 * \text{smallest dimension of confined core} \\ = 0.2 \times 1475 = 295 \text{ mm} \\ = 300 \text{ mm}$$

$$A_{sw} = 2455 \text{ mm}^2$$

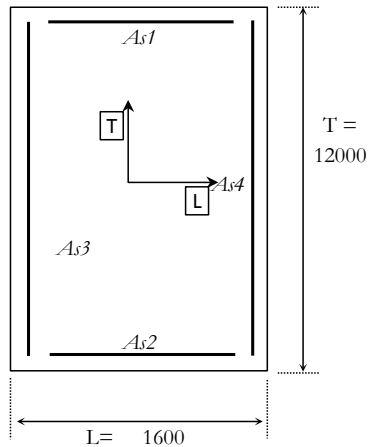
Provide 16 dia 20 Nos. @ 300 mm c/c

$$\text{Area of reinforcement provided at one section} = 4021 \text{ mm}^2 \quad \text{OK}$$

**Transverse distance b/w hoops legs or supplementary cross ties :**

$$S_T = \text{Min} \left\{ \begin{array}{l} 1/3 * \text{smallest dimension of confined core} \\ 200 \text{ mm} \end{array} \right. \\ = \text{Min} \left\{ \begin{array}{l} 0.33 \times 1475 \\ 200 \text{ mm} \end{array} \right. = 492 \text{ mm} \\ = 200 \text{ mm}$$

# **ULS SHEAR CHECK FOR ABUTMENT SHAFT :**



|          |   |          |        |
|----------|---|----------|--------|
| $f_{ck}$ | = | 45       | Mpa    |
| $f_{cd}$ | = | 20.1     | Mpa    |
| $f_{yk}$ | = | 500      | Mpa    |
| $A_c$    | = | 19200000 | $mm^2$ |
| $A_s$    | = | 273444   | $mm^2$ |

Reduction factor  $\beta$  = 0.5 for  $a_v < 0.5d$

|   |   |                                  |  |
|---|---|----------------------------------|--|
| <b>Design Shear Resitance</b> (IRC 112 / clause 10.3.2 (2)) |   |                                  |  |
| $k$   | = | Min                              | $\left\{ \begin{array}{l} 1 + \sqrt{200/d} \\ 2 \end{array} \right.$ d is depth in mm  |
| $k$   | = | 1.35355                          |  |
| $\rho_1$  | = | Min                              | $\left\{ \begin{array}{l} A_{s1}/bw \ d \\ 0.02 \end{array} \right.$   |
| $A_{s1}$  | = | 173718                           | $mm^2$ */ Reinforcement on tension face  |
| $\rho_1$  | = | 0.00905                          |  |
| $\sigma_{cp}$   | = | Axial stress                     |  |
| $v_{min}$   | = | $0.031 \ k^{3/2} \ f_{ck}^{1/2}$ |  |
|   | = | 0.32748                          |  |
| $V_{Rdc}$   | = | Max                              | $\left\{ \begin{array}{l} (0.12 \ k \ (80 \ \rho_1 \ f_{ck})^{0.33} + 0.15 \ \sigma_{cp}) \ bw \ d \\ (v_{min} + 0.15 \ \sigma_{cp}) \ bw \ d \end{array} \right.$ |
| <b>Max Shear Capacity</b>                                   |   |                                  |  |
| $v$   | = | $0.6 * (1 - f_{ck} / 310)$       | */ fck in Mpa  |
|   | = | 0.5129                           |  |
| $V_{RDC, \ max}$  | = | $0.5 \ bw \ d \ v \ f_{cd}$      |  |
|   | = | 9896.98                          | Tonne  |

**ULS CHECK FOR ABUTMENT SHAFT :**

| S.N.  | Description |  |  |  | (SHEAR CAPACITY (LONGITUDINAL DIR <sup>n</sup> )) |                |                       |                   |
|-------|-------------|--|--|--|---|----------------|-----------------------|-------------------|
|       |             |  |  |  | $\sigma_{cp} =$                                   |                | Check                 |                   |
|       |             |  |  |  | $N_{ED}/A_C$                                      |                | $V_{Rdc}$             |                   |
|       |             |  |  |  | $\beta H_L$                                       |                | $\beta H_L < V_{Rdc}$ |                   |
|       |             |  |  |  | N <sub>ED</sub>                                   | H <sub>L</sub> | $\beta H_L$           |                   |
|       |             |  |  |  | Tonne   | Tonne          | Tonne                 | N/mm <sup>2</sup> |
|       |             |  |  |  |   |                |                       | Tonne             |
| #REF! | #REF!       |  |  |  | 810.76  | 173.94         | 86.97                 | 0.42              |
| #REF! | #REF!       |  |  |  | 810.76  | 1477.22        | 738.61                | 0.42              |
| #REF! | #REF!       |  |  |  | 1421.74   | 218.96         | 109.48                | 0.74              |
| #REF! | #REF!       |  |  |  | 1421.74   | 1522.24        | 761.12                | 0.74              |
| #REF! | #REF!       |  |  |  | 1594.72   | 231.37         | 115.68                | 0.83              |
| #REF! | #REF!       |  |  |  | 1594.72   | 1100.22        | 550.11                | 0.83              |
|       |             |  |  |  |   |                |                       |                   |
| #REF! | #REF!       |  |  |  | 818.21  | 1004.68        | 502.34                | 0.43              |
| #REF! | #REF!       |  |  |  | 803.32  | 1004.68        | 502.34                | 0.42              |
| #REF! | #REF!       |  |  |  | 1395.75   | 1117.40        | 558.70                | 0.73              |
| #REF! | #REF!       |  |  |  | 1365.79   | 1117.40        | 558.70                | 0.71              |
| #REF! | #REF!       |  |  |  | 1417.79   | 1117.40        | 558.70                | 0.74              |
| #REF! | #REF!       |  |  |  | 1387.19   | 1117.40        | 558.70                | 0.72              |
|       |             |  |  |  |   |                |                       |                   |
|       |             |  |  |  |   |                |                       |                   |

**Minimum shear reinforcement**

Overall width of section = 12000 mm  
Overall depth of section = 1600 mm  
Effective Cover at section = 97 mm  
Effective depth of section = 1503 mm

$$\text{Minimum shear reinforcement ratio } (\rho_{min}) = \frac{0.072\sqrt{f_{ck}}}{f_{yk}} = 0.00097$$

$$\text{Shear reinforcement ratio } (\rho_w) = \frac{A_{sw}}{s \cdot b_w \cdot \sin \alpha}$$

(Refer clause 16.5.2 (5) of IRC :112-2011)

Therefore,

$$A_{sw(min)} / s = 11592 \text{ mm}^2/\text{m}$$

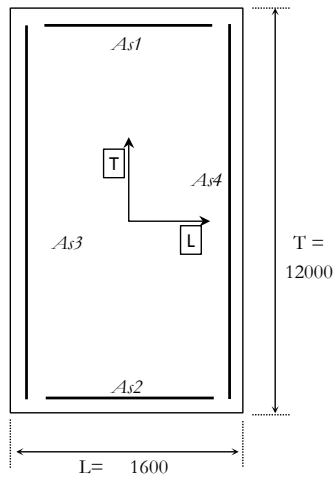
Provide 10  $\phi$  links @ 200 c/c in trans dirn & 300 c/c vertically

$$A_{sw}/s_{provided} = 15708 \text{ mm}^2/\text{m} \quad \text{OK}$$



**CHECK FOR ABUTMENT SHAFT SLENDERNESS RATIO:**

(IRC 112 / clause 8.3.2 (3))



$$\begin{aligned} A_c &= 19200000 \text{ mm}^2 \\ A_s &= 273444 \text{ mm}^2 \\ f_{cd} &= 20.1 \text{ Mpa} \\ f_{yd} &= 435 \text{ Mpa} \end{aligned}$$

**Slenderness criteria**

$$\begin{aligned} \text{Moment of Inertia about TT axis } I_{TT} &= 4.096\text{E}+12 \text{ mm}^4 \\ \text{Moment of Inertia about LL axis } I_{LL} &= 2.304\text{E}+14 \text{ mm}^4 \\ \text{Radius of gyration along LL axis } i_L &= \sqrt{I_{TT} / A} = 461.9 \text{ mm} \\ \text{Radius of gyration along TT axis } i_T &= \sqrt{I_{LL} / A} = 3464.1 \text{ mm} \end{aligned}$$

$$\begin{aligned} \text{Clear Height of compression member } l_o &= 13.18 \text{ m} \\ \text{Effective Length of column along LL -axis } l_{eL} &= 1.4 * l_o = 18.45 \text{ m} \end{aligned}$$

$$\begin{aligned} \text{Slenderness ratio along L-L axis } \lambda_L &= l_{eL} / i_L = 39.9543 \end{aligned}$$

$$\begin{aligned} \text{Effective Length of column along TT -axis } l_{eT} &= 2.3 * l_o = 30.32 \text{ m} \end{aligned}$$

$$\begin{aligned} \text{Slenderness ratio along TT' axis } \lambda_T &= l_{eT} / i_T = 8.75 \end{aligned}$$

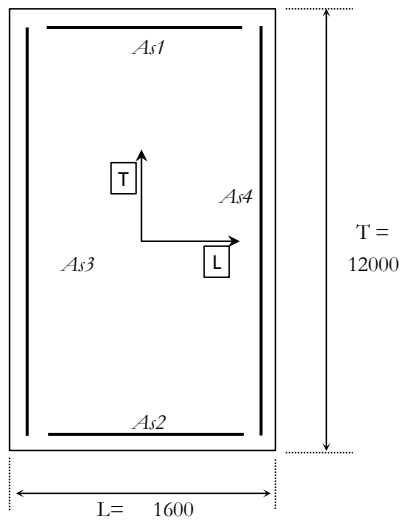
$$\begin{aligned} \text{Check } \lambda_L / \lambda_T &= 4.57 > 2 && \text{Check for limiting slenderness ratio} \\ \text{And } \lambda_T / \lambda_L &= 0.22 < 2 && \text{Ignore second order effect} \end{aligned}$$

| SUMMARY OF FORCES AT BOTTOM OF SHAFT: |                            |                                    |                |                |                  |                  |  | CHECK FOR SLENDERNESS RATIO |                       |           |           |                     |                     |                                      |
|---------------------------------------|----------------------------|------------------------------------|----------------|----------------|------------------|------------------|--|-----------------------------|-----------------------|-----------|-----------|---------------------|---------------------|--------------------------------------|
| S.N.                                  | Description                | Forces at bottom of abutment shaft |                |                |                  |                  |  | $e_L = M_{TT}/N_{ED}$       | $e_T = M_{LL}/N_{ED}$ | $e_L / L$ | $e_T / T$ | $(e_L/L) / (e_T/T)$ | $(e_T/T) / (e_L/L)$ | CHECK                                |
|                                       |                            | N <sub>ED</sub>                    | H <sub>L</sub> | H <sub>T</sub> | M <sub>ETT</sub> | M <sub>ELL</sub> |  |                             |                       |           |           |                     |                     |                                      |
|                                       |                            | Tonne                              | Tonne          | Tonne          | Tm               | Tm               |  |                             |                       |           |           |                     |                     |                                      |
| LC-1                                  | NS, LWL, Span dislodge, FP | 810.8                              | 173.9          | 0.0            | 1430.3           | 0.0              |  | 1.8                         | 0.0                   | 1.1       | 0.000     | 100.0               | 0.000               | Check for limiting slenderness ratio |
| LC-2                                  | NS, LWL, Span dislodge, EP | 810.8                              | 1477.2         | 0.0            | 9924.0           | 0.0              |  | 12.2                        | 0.0                   | 7.7       | 0.000     | 100.0               | 0.000               | Check for limiting slenderness ratio |
| LC-3                                  | NS, LWL, Min LL Lead, FP   | 1421.7                             | 219.0          | 0.0            | 2381.9           | 81.5             |  | 1.7                         | 0.1                   | 1.0       | 0.005     | 219.2               | 0.005               | Check for limiting slenderness ratio |
| LC-4                                  | NS, LWL, Min LL Lead, EP   | 1421.7                             | 1522.2         | 0.0            | 10875.6          | 81.5             |  | 7.6                         | 0.1                   | 4.8       | 0.005     | 1000.9              | 0.001               | Check for limiting slenderness ratio |
| LC-5                                  | NS, LWL, Max LL, FP        | 1594.7                             | 231.4          | 0.0            | 2664.5           | 584.9            |  | 1.7                         | 0.4                   | 1.0       | 0.031     | 34.2                | 0.029               | Check for limiting slenderness ratio |

|       |  |        |        |      |        |       |  |     |     |     |       |       |       |                                      |
|-------|--|--------|--------|------|--------|-------|--|-----|-----|-----|-------|-------|-------|--------------------------------------|
| LC-6  | NS, LWL, Max LL, EP                    | 1594.7 | 1100.2 | 0.0  | 8326.9 | 584.9 |  | 5.2 | 0.4 | 3.3 | 0.031 | 106.8 | 0.009 | Check for limiting slenderness ratio |
| 0.0   | 0.0                                    |        |        |      |        |       |  |     |     |     |       |       |       |                                      |
| LC-7  | SIS,LWL, Span dislodge ,Seismic Sx=1,S | 818.2  | 1004.7 | 33.5 | 7085.3 | 351.3 |  | 8.7 | 0.4 | 5.4 | 0.036 | 151.3 | 0.007 | Check for limiting slenderness ratio |
| LC-8  | SIS, LWL,Span dislodge ,Seismic Sx=1,S | 803.3  | 1004.7 | 33.5 | 7080.9 | 351.3 |  | 8.8 | 0.4 | 5.5 | 0.036 | 151.2 | 0.007 | Check for limiting slenderness ratio |
| LC-9  | SIS,LWL,Min LL Acc,Seismic Sx=1,Sz=    | 1395.8 | 1117.4 | 67.4 | 8631.4 | 714.3 |  | 6.2 | 0.5 | 3.9 | 0.043 | 90.6  | 0.011 | Check for limiting slenderness ratio |
| LC-10 | SIS, LWL,Min LL Acc,Seismic Sx=1,Sz=   | 1365.8 | 1117.4 | 67.4 | 8622.4 | 714.3 |  | 6.3 | 0.5 | 3.9 | 0.044 | 90.5  | 0.011 | Check for limiting slenderness ratio |
| LC-11 | SIS,LWL,Max LL,Seismic Sx=1,Sz=0.3,S   | 1417.8 | 1117.4 | 68.8 | 8644.1 | 801.8 |  | 6.1 | 0.6 | 3.8 | 0.047 | 80.9  | 0.012 | Check for limiting slenderness ratio |
| LC-12 | SIS, LWL,Max LL,Seismic Sx=1,Sz=0.3    | 1387.2 | 1117.4 | 68.8 | 8634.7 | 801.8 |  | 6.2 | 0.6 | 3.9 | 0.048 | 80.8  | 0.012 | Check for limiting slenderness ratio |

**CHECK FOR ABUTMENT SHAFT SECOND ORDER FORCES:**

( IRC 112 / clause 11.2.1)



$$\begin{aligned} A_c &= 19200000 \text{ mm}^2 \\ A_s &= 273444 \text{ mm}^2 \\ f_{cd} &= 20.1 \text{ Mpa} \\ f_{yd} &= 434.8 \text{ Mpa} \end{aligned}$$

*Slenderness criteria*

$$\begin{aligned} \text{Moment of Inertia about TT axis } I_{TT} &= 4.096\text{E}+12 \text{ mm}^4 \\ \text{Moment of Inertia about LL axis } I_{LL} &= 2.304\text{E}+14 \text{ mm}^4 \\ \text{Radius of gyration along LL axis } i_L &= \sqrt{I_{TT} / A} \\ &= 462 \text{ mm} \\ \text{Radius of gyration along TT axis } i_T &= \sqrt{I_{LL} / A} \\ &= 3464 \text{ mm} \end{aligned}$$

|   |             |   |                |
|---|-------------|---|----------------|
| Clear Height of compression member        | $l_o$       | = | 13.18 m        |
| Effective length of column along L-L      | $l_{eL}$    | = | 1.4 * $l_o$    |
|   |             | = | 18.45 m        |
| Slenderness ratio along L-L axis          | $\lambda_L$ | = | $l_{eL} / i_L$ |
|   |             | = | 39.95          |
| Effective Length of column along TT -axis | $l_{eT}$    | = | 2.3 * $l_o$    |
|   |             | = | 30.32 m        |
| Slenderness ratio along TT axis           | $\lambda_T$ | = | $l_{eT} / i_T$ |
|   |             | = | 8.75           |

Finding Limiting Value of Slenderness Ratio.

$$\lambda_{lim} = 20 A B C / \sqrt{n}$$

$$\phi(\infty, t_0) = 1.21 \text{ Creep for abutment shaft}$$

$$M_{oEqp}/M_{oEd} = \text{Ratio of BM in Quasi Permanent LC of SLS to BM in Design LC of ULS}$$

$$\phi_{ef} = \phi(\infty, t_0) * M_{oEqp}/M_{oEd}$$

$$A = 1 / (1 + 0.2 \phi_{ef})$$

$$\omega = A_s f_{yd} / (A_c f_{cd})$$

$$= 0.308$$

$$B = \sqrt{(1 + 2\omega)}$$

$$= 1.271$$

$$r_m = M_{o1} / M_{o2} \quad (\text{Ratio of First order moments at two ends of members})$$

$$= 0$$

$$C = 1.7 - r_m$$

$$= 1.7$$

$$n = N_{ED} / (A_c f_{cd})$$

$$= N_{ED} / 38592 \quad */ (N_{ED} \text{ in Tonne})$$

| SUMMARY OF FORCES AT BOTTOM OF SHAFT: |                 |                  |                  |                  |                  |
|---------------------------------------|-----------------|------------------|------------------|------------------|------------------|
| S.N.                                  | ULS FORCES      |                  |                  | SLS (QP LC)      |                  |
|                                       | N <sub>ED</sub> | M <sub>ETT</sub> | M <sub>ELL</sub> | M <sub>ETT</sub> | M <sub>ELL</sub> |
|                                       | Tonne           | Tm               | Tm               | Tm               | Tm               |
| LC-2                                  | 810.8           | 9924.0           | 0.0              | 5694.2           | -8.5             |
| LC-4                                  | 1421.7          | 10875.6          | 81.5             | 5694.2           | -8.5             |
| LC-6                                  | 1594.7          | 8326.9           | 584.9            | 5694.2           | -8.5             |
|                                       |                 |                  |                  |                  |                  |

| CHECK FOR SECOND ORDER EFFECT ( along LL Axis) |                 |      |      |                  |  |
|--|-----------------|------|------|------------------|--|
| M <sub>oEqp</sub> / M <sub>oEd</sub>           | φ <sub>ef</sub> | A    | n    | λ <sub>lim</sub> | Second Order Effect  |
|  |                 |      |      |                  | (λ < λ <sub>lim</sub> ) : Ignore<br>(λ > λ <sub>lim</sub> ) : Consider |
| 0.57   | 0.69            | 0.88 | 0.02 | 261.93           | Ignore second order effect   |
| 0.52   | 0.63            | 0.89 | 0.04 | 199.93           | Ignore second order effect   |
| 0.68   | 0.83            | 0.86 | 0.04 | 182.51           | Ignore second order effect   |
|  |                 |      |      |                  |  |

| Load Case | CHECK FOR SECOND ORDER EFFECT ( along TT Axis) |                 |      |      |                  |  |
|-----------|--|-----------------|------|------|------------------|--|
|           | Mo <sub>Eqp</sub> / Mo <sub>Ed</sub>           | ϕ <sub>ef</sub> | A    | n    | λ <sub>lim</sub> | Second Order Effect  |
|           |  |                 |      |      |                  | (λ < λ <sub>lim</sub> ) : Ignore<br>(λ > λ <sub>lim</sub> ) : Consider |
| LC-2      | 0.00   | 0.00            | 1.00 | 0.02 | 298.21           | Ignore second order effect   |
| LC-4      | 0.00   | 0.00            | 1.00 | 0.04 | 225.19           | Ignore second order effect   |
| LC-6      | 0.00   | 0.00            | 1.00 | 0.04 | 212.63           | Ignore second order effect   |



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DESIGN OF SHAFT  
SLS LOAD COMBINATION

| LC-1 | QP, LWL, FP                | Forces about toe |                |                |                 |                 |  | LC-1 |
|------|----------------------------|------------------|----------------|----------------|-----------------|-----------------|--|------|
| S.N. | Description                | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |  |      |
|      |                            | Tonne            | Tonne          | Tonne          | Tm              | Tm              |  |      |
| 1)   | Sub-structure & Foundation | 600.57           |                |                | 63.349          | 0               |  | 1    |
| 3)   | Super-structure DL         | 266.95           |                |                | 153.5           | 0               |  | 1    |
| 4)   | SIDL (excluding surfacing) | 116.99           |                |                | 67.267          | 0               |  | 1    |
| 5)   | Surfacing                  | 34.025           |                |                | 19.564          | -8.506          |  | 1    |
| 9)   | Fluid Pressure             |                  | 509.44         |                | 2258.5          |                 |  | 1    |

| S.N. | Description | Forces at bottom of abutment shaft |                |                |                 |                 |  |  |
|------|-------------|------------------------------------|----------------|----------------|-----------------|-----------------|--|--|
|      |             | V                                  | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |  |  |
|      |             | Tonne                              | Tonne          | Tonne          | Tm              | Tm              |  |  |
| LC-1 | QP, LWL, FP | 1018.5                             | 509.44         | 0              | 2562.2          | -8.506          |  |  |

| LC-2 | QP, LWL, EP                | Forces about toe |                |                |                 |                 |  | LC-2 |
|------|----------------------------|------------------|----------------|----------------|-----------------|-----------------|--|------|
| S.N. | Description                | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |  |      |
|      |                            | Tonne            | Tonne          | Tonne          | Tm              | Tm              |  |      |
| 1)   | Sub-structure & Foundation | 600.57           |                |                | 63.349          | 0               |  | 1    |
| 3)   | Super-structure DL         | 266.95           |                |                | 153.5           | 0               |  | 1    |
| 4)   | SIDL (excluding surfacing) | 116.99           |                |                | 67.267          | 0               |  | 1    |
| 5)   | Surfacing                  | 34.025           |                |                | 19.564          | -8.506          |  | 1    |
| 9.1) | Earth Pressure LWL         |                  |                |                |                 |                 |  | 1    |
|      | Horizontal Component       |                  | 871.45         |                | 5661.6          |                 |  | 1    |
|      | Vertical Component         | 338.88           |                |                | -271.1          |                 |  | 1    |

| S.N. | Description | Forces at bottom of abutment shaft |                |                |                 |                 |  |  |
|------|-------------|------------------------------------|----------------|----------------|-----------------|-----------------|--|--|
|      |             | V                                  | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |  |  |
|      |             | Tonne                              | Tonne          | Tonne          | Tm              | Tm              |  |  |
| LC-2 | QP, LWL, EP | 1357.4                             | 871.45         | 0              | 5694.2          | -8.506          |  |  |

| LC-3 | RARE, LWL, Span dislodge FP | Forces about toe |                |                |                 |                 |  | LC-3 |
|------|-----------------------------|------------------|----------------|----------------|-----------------|-----------------|--|------|
| S.N. | Description                 | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |  |      |
|      |                             | Tonne            | Tonne          | Tonne          | Tm              | Tm              |  |      |
| 1)   | Sub-structure & Foundation  | 600.57           |                |                | 63.349          | 0               |  | 1    |

|       |                        |  |        |  |        |  |  |     |
|-------|------------------------|--|--------|--|--------|--|--|-----|
| 9)    | Fluid Pressure         |  | 509.44 |  | 2258.5 |  |  | 1   |
| 10.1) | Surcharge Pressure LWL |  | 141.7  |  | 1121.7 |  |  | 0.8 |

| S.N. | Description                 | Forces at bottom of abutment shaft |                |                |                 |                 |
|------|-----------------------------|------------------------------------|----------------|----------------|-----------------|-----------------|
|      |                             | V                                  | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|      |                             | Tonne                              | Tonne          | Tonne          | Tm              | Tm              |
| LC-3 | RARE, LWL, Span dislodge FP | 600.57                             | 622.8          | 0              | 3219.3          | 0               |

| LC-4        | RARE, LWL, Span dislodge EP | Forces about toe |                |                |                 |                 |  | LC-4 |
|-------------|-----------------------------|------------------|----------------|----------------|-----------------|-----------------|--|------|
| S.N.        | Description                 | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |  |      |
|             |                             | Tonne            | Tonne          | Tonne          | Tm              | Tm              |  |      |
| 1)          | Sub-structure & Foundation  | 600.57           |                |                | 63.349          | 0               |  | 1    |
| <b>9.1)</b> | Earth Pressure LWL          |                  |                |                |                 |                 |  | 1    |
|             | Horizontal Component        |                  | 871.45         |                | 5661.6          |                 |  | 1    |
|             | Vertical Component          | 338.88           |                |                | -271.1          |                 |  | 1    |
| 10.1)       | Surcharge Pressure LWL      |                  | 141.7          |                | 1121.7          |                 |  | 0.8  |

| S.N. | Description                 | Forces at bottom of abutment shaft |                |                |                 |                 |
|------|-----------------------------|------------------------------------|----------------|----------------|-----------------|-----------------|
|      |                             | V                                  | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|      |                             | Tonne                              | Tonne          | Tonne          | Tm              | Tm              |
| LC-4 | RARE, LWL, Span dislodge EP | 939.45                             | 984.81         | 0              | 6351.2          | 0               |

| LC-6        | RARE, LWL, Min LL acomp, EP          | Forces about toe |                |                |                 |                 |  | LC-6 |
|-------------|--------------------------------------|------------------|----------------|----------------|-----------------|-----------------|--|------|
| S.N.        | Description                          | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |  |      |
|             |                                      | Tonne            | Tonne          | Tonne          | Tm              | Tm              |  |      |
| 1)          | Sub-structure & Foundation           | 600.57           |                |                | 63.349          | 0               |  | 1    |
| 3)          | Super-structure DL                   | 266.95           |                |                | 153.5           | 0               |  | 1    |
| 4)          | SIDL (excluding surfacing)           | 116.99           |                |                | 67.267          | 0               |  | 1    |
| 5)          | Surfacing                            | 34.025           |                |                | 19.564          | -8.506          |  | 1    |
| 6.2)        | Live Load Vertical Load Min Reaction | 28.8             |                |                | 16.56           | 83.807          |  | 0.75 |
| 7)          | Live Load Horizontal Forces          |                  | 39.153         |                | 521.99          |                 |  | 0.75 |
| <b>9.1)</b> | Earth Pressure LWL                   |                  |                |                |                 |                 |  | 1    |
|             | Horizontal Component                 |                  | 871.45         |                | 5661.6          |                 |  | 1    |
|             | Vertical Component                   | 338.88           |                |                | -271.1          |                 |  | 1    |
| 10.1)       | Surcharge Pressure LWL               |                  | 141.7          |                | 1121.7          |                 |  | 0.8  |

| S.N. | Description                 | Forces at bottom of abutment shaft |                |                |                 |                 |
|------|-----------------------------|------------------------------------|----------------|----------------|-----------------|-----------------|
|      |                             | V                                  | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|      |                             | Tonne                              | Tonne          | Tonne          | Tm              | Tm              |
| LC-6 | RARE, LWL, Min LL acomp, EP | 1379                               | 1014.2         | 0              | 6995.4          | 54.349          |

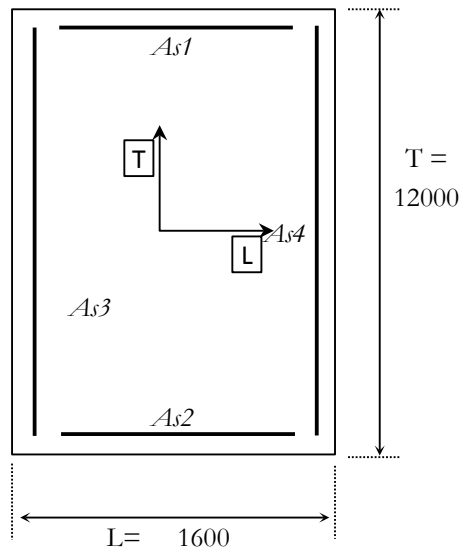
| LC-8        | RARE, LWL, Max LL lead, EP           | Forces about toe |                |                |                 |                 |  | LC-8 |
|-------------|--------------------------------------|------------------|----------------|----------------|-----------------|-----------------|--|------|
| S.N.        | Description                          | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |  |      |
|             |                                      | Tonne            | Tonne          | Tonne          | Tm              | Tm              |  |      |
| 1)          | Sub-structure & Foundation           | 600.57           |                |                | 63.349          | 0               |  | 1    |
| 3)          | Super-structure DL                   | 266.95           |                |                | 153.5           | 0               |  | 1    |
| 4)          | SIDL (excluding surfacing)           | 116.99           |                |                | 67.267          | 0               |  | 1    |
| 5)          | Surfacing                            | 34.025           |                |                | 19.564          | -8.506          |  | 1    |
| 6.1)        | Live Load Vertical Load Max Reaction | 137.4            |                |                | 79.005          | 399.83          |  | 1    |
| 7)          | Live Load Horizontal Forces          |                  | 39.153         |                | 521.99          |                 |  | 1    |
| <b>9.1)</b> | Earth Pressure LWL                   |                  |                |                |                 |                 |  | 1    |
|             | Horizontal Component                 |                  | 871.45         |                | 5661.6          |                 |  | 1    |
|             | Vertical Component                   | 338.88           |                |                | -271.1          |                 |  | 1    |
| 10.1)       | Surcharge Pressure LWL               |                  | 141.7          |                | 1121.7          |                 |  | 0.8  |

| S.N. | Description                | Forces at bottom of abutment shaft |                |                |                 |                 |
|------|----------------------------|------------------------------------|----------------|----------------|-----------------|-----------------|
|      |                            | V                                  | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|      |                            | Tonne                              | Tonne          | Tonne          | Tm              | Tm              |
| LC-8 | RARE, LWL, Max LL lead, EP | 1494.8                             | 1024           | 0              | 7192.5          | 391.33          |



**FORCES AT SHAFT BOTTOM:**

**SLS LOAD COMBINATION :**

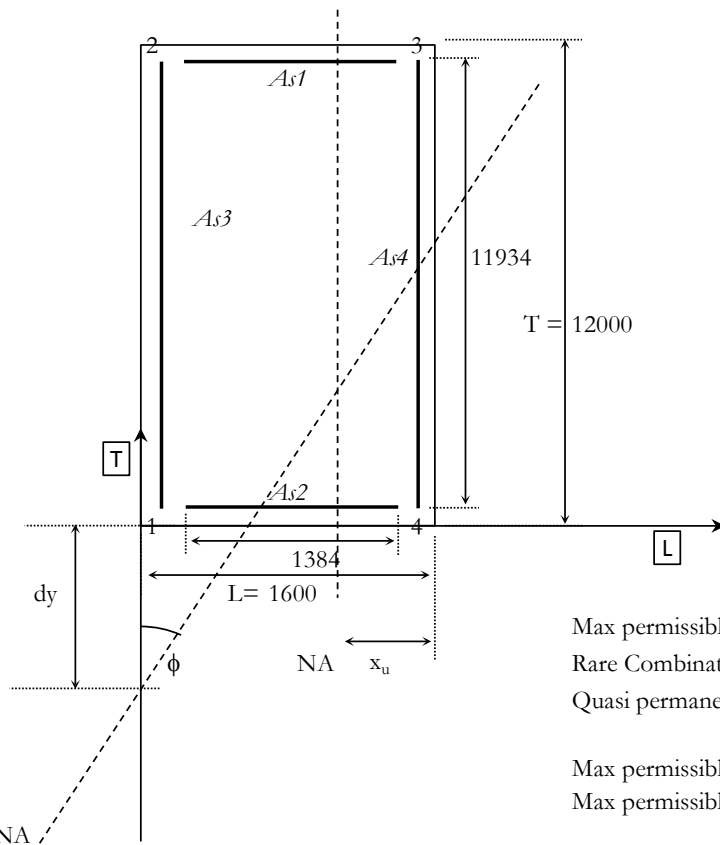


**SLS CHECK FOR ABUTMENT SHAFT :**

| S.N. | Description                 | Forces at bottom of abutment shaft |         |       |           |             |
|------|-----------------------------|------------------------------------|---------|-------|-----------|-------------|
|      |                             | $N_{ED}$                           | $H_L$   | $H_T$ | $M_{ETT}$ | $M_{ELL}$   |
|      |                             | Tonne                              | Tonne   | Tonne | Tm        | Tm          |
| LC-3 | RARE, LWL, Span dislodge FP | 600.566                            | 622.802 | 0     | 3219.25   | 0           |
| LC-4 | RARE, LWL, Span dislodge EP | 939.445                            | 984.811 | 0     | 6351.21   | 0           |
| LC-5 | RARE, LWL, Min LL acomp, FP | 1040.13                            | 652.167 | 0     | 3863.49   | 54.34908353 |
| LC-6 | RARE, LWL, Min LL acomp, EP | 1379.01                            | 1014.18 | 0     | 6995.45   | 54.34908353 |
| LC-7 | RARE, LWL, Max LL lead, FP  | 1155.93                            | 661.955 | 0     | 4060.57   | 391.3286022 |
| LC-8 | RARE, LWL, Max LL lead, EP  | 1494.81                            | 1023.96 | 0     | 7192.53   | 391.3286022 |

## STRESS CHECK

## SECTION AT SHAFT BOTTOM



### Section Dimensions:

|   |   |       |    |
|---|---|-------|----|
| D | = | 1600  | mm |
| B | = | 12000 | mm |

### Material Properties:

|     |   |        |                   |
|-----|---|--------|-------------------|
| fck | = | 45     | N/mm <sup>2</sup> |
| fyk | = | 500    | N/mm <sup>2</sup> |
| Es  | = | 200000 | N/mm <sup>2</sup> |

Max permissible Stress in Concrete

Rare Combination = 21.6 Mpa

Quasi permanent Combination = 16.2 Mpa

Max permissible Stress in Steel (QLS) = 400 Mpa

Max permissible Stress in Steel (Rare) = 300 Mpa

### Reinforcement Details :

| Reinf. | Dia | Spacing | Cover | Eff. cover | Nos. | Spacing | Total As | From |       | To   |       | As per unit |
|--------|-----|---------|-------|------------|------|---------|----------|------|-------|------|-------|-------------|
|        |     |         |       |            |      |         |          | L    | T     | L    | T     |             |
| As1    | 32  | 150     | 50    | 66         | 8    | 154.1   | 6434.0   | 305  | 11934 | 1384 | 11934 | 6.0         |
| As2    | 32  | 150     | 50    | 66         | 8    | 154.1   | 6434.0   | 305  | 66    | 1384 | 66    | 6.0         |
| As3    | 32  | 110     | 75    | 91         | 108  | 110.9   | 86859    | 91   | 66    | 91   | 11934 | 7.3         |
|        | 32  | 110     | 139   | 155        | 108  | 110.9   | 86858.8  | 155  | 66    | 155  | 11934 | 7.3         |
| As4    | 32  | 110     | 50    | 66         | 108  | 110.9   | 86859    | 1534 | 66    | 1534 | 11934 | 7.3         |
| Closed |     |         |       |            |      |         |          |      |       |      |       |             |

### SECTION COORDINATE

| S.N    | x    | y     |
|--------|------|-------|
| 1      | 0    | 0     |
| 2      | 0    | 12000 |
| 3      | 1600 | 12000 |
| 4      | 1600 | 0     |
| 5      | 0    | 0     |
| Closed |      |       |

### Properties of Gross Cross-section

| Properties      | @ XY axis                | @ centroidal axis      |
|-----------------|--------------------------|------------------------|
| A               | = 2E+07 mm <sup>2</sup>  | 2E+07 mm <sup>2</sup>  |
| cgL             | = 800 mm                 | 800 mm                 |
| cgT             | = 6000 mm                | 6000 mm                |
| I <sub>LL</sub> | = 9E+14 mm <sup>4</sup>  | 2E+14 mm <sup>4</sup>  |
| I <sub>TT</sub> | = 2.E+13 mm <sup>4</sup> | 4.E+12 mm <sup>4</sup> |
| I <sub>LT</sub> | = 9.E+13 mm <sup>4</sup> | 0.E+00 mm <sup>4</sup> |

### Modulus of Elasticity for Concrete

|                       |            |   |                     |  |
|-----------------------|------------|---|---------------------|--|
| Design Bending Moment | $M_{RARE}$ | = | 7192.53             | Tm   |
|                       | $M_{QP}$   | = | 5694.17             | Tm   |
|                       | $M_{ST}$   | = | $M_{RARE} - M_{QP}$ | (Bending Moment due to short term loading) |
|                       |            | = | 1498.36             | Tm   |

Modulus of Elasticity for Concrete

For short term loading  $E_{cm}$  = 34313 Mpa

Creep coefficient  $\phi$  = 1

For long term loading  $E_{cm}'$  = 17156.5 Mpa

Reinf. modulus of elasticity  $E_s$  = 200000 N/mm<sup>2</sup>

Modular ratio for QP Combination =  $E_s / E_{cm}'$  = 11.66

Equivalent Modulus of Elasticity for Rare Combination :

$$E_{c,eq} = \frac{E_{cm} * (M_{QP} + M_{ST})}{M_{ST} + (1 + \phi) * M_{QP}} = 19151.31 \text{ MPa}$$

Modular ratio for Rare Combination =  $E_s / E_{c,eq}$  = 10.44

| LC   | Forces  |          |          | Modular ratio | Finding Position of Neutral Axis |        |                |        |                            |        |           |
|------|---------|----------|----------|---------------|----------------------------------|--------|----------------|--------|----------------------------|--------|-----------|
|      | P       | $M_{TT}$ | $M_{LL}$ |               | First Trail                      |        | Valuse Adopted |        | Value suggested by program |        |           |
|      | T       | Tm       | Tm       |               | $\phi$                           | dy     | $\phi$         | dy     | $\phi$                     | dy     | NA_stress |
|      |         |          |          |               | radian                           | mm     | radian         | mm     | radian                     | mm     | Mpa       |
| LC-1 | 1018.53 | 2562.21  | -8.41    | 11.66         | 4.7                              | 1E+07  | 4.7            | 7E+06  | 1.6                        | 1E+07  | -0.60     |
| LC-2 | 1357.41 | 5694.17  | -8.41    | 11.66         | 4.7                              | 3E+07  | 4.7            | -7E+07 | 1.6                        | 4E+07  | -42.86    |
| LC-3 | 600.57  | 3219.25  | 0.10     | 10.44         | 4.7                              | -1E+09 | 4.7            | -5E+06 | 4.7                        | -1E+08 | -4.31     |
| LC-4 | 939.45  | 6351.21  | 0.10     | 10.44         | 4.7                              | -3E+09 | 4.7            | -1E+08 | 4.7                        | -2E+09 | -24.30    |
| LC-5 | 1040.13 | 3863.49  | 54.45    | 10.44         | 4.7                              | -3E+06 | 4.7            | -2E+06 | 4.7                        | -3E+06 | -5.31     |
| LC-6 | 1379.01 | 6995.45  | 54.45    | 10.44         | 4.7                              | -6E+06 | 4.7            | -4E+06 | 4.7                        | -6E+06 | -8.50     |
| LC-7 | 1155.93 | 4060.57  | 391.43   | 10.44         | 4.7                              | -5E+05 | 4.7            | -2E+05 | 4.7                        | -4E+05 | -5.97     |
| LC-8 | 1494.81 | 7192.53  | 391.43   | 10.44         | 4.7                              | -8E+05 | 4.7            | -5E+05 | 4.7                        | -8E+05 | -10.91    |

| LOAD COMBIANTIONS |                          | x                             | y                                  |  | x                            | y                                   |  | Dist.<br>from<br>N.A<br>(mm) (4) |
|-------------------|--------------------------|-------------------------------|------------------------------------|--|------------------------------|-------------------------------------|--|----------------------------------|
|                   |                          | 1600                          | 0                                  |  | 0                            | 12000                               |  |                                  |
|                   |                          | Max. Concrete<br>Stress (Mpa) | Permissible conc.<br>stresses(Mpa) |  | Max. Tensile Stress<br>(Mpa) | Permissible steel<br>stresses (Mpa) |  |                                  |
| LC-1              | QP, LWL, FP              | 4.0                           | 16.2 OK                            |  | -32.4                        | -400 OK                             |  | 938.6                            |
| LC-2              | QP, LWL, EP              | 11.1                          | 16.2 OK                            |  | -189.6                       | -400 OK                             |  | 648.6                            |
| LC-3              | RARE, LWL, Span dislodge | 5.1                           | 21.6 OK                            |  | -47.2                        | -400 OK                             |  | -845.3                           |
| LC-4              | RARE, LWL, Span dislodge | 12.5                          | 21.6 OK                            |  | -275.0                       | -400 OK                             |  | -515.4                           |
| LC-5              | RARE, LWL, Min LL        | 8.0                           | 21.6 OK                            |  | -129.6                       | -400 OK                             |  | -631.1                           |
| LC-6              | RARE, LWL, Min LL        | 14.4                          | 21.6 OK                            |  | -272.7                       | -400 OK                             |  | -570.5                           |
| LC-7              | RARE, LWL, Max LL lead,  | 8.6                           | 21.6 OK                            |  | -138.9                       | -400 OK                             |  | -641.8                           |
| LC-8              | RARE, LWL, Max LL lead,  | 14.9                          | 21.6 OK                            |  | -292.4                       | -400 OK                             |  | -560.9                           |

First Trail NA

$$\tan(\phi) = \frac{M_{LL} * I_{TT} / M_{TT} / I_{LL}}{}$$

$$\tan(\phi) = \frac{(e_L - e_L') * I_{LL} - (e_T - e_T') * I_{LT}}{(e_T - e_T') * I_{TT} - (e_L - e_L') * I_{LT}}$$

$$\sigma_{(L1, T1)} = \frac{P}{A_{eff}} + \frac{P * (e_L - e_L') - P * (e_T - e_T') * (I_{LTeff} / I_{Leff})}{I_{Teff} - (I_{LTeff}^2 / I_{Leff})} (L1 - Cg_{Leff})$$

$$+ \frac{P * (e_T - e_T') - P * (e_L - e_L') * (I_{LTeff} / I_{Teff})}{I_{Leff} - (I_{LTeff}^2 / I_{Teff})} (T1 - Cg_{Teff})$$

**(SLS) CHECK FOR CRACK WIDTH (QUASI PERMANENT LOAD COMBINATIONS)**

Minimum Reinforcement for crack control :

$$A_{s,min} = k_c k_{ct,eff} A_{ct} / \sigma_s \quad (IRC 112 / clause 12.3.3 (2))$$

For Web

$$k_c = 0.4 \text{ For Bending member}$$

$$h = 1.6 \text{ m}, \quad b = 1 \text{ m}$$

$$k = 0.65$$

$$f_{ct,eff} = \text{Max} (f_{ctm}, 2.9)$$

$$= 3.28 \text{ Mpa}$$

$A_{ct}$  = Area of concrete within tensile zone just before the first crack form, section behaves elastically until the tensile fiber stress reaches  $f_{ctm}$ . hence Neutral axis depth will be considered for gross section

$$A_{ct} = b * h / 2$$

$$= 0.8 \text{ m}^2$$

$\sigma_s$  = Maximum stress permitted in reinf. Immediately after formation of crack

$$= f_{yk}$$

$$= 500 \text{ Mpa}$$

$$A_{s,min} = 1363.12 \text{ mm}^2/\text{m} < 14476 \text{ mm}^2/\text{m} \text{ on tension face} \quad \text{OK}$$

$$< 7238 \text{ mm}^2/\text{m} \text{ on compression face} \quad \text{OK}$$

Calculation of crack width : (IRC 112 / clause 12.3.4)

$$w_{k,max} = 0.3 \text{ mm}$$

$$\text{Clear cover } c = 75 \text{ mm}$$

$$\text{Bar dia } \phi_{eq} = 32.00 \text{ mm}$$

$$5 (c + \phi_{eq} / 2) = 455 \text{ mm}$$

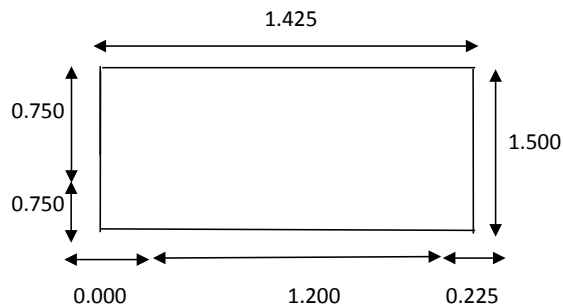
$$\text{Spacing b/w bars} = 110 \text{ mm} < 455 \text{ mm}$$

$$s_{rmax} = \text{Maximum crack spacing}$$

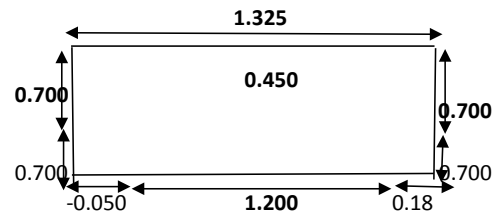
The Following formula can be used for calculation of maximum crack spacing.

|                                 |   |   |  |     |   |       |     |   |         |     |   |        |
|---------------------------------|---|---|--|-----|---|-------|-----|---|---------|-----|---|--------|
|                                 | = | $3.4c + 0.17 \phi / \rho_{P,eff}$   |  |     |   |       |     |   |         |     |   |        |
|                                 | = | 385.162 mm  |  |     |   |       |     |   |         |     |   |        |
| $h_{c,eff}$                     | = | Min $\left\{ \begin{array}{l} 2.5 (h - d) \\ (h - x)/3 \\ h/2 \end{array} \right.$  | <table border="1"> <tr> <td><math>h</math></td><td>=</td><td>1.6 m</td></tr> <tr> <td><math>d</math></td><td>=</td><td>1.347 m</td></tr> <tr> <td><math>x</math></td><td>=</td><td>0.56 m</td></tr> </table> | $h$ | = | 1.6 m | $d$ | = | 1.347 m | $x$ | = | 0.56 m |
| $h$                             | = | 1.6 m   |  |     |   |       |     |   |         |     |   |        |
| $d$                             | = | 1.347 m   |  |     |   |       |     |   |         |     |   |        |
| $x$                             | = | 0.56 m  |  |     |   |       |     |   |         |     |   |        |
|                                 | = | 0.34638 m   | */ (for Quasi Permanent Load combination)  |     |   |       |     |   |         |     |   |        |
| width b                         | = | 1 m   |  |     |   |       |     |   |         |     |   |        |
| $A_{c,eff}$                     | = | $h_{c,eff} * b$   | = 0.34638 m <sup>2</sup>   |     |   |       |     |   |         |     |   |        |
| $\rho_{P,eff}$                  | = | $A_s / A_{c,eff}$   |  |     |   |       |     |   |         |     |   |        |
|                                 | = | 14476.5 /   | 346375   |     |   |       |     |   |         |     |   |        |
|                                 | = | 0.04179   |  |     |   |       |     |   |         |     |   |        |
| $\sigma_{sc}$                   | = | Stress in tension Reinforcement assuming cracked section  |  |     |   |       |     |   |         |     |   |        |
|                                 | = | 189.57 Mpa  | */ (for Quasi Permanent Load combination)  |     |   |       |     |   |         |     |   |        |
| $E_s$                           | = | 200000 Mpa  |  |     |   |       |     |   |         |     |   |        |
| $E_{cm}'$                       | = | 17156 Mpa   | */ (for Long term loading)   |     |   |       |     |   |         |     |   |        |
| $\alpha_e$                      | = | $E_s / E_{cm}$  |  |     |   |       |     |   |         |     |   |        |
| $\alpha_e$                      | = | 11.657  |  |     |   |       |     |   |         |     |   |        |
| kt                              | = | 0.5   | (factor dependent on duration of load)   |     |   |       |     |   |         |     |   |        |
| $\epsilon_{sm} - \epsilon_{cm}$ | = | Max $\left\{ \begin{array}{l} \frac{\sigma_{sc} - k_t f_{ct,eff} (1 + \alpha_e \rho_{P,eff}) / \rho_{P,eff}}{E_s} \\ 0.6 \sigma_{sc} / E_s \end{array} \right.$ |  |     |   |       |     |   |         |     |   |        |
|                                 | = | 0.00066   |  |     |   |       |     |   |         |     |   |        |
| $w_k$                           | = | $s_{rmax} (\epsilon_{sm} - \epsilon_{cm})$  |  |     |   |       |     |   |         |     |   |        |
|                                 | = | 0.253 mm  | < 0.300 mm OK  |     |   |       |     |   |         |     |   |        |

## DESIGN OF ABUTMENT CAP



**Abutment Cap Concrete Dimension**



**Transverse Reinforcement in Cap**

The Abutment Cap is designed as per Cl. 710.8.7 of IRC:78-2014

|   |   |                   |   |               |
|---|---|-------------------|---|---------------|
| Concrete Vol. per m width of cap                | = | 1.425 x 0.225     | = | 0.321 Cum/M   |
| Vol. of steel to be provided = 1% of cap volume | = |                   | = | 0.00321 Cum/M |
| Wt. of Steel required                           | = | 0.00320625 x 7850 | = | 26.00 Kg/M    |
| Longitudinal steel required                     | = | 0.5 x 26          | = | 13.00 Kg/M    |
| Transverse steel required                       | = | 0.5 x 26          | = | 13.00 Kg/M    |
| Length of outer stirrup                         | = |                   | = | 5.450 m       |
| Providing 12 mm dia bar Wt. of each stirrup     | = | 5.45 x 0.889      | = | 4.845 Kg      |
| No. of stirrup required per m width of cap      | = |                   | = | 3.0           |
| Required spacing of stirrup                     | = | 1000/3            | = | 333 mm C/C    |

**Provide 12 mm dia 2 Legged Stirrups @ 150 mm C/C = 32.30 Kg/M OK**

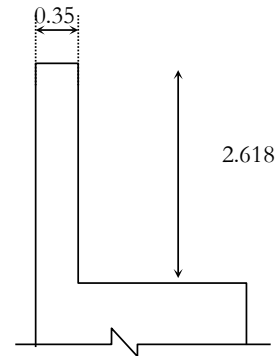
Providing 12 mm bars in longitudinal direction, wt of each bar 0.889 Kg/M

No. of Longitudinal bars required = 13/0.889 = 15 Nos.

**Provide 12 mm dia 20 Nos. Long. bar distributed at top and bottom = 17.78 Kg/M OK**

### DESIGN OF DIRT WALL :

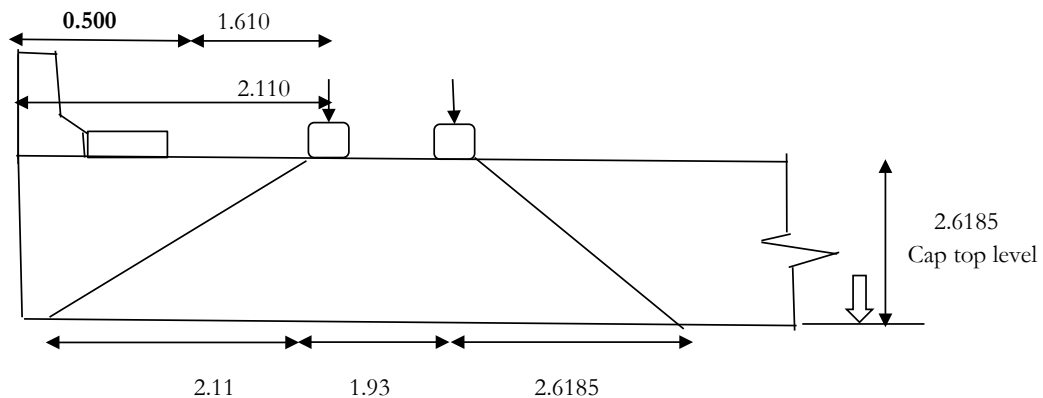
|                                 |                 |                      |
|---------------------------------|-----------------|----------------------|
| Density of Earth                | =               | 2.0 T/m <sup>3</sup> |
| Earth Pressure coefficient Ka   | =               | 0.312                |
| Earth Pressure                  | =               | $1/2 K_a \gamma h^2$ |
|                                 | =               | 2.139 T/m            |
| Lever arm                       | =               | 0.42 *h              |
|                                 | =               | 1.100 m              |
| Moment at bottom                | M <sub>EP</sub> | = 2.353 Tm/m         |
| Live Load surcharge intensity q | =               | 2.4 t/m <sup>2</sup> |
| Live load surcharge Pressure    | =               | K <sub>a</sub> *q*h  |
|                                 | =               | 1.961 T/m            |
| Lever arm                       | =               | 0.5 *h               |
|                                 | =               | 1.309 m              |
| Moment at bottom                | M <sub>SP</sub> | = 2.567 Tm/m         |



### Braking force on dirt wall

20T 70R Axle load is considered over dirt wall

|               |   |       |
|---------------|---|-------|
| Braking force | = | 4.0 T |
|---------------|---|-------|



|  |   |                |   |           |
|--|---|----------------|---|-----------|
| Effective width of Dispersion          | = | 2.11+1.93+2.62 | = | 6.66      |
| Braking Force per m width of Dirt wall | = | 4/6.66         | = | 0.60 T/m  |
| Moment due to Braking Force            | = | 0.6*(2.62+1.2) | = | 2.29 Tm/m |

### ULS DESIGN FORCES:

| LOADS              |   | Unfactored |      | Load Factor | Factored Forces |              |
|--------------------|---|------------|------|-------------|-----------------|--------------|
|                    |   | Force      | BM   |             | Force           | BM           |
|                    |   | T          | Tm   |             | T               | Tm           |
| Earth Pressure     | = | 2.14       | 2.35 | 1.5         | 3.21            | 3.53         |
| Surcharge Pressure | = | 1.96       | 2.57 | 1.2         | 2.35            | 3.08         |
| Braking force      | = | 0.60       | 2.29 | 1.5         | 0.90            | 3.44         |
| <b>Total</b>       |   |            |      |             | <b>6.46</b>     | <b>10.05</b> |



***SLS DESIGN FORCES:***

| LOADS              |   | Unfactored |       | SLS RARE COMB. |             |             | SLS QUASI PER. COMB. |             |             |
|--------------------|---|------------|-------|----------------|-------------|-------------|----------------------|-------------|-------------|
|                    |   | Force      | BM    | Load Factor    | Force       | BM          | Load Factor          | Force       | BM          |
|                    |   | T          | Tm    |                | T           | Tm          |                      | T           | Tm          |
| Earth Pressure     | = | 2.139      | 2.353 | 1              | 2.14        | 2.35        | 1                    | 2.14        | 2.35        |
| Surcharge Pressure | = | 1.961      | 2.567 | 0.8            | 1.57        | 2.05        | 0                    | 0           | 0           |
| Braking force      | = | 0.60       | 2.29  | 1              | 0.60        | 2.29        | 0                    | 0           | 0           |
| <b>Total</b>       |   |            |       |                | <b>4.31</b> | <b>6.70</b> |                      | <b>2.14</b> | <b>2.35</b> |

***ULS DESIGN FORCES:***

| LOADS                 |   | Unfactored |       | Load Factor | Factored Forces |      |
|-----------------------|---|------------|-------|-------------|-----------------|------|
|                       |   | Force      | BM    |             | Force           | BM   |
|                       |   | T          | Tm    |             | T               | Tm   |
| NON-SEISMIC COMPONENT |   |            |       |             |                 |      |
| Earth Pressure        | = | 2.139      | 2.353 | 1.0         | 2.139           | 2.35 |
| Surcharge Pressure    | = | 1.961      | 2.567 | 0.2         | 0.392           | 0.51 |
| Braking force         | = | 0.120      | 0.459 | 0.2         | 0.024           | 0.09 |
| SEISMIC COMPONENT     |   |            |       |             |                 |      |
| Earth Pressure        | = | 0.000      | 0.000 | 1.5         | 0.000           | 0.00 |
| Surcharge Pressure    | = | 0.000      | 0.000 | 0.3         | 0.000           | 0.00 |
| Total                 |   |            |       |             | 2.56            | 2.96 |

**ULS DESIGN :**

Design Bending Moment  $M_{ED}$  = 10.05 Tm

D = 0.35 m \*/ overall depth at d from face of support

d = 0.308 m \*/ deff at d from face of support

Clear Cover = 50 mm

Ast Provided = 16  $\phi$  @ 150 c/c  
= 1340 mm<sup>2</sup>/m

Grade of Concrete fck = 45 Mpa

Grade of steel fyk = 500 Mpa

xu = 0.87 fyk Ast / 0.362 fck b  
= 36 mm

x<sub>u</sub>max = 0.609 d'  
= 187 mm

UNDER REINFORCED

|                      |   |         |
|----------------------|---|---------|
| fyk                  | = | 500 Mpa |
| ε <sub>uk</sub>      | = | 0.0025  |
| ε <sub>ud</sub>      | = | 0.00225 |
| fck                  | = | 45 Mpa  |
| ε <sub>cu2</sub>     | = | 0.0035  |
| xu <sub>max</sub> /d | = | 0.6087  |

$$\begin{aligned}
 A_{st} \text{ calculated} &= M / 0.87 f_{yk} (d' - 0.416 x_u) \\
 &= 788 \text{ mm}^2/\text{m} \\
 A_{st} \text{ minimum} &= 0.15\% * b * d \\
 &= 525 \text{ mm}^2/\text{m} \\
 A_{st} \text{ required} &= \text{Max}(788, 525) \\
 &= 788 \text{ mm}^2/\text{m} \\
 \text{Increase required reinforcement by 50\%} &= 1182 \text{ mm}^2/\text{m} < 1340 \text{ mm}^2/\text{m} \quad \text{OK} \\
 \text{Provide } 16 \text{ mm dia bars @ } 150 \text{ mm C/C vertical bars on both faces}
 \end{aligned}$$

### Horizontal Reinforcement

$$\begin{aligned}
 \text{Total horiz steel required} &= 25\% \text{ of vertical bars or } 0.001 A_c \text{ whichever is more on each face} \\
 &= 350 \text{ mm}^2 \\
 \text{Provide } 10 \text{ mm dia @ } 150 \text{ C/C horz bars on each face} &= 523 \text{ mm}^2 \quad \text{OK}
 \end{aligned}$$

### (ULS) CHECK FOR SHEAR FORCE

$$\text{Factored Shear Force } V_{ED} = 6.46 \text{ Tonne}$$

$$\begin{aligned}
 D &= 0.350 \text{ m} \quad */ \text{ overall depth at face of support} \\
 d &= 0.308 \text{ m} \quad */ \text{ deff at face of support}
 \end{aligned}$$

Design Shear Resitance

$$\begin{aligned}
 k &= \text{Min} \left\{ \begin{array}{l} 1 + \sqrt{200/d} \\ 2 \end{array} \right. \quad d \text{ is depth in mm} \\
 &= 1.806
 \end{aligned}$$

$$\begin{aligned}
 \rho_1 &= \text{Min} \left\{ \begin{array}{l} A_{sl} / b_w d \\ 0.02 \end{array} \right. \\
 &= 0.0044
 \end{aligned}$$

$$\sigma_{cp} = 0 \text{ Mpa}$$

$$\begin{aligned}
 v_{\min} &= 0.031 k^{3/2} f_{ck}^{1/2} \\
 &= 0.505
 \end{aligned}$$

$$\begin{aligned}
 V_{Rdc} &= \text{Max} \left\{ \begin{array}{l} (0.12 k (80 \rho_1 f_{ck})^{0.33} + 0.15 \sigma_{cp}) b_w d \\ (v_{\min} + 0.15 \sigma_{cp}) b_w d \end{array} \right. \quad (\text{IRC 112 / clause 10.3.2 (2)}) \\
 &= 16.55 \text{ Tonne} > 6.46 \text{ Tonne} \quad \text{OK}
 \end{aligned}$$

### Max Shear Capacity of section

$$\begin{aligned}
 v &= 0.6 * (1 - f_{ck} / 310) \quad */ \text{ fck in Mpa} \\
 &= 0.513
 \end{aligned}$$

$$\begin{aligned}
 f_{cd} &= 0.4467 * f_{ck} \\
 &= 20.10 \text{ Mpa}
 \end{aligned}$$

$$V_{RDC, \max} = 0.5 b w d v_{fd} = 159 \text{ Tonne} > 6.5 \text{ Tonne OK}$$

### (SLS) CHECK FOR STRESSES (RARE & QUASI PERMANENT LOAD COMBINATIONS)

$$\begin{aligned} \text{Design Bending Moment } M_{RARE} &= 6.70 \text{ Tm} \\ M_{QP} &= 2.35 \text{ Tm} \\ M_{ST} &= M_{RARE} - M_{QP} \quad (\text{Bending Moment due to short term loading}) \\ &= 4.35 \text{ Tm} \end{aligned}$$

$$\begin{aligned} \text{Modulus of Elasticity for Concrete} \\ \text{For short term loading } E_{cm} &= 34313 \text{ Mpa} \\ \text{Creep coefficient } \phi &= 1.21 \\ \text{For long term loading } E_{cm}' &= 15549 \text{ Mpa} \end{aligned}$$

$$\text{Reinf. modulus of elasticity } E_s = 200000 \text{ N/mm}^2$$

$$\text{Modular ratio for QP Combination} = E_s / E_{cm}' = 12.86$$

Equavalent Modulus of Elasticity for Rare Combination :

$$E_{c,eq} = \frac{E_{cm} * (M_{QP} + M_{ST})}{M_{ST} + (1 + \phi) * M_{QP}} = 24100 \text{ MPa}$$

$$\text{Modular ratio for Rare Combination} = E_s / E_{c,eq} = 8.30$$

| Formula used for calculation of stress    |   |
|---|---|
| dc (depth of neutral axis)                | $= \frac{-m * A_s + \sqrt{(m^2 * A_s^2 + 2 * m * A_s * b * d)}}{b}$ |
| $I_{NA}$ (Transformed)                    | $= b * dc^3 / 3 + m * A_s * (d - dc)^2$                             |
| Compressive stress in concrete $\sigma_c$ | $= M_{RARE} * dc / I_{NA}$  |
| Tensile stress in steel $\sigma_s$        | $= m * M_{RARE} * (d - dc) / I_{NA}$                                |

| <i>Description</i>                        | <i>Stress Check For Rare Combination</i> | <i>Stress Check For QP Combination</i> |
|---|--|--|
| Design Moment                             | = 6.70 Tm                                | = 2.35 Tm                              |
| Total Depth at section                    | = 0.35 m                                 | = 0.35 m                               |
| deff                                      | = 0.308 m                                | = 0.308 m                              |
| width b                                   | = 1 m                                    | = 1 m                                  |
| $A_{st, provided}$                        | = 1340.413 mm <sup>2</sup> /m            | = 1340.41 mm <sup>2</sup> /m           |
| Modular ratio                             | = 8.30                                   | = 12.86                                |
| dc (depth of neutral axis)                | = 72.40 mm                               | = 87.25 mm                             |
| $I_{NA}$ (Transformed)                    | = 7.44E+08 mm <sup>4</sup>               | = 1.06E+09 mm <sup>4</sup>             |
| Compressive stress in concrete $\sigma_c$ | = 6.52 N/mm <sup>2</sup>                 | = 1.93 N/mm <sup>2</sup>               |
| Permissible Compressive stress            | = 21.6 N/mm <sup>2</sup> OK              | = 16.2 N/mm <sup>2</sup> OK            |
| Tensile stress in steel $\sigma_s$        | = 176 N/mm <sup>2</sup>                  | = 63 N/mm <sup>2</sup>                 |

|                            |   |                          |   |                          |
|----------------------------|---|--------------------------|---|--------------------------|
| Permissible tensile stress | = | 300 N/mm <sup>2</sup> OK | = | 400 N/mm <sup>2</sup> OK |
|----------------------------|---|--------------------------|---|--------------------------|

### **(SLS) CHECK FOR CRACK WIDTH (QUASI PERMANENT LOAD COMBINATIONS)**

#### **Minimum Reinforcement for crack control :**

$$A_{s,min} = k_c k_{ct,eff} A_{ct} / \sigma_s \quad (IRC 112 / clause 12.3.3 (2))$$

For Web

$$k_c = 0.4 \text{ For Bending member}$$

$$h = 0.35 \text{ m}, \quad b = 1 \text{ m}$$

$$k = 1$$

$$f_{ct,eff} = f_{ctm}$$

$$= 3.28 \text{ Mpa}$$

$A_{ct}$  = Area of concrete within tensile zone just before the first crack form, section behaves elastically until the tensile fiber stress reaches  $f_{ctm}$ . hence Neutral axis depth will be considered for gross section

$$A_{ct} = b * h/2$$

$$= 0.175 \text{ m}^2$$

$\sigma_s$  = Maximum stress permitted in reinf. Immediately after formation of crack

$$= f_{yk}$$

$$= 500 \text{ Mpa}$$

$$A_{s,min} = 459 \text{ mm}^2/\text{m} < 1340 \text{ mm}^2/\text{m} \text{ OK}$$

#### **Calculation of Crack Width :** (IRC 112 / clause 12.3.4)

$$w_{k,max} = 0.3 \text{ mm}$$

Clear cover  $c = 50 \text{ mm}$

Bar dia  $\phi_{eq} = 16 \text{ mm}$

$$5 (c + \phi_{eq}/2) = 290 \text{ mm}$$

Spacing b/w bars = 150 mm < 290 mm

$s_{rmax}$  = Maximum crack spacing

The Following formula can be used for calculation of maximum crack spacing.

$$= 3.4c + 0.17 \phi / \rho_{Peff}$$

$$= 348 \text{ mm}$$

$$h_{c,eff} = \text{Min} \begin{cases} 2.5 (h - d) \\ (h - x)/3 \\ h/2 \end{cases}$$

$$= 0.0876 \text{ m}$$

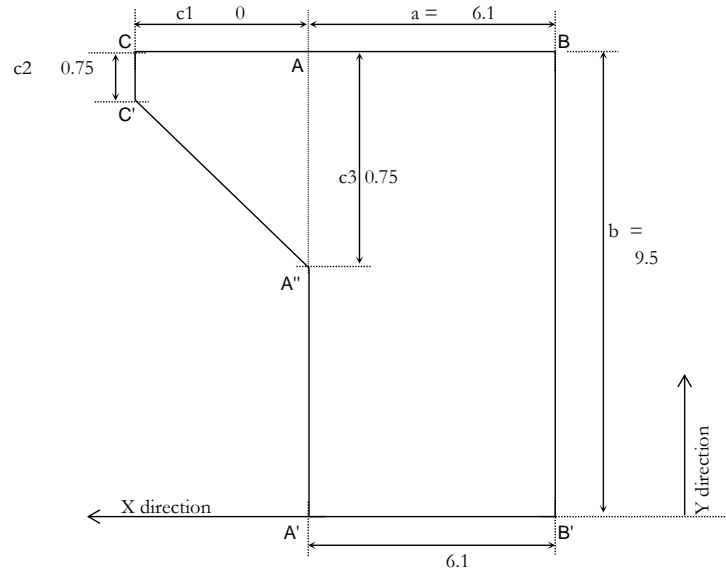
|     |   |           |   |
|-----|---|-----------|---|
| $h$ | = | 0.35 m    |   |
| $d$ | = | 0.308 m   | */ (for Quasi Permanent Load combination) |
| $x$ | = | 0.08725 m |   |

width  $b = 1 \text{ m}$

$$A_{c,eff} = h_{c,eff} * b = 0.0876 \text{ m}^2$$

|                                 |   |   |  |
|---------------------------------|---|---|--|
| $\rho_{P,eff}$                  | = | $A_s / A_{c,eff}$   |  |
|                                 | = | $1340 /$  | $87584$  |
|                                 | = | $0.015304$  |  |
| $\sigma_{sc}$                   | = | Stress in tension Reinforcement assuming cracked section  |  |
|                                 | = | $63 \text{ Mpa}$  | $*/ (\text{for Quasi Permanent Load combination})$ |
| $E_s$                           | = | $200000 \text{ Mpa}$  |  |
| $E_{cm}'$                       | = | $15549 \text{ Mpa}$   | $*/ (\text{for Long term loading})$                |
| $\alpha_e$                      | = | $E_s / E_{cm}$  |  |
| $\alpha_e$                      | = | $12.86$   |  |
| $k_t$                           | = | $0.5$   | $(\text{factor dependent on duration of load})$    |
| $\epsilon_{sm} - \epsilon_{cm}$ | = | $\text{Max} \left\{ \frac{\sigma_{sc} - k_t f_{ct,eff} (1 + \alpha_e \rho_{P,eff}) / \rho_{P,eff}}{E_s} \right.$ $\left. 0.6 \sigma_{sc} / E_s \right.$ |  |
|                                 | = | $0.000189$  |  |
| $w_k$                           | = | $s_{rmax} (\epsilon_{sm} - \epsilon_{cm})$  |  |
|                                 | = | $0.066 \text{ mm}$  | $< 0.300 \text{ mm} \quad \text{OK}$               |

## DESIGN OF RETURN WALL



Width of Solid return wall (a) = 6.1 m  
Height of Solid return wall (b) = 9.5 m

Width of Cantilever return wall c1 = 0 m  
Height of Cantilever return at Tip c2 = 0.75 m  
Height of Cantilever return taper c3-c2 = 0.00 m  
Height of Cantilever return at Root c3 = 0.75 m

Thickness of Solid Return at farther end t1 = 0.5 m  
Thickness of Solid Return at top t2 = 0.5 m  
Thickness of Solid Return at bottom t3 = 0.5 m  
Thickness of Cantilever return = 0.5 m  
Unit wt of Soil = 2.0 t/m<sup>3</sup>

a/b = 0.642

### Case (1) For Uniformly Distributed Load Over Entire Plate

|            |   |       |            |   |       |            |   |       |
|------------|---|-------|------------|---|-------|------------|---|-------|
| For a/b    | = | 0.5   | For a/b    | = | 0.750 | For a/b    | = | 0.642 |
| $\beta_1$  | = | 0.631 | $\beta_1$  | = | 1.246 | $\beta_1$  | = | 0.981 |
| $\beta_2$  | = | 0.632 | $\beta_2$  | = | 1.186 | $\beta_2$  | = | 0.947 |
| $\gamma_1$ | = | 0.874 | $\gamma_1$ | = | 1.129 | $\gamma_1$ | = | 1.019 |
| $\gamma_2$ | = | 0.557 | $\gamma_2$ | = | 0.829 | $\gamma_2$ | = | 0.712 |

Live Load Surcharge:

$$q = 0.312 \times 2 \times 1.2 = 0.749 \text{ t/m}^2$$

$$\sigma_{bmax} = \frac{\beta_1 \times q \times b^2}{t^2} = \frac{0.981 \times 0.749 \times 90.250}{0.25} = 265.07 \text{ t/m}^2$$

For 1000 mm of width

$$Z = \frac{1000 \times 250000}{6} = 4.17E+07 \text{ mm}^3 = 0.04167 \text{ m}^3$$

Hence Moment /m width along Y direction

$$M_Y / \text{m width} = 265.067 \times 0.042 = 11.044 \text{ t-m/m}$$

$$\sigma_{\text{amax}} = \frac{\beta_2 \times q \times b^2}{t^2} = \frac{0.947 \times 0.749 \times 90.250}{0.25} = 255.96 \text{ t/m}^2$$

For 1000 mm of width

$$Z = \frac{1000 \times 250000}{6} = 41666667 \text{ mm}^3 = 0.042 \text{ m}^3$$

Hence Moment /m width along X direction

$$M_X / \text{m width} = 255.964 \times 0.042 = 10.665 \text{ t-m/m}$$

#### Case (2) For Triangular Loading Due to Earth Pressure

|            |   |       |            |   |       |            |   |       |
|------------|---|-------|------------|---|-------|------------|---|-------|
| For a/b    | = | 0.5   | For a/b    | = | 0.75  | For a/b    | = | 0.642 |
| $\beta_1$  | = | 0.328 | $\beta_1$  | = | 0.537 | $\beta_1$  | = | 0.447 |
| $\beta_2$  | = | 0.2   | $\beta_2$  | = | 0.276 | $\beta_2$  | = | 0.243 |
| $\gamma_1$ | = | 0.483 | $\gamma_1$ | = | 0.551 | $\gamma_1$ | = | 0.522 |
| $\gamma_2$ | = | 0.195 | $\gamma_2$ | = | 0.23  | $\gamma_2$ | = | 0.215 |

Earth pressure:

$$q = 0.312 \times 2 \times 9.5 = 5.928 \text{ t/m}^2$$

$$\sigma_{\text{bmax}} = \frac{\beta_1 \times q \times b^2}{t^2} = \frac{0.447 \times 5.928 \times 90.250}{0.25} = 956 \text{ t/m}^2$$

For 1000 mm of width

$$Z = \frac{1000 \times 250000}{6} = 4.167E+07 \text{ mm}^3 = 0.042 \text{ m}^3$$

Hence Moment /m width along Y direction

$$M_Y /m \text{ width} = 956 \times 0.042 = 39.840 \text{ t-m/m}$$

$$\sigma_{amax} = \frac{\beta_2 \times q \times b^2}{t^2} = \frac{0.243 \times 5.93 \times 90.25}{0.25} = 520.45 \text{ t/m}^2$$

For 1000 mm of width

$$Z = \frac{1000 \times 250000}{6} = 4.167E+07 \text{ mm}^3$$

$$= 0.042 \text{ m}^3$$

Hence Moment /m width along X direction

$$M_X /m \text{ width} = 520.45 \times 0.0417 = 21.685 \text{ t-m/m}$$

Total Moment in Solid Return /m height = 32.35 t-m/m Along X-direction

Total Moment in Solid Return /m width = 50.88 t-m/m Along Y-direction

**Forces at the cantilever return wall (AA') :**

| Forces at                   | Due to Earth Pressure                                     | Due to Surcharge Pressure                                 |
|-----------------------------|---|---|
| Force at CC'                | $1/2 \times 0.312 \times 2 \times 0.75^2$<br>= 0.176 t/m  | $0.312 \times 1.2 \times 2 \times 0.75$<br>= 0.562 t/m    |
| Force at AA''               | $1/2 \times 0.312 \times 2 \times 0.75^2$<br>= 0.176 t/m  | $0.312 \times 1.2 \times 2 \times 0.75$<br>= 0.562 t/m    |
| Total Force                 | $(0.176+0.176)/2 \times 0$<br>= 0.000 T                   | $(0.562+0.562)/2 \times 0$<br>= 0.000 T                   |
| Lever arm from AA''         | $(2 \times 0.1755 + 0) / ( + 0) \times 0$<br>/ 3<br>= 0 m | $(2 \times 0.5616 + 0) / ( + 0) \times 0$<br>/ 3<br>= 0 m |
| Moment at Face AA''         | 0*0<br>0.000 Tm   | 0*0<br>0.000 Tm   |
| Moment at AA' per m /height | 0/0.75<br>= 0.000 tm/m                                    | 0/0.75<br>= 0.000 tm/m                                    |
|                             |   |   |



|   |                                  |                               |
|---|----------------------------------|-------------------------------|
| Lever arm from BB'  | 6.1 + 0<br>= 6.1 m               | 6.1 + 0<br>= 6.1 m            |
| Moment at Face BB'  | 0*6.1<br>= 0.000 Tm              | 0*6.1<br>= 0.000 Tm           |
| Moment at BB' per m /height<br>*/ Assumed 50% height is effective | 0/4.75<br>= 0.00 tm/m            | 0/4.75<br>= 0.00 tm/m         |
|   |                                  |                               |
| Lever arm from A'B'   | 9.5-(0.75+0.75)*2/3<br>= 8.500 m | 9.5-(0.75+0.75)/2<br>= 8.75 m |
| Moment at Face BB'  | 0*8.5<br>= 0.000 Tm              | 0*8.75<br>= 0.000 Tm          |
| Moment at AB' per m /width<br>*/ Assumed 50% width is effective   | 0/3.05<br>= 0.00 tm/m            | 0/3.05<br>= 0.00 tm/m         |

**Design Bending Moment at Face of Cantilever Return Wall (Horizontal Reinforcement):**

| Force due to                   | Unfactored<br>Bending Moment<br>at Face AA" | Load Factor |      |    |
|--------------------------------|---|-------------|------|----|
|                                |   | ULS         | SLS  |    |
|                                |   |             | Rare | QP |
| Earth Pressure                 | 0.00 tm/m                                   | 1.5         | 1    | 1  |
| Surcharge Pressure             | 0.00 tm/m                                   | 1.2         | 0.8  | 0  |
| ULS Design Bending moment      | =   | 0.00 Tm/m   |      |    |
| SLS Rare Design Bending moment | =   | 0.00 Tm/m   |      |    |
| SLS QP Design Bending moment   | =   | 0.00 Tm/m   |      |    |

**Design Forces for Solid Return wall:**

**Bending Moment At Face BB' ( Horizontal Reinforcement)**

| Force due to                                   | Unfactored<br>Bending Moment<br>at Face BB' | Load Factor |      |    |
|--|---|-------------|------|----|
|  |   | ULS         | SLS  |    |
|  |   |             | Rare | QP |
| Earth Pressure From cantilever return wall     | 0.00 tm/m                                   | 1.5         | 1    | 1  |
| Earth Pressure over solid return wall          | 21.685 tm/m                                 | 1.5         | 1    | 1  |
| Surcharge Pressure From cantilever return wall | 0.00 tm/m                                   | 1.2         | 0.8  | 0  |
| Surcharge Pressure over solid return wall      | 10.665 tm/m                                 | 1.2         | 0.8  | 0  |
| ULS Design Bending moment = 45.33 Tm           |   |             |      |    |
| SLS Rare Design Bending moment = 30.22 Tm      |   |             |      |    |
| SLS QP Design Bending moment = 21.69 Tm        |   |             |      |    |

**Design Bending Moment At Face A'B' (Vertical Reinforcement)**

| Force due to                                   | Unfactored<br>Bending Moment<br>at Face A'B' | Load Factor |      |    |
|--|--|-------------|------|----|
|  |  | ULS         | SLS  |    |
|  |  |             | Rare | QP |
| Earth Pressure From cantilever return wall     | 0.00 tm/m                                    | 1.5         | 1    | 1  |
| Earth Pressure over solid return wall          | 39.84 tm/m                                   | 1.5         | 1    | 1  |
| Surcharge Pressure From cantilever return wall | 0.00 tm/m                                    | 1.2         | 0.8  | 0  |
| Surcharge Pressure over solid return wall      | 11.04 tm/m                                   | 1.2         | 0.8  | 0  |
| ULS Design Bending moment = 73.01 Tm           |  |             |      |    |
| SLS Rare Design Bending moment = 48.68 Tm      |  |             |      |    |
| SLS QP Design Bending moment = 39.84 Tm        |  |             |      |    |

**SHEAR FORCE CALCULATION FOR RETURN WALL :***Case (1) For uniformly distributed load over entire plate*

$$R1 = \gamma_1 q b = 1.019 \times 0.749 \times 9.5 = 7.25 \text{ t-m/m}^2$$

$$R2 = \gamma_2 q b = 0.712 \times 0.749 \times 9.5 = 5.06 \text{ t-m/m}^2$$

*Case (2) For Triangular loading due to earth pressure*

$$R1 = \gamma_1 q b = 0.522 \times 5.928 \times 9.5 = 29.38 \text{ t-m/m}^2$$

$$R2 = \gamma_2 q b = 0.215 \times 5.928 \times 9.5 = 12.10 \text{ t-m/m}^2$$

*Design Shear Force At Face A'B' (Vertical Reinforcement)*

| Force due to  | Unfactored<br>Bending Moment<br>at Face A'B' | ULS Load Factor |
|---|--|-----------------|
| Earth Pressure over solid return wall               | 29.38 tm/m                                   | 1.50            |
| Surcharge Pressure over solid return wall           | 7.25 tm/m                                    | 1.20            |
| Design Shear Force $V_{ED} = 52.76 \text{ t-m/m}^2$ |  |                 |

*Design Shear Force At Face A'B' (Vertical Reinforcement)*

| Force due to  | Unfactored<br>Bending Moment<br>at Face BB' | ULS Load Factor |
|---|---|-----------------|
| Earth Pressure over solid return wall               | 12.10 tm/m                                  | 1.50            |
| Surcharge Pressure over solid return wall           | 5.06 tm/m                                   | 1.20            |
| Design Shear Force $V_{ED} = 24.23 \text{ t-m/m}^2$ |   |                 |

### DESIGN OF RETURN WALL :

#### MATERIAL PROPERTIES :

|   |   |    |            |
|---|---|----|------------|
| Grade of concrete                               | = | M  | 30 MPa     |
| Grade of Reinforcement                          | = | Fe | 500 MPa    |
| fywd = 0.8 fyk                                  | = |    | 400 MPa    |
| Clear cover                                     | = |    | 75 mm      |
| Modulus of Elasticity steel Es                  | = |    | 200000 Mpa |
| For short Term loading Ecm                      | = |    | 34313 Mpa  |
| For long Term loading Ecm'                      | = |    | 17156 Mpa  |
| f <sub>cteff</sub> Mean tensile strength = fctm | = |    | 3.28 Mpa   |
| fed   | = |    | 20.10 Mpa  |
| Creep factor $\phi$                             | = |    | 1.00       |
| $\epsilon_{uk}$                                 | = |    | 0.0025     |
| $\epsilon_{ud}$                                 | = |    | 0.0022     |
| $\epsilon_{cu2}$                                | = |    | 0.0035     |
| $x_{u,max}/d$                                   | = |    | 0.6167     |

#### PERMISSIBLE STRESSES

##### 1) Permissible concrete compressive stresses

| Load Combi | Permissible Stress |            |
|------------|--------------------|------------|
| SLS Rare   | 0.48 fck           | = 14.4 Mpa |
| SLS QP     | 0.36 fck           | = 10.8 Mpa |

2) Permissible Tensile stress in steel (Rare) = 0.6 fy = 300 Mpa

Permissible Tensile stress in steel (QLS) = 0.8 fy = 400 Mpa

##### 3) Permissible crack width w<sub>k</sub>

SLS QP Load combination = 0.3 mm

#### A) ULS CAPACITY CHECK

| Load comb.                               | M <sub>ED</sub> | b    | Overall<br>depth D | d   | Area of steel provided |         |                               | x <sub>max</sub> | xu = 0.87 fyk<br>Ast / 0.362 fck<br>b | Check           | Ast,calc = M / 0.87<br>fyk (d'-0.416<br>xu) | Check  | Ast min | Ast provided > Ast<br>min | ΔF <sub>d</sub> | z = d-<br>0.416 xu | M <sub>ED</sub> /z<br>+ ΔF <sub>D</sub> | M <sub>Rd</sub> = 0.87 fyk<br>Ast (d-0.416<br>xu) | M <sub>RD</sub> /z | Check  |
|--|-----------------|------|--------------------|-----|------------------------|---------|-------------------------------|------------------|---------------------------------------|-----------------|---|--|---------|---------------------------|-----------------|--------------------|---|---|--------------------|--|
|  |                 |      |                    |     | Dia                    | Spacing | Λ <sub>st</sub> ,<br>Provided |                  |                                       |                 |   | Λ <sub>st</sub> Calc < Λ <sub>st</sub><br>Provided |         |                           |                 |                    |   |   |                    | M <sub>RD</sub> /z ><br>M <sub>ED</sub> /z + ΔF <sub>D</sub> |
|  | Tm              | mm   | mm                 | mm  | mm                     | mm      | mm <sup>2</sup>               | mm               | mm                                    | mm <sup>2</sup> | OK  | mm <sup>2</sup>                                    | T       | m                         | T               | Tm                 | Tm/m                                    | M <sub>ED</sub> /z + ΔF <sub>D</sub>              |                    |  |
| Face of cantilever wing wall<br>ULS BM   | 0.00            | 1000 | 500                | 419 | 12                     | 100     | 1131                          | 258              | 45                                    | UR, OK          | 0   | OK   | 628.5   | OK                        | 0.00            | 400                | 0                                       | 20  | 49                 | OK   |
| Design of Section At Face BB''<br>ULS BM | 45.33           | 1000 | 500                | 415 | 20                     | 100     | 3142                          | 256              | 126                                   | UR, OK          | 2873  | OK   | 623     | OK                        | 0.00            | 363                | 125                                     | 50  | 137                | OK   |
| Design of Section At Face AB''<br>ULS BM | 73.01           | 1000 | 500                | 413 | 25                     | 100     | 4909                          | 254              | 197                                   | UR, OK          | 5075  | Revise   | 619     | OK                        | 0.00            | 331                | 221                                     | 71  | 214                | REVISE   |

## B) SLS STRESS CHECK

Rare Load combination.

$$E_{c,eq} = \frac{E_{cm} * (M_{QP} + M_{ST})}{M_{ST} + (1 + \phi) * M_{QP}}$$

$$M_{ST} = M_{RARE} - M_{QP}$$

$$m = E_s / E_{c,eq}$$

Quasi Permanent Load Combination

$$m = E_s / E_{cm}'$$

| Formula used for calculation of stress    |   |
|---|---|
| dc (depth of neutral axis)                | $= \frac{-m * A_s + \sqrt{(m^2 * A_s^2 + 2 * m * A_s * b * d)}}{b}$ |
| $I_{NA}$ (Transformed)                    | $= b * dc^3 / 3 + m * A_s * (d - dc)^2$                             |
| Compressive stress in concrete $\sigma_c$ | $= M_{RARE} * dc / I_{NA}$  |
| Tensile stress in steel $\sigma_s$        | $= m * M_{RARE} * (d - dc) / I_{NA}$                                |

Stress Check for SLS Load Combinations

| Load comb.                                  | M<br>(tm/m) | b<br>mm | d<br>mm | $A_{st,}$<br>Provided<br>mm <sup>2</sup> | modular<br>ratio | N.A.<br>depth<br>(dc)<br>mm | $I_{NA}$<br>mm <sup>4</sup> | Comp<br>stress<br>Mpa | Max C.<br>Stress<br>Mpa | Check  | Tensile<br>stress<br>Mpa | Max T<br>Stress<br>Mpa | Check |
|---|-------------|---------|---------|--|------------------|-----------------------------|-----------------------------|-----------------------|-------------------------|--------|--------------------------|------------------------|-------|
| <i>Face of cantilever wing wall</i>         |             |         |         |  |                  |                             |                             |                       |                         |        |                          |                        |       |
| SLS (R Comb.)                               | 0.00        | 1000    | 419     | 1131                                     | 5.83             | 68.02                       | 9E+08                       | 0.00                  | 14.4                    | OK     | 0.00                     | 300                    | OK    |
| SLS (QP Comb.)                              | 0.00        | 1000    | 419     | 1131                                     | 11.66            | 92.75                       | 2E+09                       | 0.00                  | 10.8                    | OK     | 0.00                     | 400                    | OK    |
| <i>Section at deff from face of colonne</i> |             |         |         |  |                  |                             |                             |                       |                         |        |                          |                        |       |
| SLS (R Comb.)                               | 30.22       | 1000    | 415     | 3142                                     | 10.01            | 133.15                      | 3E+09                       | 12.25                 | 14.4                    | OK     | 260                      | 300                    | OK    |
| SLS (QP Comb.)                              | 21.69       | 1000    | 415     | 3142                                     | 11.66            | 141.53                      | 4E+09                       | 8.33                  | 10.8                    | OK     | 188                      | 400                    | OK    |
| <i>Section just below bearing</i>           |             |         |         |  |                  |                             |                             |                       |                         |        |                          |                        |       |
| SLS (R Comb.)                               | 48.68       | 1000    | 413     | 4909                                     | 10.60            | 161.59                      | 5E+09                       | 16.80                 | 14.4                    | Revise | 276                      | 300                    | OK    |
| SLS (QP Comb.)                              | 39.84       | 1000    | 413     | 4909                                     | 11.66            | 167.46                      | 5E+09                       | 13.34                 | 10.8                    | Revise | 228                      | 400                    | OK    |

**C) SLS CRACK WIDTH CHECK (QUASI PERMANENT LOAD COMBINATION)**

**1) CHECK  $A_{st,min}$  for crack control**

| Load comb.                           | b    | h   | d   | Act =bh/2       | σs = fyk | k    | kc  | A <sub>s,min</sub> =k <sub>c</sub> k f <sub>ct,eff</sub> | A <sub>s,provided</sub> | check |
|--------------------------------------|------|-----|-----|-----------------|----------|------|-----|--|-------------------------|-------|
|                                      | mm   | mm  | mm  | mm <sup>2</sup> | Mpa      |      |     | A <sub>ct</sub> / σ <sub>s</sub>                         |                         |       |
|                                      | mm   | mm  | mm  | mm <sup>2</sup> | Mpa      |      |     | mm <sup>2</sup>  | mm <sup>2</sup>         |       |
| Section at face of columne           |      |     |     |                 |          |      |     |  |                         |       |
| SLS QP                               | 1000 | 500 | 349 | 250000          | 500      | 0.86 | 0.4 | 564  | 1131                    | OK    |
| Section at deff from face of columne |      |     |     |                 |          |      |     |  |                         |       |
| SLS QP                               | 1000 | 500 | 345 | 250000          | 500      | 0.86 | 0.4 | 564  | 3142                    | OK    |
| Section just below bearing           |      |     |     |                 |          |      |     |  |                         |       |
| SLS QP                               | 1000 | 500 | 343 | 250000          | 500      | 0.86 | 0.4 | 564  | 4909                    | OK    |

| h   | k    |
|-----|------|
| 0   | 1    |
| 0.3 | 1    |
| 0.8 | 0.65 |
| 3   | 0.65 |
|     |      |

**2) CHECK FOR MAXIMUM SPACING b/w bars.**

| Load comb.                                   | Bar dia     | cover | Spacing b/w bars |            | Check |
|--|-------------|-------|------------------|------------|-------|
|  |             |       | Provided         | Calculated |       |
|  | $\phi_{eq}$ | c     | mm               | mm         |       |
| <i>Section at face of columnne</i>           |             |       |                  |            |       |
| SLS QP                                       | 12          | 75    | 100              | 405        | OK    |
| <i>Section at deff from face of columnne</i> |             |       |                  |            |       |
| SLS QP                                       | 12          | 75    | 100              | 405        | OK    |
| <i>Section just below bearing</i>            |             |       |                  |            |       |
| SLS QP                                       | 12          | 75    | 100              | 405        | OK    |

### 3) CHECK FOR CRACK WIDTH

| Load comb.                                     | $h_{c,eff} = \text{Min} [ 2.5 ( h - d ) , ( h - x/3 ) , h/2 ]$ | $A_{c,eff} = h_{c,eff} * b$ | $A_{s,provided}$ | $\rho_{peff} = A_s / A_{c,eff}$ | $s_{max} = 3.4c + 0.17 \phi / \rho_{peff}$ | $\sigma_{sc}$ | $x = \text{neutral axis depth}$ | kt  | $\alpha_e = E_s / E_{cm}$ | $\epsilon_{sm} - \epsilon_{cm} = \text{Max} [ [ \sigma_{sc} - k_t f_{ct,eff} ( 1 + \alpha_e \rho_{peff} ) / \rho_{peff} ] / E_s , 0.6 \sigma_{sc} / E_s ]$ | $w_k$ | check |
|--|--|-----------------------------|------------------|---------------------------------|--|---------------|---------------------------------|-----|---------------------------|--|-------|-------|
|  | mm   | mm <sup>2</sup>             | mm <sup>2</sup>  |                                 | mm   | Mpa           | mm                              |     |                           |  |       |       |
| Section at face of columne<br>SLS QP           | 250  | 250000                      | 1130.97          | 0.005                           | 705.939                                    | 0.00          | 92.75                           | 0.5 | 11.66                     | 0  | 0.000 | OK    |
| Section at deff from face of columne<br>SLS QP | 250  | 250000                      | 3142             | 0.013                           | 417.338                                    | 187.66        | 141.53                          | 0.5 | 11.66                     | 0.0006   | 0.235 | OK    |
| Section just below bearing<br>SLS QP           | 250  | 250000                      | 4908.74          | 0.020                           | 358.896                                    | 227.55        | 167.46                          | 0.5 | 11.66                     | 0.0007   | 0.245 | OK    |

### D) CHECK FOR SHEAR: (IRC 112 / clause 10.3.2 (2) )

Check of Shear Reinforcement Requirement

| Load comb.          | $V_{ED}$ | $\beta$ | $\beta V_{ED}$ | d      | bw   | $k = \text{Min} [ 1 + \sqrt{200/d} , 2 ]$ | $A_{sl}$        | $\rho 1 = \text{Min} [ A_{sl} / bw d , 0.02 ]$ | $v_{min} = 0.031 k^{3/2} f_{ck}^{1/2}$ | $\sigma_{cp}$ | $V_{kac} = \text{Max} [ ( 0.12 k ( 80 \rho 1 f_{ck} )^{0.33} + 0.15 \sigma_{cp} ) bw d , ( v_{min} + 0.15 \sigma_{cp} ) bw d ]$ | Check                    |
|---------------------|----------|---------|----------------|--------|------|---|-----------------|--|--|---------------|---|--------------------------|
|                     | T        |         | T              | mm     | mm   |   | mm <sup>2</sup> |  |  | Mpa           | Tonne   |                          |
| At face BB'<br>ULS  | 24.23    | 0.25    | 6.06           | 419    | 1000 | 1.69                                      | 1130.97         | 0.0027   | 0.373                                  | 0             | 15.75   | No Shear reinf. Required |
| At face A'B'<br>ULS | 52.76    | 0.25    | 13.19          | 415.00 | 1000 | 1.69                                      | 3141.59         | 0.0076   | 0.374                                  | 0             | 21.97   | No Shear reinf. Required |

| <b>Check for Maximum Shear Capacity :</b> |          |      |     |            |               |     |   |       | $\theta = 0.5 \sin^{-1} \left[ \frac{2 * V_{NS}}{(\alpha_{cw} * b_w * z * v1 * f_{cd})} \right]$ | $\theta$ adopted | $\Delta F_d = 0.5 V_{ED} \cot \theta$ |
|---|----------|------|-----|------------|---------------|-----|---|-------|--|------------------|---------------------------------------|
| Load comb.                                | $V_{ED}$ | bw   | d   | $z = 0.9d$ | $\alpha_{cw}$ | v1  | $V_{edmax} = \alpha_{cw} * b_w * z * v1 * f_{cd} / 2$ | Check |  |                  |                                       |
|   | T        | mm   | mm  | mm         |               |     | Tonne   |       | deg  | deg              | T                                     |
| At face A'B<br>ULS                        | 24.23    | 1000 | 419 | 377.1      | 1             | 0.6 | 227   | OK    | 3.06   | 45               | 12.11                                 |
| At face BB'<br>ULS                        | 52.76    | 1000 | 415 | 374        | 1             | 0.6 | 225   | OK    | 6.77   | 45               | 26.38                                 |

$\Delta F_d$  = Additional Tensile force, to be accounted in longitudinal reinforcement



## Design of Seismic Stopper in Transverse Direction

### Stopper Details :

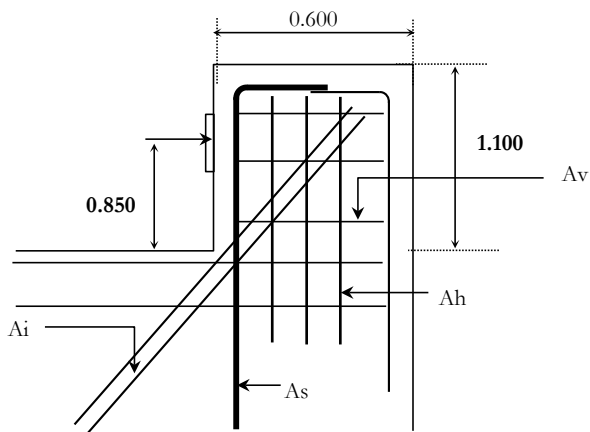
Width of stopper = 1020 mm  
Overall depth h = 600 mm

Clear cover to Reinforcement = 50 mm  
Dia of main reinforcement = 32 mm

Effective Depth provided d = 534 mm

Shear span  $a_v$  = 850 mm

$a_v/d = 1.592 > 1$   
Design as Flexural Member



### Material properties :

Grade of concrete  $f_{ck}$  = 45 Mpa  
 $f_{cd}$  = 20.1 Mpa

Grade of reinforcement  $f_y$  = 500 Mpa  
 $f_{yd} = 0.87 f_y = 435$  Mpa

### Design Load calculation :

Seismic Zone = V

Type of soil = medium

Zone factor Z = 0.36

Importance factor I = 1.2

Sa/g -Transverse Seismic Case = 1

Seis. Coeff. -Trans.,  $A_{hT} = (Z/2) * (I) * (S_a/g)_{(Trans.)}$  = 0.216

Response Reduction Factor,  $R_{trans.}$  = 1

Design Seis. Coeff. -Trans.  $A_{hT} = A_h' / R_{(Trans.)}$  = 0.216

Total weight of super-structure DL+SIDL = 836 Tonne

Seismic Component in Transverse direction = 181 Tonne

Total Horizontal force = 181 Tonne

Nos. of Stopper sharing loads = 2 Nos

Horizontal force over each stopper = 90.28 Tonne

Unfactored Vertical force V = 90.28 Tonne

Unfactored Horizontal Force H = 18.06 Tonne

Load factor = 1.5

Factored Vertical Load  $V_u$  = 135.42 T

Factored Horizontal Force  $H_u$  = 27.08 T

Lever arm = 394 0.85 m

**Design of Stopper :**

|                       |          |   |                                     |
|-----------------------|----------|---|-------------------------------------|
| Design Bending Moment | $M_{ED}$ | =   | 115.11 Tm                           |
| D                     | =        | 0.6 m   | */ overall depth at face of support |
| d                     | =        | 0.534 m   | */ deff at face of support          |
| Clear Cover           | =        | 50 mm   |                                     |
| Ast Provided          | =        | 32 $\phi$ @ 8 Nos                                 |                                     |
|                       | =        | 6434 mm <sup>2</sup> /m                           |                                     |
|                       | =        | 1.205 %   |                                     |
| Grade of Concrete fck | =        | 45 Mpa  |                                     |
| Grade of steel fyk    | =        | 500 Mpa   |                                     |
| xu                    | =        | 0.87 fyk Ast / 0.362 fck b                        |                                     |
|                       | =        | 168 mm  |                                     |
| x <sub>umax</sub>     | =        | 0.609 d'  |                                     |
|                       | =        | 325 mm  | UNDER REINFORCED                    |
| Ast calculated        | =        | M/ 0.87 fyk (d'-0.416 xu)                         |                                     |
|                       | =        | 5704 mm <sup>2</sup> /m                           |                                     |
| Ast minimum           | =        | 0.15% * b*d                                       |                                     |
|                       | =        | 918 mm <sup>2</sup> /m                            |                                     |
| Ast required          | =        | Max( 5704 , 918 )                                 |                                     |
|                       | =        | 5704 mm <sup>2</sup> /m < 6434 mm <sup>2</sup> /m | OK                                  |

**(ULS) CHECK FOR SHEAR FORCE**

$$\text{Factored Shear Force } V_{ED} = 135.4 \text{ T/m}$$

$$\begin{aligned} \text{Reduction factor } \beta_1 &= a_v/2d \\ &= 1 \quad \text{*/ no reduction is applied} \end{aligned}$$

$$\begin{aligned} \text{Design Shear Force } V_{NS}' &= \beta_1 * V_{NS} \\ &= 135.42 \text{ Tonne} \end{aligned}$$

**Max Shear Capacity of section**

$$\begin{aligned} v &= 0.6 * (1 - f_{ck} / 310) \quad \text{*/ } f_{ck} \text{ in mm} \\ &= 0.513 \end{aligned}$$

$$\begin{aligned} f_{cd} &= 20.10 * f_{ck} \\ &= 905 \text{ Mpa} \end{aligned}$$

$$\begin{aligned} V_{RDC, \max} &= 0.5 b_w d v f_{cd} \\ &= 12634 \text{ Tonne} > 135.4 \text{ Tonne} \quad \text{OK} \end{aligned}$$

$$\begin{aligned} D &= 0.6 \text{ m} \quad \text{*/ overall depth at face of support} \\ d &= 0.534 \text{ m} \quad \text{*/ deff at face of support} \end{aligned}$$

**Check for Design Shear Reinforcement :**

$$k = \text{Min} \left\{ \begin{array}{l} 1 + \sqrt{200/d} \\ 2 \end{array} \right. \quad \text{d is depth in mm}$$

$$k = 1.612$$

$$\rho_1 = \text{Min} \left\{ \begin{array}{l} A_{sl} / b_w d \\ 0.02 \end{array} \right.$$

$$\rho_1 = 0.0118$$

$$\sigma_{cp} = 0 \text{ Mpa}$$

$$\begin{aligned} v_{\min} &= 0.031 k^{3/2} f_{ck}^{1/2} \\ &= 0.426 \end{aligned}$$

$$V_{Rdc} = \text{Max} \left\{ \begin{array}{l} (0.12 k (80 \rho_1 f_{ck})^{0.33} + 0.15 \sigma_{cp}) b_w d \\ (v_{\min} + 0.15 \sigma_{cp}) b_w d \end{array} \right. \quad (\text{IRC 112 / clause 10.3.2 (2)})$$

$$= 36.3 \text{ Tonne} < 135.4 \text{ Tonne} \quad \text{PROVIDE DESIGN SHEAR REINF.}$$

***FINDING VALUE OF  $\theta$  AT DESIGN SECTIONS FOR DESIGN SHEAR REINFORCEMENT***

$$\begin{aligned} V_{Rd\max} &= V_{NS} \\ \theta &= 0.5 \sin^{-1} (2 V_{NS} / \alpha_{cw} b_w z v_1 f_{cd}) \\ &= 0.30 \text{ deg} \end{aligned}$$

$$\theta \text{ adopted} = 45 \text{ deg}$$

|               |   |           |
|---------------|---|-----------|
| $\alpha_{cw}$ | = | 1         |
| $v_1$         | = | 0.6       |
| $z$           | = | $0.9 * d$ |
|               | = | 0.481 m   |

***FINDING DESIGN SHEAR REINFORCEMENT REQUIREMENT***

$$V_{NS} = V_{Rds} = (A_{sw}/s) * z * f_{ywd} * \cot \theta \quad (\text{IRC 112 / clause 10.3.3.2 Eq 10.7})$$

$$A_{sw} = V_{NS} * s / z f_{ywd} \cot \theta$$

$$f_{ywd} = 0.8 f_{yk} / \gamma_s$$

$$f_{ywd} = 348 \text{ Mpa}$$

$$A_{sw} = 810 \text{ mm}^2$$

|            |   |      |
|------------|---|------|
| $\gamma_s$ | = | 1.15 |
|------------|---|------|

**Minimum shear reinforcement (IRC 112 / clause 10.3.3.5 Eq 10.20)**

$$A_{sw, \min} = \rho_{w, \min} * s * b_w$$

$$\rho_{w, \min} = (0.072 \sqrt{f_{ck}}) / f_{yk}$$

$$= 0.00097$$

$$A_{sw, \min} = 97 \text{ mm}^2$$

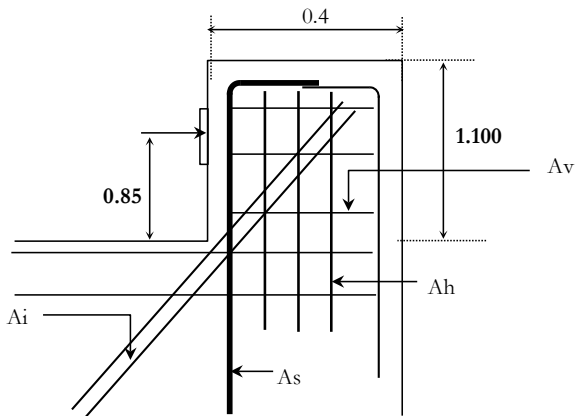
$$\text{Provide } 16 \text{ dia } 6 \text{ legged stp. /m @ } 100 \text{ c/c}$$

$\Rightarrow$  1206 mm<sup>2</sup> @ 100 mm c/c > 810 mm<sup>2</sup> OK

## Design of Seismic Stopper in Longitudinal direction action in Dirt Wall

### Stopper Details :

|                              |   |           |
|------------------------------|---|-----------|
| Width of stopper             | = | 800 mm    |
| Overall depth h              | = | 400 mm    |
| Clear cover to Reinforcement | = | 50 mm     |
| Dia of main reinforcement    | = | 32 mm     |
| Effective Depth provided d   | = | 334 mm    |
| Shear span $a_v$             | = | 850 mm    |
| $a_v/d$                      | = | 2.545 > 1 |
| Design as Flexural Member    |   |           |



### Material properties :

|                        |                     |   |          |
|------------------------|---------------------|---|----------|
| Grade of concrete      | $f_{ck}$            | = | 45 Mpa   |
|                        | $f_{cd}$            | = | 20.1 Mpa |
| Grade of reinforcement | $f_y$               | = | 500 Mpa  |
|                        | $f_{yd} = 0.87 f_y$ | = | 435 Mpa  |

### Design Load calculation :

|   |   |             |
|---|---|-------------|
| Seismic Zone  | = | V           |
| Type of soil  | = | medium      |
| Zone factor Z   | = | 0.36        |
| Importance factor I   | = | 1.2         |
| Sa/g -Transverse Seismic Case                                     | = | 1           |
| Seis. Coeff. -Trans., $A_{hT} = (Z/2) * (I) * (S_a/g)_{(Trans.)}$ | = | 0.216       |
| Response Reduction Factor, $R_{trans.}$                           | = | 1           |
| Design Seis. Coeff. -Trans. $A_{hT} = A_h' / R_{(Trans.)}$        | = | 0.216       |
| Total weight of super-structure DL+SIDL                           | = | 836 Tonne   |
| Seismic Component in Transverse direction                         | = | 181 Tonne   |
| Total Horizontal force  | = | 181 Tonne   |
| Nos. of Stopper sharing loads                                     | = | 4 Nos       |
| Horizontal force over each stopper                                | = | 45.14 Tonne |
| Unfactored Vertical force V                                       | = | 45.14 Tonne |
| Unfactored Horizontal Force H                                     | = | 9.03 Tonne  |
| Load factor   | = | 1.5         |
| Factored Vertical Load $V_u$                                      | = | 67.71 T     |
| Factored Horizontal Force $N_u$                                   | = | 13.54 T     |
| Lever arm   | = | 0.85 m      |
| LL Dispersion in Dirt Wall through Girder                         | = | 1.4 m       |

**Design of Stopper :**

|                       |          |   |                                     |
|-----------------------|----------|---|-------------------------------------|
| Design Bending Moment | $M_{ED}$ | =   | 41.11 Tm                            |
| D                     | =        | 0.4 m   | */ overall depth at face of support |
| d                     | =        | 0.334 m   | */ deff at face of support          |
| Clear Cover           | =        | 50 mm   |                                     |
| Ast Provided          | =        | 32 $\phi$ @ 5 Nos                                 |                                     |
|                       | =        | 4021 mm <sup>2</sup> /m                           |                                     |
|                       | =        | 1.204 %   |                                     |
| Grade of Concrete fck | =        | 45 Mpa  |                                     |
| Grade of steel fyk    | =        | 500 Mpa   |                                     |
| xu                    | =        | 0.87 fyk Ast / 0.362 fck b                        |                                     |
|                       | =        | 134 mm  |                                     |
| x <sub>umax</sub>     | =        | 0.609 d'  |                                     |
|                       | =        | 203 mm  | UNDER REINFORCED                    |
| Ast calculated        | =        | M/ 0.87 fyk (d'-0.416 xu)                         |                                     |
|                       | =        | 3397 mm <sup>2</sup> /m                           |                                     |
| Ast minimum           | =        | 0.15% * b*d                                       |                                     |
|                       | =        | 480 mm <sup>2</sup> /m                            |                                     |
| Ast required          | =        | Max( 3397 , 480 )                                 |                                     |
|                       | =        | 3397 mm <sup>2</sup> /m < 4021 mm <sup>2</sup> /m | OK                                  |

**(ULS) CHECK FOR SHEAR FORCE**

$$\text{Factored Shear Force } V_{ED} = 67.7 \text{ T/m}$$

$$\begin{aligned} \text{Reduction factor } \beta_1 &= \frac{a_v}{2d} \\ &= 1 \quad \text{*/ no reduction is applied} \end{aligned}$$

$$\begin{aligned} \text{Design Shear Force } V_{NS}' &= \beta_1 * V_{NS} \\ &= 67.71 \text{ Tonne} \end{aligned}$$

**Max Shear Capacity of section**

$$\begin{aligned} v &= 0.6 * (1 - f_{ck} / 310) \quad \text{*/ } f_{ck} \text{ in mm} \\ &= 0.513 \end{aligned}$$

$$\begin{aligned} f_{cd} &= 20.10 * f_{ck} \\ &= 905 \text{ Mpa} \end{aligned}$$

$$\begin{aligned} V_{RDC, \max} &= 0.5 b_w d v f_{cd} \\ &= 6198 \text{ Tonne} > 67.7 \text{ Tonne} \quad \text{OK} \end{aligned}$$

$$\begin{aligned} D &= 0.4 \text{ m} \quad \text{*/ overall depth at face of support} \\ d &= 0.33 \text{ m} \quad \text{*/ deff at face of support} \end{aligned}$$

**Check for Design Shear Reinforcement :**

$$\begin{aligned} k &= \text{Min} \left\{ \begin{array}{l} 1 + \sqrt{200/d} \\ 2 \end{array} \right. \quad d \text{ is depth in mm} \\ k &= 1.774 \end{aligned}$$

$$\begin{aligned} \rho_1 &= \text{Min} \left\{ \begin{array}{l} A_{sl} / b_w d \\ 0.02 \end{array} \right. \\ \rho_1 &= 0.0150 \end{aligned}$$

$$\sigma_{cp} = 0 \text{ Mpa}$$

$$\begin{aligned} v_{\min} &= 0.031 k^{3/2} f_{ck}^{1/2} \\ &= 0.491 \end{aligned}$$

$$\begin{aligned} V_{Rdc} &= \text{Max} \left\{ \begin{array}{l} (0.12 k (80 \rho_1 f_{ck})^{0.33} + 0.15 \sigma_{cp}) b_w d \\ (v_{\min} + 0.15 \sigma_{cp}) b_w d \end{array} \right. \quad (\text{IRC 112 / clause 10.3.2 (2)}) \\ &= 21.2 \text{ Tonne} < 67.7 \text{ Tonne} \quad \text{PROVIDE DESIGN SHEAR REINF.} \end{aligned}$$

***FINDING VALUE OF  $\theta$  AT DESIGN SECTIONS FOR DESIGN SHEAR REINFORCEMENT***

$$\begin{aligned} V_{Rd\max} &= V_{NS} \\ \theta &= 0.5 \sin^{-1} (2 V_{NS} / \alpha_{cw} b_w z v_1 f_{cd}) \\ &= 0.24 \text{ deg} \\ \theta \text{ adopted} &= 45 \text{ deg} \end{aligned}$$

|               |   |         |
|---------------|---|---------|
| $\alpha_{cw}$ | = | 1       |
| $v_1$         | = | 0.6     |
| $z$           | = | 0.9*d   |
|               | = | 0.301 m |

***FINDING DESIGN SHEAR REINFORCEMENT REQUIREMENT***

$$\begin{aligned} V_{NS} &= V_{Rds} = (A_{sw}/s) * z * f_{ywd} * \cot \theta \quad (\text{IRC 112 / clause 10.3.3.2 Eq 10.7}) \\ A_{sw} &= V_{NS} * s / z f_{ywd} \cot \theta \\ f_{ywd} &= 0.8 f_{yk} / \gamma_s \\ f_{ywd} &= 348 \text{ Mpa} \\ A_{sw} &= 648 \text{ mm}^2 \end{aligned}$$

|            |   |      |
|------------|---|------|
| $\gamma_s$ | = | 1.15 |
|------------|---|------|

**Minimum shear reinforcement (IRC 112 / clause 10.3.3.5 Eq 10.20)**

$$\begin{aligned} A_{sw, \min} &= \rho_{w, \min} * s * b_w \\ \rho_{w, \min} &= (0.072 \sqrt{f_{ck}}) / f_{yk} \\ &= 0.00097 \\ A_{sw, \min} &= 96.6 \text{ mm}^2 \end{aligned}$$

$$\begin{aligned} \text{Provide } 16 \text{ dia } 4 \text{ legged stp. / m @ } 100 \text{ c/c} &= 804 \text{ mm}^2 > 648 \text{ mm}^2 \quad \text{OK} \\ \Rightarrow & \end{aligned}$$

## *Design of Abutment A2 of Major Bridge*

| Sr.No. | Chainage |
|--------|----------|
| 1      | 2+645    |



## BASIC DESIGN DATA

### 1 Basic Design Data

#### 1.1 Span and Cross section Data

|                                      |   |          |
|--------------------------------------|---|----------|
| C/C of bearing                       | = | 12.000 m |
| C/C of expansion gap                 | = | 12.850 m |
| Distance of bearing to expansion gap | = | 0.450 m  |
| Exp. Gap                             | = | 50 mm    |
| Carriageway width                    | = | 7.50 m   |
| Total width                          | = | 12.00 m  |
| Footpath Width (Left side)           | = | 1.50 m   |
| Footpath Width (Right side)          | = | 1.50 m   |
| Crash Barrier Width (Left side)      | = | 0.50 m   |
| Crash Barrier Width (Right side)     | = | 0.50 m   |
| Handrail Width (Left side)           | = | 0.00 m   |
| Handrail Width (Right side)          | = | 0.00 m   |
| Skew Angle                           | = | 0.0 °    |

#### 1.2 Superstructure Details

|  |   |          |                            |
|--|---|----------|----------------------------|
| Depth of superstructure                      | = | 1.000 m  |                            |
| Depth of Girder                              | = | 1.000 m  |                            |
| Thickness of Deck Slab                       | = | 0.000 m  |                            |
| Thickness of wearing coat                    | = | 0.065 m  |                            |
| No. of Girders                               | = | 4        |                            |
| No. of Corrs Girders                         | = | 0        |                            |
| Distance of FRL from bearing of least height | = | 1.07 m   |                            |
| Spacing between girders                      | = | 3.0 m    |                            |
| Cross-slope                                  | = | 2.50%    |                            |
| Thickness of bearing (assumed)               | = | 0.150 m  |                            |
| Type of Bearing                              | = | Pot ptfe | assumed for design purpose |
| Thickness of pedestal (minimum)              | = | 0.350 m  |                            |
| Thickness of nearest bearing+pedestal        | = | 0.500 m  |                            |

#### 1.3 Material Data

|  |           |   |                       |                        |
|--|-----------|---|-----------------------|------------------------|
| Grade of concrete                            | $f_{ck}$  | = | M35                   |                        |
| Grade of steel                               | $f_{yk}$  | = | Fe500                 |                        |
| Density of Steel                             |           | = | 7.85 t/m <sup>3</sup> |                        |
| Density of wearing course                    |           | = | 2.2 t/m <sup>3</sup>  |                        |
| Coefficient of Thermal Expansion of concrete |           | = | 1.20E-05 /°C          | (Cl.215.4, IRC 6 2014) |
| Shrinkage strain                             |           | = | 2.0E-04               | (Cl.217.3, IRC 6 2014) |
| Modulus of Elasticity of steel               | $E_s$     | = | 2.0E+05 MPa           |                        |
| Modulus of Elasticity of concrete            | $E_c$     | = | 3.2E+04 MPa           |                        |
| Mean axial tensile strength of concrete      | $f_{ctm}$ | = | 2.8 MPa               |                        |
| Relative humidity                            |           | = | 70                    |                        |
| Exposure condition                           |           | = | Moderate              |                        |

#### 1.4 Typical Levels

|                                       |                         |   |          |
|---------------------------------------|-------------------------|---|----------|
| Formation Level "FRL"                 | For design purpose only | = | 302.00 m |
| Dirt wall level                       |                         | = | 302.00 m |
| Max. Abutment cap level "CTL"         |                         | = | 300.78 m |
| Front Ground level "GL" / Scour Level |                         | = | 296.60 m |
| Lower water Level                     |                         | = | 296.60 m |
| Highest flood level "HFL"             |                         | = | 296.60 m |
| Foundation Level                      |                         | = | 296.50 m |

#### 1.5 Soil Parameters

|  |                      |   |                      |
|--|----------------------|---|----------------------|
| Angle of internal friction,                              | $\phi$               | = | 30 °                 |
| Angle of friction between soil and concrete              | $\delta$             | = | 20 °                 |
| 1/2 $d_{dry}$  | $\delta_{submerged}$ | = | 10 °                 |
| Surcharge angle  | $\iota$              | = | 0 °                  |
| Dry density of earth                                     | $\gamma_{dry}$       | = | 2.0 t/m <sup>3</sup> |
| Saturated density of earth                               | $\gamma_{sat}$       | = | 2.0 t/m <sup>3</sup> |
| water density  | $\gamma_{water}$     | = | 1.0 t/m <sup>3</sup> |
| Submerged density of earth                               | $\gamma_{sub}$       | = | 1.0 t/m <sup>3</sup> |
| coeff. Of friction b/w footing base & earth              | $\mu$                | = | 0.80                 |
| Live load surcharge                                      |                      | = | 1.20                 |
| Type of soil   |                      | = | Rock                 |
| Coefficient of friction between (Soil/Rock and concrete) |                      | = | 0.80                 |

**1.6 Abutment Dimensions**

|  |   |        |
|--|---|--------|
| Length of abutment cap in L-L direction at top | = | 1.28 m |
| Length of footing                              | = | 3.90 m |
| Length of heel                                 | = | 1.50 m |
| Thickness of base slab                         | = | 0.30 m |
| Heel thickness at root                         | = | 0.60 m |
| Toe thickness at root                          | = | 0.60 m |
| Length of heel                                 | = | 1.40 m |
| Stem top thickness                             | = | 1.00 m |
| Stem bottom thickness                          | = | 1.00 m |
| Dirtwall thickness                             | = | 0.35 m |
| Depth of abutment cap (Constant portion)       | = | 0.60 m |
| Depth of abutment cap (Varying portion)        | = | 0.60 m |
| Thickness of return wall (Avg.)                | = | 0.65 m |
| No. of return wall                             | = | 2      |
| Provision of weep holes in abutment wall       | = | Yes    |

**1.7 Partial Safety Factors**

(As per Annex B of IRC:6-2014)

**Also refer latest amendment, notification no 78, dated october 2014**

Partial safety factor for relevant loads are presented here

**For Loads****Ultimate Limit State (For Verification of Equilibrium)**

(Table 3.1, Annex B, IRC:6-2020)

| Load  | Basic Comb             |           | Seismic Comb           |           |
|---|------------------------|-----------|------------------------|-----------|
|   | Overturning or Sliding | Resisting | Overturning or Sliding | Resisting |
| Dead Load                                     | 1                      | 1         | 1.00                   | 1.00      |
| SIDL (except surfacing)                       | 1                      | 1         | 1.00                   | 1.00      |
| SIDL (surfacing)                              | 1                      | 1         | 1.00                   | 1.0       |
| Live load and associated loads (Leading)      | 1                      | 0         | -                      | -         |
| Live load and associated loads (Accompanying) | 1                      | 0         | 0.2                    | 0         |
| Water Current                                 | 1.0                    | 0         | 1.0                    | -         |
| Buoyancy                                      | 1.0                    | -         | 1.0                    | -         |
| Earth Pressure                                | 1                      | -         | 1.0                    | -         |
| Live Load Surcharge                           | 1                      | 0         | -                      | -         |
| Thermal Load (Leading)                        | 1                      | 0         | -                      | -         |
| Thermal Load (Accompanying)                   | 1                      | 0         | 0.5                    | -         |
| Seismic Effect (During service)               | -                      | -         | 1.0                    | -         |
| Seismic Effect (During construction)          | -                      | -         | 0.5                    | -         |

**Ultimate Limit State (For Verification of Structural Strength)**

(Table 3.2, Annex B, IRC:6-2020)

| Load  | Basic Comb | Seismic Comb |
|---|------------|--------------|
| Dead Load                                     | 1.35       | 1.35         |
| SIDL (except surfacing)                       | 1.35       | 1.35         |
| SIDL (surfacing)                              | 1.75       | 1.75         |
| Live load and associated loads (Leading)      | 1.5        | 0            |
| Live load and associated loads (Accompanying) | 1.15       | 0.2          |
| Water Current                                 | 1          | 1            |
| Buoyancy                                      | 0.15       | 1            |
| Earth Pressure                                | 1.5        | 1.5          |
| Live Load Surcharge                           | 1.2        | 0.2          |
| Seismic Effect (During service)               | -          | 1.5          |
| Seismic Effect (During construction)          | -          | 0.75         |

**Serviceability Limit State**

| Load  | Rare Comb | Quasi-permanent Comb |
|---|-----------|----------------------|
| Dead Load                                     | 1         | 1                    |
| SIDL (except surfacing)                       | 1         | 1                    |
| SIDL (surfacing)                              | 1.2       | 1.2                  |
| Live load and associated loads (Leading)      | 1         | 0                    |
| Live load and associated loads (Accompanying) | 0.75      | 0                    |
| Earth Pressure                                | 1.0       | 1.0                  |
| Live Load Surcharge                           | 0.8       | 0                    |
| Water Current                                 | 1         | -                    |
| Buoyancy                                      | 0.15      | 0.15                 |
| Thermal Load (Leading)                        | 1.0       | -                    |
| Thermal Load (Accompanying)                   | 0.6       | 0.5                  |

**Combination for Base Pressure and Design of Foundation**

(Table 3.4, Annex B, IRC:6-2014)

| Load  | Comb 1 | Comb 2 | Seismic Comb |
|---|--------|--------|--------------|
| Dead Load                                     | 1.35   | 1      | 1.35         |
| SIDL (except surfacing)                       | 1.35   | 1      | 1.35         |
| SIDL (surfacing)                              | 1.75   | 1      | 1.75         |
| Live load and associated loads (Leading)      | 1.5    | 1.3    | 0            |
| Live load and associated loads (Accompanying) | 1.15   | 1      | 0.2          |
| Water Current                                 | 1      | 1      | 1            |
| Buoyancy (Base Pressure)                      | 1      | 1      | 1            |
| Buoyancy (Structural Design)                  | 0.15   | 0.15   | 0.15         |
| Earth Pressure                                | 1.5    | 1.3    | 0            |
| Live Load Surcharge                           | 1.2    | 1      | 0.2          |
| Thermal load                                  | 0.9    | 0.8    | 0.5          |
| Seismic Effect (During service)               | -      | -      | 1.5          |
| Seismic Effect (During construction)          | -      | -      | 0.75         |

**For Materials**

| Material          | Basic Comb | Seismic Comb |
|-------------------|------------|--------------|
| Concrete          | 1.5        | 1.5          |
| Reinforcing steel | 1.15       | 1.15         |

#### 1.80 Clear Cover

|               |   |       |
|---------------|---|-------|
| Dirt Wall     | = | 50 mm |
| Abutment Cap  | = | 50 mm |
| Abutment Stem | = | 50 mm |
| Footing       | = | 75 mm |

#### 1.9

|  |   |        |
|--|---|--------|
| Seismic Zone                           | = | V      |
| Type of soil                           | = | medium |
| Zone factor                            | = | 0.36   |
| Importance factor                      | = | 1.2    |
| Response Reduction Factor, $R_{long}$  | = | 3      |
| Response Reduction Factor, $R_{trans}$ | = | 1      |
| Response Reduction Factor, $R_{vert}$  | = | 3      |

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## SALIENT FEATURES OF THE BRIDGE :

|                                       |   |         |
|---------------------------------------|---|---------|
| Span c/c of brg.                      | = | 12 m    |
| c/L of brg. c/L of exp. J             | = | 0.45 m  |
| Exp. Gap                              | = | 50 mm   |
| Overall span                          | = | 12.85 m |
| Depth of super-structure              | = | 1 m     |
| Wearing Coat thickness                | = | 65 mm   |
| Depth of Bearing + Pedestal (minimum) | = | 0.5 mm  |
| Overall Deck width                    | = | 12.00 m |
| Clear carriageway width               | = | 7.50 m  |
| Cross Camber                          | = | 2.50%   |

## MATERIAL USED & THERE PROPERTIES :

### CONCRETE

|   |      |   |            |
|---|------|---|------------|
| Grade of Concrete                           | fck  | = | M 35 Mpa   |
| Mean value of concrete compressive strength | fcm  | = | M 45 Mpa   |
| Design Concrete compressive strength        | fcd  | = | 0.447 *fck |
|   |      | = | 15.633 MPa |
| Secant Modulus of Elasticity                | Ecm  | = | 32308 MPa  |
| Mean axial tensile strength                 | fctm | = | 2.77 Mpa   |

### REINFORCING STEEL

|  |     |   |            |
|--|-----|---|------------|
| Grade of Reinforcement                 | fyk | = | Fe 500 Mpa |
| Design yield strength of reinforcement | fyd | = | 0.870 *fyk |
|  |     | = | 435 Mpa    |
| Modulus of Elasticity                  | Es  | = | 200000 Mpa |

|               |   |                       |
|---------------|---|-----------------------|
| Steel Density | = | 7.85 t/m <sup>3</sup> |
| Steel Density | = | 2.5 t/m <sup>4</sup>  |

## ANALYSES ASSUMPTION

### Enviromental parameters

|                    |   |          |
|--------------------|---|----------|
| Relative humidity  | = | 70 %     |
| Exposure condition | = | Moderate |

|                                    |            |   |                  |
|------------------------------------|------------|---|------------------|
| Modulus of Elasticity for Concrete |            |   |                  |
| For short Term loading             | <b>Ecm</b> | = | <b>32308 Mpa</b> |
| For long Term loading              | Ecm'       | = | Ecm/ (1+φ)       |
| φ = Creep coefficient              |            |   |                  |

|                                  |             |   |                                  |
|----------------------------------|-------------|---|----------------------------------|
| Creep coefficient for Foundation | φ           | = | 1 ( As ho = ∞ , For foundations) |
|                                  | <b>Ecm'</b> | = | <b>16154.1 Mpa</b>               |

**Creep for abutment shaft**

|   |       |   |   |
|---|-------|---|---|
| Cross-sectional Area  | Ac    | = | 12.00 m <sup>2</sup>                              |
| Perimeter in contact with atmosphere u                              |       | = | 12.00 m   |
| Notational size ho  | 2Ac/u | = | 2000 mm   |
| Age of concrete at the time of loading to t <sub>∞</sub> considered |       | = | 90 days   |
|   |       | = | 36500 days  |
| φ (∞,90)  |       | = | 1.34 (Refer Appendix B)                           |
|   |       | ≡ | 1.47 *(Increased by 10% on the conservative side) |
|   | Ecm'  | = | 13070 N/mm <sup>2</sup>                           |

**SERVICEABILITY LIMIT STATE :**

|  |                    |          |            |
|--|--------------------|----------|------------|
| Max permissible Stress in Concrete     |                    |          |            |
| Rare Combination                       | =                  | 0.48*fck | = 16.8 Mpa |
| Quasi permanent Combination            | =                  | 0.36*fck | = 12.6 Mpa |
| Max permissible Stress in Steel (QLS)  | =                  | 0.8*fyk  | = 400 Mpa  |
| Max permissible Stress in Steel (Rare) | =                  | 0.6*fyk  | = 300 Mpa  |
| Permissible crack width                | w <sub>k,max</sub> | =        | 0.3 mm     |

**Backfill Soil Parameter**

|                        |   |   |   |                    |
|------------------------|---|---|---|--------------------|
| φ                      | = | Angle of internal friction,                 | = | 30 °               |
| δ                      | = | Angle of friction between soil and concrete | = | 20 °               |
| δ <sub>submerged</sub> | = | 1/2 d <sub>dry</sub>                        | = | 10 °               |
| ι                      | = | Surcharge angle                             | = | 0 °                |
| γ <sub>dry</sub>       | = | Dry density of earth                        | = | 2 t/m <sup>3</sup> |
| γ <sub>sat</sub>       | = | Saturated density of earth                  | = | 2 t/m <sup>3</sup> |
| γ <sub>water</sub>     | = | water density                               | = | 1 t/m <sup>3</sup> |
| γ <sub>sub</sub>       | = | Submerged density of earth                  | = | 1 t/m <sup>3</sup> |
| μ                      | = | coeff. Of friction b/w footing base & earth | = | 0.8                |

**Live Load Surcharge :**

|                                 |                   |                      |
|---------------------------------|-------------------|----------------------|
| Equivelent to                   | 1.20 m Earth Fill |                      |
| Live Load surcharge intensity q | =                 | 2.4 t/m <sup>2</sup> |

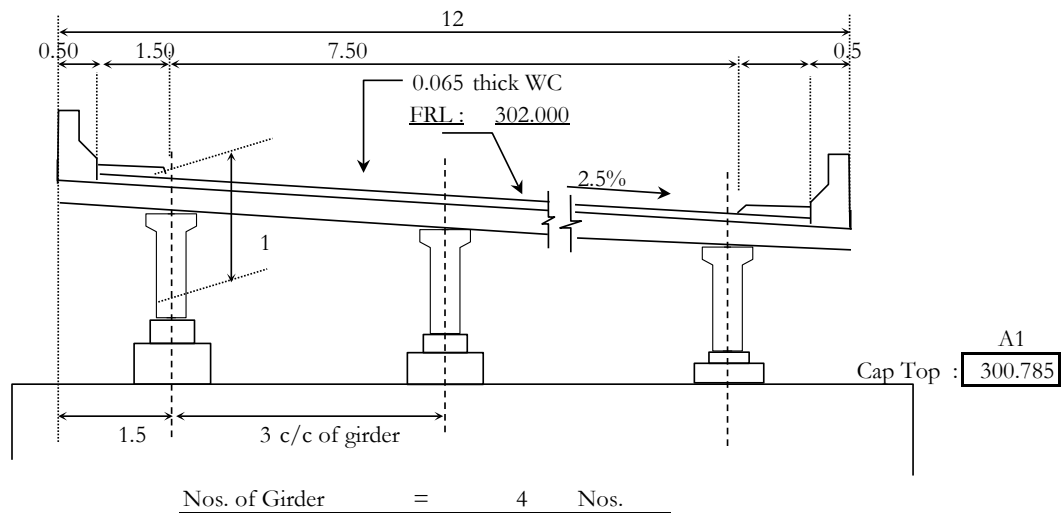
**SEISMIC PARAMETER**

|   |   |   |        |
|---|---|---|--------|
| Seismic Zone                                    |   | = | V      |
| Type of soil                                    |   | = | medium |
| Zone factor                                     | Z | = | 0.36   |
| Importance factor                               | I | = | 1.2    |
| Response Reduction Factor, R <sub>long</sub> .  |   | = | 3      |
| Response Reduction Factor, R <sub>trans</sub> . |   | = | 1      |
| Response Reduction Factor, R <sub>vert</sub> .  |   | = | 3      |

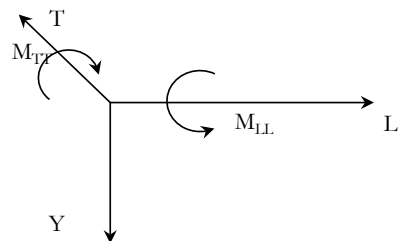
#### LEVEL DETAILS :

|                    |   |           |
|--------------------|---|-----------|
| Formation level    | = | 302.000 m |
| Lowest water level | = | 296.600 m |
| HFL                | = | 296.600   |
| Ground Level / MSL | = | 296.600 m |
| MSL                | = | 296.600 m |
| Founding Level     | = | 296.500 m |

|                  |   |                        |                                      |
|------------------|---|------------------------|--------------------------------------|
| Bearing capacity | = | 60.00 t/m <sup>2</sup> | */( Working State, Non-Seismic case) |
|                  | = | 75.00 t/m <sup>2</sup> | */( Working State, Seismic Case)     |



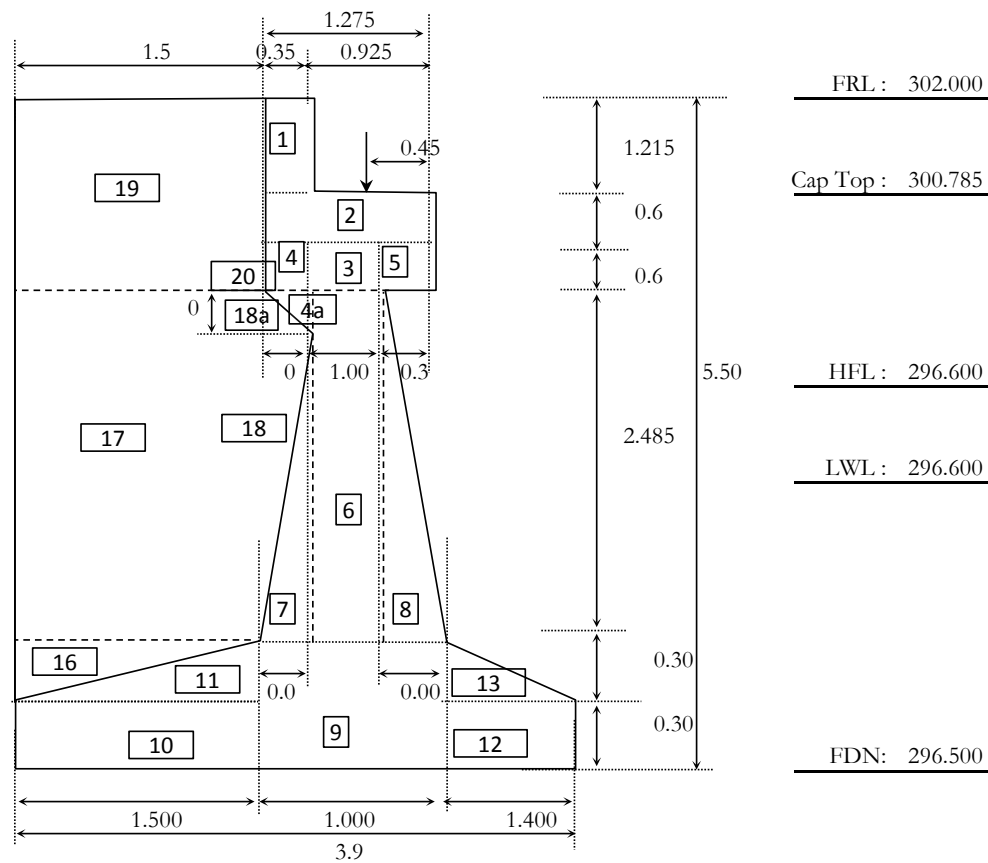
#### Sign Convention :



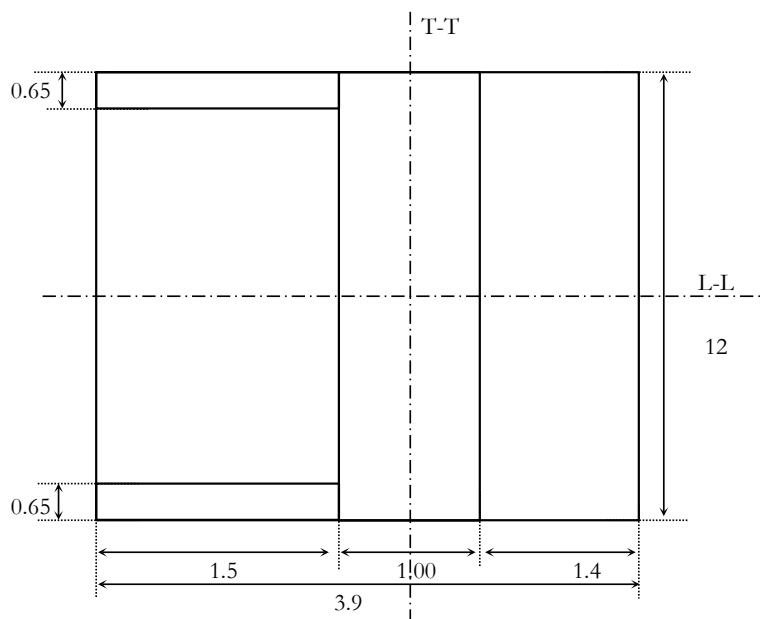
Showing +ve Force & Moment Direction

**ABUTMENT COMPONENT :-**

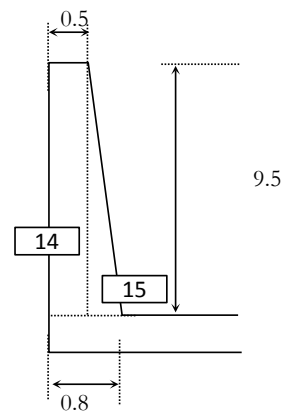
Length of Abutment = 12.00 m



$\alpha$  = Angle of wall face with horizontal = 90.00 °



FOOTING PLAN



RETURN WALL



### FORCES DUE TO SELFWEIGHT OF SUB STRUCTURE & FOUNDATION :

Forces @ Footing Base

$e_L$  = Cg. w.r.t. Toe Edge (along L-L axis)  
 $e_T$  = Cg. Form c/L of base ( along T-T axis)  
 $e_Y$  = Cg. From Footing base

| <b>Calculating Selfweight of Sub-structure :</b>        |             |  |       |    |                |               |             |              |              |
|---|-------------|--|-------|----|----------------|---------------|-------------|--------------|--------------|
| Element   | Area Factor | B  | H     | L  | V              | W             | $e_Y$       | $e_L$        | $e_T$        |
|   |             | m  | m     | m  | m <sup>3</sup> | Tonne         | m           | m            | m            |
| <b>Dirt Wall &amp; Abutment Cap</b>                     |             |  |       |    |                |               |             |              |              |
| 1   | 1           | 0.35   | 1.215 | 12 | 5.11           | 12.76         | 4.89        | -2.225       | 0            |
| 2   | 1           | 1.275  | 0.6   | 12 | 9.18           | 22.95         | 3.98        | -1.76        | 0            |
| 3   | 1           | 1.275  | 0.6   | 12 | 9.18           | 22.95         | 3.38        | -1.7625      | 0            |
| 4   | 0           | 0  | 0.6   | 12 | 0.00           | 0.00          | 3.48        | -2.4         | 0            |
| 4(a)  | 0           | 0  | 0     | 12 | 0.00           | 0.00          | 3.08        | -2.4         | 0            |
| 5   | 0           | 0.275  | 0.6   | 12 | 0.00           | 0.00          | 3.48        | -1.308       | 0            |
| <b>Total</b>  |             |  |       |    | <b>23.47</b>   | <b>58.66</b>  | <b>3.95</b> | <b>-1.86</b> | <b>0.00</b>  |
| */ Increase Abutment cap weight by                      |             | 0% on account of bearing, bearing pedestal, stopper etc. |       |    |                |               |             |              |              |
| <i>Abutment Cap weight Considered</i>                   |             |  |       |    | <i>23.47</i>   | <i>58.66</i>  | <i>3.95</i> | <i>-1.86</i> | <i>0.00</i>  |
| <b>Abutment Shaft</b>                                   |             |  |       |    |                |               |             |              |              |
| 6   | 1           | 1  | 2.48  | 12 | 29.81          | 74.5          | 1.84        | -1.9         | 0            |
| 7   | 0.5         | 0  | 2.48  | 12 | 0.00           | 0.0           | 1.43        | -2.4         | 0            |
| 8   | 0.5         | 0  | 2.48  | 12 | 0.00           | 0.0           | 1.43        | -1.400       | 0            |
| <i>Abutment shaft weight considered.</i>                |             |  |       |    | <i>29.81</i>   | <i>74.54</i>  | <i>1.84</i> | <i>-1.90</i> | <i>0.00</i>  |
| <b>Total Sub-structure self weight at base of shaft</b> |             |  |       |    | <b>53.28</b>   | <b>133.20</b> | <b>2.77</b> | <b>-1.88</b> | <b>0.000</b> |

### Calculating Selfweight Foundation:

| Element                              | Area Fact | No.s | B   | H   | L   | V              | W             | $e_Y$       | $e_L$        | $e_T$       |
|--------------------------------------|-----------|------|-----|-----|-----|----------------|---------------|-------------|--------------|-------------|
|                                      |           |      | m   | m   | m   | m <sup>3</sup> | Tonne         | m           | m            | m           |
| <b>Footing</b>                       |           |      |     |     |     |                |               |             |              |             |
| 9                                    | 1         | 1    | 1   | 0.6 | 12  | 7.20           | 18.00         | 0.30        | -1.9         | 0           |
| 10                                   | 1         | 1    | 1.5 | 0.3 | 12  | 5.40           | 13.50         | 0.15        | -3.15        | 0           |
| 11                                   | 0.5       | 1    | 1.5 | 0.3 | 12  | 2.70           | 6.75          | 0.40        | -2.90        | 0           |
| 12                                   | 1         | 1    | 1.4 | 0.3 | 12  | 5.04           | 12.60         | 0.15        | -0.7         | 0           |
| 13                                   | 0.5       | 1    | 1.4 | 0.3 | 12  | 2.52           | 6.30          | 0.40        | -0.933       | 0           |
| <b>Total Footing weight</b>          |           |      |     |     |     | <b>22.86</b>   | <b>57.15</b>  | <b>0.25</b> | <b>-1.94</b> | <b>0.00</b> |
| <b>Return wall</b>                   |           |      |     |     |     |                |               |             |              |             |
| 14                                   | 1         | 2    | 0.5 | 9.5 | 1.5 | 14.25          | 35.63         | 4.75        | -3.15        | 0           |
| 15                                   | 0.5       | 2    | 0.3 | 9.5 | 1.5 | 4.28           | 10.69         | 3.17        | -3.15        | 0           |
| <b>Total Footing weight</b>          |           |      |     |     |     | <b>18.53</b>   | <b>46.31</b>  | <b>4.38</b> | <b>-3.15</b> | <b>0.00</b> |
| <b>Total Sub-structure + Footing</b> |           |      |     |     |     | <b>94.66</b>   | <b>236.66</b> | <b>2.48</b> | <b>-2.15</b> | <b>0.00</b> |

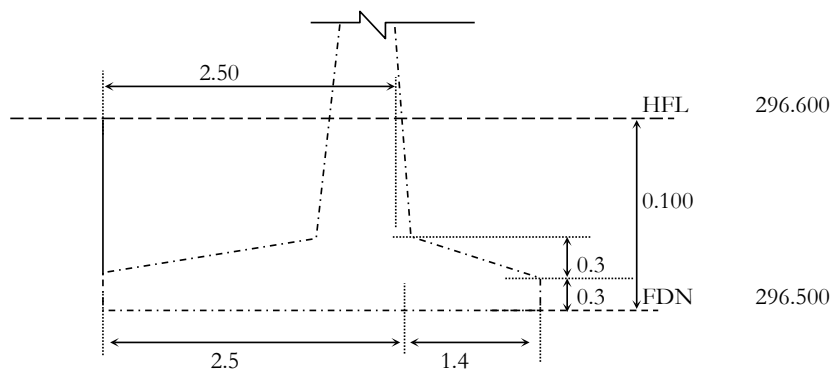
|  |   |             |
|--|---|-------------|
| Total Weight of sub-structure & foundation | = | 236.66 T    |
| Lever arm about toe (along L-L axis)       | = | -2.15 m     |
| Moment $M_{TT}$                            | = | -507.798 Tm |
| Lever arm about c/L base (along T-T axis)  | = | 0 m         |
| Moment $M_{LL}$                            | = | 0 Tm        |

#### Calculating Weight of Backfill Dry Condition

| Element           | Area Fact | No.s | B    | H     | L    | V              | W      | $e_Y$ | $e_L$  | $e_T$ |
|-------------------|-----------|------|------|-------|------|----------------|--------|-------|--------|-------|
|                   |           |      | m    | m     | m    | m <sup>3</sup> | Tonne  | m     | m      | m     |
| Earth Fill Weight |           |      |      |       |      |                |        |       |        |       |
| 16                | 0.5       | 1    | 1.5  | 0.3   | 10.7 | 2.41           | 4.82   | 0.50  | -3.4   | 0     |
| 17                | 1         | 1    | 1.5  | 4.900 | 10.7 | 78.65          | 157.29 | 2.75  | -3.15  | 0     |
| 18                | 0.5       | 1    | 0    | 2.485 | 10.7 | 0.00           | 0.00   | 2.26  | -2.4   | 0     |
| 18a               | 0.5       | 1    | 0    | 0.000 | 10.7 | 0.00           | 0.00   | 3.08  | -2.400 | 0     |
| 19                | 1         | 1    | -0.5 | 0.000 | 10.7 | 0.00           | 0.00   | 5.50  | -4.15  | 0     |
| 20                | 0         | 1    | 0    | 0.6   | 10.7 | 0.00           | 0.00   | 3.28  | -2.400 | 0     |
| Total Earth Fill  |           |      |      |       |      | 81.05          | 162.11 | 2.68  | -3.16  | 0.00  |

|   |   |             |
|---|---|-------------|
| Total Weight of backfill                  | = | 162.11 T    |
| Lever arm about toe (along L-L axis)      | = | -3.16 m     |
| Moment $M_{TT}$                           | = | -511.835 Tm |
| Lever arm about c/L base (along T-T axis) | = | 0 m         |
| Moment $M_{LL}$                           | = | 0 Tm        |

#### Calculation of Buoyancy



| Element           | Area Fact | No.s | B    | H   | L  | V              | W      | e <sub>Y</sub> | e <sub>L</sub> | e <sub>T</sub> |
|-------------------|-----------|------|------|-----|----|----------------|--------|----------------|----------------|----------------|
|                   |           |      | m    | m   | m  | m <sup>3</sup> | Tonne  | m              | m              | m              |
| Earth Fill Weight |           |      |      |     |    |                |        |                |                |                |
| 1                 | 1         | -1   | 2.50 | 0.1 | 12 | -3.00          | -3.00  | 0.05           | -2.65          | 0              |
| 2                 | 0.5       | -1   | 0.00 | 0.1 | 12 | 0.00           | 0.00   | 0.07           | -1.40          | 0              |
| 3                 | 1         | -1   | 1.4  | 0.3 | 12 | -5.04          | -5.04  | 0.15           | -0.7           | 0              |
| 4                 | 0.5       | -1   | 1.4  | 0.3 | 12 | -2.52          | -2.52  | 0.40           | 0.93           | 0              |
| Total Earth Fill  |           |      |      |     |    | -10.56         | -10.56 | 0.18           | -0.86          | 0.00           |

|   |   |          |
|---|---|----------|
| Total buoyant weight                      | = | -10.56 T |
| Lever arm about toe (along L-L axis)      | = | -0.86 m  |
| Moment M <sub>TT</sub>                    | = | 9.126 Tm |
| Lever arm about c/L base (along T-T axis) | = | 0.00 m   |
| Moment M <sub>LL</sub>                    | = | 0 Tm     |

### Finding Creep Coefficient

$$f_{ck} = 35 \text{ Mpa} \quad (\text{Considering Precast Beam material})$$

$$f_{cm} = 45 \text{ Mpa}$$

$$t = 36500 \text{ days}$$

$$t_o = 90 \text{ days}$$

$$\phi(t, t_o) = \phi_o \beta_c(t, t_o)$$

$$\phi_o = \phi_{RH} \beta(f_{cm}) \beta(t_o)$$

$$\phi_{RH} = \begin{cases} 1 + \frac{1 - RH/100}{0.1 (h_o)^{1/3}} & \text{for } f_{cm} \leq 45 \text{ Mpa} \\ \left[ 1 + \frac{1 - RH/100}{0.1 (h_o)^{1/3}} \alpha_1 \right] * \alpha_2 & \text{for } f_{cm} > 45 \text{ Mpa} \end{cases}$$

$$RH = \text{Relative humidity}$$

$$= 70 \%$$

$$h_o = 2000 \text{ mm}$$

$$\alpha_1 = [43.75 / f_{cm}]^{0.7} = 0.98047$$

$$\alpha_2 = [43.75 / f_{cm}]^{0.2} = 0.99438$$

$$\phi_{RH} = 1.23811$$

$$\beta(f_{cm}) = 18.78 / \sqrt{f_{cm}}$$

$$= 2.79956$$

$$\beta(t_o) = 1 / (0.1 + t_o^{0.2})$$

$$= 0.3907$$

$$\phi_o = 1.35423$$

$$\beta_c(t, t_o) = [(t - t_o) / (\beta_H + t - t_o)]^{0.3}$$

$$\beta_H = \begin{cases} \text{Min} \begin{cases} 1.5 [1 + (0.012 RH)^{18}] h_o + 250 \\ 1500 \end{cases} & \text{for } f_{cm} \leq 35 \text{ Mpa} \\ \text{Min} \begin{cases} 1.5 [1 + (0.012 RH)^{18}] h_o + 250 \alpha_3 \\ 1500 * \alpha_3 \end{cases} & \text{for } f_{cm} > 35 \text{ Mpa} \end{cases}$$

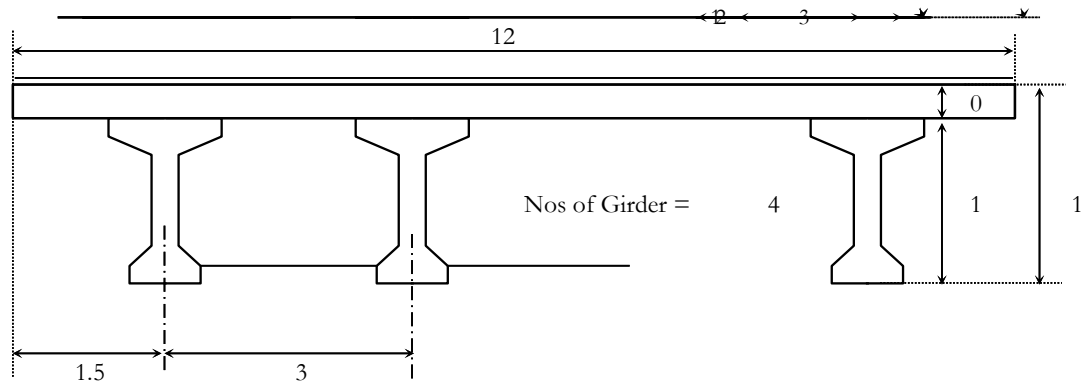
$$\alpha_2 = [43.75 / f_{cm}]^{0.5} = 0.986$$

$$\beta_H = 1479.02$$

|                     |       |
|---------------------|-------|
| $\beta_c(t, t_o) =$ | 0.988 |
| $\phi(t, t_o) =$    | 1.34  |

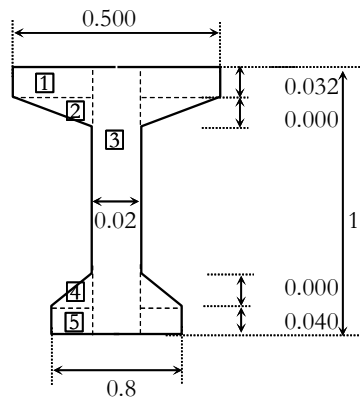
### DEAD LOAD CALCULATION OF SUPER-STRUCTURE :

|                                |   |          |
|--------------------------------|---|----------|
| Overall Span                   | = | 12.85 m  |
| C/c of Bearing                 | = | 12 m     |
| Total Deck Width               | = | 12 m     |
| Thickness of Deck width        | = | 0 m      |
| Total depth of super-structure | = | 1 m      |
| Nos. of Girder                 | = | 4 Nos.   |
| Depth of girder                | = | 1 m      |
| c/c of Girders                 | = | 3 m      |
| Nos. of Cross Girder           | = | 0        |
| Density of Steel               | = | 7.85 T/m |

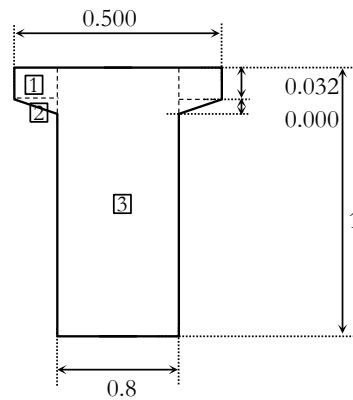


Super-Structure Cross-section

### Girder Cross-Section :

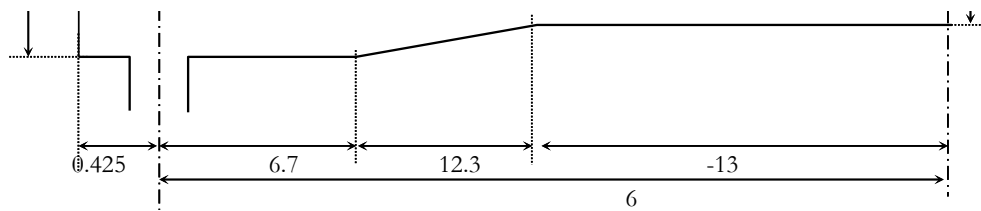


Section at Mid Span



Section at Support

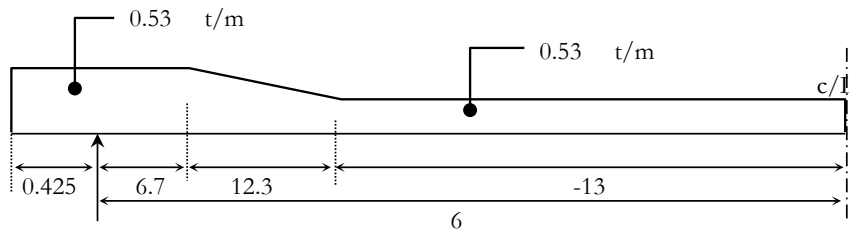




| Section Property of Girder At Mid Span |        |       |       |      |                |                  |
|--|--------|-------|-------|------|----------------|------------------|
| Element No.                            | Factor | B     | D     | Nos. | A              | cg <sub>y'</sub> |
|  |        | m     | m     |      | m <sup>2</sup> | m                |
| 1                                      | 1      | 0.500 | 0.032 | 1    | 0.016          | 0.016            |
| 2                                      | 0.5    | 0.500 | 0     | 2    | 0.0000         | 0.032            |
| 3                                      | 1      | 0.02  | 1     | 1    | 0.020          | 0.5              |
| 4                                      | 0.5    | 0.8   | 0     | 2    | 0.000          | 0.96             |
| 5                                      | 1      | 0.8   | 0.04  | 1    | 0.032          | 0.98             |
|  |        |       |       |      |                |                  |
| <b>Total</b>                           |        |       |       |      | <b>0.06800</b> | <b>0.612</b>     |

| Section Property of Girder At Support Section |        |       |       |      |                |                  |
|---|--------|-------|-------|------|----------------|------------------|
| Element No.                                   | Factor | B     | D     | Nos. | A              | cg <sub>y'</sub> |
|   |        | m     | m     |      | m <sup>2</sup> | m                |
| 1   | 1      | 0.500 | 0.032 | 1    | 0.016          | 0.016            |
| 2   | 1      | 0.02  | 1     | 1    | 0.020          | 0.5              |
| 3   | 1      | 0.8   | 0.040 | 1    | 0.032          | 0.02             |
|   |        |       |       |      |                |                  |
| <b>Total</b>                                  |        |       |       |      | <b>0.06800</b> | <b>0.160</b>     |

Self weight of Precast Beam



| Reaction due to self weight of each girder |             |             |             |  |                   |
|--|-------------|-------------|-------------|--|-------------------|
| Description                                | wt/m<br>T/m | Length<br>m | weight<br>T |  | cg. From top<br>m |
| Weight of Support Section                  | 0.53        | 7.125       | 3.80        |  | 0.160             |
| Weight of Transition section               | 0.53        | 12.30       | 6.57        |  | 0.386             |
| Weight of mid span                         | 0.53        | -13.00      | -6.94       |  | 0.612             |
| <b>Total Reaction</b>                      |             |             | <b>3.43</b> |  | <b>-0.321</b>     |
|  |             |             |             |  |                   |
| Total weight of one Girder                 | =           | 6.86 Tonne  |             |  |                   |
| Total Nos. of girder                       | =           | 4 Nos.      |             |  |                   |
| Total weight of all girders                | =           | 27.44 Tonne |             |  |                   |



| <u>Calculating weight of superstructure</u> |   | Weight          | Cg. From Deck Top |
|---|---|-----------------|-------------------|
| Weight of all Girder                        | = | 0.00 T          | -0.32 m           |
| Weight of Concrete Deck                     | = | 0.00 T          | 0.00 m            |
| Weight of 12 m solid slab                   | = | 264.00 T        |                   |
| End cross girder Diaphragm                  | = | 46.25 T         | 0.48 m            |
| <b>Total Weight</b>                         | = | <b>310.25 T</b> |                   |
| Increase Concrete weight by 0%              | = | 310.25 T        | 0.072 m           |
| Reaction Over Each End                      | = | 155.13 Tonne    |                   |

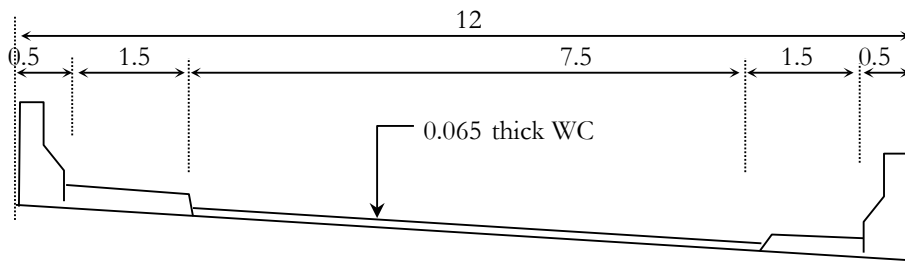
|                                       |   |                    |
|---------------------------------------|---|--------------------|
| <b>Total Reaction at Each support</b> | = | <b>155.1 Tonne</b> |
| <b>Cg. From Deck Top</b>              | = | <b>0.072 m</b>     |

*Forces due to Super-Structure DL about base slab toe :*

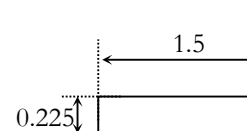
|   |   |              |
|---|---|--------------|
| Vertical Load (Sup DL Reaction)           | = | 155.13 Tonne |
| Lever arm about toe (along L-L axis)      | = | -1.6 m       |
| Moment $M_{TT}$                           | = | -244.32 Tm   |
| Lever arm about c/L base (along T-T axis) | = | 0 m          |
| Moment $M_{LL}$                           | = | 0 Tm         |
| Cg. From base slab bottom                 | = | 5.36 m       |



## Calculation of SIDL



|                               |   |                      |
|-------------------------------|---|----------------------|
| Overall span                  | = | 24.85 m              |
| Crash barrier weight          | = | 1 t/m                |
| Cg. From crash barrier bottom | = | 0.476 m              |
| Footpath weight               | = | 0.84375 t/m          |
| Cg. Of Footpath above deck    | = | 0.1125 m             |
| Wearing coat                  | = | 2.2 t/m <sup>2</sup> |



## Forces & Moments @ Foundation base

| Element                     | Description         | wt/m<br>t/m | L<br>m | W<br>Tonne | e <sub>Y</sub><br>m | e <sub>T</sub><br>m |
|-----------------------------|---------------------|-------------|--------|------------|---------------------|---------------------|
| SIDL (excluding surfacing)  |                     |             |        |            |                     |                     |
| 1                           | Crash barrier Left  | 1           | 24.85  | 24.85      | 0.476               | -5.75               |
| 2                           | Crash barrier Right | 1           | 24.85  | 24.85      | 0.476               | 5.75                |
| 3                           | Footpath Left       | 0.84375     | 24.85  | 20.97      | 0.1125              | -4.75               |
| 4                           | Footpath Right      | 0.84375     | 24.85  | 20.97      | 0.1125              | 4.75                |
| <i>Total Load</i>           |                     |             |        | 91.63      | 0.31                | 0.00                |
|                             |                     |             |        |            |                     |                     |
| <i>Reaction per support</i> |                     |             |        | 45.82      | 0.31                | 0.00                |

## Forces due to Super-Structure SIDL about base slab toe :

|   |   |             |
|---|---|-------------|
| Vertical Load (Sup SIDL Reaction)         | = | 45.82 Tonne |
| Lever arm about toe (along L-L axis)      | = | -1.575 m    |
| Moment $M_{TT}$                           | = | -72.1621 Tm |
|   |   |             |
| Lever arm about c/L base (along T-T axis) | = | 0.00 m      |
| Moment $M_{LL}$                           | = | 0.00 Tm     |
|   |   |             |
| Cg. From base Slab bottom                 | = | 5.74 m      |

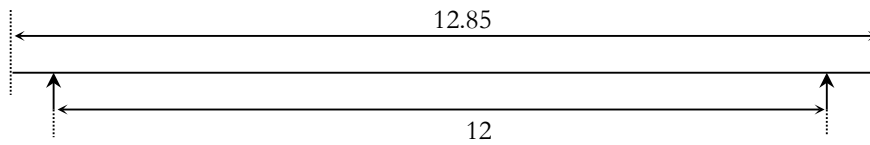
**Selfweight of surfacing**

| Element                     | Description  | wt/m <sup>2</sup> | B   | L     | W     | e <sub>Y</sub> | e <sub>T</sub> |
|-----------------------------|--------------|-------------------|-----|-------|-------|----------------|----------------|
|                             |              | t/m <sup>2</sup>  | m   | m     | Tonne | m              | m              |
| Surfacing<br>1              | Wearing coat | 2.2               | 7.5 | 24.85 | 26.65 | 0.033          | -0.25          |
| <i>Total Load</i>           |              |                   |     |       | 26.65 | 0.033          | -0.25          |
|                             |              |                   |     |       |       |                |                |
| <i>Reaction per support</i> |              |                   |     |       | 13.33 | 0.033          | -0.25          |

***Forces due to Super-Structure Surfacing about base slab toe :***

|   |   |             |
|---|---|-------------|
| Vertical Load (Sup Surfacing Reaction)    | = | 13.33 Tonne |
| Lever arm about toe (along L-L axis)      | = | -1.575 m    |
| Moment $M_{TT}$                           | = | -20.9882 Tm |
|   |   |             |
| Lever arm about c/L base (along T-T axis) | = | -0.25 m     |
| Moment $M_{LL}$                           | = | -3.33145 Tm |
|   |   |             |
| Cg. From base Slab bottom                 | = | 5.47 m      |

### FINDING LIVE LOAD REACTIONS OVER ABUTMENT



SPAN\_1                      0.425                      12                      0.425

| CLASS A |   |     |     |     |     |      |      |     |
|---------|---|-----|-----|-----|-----|------|------|-----|
| TYPE    | 1 | 6.8 | 6.8 | 6.8 | 6.8 | 11.4 | 11.4 | 2.7 |
| DIST    |   | 3   | 3   | 3   | 4.3 | 1.2  | 3.2  | 1.1 |

| CLASS 70R Wheeled |   |      |      |      |      |      |      |    |
|-------------------|---|------|------|------|------|------|------|----|
| TYPE              | 2 | 8    | 12   | 12   | 17   | 17   | 17   | 17 |
| DIST              |   | 3.96 | 1.52 | 2.13 | 1.37 | 3.05 | 1.37 |    |

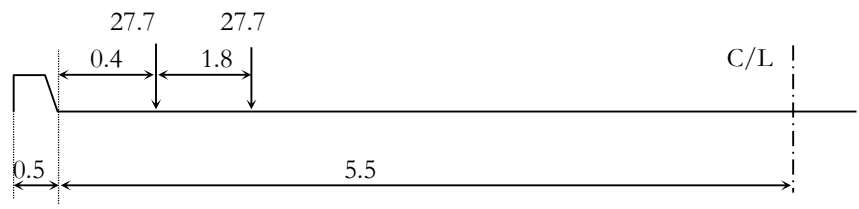
| CLASS 70R Tracked |   |      |      |      |      |      |   |  |
|-------------------|---|------|------|------|------|------|---|--|
| TYPE              | 3 | 7    | 14   | 14   | 14   | 14   | 7 |  |
| DIST              |   | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 |   |  |

| Reactions                      | R11<br>Tonne | R12<br>Tonne | Transverse Ecc |
|--------------------------------|--------------|--------------|----------------|
| <b>Maximum Reaction Case :</b> |              |              |                |
| Class A                        | 29.1         | 14.1         | 4.2            |
| Class 70R wheeled              | 60.7         | 31.3         | 2.91           |
| Class 70R tracked              | 57.2         | 12.8         | 3.28           |
| Class A 2Lane                  | 58.3         | 28.1         | 2.45           |
| Class A 3Lane                  | 87.4         | 42.2         | 0.70           |
| Class 1A+70RW                  | 89.9         | 45.3         | 3.20           |
| <b>Governing Case</b>          | <b>89.9</b>  | <b>45.3</b>  | <b>2.9</b>     |
|                                |              |              |                |

| <b>Forces due to LL about base slab toe :</b> |   | <b>Max Reaction</b> | <b>Min Reaction</b> |  |
|---|---|---------------------|---------------------|--|
| Vertical Load (CW LL Reaction)                | = | 89.87 Tonne         | 45.33 Tonne         |  |
| Lever arm about toe (along L-L axis)          | = | -1.575 m            | -1.575 m            |  |
| Moment $M_{TT}$                               | = | -141.54 Tm          | -71.4 Tm            |  |
| Lever arm about c/L base (along T-T axis)     | = | 2.91 m              | 2.91 m              |  |
| Moment $M_{LL}$                               | = | 261.51 Tm           | 131.92 Tm           |  |

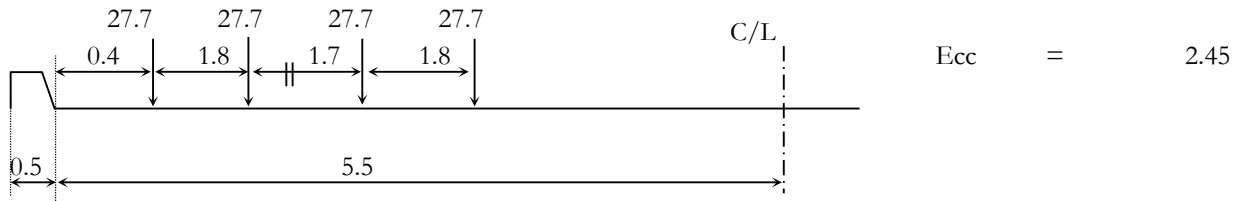
Maximum Possible Eccentricity in transverse direction

Class A

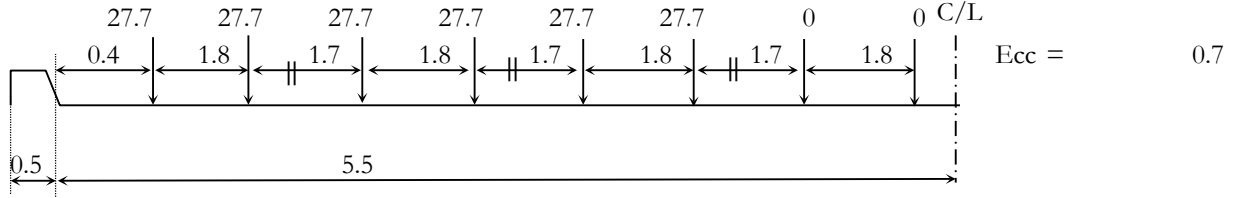


Ecc = 4.2

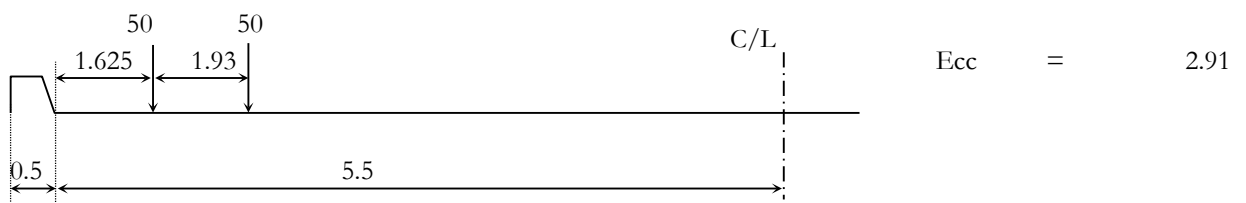
### Class A 2 Lane



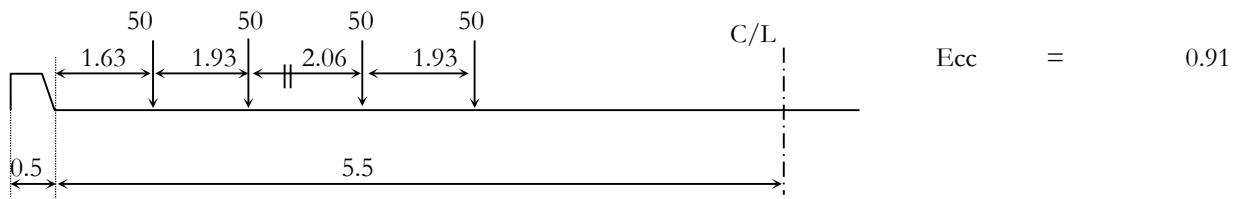
### Class A 3 Lane



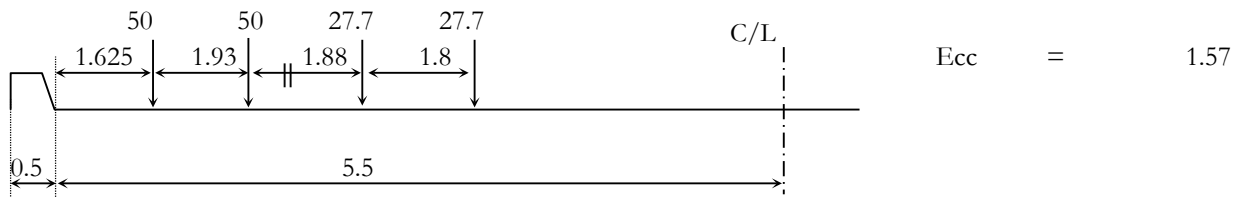
### Class 70R Wheeled



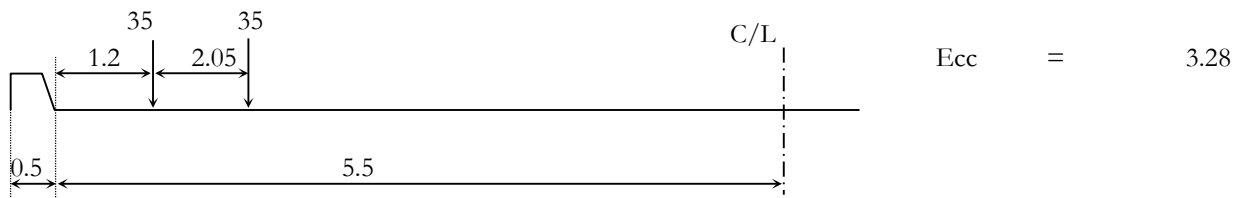
### Class 70R Wheeled 2 Lane



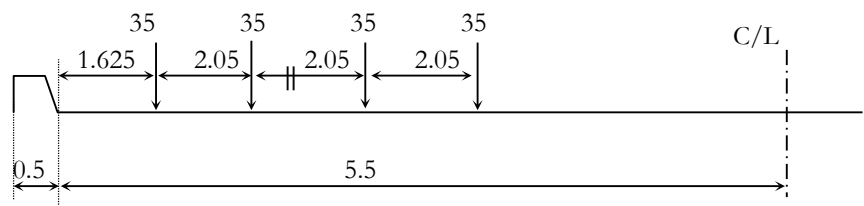
### Class A 1 Lane + Class 70R Wheeled II



### Class 70R Tracked

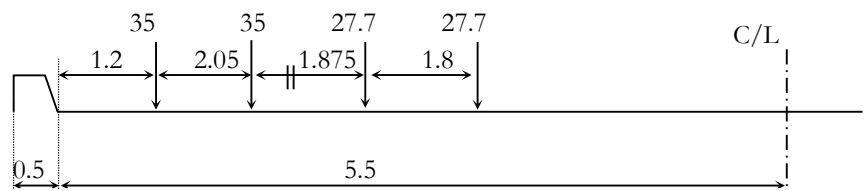


**Class 70R Tracked 2 lanes**



Ecc = 0.80

**Class A 1 Lane + Class 70R Tracked II**



Ecc = 1.60

## Calculation of Longitudinal Forces

### Maximum LL over span :

|            |   |             |
|------------|---|-------------|
| Class A    | = | 89.87 tonne |
| Class 70 R | = | 60.73 tonne |

$$\begin{aligned} \text{Breaking Force } F_h &= 89.867 \times 0.2 + 0.00 \times 0.05 \\ &= 17.97 \text{ tonne} \end{aligned}$$

$$\text{Coefficient of thermal expansion} = 0.0000117 / ^\circ\text{C}$$

$$\text{Maximum temperature} = 45.2 ^\circ\text{C}$$

$$\text{Minimum temperature} = -2.9 ^\circ\text{C}$$

$$\text{Bridge Temperature} = 31.15 ^\circ\text{C}$$

$$\text{Longitudinal strain} = 0.00036$$

$$\text{Shrinkage coefficient} = 0.0002$$

$$\text{Total strain for longitudinal movement} = 0.00056$$

$$\begin{aligned}
 \text{Horizontal movement} &= \frac{0.00056 \times 50.00 \times 1000}{2} \\
 &= 14.111 \text{ mm} \\
 \text{Size of bearing} &= 500 \times 500 \times 142 \text{ mm} \\
 \text{Strain in bearing} &= \frac{14.111}{142} = 0.09938 \\
 \text{Shear modulus} &= 1 \text{ Mpa} \\
 \text{Shear force per Bearing} &= 0.0994 \times 1.0 \times 500 \times 500 \\
 &= 24844 \text{ N} = 2.533 \text{ t} \\
 \text{Total shear force for 4 bearings ( with 5 \% increase )} &= 2.533 \times 4 \times 1.05 \\
 &= 10.637 \text{ t} \\
 \text{Refer IRC : 6 clause 214.5.1.5;} \\
 &10 \% \text{ increase for variation in movement of span} \\
 \text{Total shear force} &= 1.1 \times 10.637 \\
 &= 11.700 \text{ t}
 \end{aligned}$$

As per clause 214.2 of IRC:6, horizontal braking force  $F_h$ , for each span is:

$$\text{For Class A Single lane} \quad F_h = 0.2 \times 55.40 = 11.08 \text{ t}$$

$$\text{Class A 2 lane} \quad F_h = 0.2 \times 110.80 = 22.16 \text{ t}$$

$$\text{For class 70R wheeled} \quad F_h = 0.2 \times 100.0 = 20 \text{ t}$$

Longitudinal force per support

$$\text{For Class A 2 lane} = \frac{22.160}{2} + 11.700 = 22.78 \text{ t}$$

$$\text{For 70 R} = \frac{20}{2} + 11.700 = 21.70 \text{ t}$$

Horizontal force at Brg. Level

$$\begin{aligned}
 F_{\text{Longitudinal}} &= \text{Max. of } \begin{cases} \text{i)} &= 22.8 \text{ tonne} \\ \text{ii)} &= 21.7 \text{ tonne} \end{cases} \\
 &= \text{MAX}(22.78, 21.7) \\
 &= 22.78 \text{ tonne}
 \end{aligned}$$

$$F_{\text{Longitudinal}} = \underline{\underline{22.78 \text{ tonne}}}$$

| Forces due to LL Longitudinal Forces, about base slab toe : |   |            |
|---|---|------------|
| Longitudinal Force  | = | 22.8 Tonne |
| Lever arm from footing base                                 | = | 4.44 m     |
| Moment in about transverse axis $M_{TT}$                    | = | 101.0 tm   |



### Calculation of Longitudinal Forces

Horizontal force at bearing level in the longitudinal direction at **fixed bearing** (other than elastomeric bearing)

$$= \text{Maximum of } \begin{cases} \text{i) } F_h - \mu (R_g + R_q) \\ \text{ii) } F_h / 2 + \mu (R_g + R_q) \end{cases} \quad \text{Refer Clause 211.5 IRC: 6-2010}$$

Where

$F_h$  = Applied Horizontal force

$R_g$  = Reaction at free end due to dead load and SIDL

$R_q$  = Reaction at free end due to live load load

$\mu$  = Coefficient of Friction at movable bearing = 0.03 or 0.05 which ever govern

\*  $F_h$  (braking force) is considered 20 % of the first train load + 10 % of the load of the succeeding trains or part thereof.

Reaction due to dead load and SIDL

$$\begin{aligned} R_g &= \text{DL} \quad \text{SIDL} \quad \text{Surfacing} \\ &= 155.13 + 45.82 + 13.33 \\ &= 214.27 \text{ tonne} \end{aligned}$$

$$R_q \text{ max} = 89.87 \text{ tonne}$$

Corresponding Live load over Span = 100 tonne of Class 70 R

$$\begin{aligned} \text{Braking Force } F_h &= 100 \times 0.2 + 55.4 \times 0.05 \\ &= 22.77 \text{ tonne} \end{aligned}$$

$$\begin{aligned} F_{\text{Longitudinal}} &= \text{Max of } \begin{cases} F_h - \mu (R_g + R_q) = 22.77 - 0.03 \times (89.8667 + 214.268) \\ F_h / 2 + \mu (R_g + R_q) = 11.385 + 0.05 \times (89.8667 + 214.268) \end{cases} \\ &= \text{Max of } (13.646, 26.592) \\ &= \underline{\underline{26.6 \text{ tonne}}} \end{aligned}$$

| Forces due to LL Longitudinal Forces, about base slab toe : |   |            |
|---|---|------------|
| Longitudinal Force  | = | 26.6 Tonne |
| Lever arm from footing base                                 | = | 4.44 m     |
| Moment in about transverse axis $M_{TT}$                    | = | 117.9 tm   |

**CALCULATION OF LONGITUDINAL HORIZONTAL FORCES (NORMAL and SEISMIC LONGITUDINAL CASE):**

Maximum LL over span :

Class A = 87.42 tonne  
Class 70 R = 60.73 tonne

Minimum LL over span :

Class A = 14.06 tonne  
Class 70 R = 12.83 tonne

Breaking Force  $F_h$  =  $101.480 \times 0.2 + 0.00 \times 0.05$   
= 20.30 tonne

$\mu R$  =  $0.05 \times \left( \frac{DL}{155.13} + \frac{SIDL}{59.14} \right)$

=  $0.05 \times 214.27$  = 10.71 tonne

$F_h/2$  =  $20.30 / 2.00$  = 10.15 tonne

$F_h/2$  or  $\mu R$  = (whichever is maximum) = 10.71 tonne

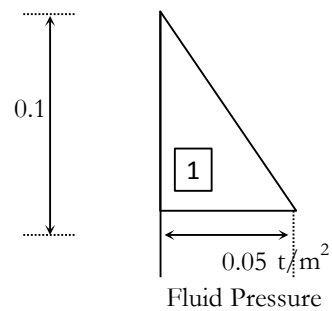
| <b>Forces due to LL Longitudinal Forces, about base slab toe :</b> |   |                   |
|--|---|-------------------|
| Longitudinal Force   | = | <b>26.6 Tonne</b> |
| Lever arm from footing base  | = | 4.44 m            |
| Moment in about transverse axis $M_{TT}$                           | = | <b>117.9 tm</b>   |

### **FLUID PRESSURE CALCULATION UP TO FOUNDING LEVEL :**

Fluid density = 0.48 t/m<sup>3</sup>  
 Abutment Length L = 12 m  
 Footing Base width B = 3.9 m

GL 296.600

Found.L 296.500



Total Fluid Pressure

| Component | Factor | p                | h   | L  | F     | ey    |
|-----------|--------|------------------|-----|----|-------|-------|
|           |        | T/m <sup>2</sup> | m   | m  | Tonne | m     |
| 1         | 0.5    | 0.048            | 0.1 | 12 | 0.03  | 0.033 |
| Total     |        |                  |     |    | 0.03  | 0.033 |

**Total fluid Pressure** = **0.03 Tonne**  
**Lever arm** = **0.03**  
**Moment M<sub>TT</sub>** = **0.00 Tm**  
  
**Net Moment M<sub>TT</sub>** = **0.00 Tm**

### **SUMMARY FLUID PRESSURE :**

| Description      | Fluid Pressure               |                        |
|------------------|------------------------------|------------------------|
|                  | Horizontal (H <sub>L</sub> ) | M <sub>TT</sub> (Dest) |
|                  | Tonne                        | Tm                     |
| 1) LWL Condition | 0.03                         | 0.00                   |

# **CALCULATION OF SEISMIC ACCELERATION SA/G (As per Appendix A1 of IRC SP 114-2018)**

(Notifications of IRC SP 114-2018, Pg 50)

|                           |       |           |        |
|---------------------------|-------|-----------|--------|
| Seismic Zone              |       | Zone      | V      |
| Type of soil              |       | Soil Type | medium |
| Zone factor               |       | Z         | 0.36   |
| Importance Factor         |       | I         | 1.2    |
| Response Reduction Factor | Long  | R.L       | 3.00   |
|                           | Trans | R.T       | 1.00   |

| PARAMETERS   | unit            | Longitudinal | Transverse |
|--|-----------------|--------------|------------|
| Area of Bearing  | mm <sup>2</sup> | 250000       | 250000     |
| Total no. of Bearing   | Nos             | 4            | 4          |
| Total thickness of elastomer   | mm              | 142          | 142        |
| Hardness, IRHD   |                 | 60           | 60         |
| Shear modulus of Elastomer   | Mpa             | 0.9          | 0.9        |
| Stiffness of Elastomer =NAG/t  | N/mm            | 8239         | 8239       |
| Distance of cg of super structure from top of bearing (assuming CG is at centre of superstructure) | m               | 4.550        | 4.550      |
| Force required for 1mm deflection in bearing   | KN              | 8.23943662   | 8.23943662 |
| Corresponding deflection in pier due to force KN for longitudinal direction                        | mm              | 0.006        |            |
| Moment due to force KN in transverse direction   | KN-m            |              | 37.49      |
| Corresponding deflection in pier due to KN and moment KN-m for transverse direction                | mm              |              | 0.00060    |
| Total deflection in( pier and bearing )  | mm              | 1.006        | 1.001      |
| Equivalent stiffness of system   | N/mm            | 8190.46      | 8237.56    |
| Force required for total deflection of 1mm (pier and bearing )(F)                                  | KN              | 8.190        | 8.238      |
| Appropriate Lumped Mass (Total mass)   | KN              | 2322         | 2322       |
| Time Period<br>$\frac{2}{\sqrt{\frac{D}{1000F}}}$  | sec             | 1.065        | 1.062      |
| Avg. response Acc. coeff. for Hard soil sites (Sa/g)   |                 | 0.939        | 0.942      |

Deflection calculations for abutment

For Elastomeric Bearings R =1

1. For Longitudinal direction ,force is acting at top of bearing hence.

$$\text{Deflection} = \frac{PL^3}{3EI}$$

2. For transeverse direction,force is acting at c.g of superstructure hence

$$\text{Deflection} = \frac{PL^3}{3EI} + \frac{ML^2}{2EI}$$

$$\text{Stiffness of Abutment, K2 L} = \frac{3.E.I}{L^3} = 1377948 \text{ N/mm}$$

$$\text{Stiffness of Abutment, K2 T} = \frac{3.E.I}{L^3} = 36122072 \text{ N/mm}$$

$$\text{Cross Camber} = 749.98\%$$

$$\text{Wearing Coat} = 65 \text{ mm}$$

**Bearing Stiffness has been increased by 30% as per annexure D IRC:83-2018 (part -II)**

$$\text{Depth of superstructure} = 1.000 \text{ m}$$

$$E = 32308 \text{ N/mm}^2 \quad B = 6.40 \text{ m}$$

$$I_L = 1.04167E+12 \text{ mm}^4 \quad D = 1.25 \text{ m}$$

$$I_T = 2.73067E+13 \text{ mm}^4$$

$$L_H = 4185 \text{ mm}$$

$$L_T = 4185 \text{ mm}$$

$$\frac{S_a}{g} = \begin{cases} \text{For rocky or hard soil site} : \begin{cases} 2.5 & 0 < T < 0.40 \text{ s} \\ 1/T & 0.40 \text{ s} < T < 4.00 \text{ s} \\ 0.25 & T > 4.00 \text{ s} \end{cases} \\ \text{For medium stiff soil sites} : \begin{cases} 2.5 & 0 < T < 0.55 \text{ s} \\ 1.36/T & 0.55 \text{ s} < T \leq 4.00 \text{ s} \\ 0.34 & T > 4.00 \text{ s} \end{cases} \\ \text{For soft soil sites} : \begin{cases} 2.5 & 0 \leq T \leq 0.67 \text{ s} \\ 1.67/T & 0.67 \text{ s} \leq T \leq 4.00 \text{ s} \\ 0.42 & T > 4.00 \text{ s} \end{cases} \end{cases}$$

## ACTIVE EARTH PRESSURE CALCULATION FOR OVER-TURNING & SLIDING:

### A) Non-Seismic Case :

Coefficient of Active Earth Pressure

$$K_a = \frac{\sin^2(\alpha + \phi)}{\sin^2 \alpha \cdot \sin(\alpha - \delta) \cdot \left[ 1 + \sqrt{\frac{\sin(\phi + \delta) \cdot \sin(\phi - i)}{\sin(\alpha - \delta) \cdot \sin(\alpha + i)}} \right]^2}$$

Active earth pressure

Backfill Soil Parameter

|                             |   |                    |   |               |
|-----------------------------|---|--------------------|---|---------------|
| $\phi$                      | = | 30 °               | = | 0.524 Radians |
| $\delta$                    | = | 20 °               | = | 0.349 Radians |
| $\delta_{\text{submerged}}$ | = | 10 °               | = | 0.175 Radians |
| $i$                         | = | 0 °                | = | 0 Radians     |
| $\alpha$                    | = | 90.00 °            | = | 1.571 Radians |
| $\gamma_{\text{dry}}$       | = | 2 t/m <sup>3</sup> |   |               |
| $\gamma_{\text{sat}}$       | = | 2 t/m <sup>3</sup> |   |               |
| $\gamma_{\text{sub}}$       | = | 1 t/m <sup>3</sup> |   |               |

|                        |   |   |                      |
|------------------------|---|---|----------------------|
| LL surcharge intensity | q | = | 2.4 t/m <sup>2</sup> |
|------------------------|---|---|----------------------|

|                 |   |   |      |
|-----------------|---|---|------|
| Abutment Length | L | = | 12 m |
|-----------------|---|---|------|

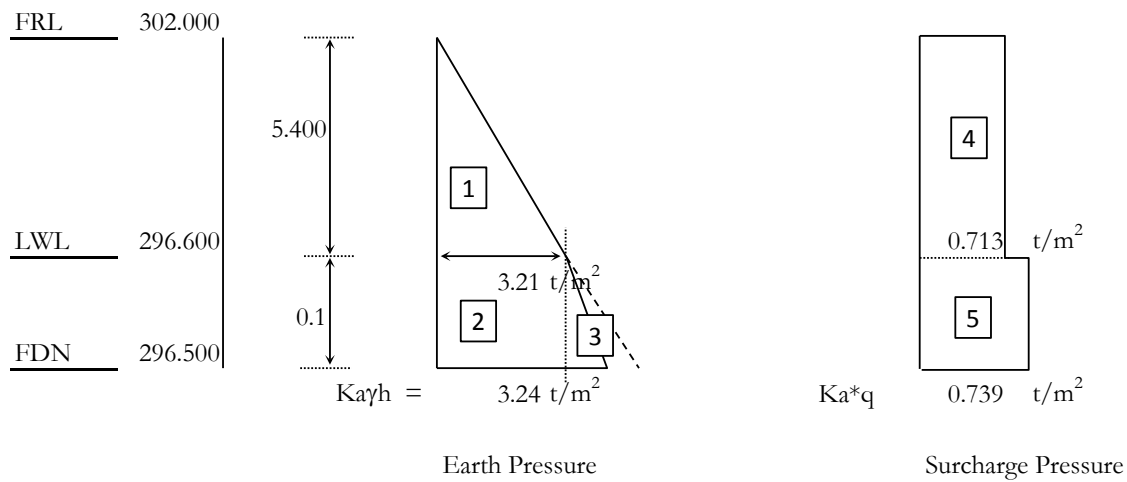
|                    |   |   |       |
|--------------------|---|---|-------|
| Footing Base width | B | = | 3.9 m |
|--------------------|---|---|-------|

|                   |   |       |
|-------------------|---|-------|
| $K_a \text{ Dry}$ | = | 0.297 |
|-------------------|---|-------|

|                          |   |       |
|--------------------------|---|-------|
| $K_a' \text{ Submerged}$ | = | 0.308 |
|--------------------------|---|-------|

### 1) LWL CONDITION

|                             |   |                      |
|-----------------------------|---|----------------------|
| $K_a$                       | = | 0.297                |
| $K_a'$                      | = | 0.308                |
| $\gamma_{\text{dry}}$       | = | 2 t/m <sup>3</sup>   |
| $\gamma_{\text{sub}}$       | = | 1 t/m <sup>3</sup>   |
| $\delta$                    | = | 20 °                 |
| $\delta_{\text{submerged}}$ | = | 10 °                 |
| q                           | = | 2.4 t/m <sup>2</sup> |
| L                           | = | 12 m                 |
| B                           | = | 3.9 m                |



#### Total Active Earth Presure

| Component | Factor | p                | h   | L  | F         | $\delta$ | F*Cos $\delta$ | ey    | F*Sin $\delta$ | ex   |
|-----------|--------|------------------|-----|----|-----------|----------|----------------|-------|----------------|------|
|           |        | T/m <sup>2</sup> | m   | m  | Tonne     | deg      | Tonne          | m     | Tonne          | m    |
| 1         | 0.5    | 3.2076           | 5.4 | 12 | 103.93    | 20       | 97.66          | 2.368 | 35.54          | -3.9 |
| 2         | 1      | 3.2076           | 0.1 | 12 | 3.85      | 10       | 3.79           | 0.05  | 0.67           | -3.9 |
| 3         | 0.5    | 0.0308           | 0.1 | 12 | 0.02      | 10       | 0.02           | 0.033 | 0.00           | -3.9 |
| Total     |        |                  |     |    | 107.79384 |          | 101.468        | 2.281 | 36.21647       | -3.9 |

|                                    |   |                     |
|------------------------------------|---|---------------------|
| <b>Total Active Earth Pressure</b> | = | <b>107.79 Tonne</b> |
| <b>Horizontal Component</b>        | = | <b>101.47</b>       |
| <b>Lever arm</b>                   | = | <b>2.28</b>         |
| <b>Moment M<sub>TT</sub></b>       | = | <b>231.45 Tm</b>    |
| <b>Vertical Component</b>          | = | <b>36.22</b>        |
| <b>Lever arm</b>                   | = | <b>-3.90 m</b>      |
| <b>Moment M<sub>TT</sub></b>       | = | <b>-141.24 Tm</b>   |
| <b>Net Moment M<sub>TT</sub></b>   | = | <b>90.20 Tm</b>     |

#### Total Surcharge pressure

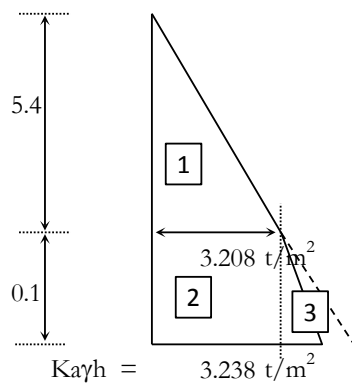
| Component | Factor | p                | h   | L  | F       | ey      |
|-----------|--------|------------------|-----|----|---------|---------|
|           |        | T/m <sup>2</sup> | m   | m  | Tonne   | m       |
| 4         | 1      | 0.7128           | 5.4 | 12 | 46.1894 | 2.8     |
| 5         | 1      | 0.7392           | 0.1 | 12 | 0.88704 | 0.05    |
| Total     |        |                  |     |    | 47.0765 | 2.74818 |

|                          |   |             |
|--------------------------|---|-------------|
| Total Surcharge Pressure | = | 47.08 Tonne |
| Lever arm above base     | = | 2.75 m      |
| Moment $M_{TT}$          | = | 129.37 Tm   |

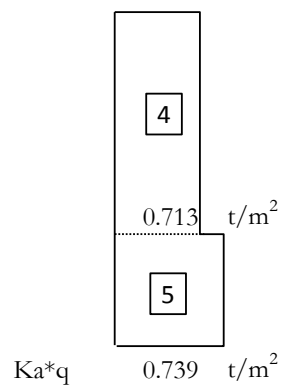
## 2) HFL CONDITION

|                      |   |                      |
|----------------------|---|----------------------|
| $K_a$                | = | 0.297                |
| $K_a'$               | = | 0.308                |
| $\gamma_{dry}$       | = | 2 t/m <sup>3</sup>   |
| $\gamma_{sub}$       | = | 1 t/m <sup>3</sup>   |
| $\delta$             | = | 20 °                 |
| $\delta_{submerged}$ | = | 10 °                 |
| $q$                  | = | 2.4 t/m <sup>2</sup> |
| $L$                  | = | 12 m                 |
| $B$                  | = | 3.9 m                |

|     |         |
|-----|---------|
| FRL | 302.000 |
| HFL | 296.600 |
| FDN | 296.500 |



Earth Pressure



Surcharge Pressure

Total Active Earth Pressure

| Component | Factor | p                | h   | L  | F         | $\delta$ | F*Cos $\delta$ | ey    | F*Sin $\delta$ | ex   |
|-----------|--------|------------------|-----|----|-----------|----------|----------------|-------|----------------|------|
|           |        | T/m <sup>2</sup> | m   | m  | Tonne     | deg      | Tonne          | m     | Tonne          | m    |
| 1         | 0.5    | 3.2076           | 5.4 | 12 | 103.93    | 20       | 97.66          | 2.368 | 35.54          | -3.9 |
| 2         | 1      | 3.2076           | 0.1 | 12 | 3.85      | 10       | 3.79           | 0.05  | 0.67           | -3.9 |
| 3         | 0.5    | 0.0308           | 0.1 | 12 | 0.02      | 10       | 0.02           | 0.033 | 0.00           | -3.9 |
| Total     |        |                  |     |    | 107.79384 |          | 101.468        | 2.281 | 36.21647       | -3.9 |

|                                    |   |                     |
|------------------------------------|---|---------------------|
| <b>Total Active Earth Pressure</b> | = | <b>107.79 Tonne</b> |
| <b>Horizontal Component</b>        | = | <b>101.47</b>       |
| <b>Lever arm</b>                   | = | <b>2.28</b>         |
| <b>Moment M<sub>TT</sub></b>       | = | <b>231.45 Tm</b>    |
| <b>Vertical Component</b>          | = | <b>36.22</b>        |
| <b>Lever arm</b>                   | = | <b>-3.90 m</b>      |
| <b>Moment M<sub>TT</sub></b>       | = | <b>-141.24 Tm</b>   |
| <b>Net Moment M<sub>TT</sub></b>   | = | <b>90.20 Tm</b>     |

Total Surcharge pressure

| Component | Factor | p                | h   | L  | F       | ey      |
|-----------|--------|------------------|-----|----|---------|---------|
|           |        | T/m <sup>2</sup> | m   | m  | Tonne   | m       |
| 4         | 1      | 0.7128           | 5.4 | 12 | 46.1894 | 2.8     |
| 5         | 1      | 0.7392           | 0.1 | 12 | 0.88704 | 0.05    |
| Total     |        |                  |     |    | 47.0765 | 2.74818 |

|                                 |   |                    |
|---------------------------------|---|--------------------|
| <b>Total Surcharge Pressure</b> | = | <b>47.08 Tonne</b> |
| <b>Lever arm above base</b>     | = | <b>2.75 m</b>      |
| <b>Moment M<sub>TT</sub></b>    | = | <b>129.37 Tm</b>   |



**SUMMARY OF FORCES FOR OVERTURNING AND SLIDING****SUMMARY ACTIVE EARTH PRESSURE :**

| Description      | Earth Pressure       |                 |                |                 |
|------------------|----------------------|-----------------|----------------|-----------------|
|                  | Horizontal ( $H_L$ ) | $M_{TT}$ (Dest) | Vertical ( V ) | $M_{TT}$ (Steb) |
|                  | Tonne                | Tm              | Tonne          | Tm              |
| 1) LWL Condition | 101.47               | 231.45          | 36.22          | -141.2          |
| 1) HFL Condition | 101.47               | 231.45          | 36.22          | -141.2          |

**SUMMARY SURCHARGE PRESSURE :**

| Description      | Surcharge Pressure   |                 |
|------------------|----------------------|-----------------|
|                  | Horizontal ( $H_L$ ) | $M_{TT}$ (Dest) |
|                  | Tonne                | Tm              |
| 1) LWL Condition | 47.08                | 129.37          |
| 2) HFL Condition | 47.08                | 129.37          |

**SUMMARY OF FORCES FOR BASE PRESSURE**

|                                 |   |       |
|---------------------------------|---|-------|
| Total base width                | = | 3.9 m |
| Distance from toe to shaft back | = | 2.4 m |

**SUMMARY ACTIVE EARTH PRESSURE :**

| Description      | Earth Pressure       |                 |                |                 |
|------------------|----------------------|-----------------|----------------|-----------------|
|                  | Horizontal ( $H_L$ ) | $M_{TT}$ (Dest) | Vertical ( V ) | $M_{TT}$ (Steb) |
|                  | Tonne                | Tm              | Tonne          | Tm              |
| 1) LWL Condition | 101.47               | 231.45          | 36.22          | -86.92          |
| 1) HFL Condition | 101.47               | 231.45          | 36.22          | -86.92          |

**SUMMARY SURCHARGE PRESSURE :**

| Description      | Surcharge Pressure   |                 |
|------------------|----------------------|-----------------|
|                  | Horizontal ( $H_L$ ) | $M_{TT}$ (Dest) |
|                  | Tonne                | Tm              |
| 1) LWL Condition | 47.08                | 129.37          |
| 2) HFL Condition | 47.08                | 129.37          |

## SEISMIC FORCE CALCULATION :

$$\text{Time Period Calculation} \quad T = 2 \sqrt{\frac{D}{1000 F}}$$

$$\begin{aligned} D &= \text{Approximate DL of super-structure \& LL in Tonne (DL+20\% LL)} \\ &= 214.27 + 18 \text{ t} \\ &= 232.241 \text{ Tonne} \end{aligned}$$

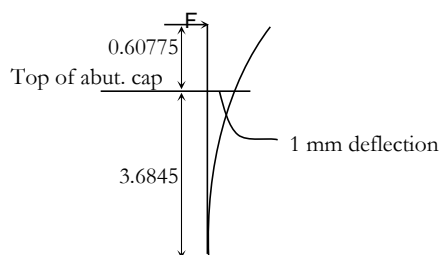
$$F = \text{Horizontal force in Tonne required to be applied at center of mass of super-structure for 1 mm deflection at the top of pier / abutment along the considered direction of horizontal force.}$$

$$F = \frac{6 E I}{x^2(3L-x)} \quad \text{for 1 mm deflection at } x$$

$$E = 32308 \text{ N/mm}^2$$

Column Cross-Section

$$\begin{aligned} B &= 12 \text{ m} \\ D &= 1 \text{ m (Average)} \\ I_L &= 1E+12 \text{ m}^4 \\ I_T &= 1.44E+14 \text{ m}^4 \end{aligned}$$



$$\text{Force required in Long. Dir. } F_L = 155.3 \text{ tonne}$$

$$\text{Force required in Long. Dir. } F_T = 22369.1 \text{ tonne}$$

$$\text{Time Period -Longitudinal Seismic Case} = 0.077$$

$$\text{Time Period -Transverse Seismic Case} = 0.01$$

$$\text{Sa/g -Longitudinal Seismic Case} = 0.94 \quad (\text{Amendment no. 1/ August 2013/}$$

$$\text{Sa/g -Transverse Seismic Case} = 0.94 \quad \text{IRC:6-2010 clause}$$

$$\text{Sa/g -Vertical Seismic Case} = 0.94 \quad 219.5)$$

$$\text{Seismic Zone} = V$$

$$\text{Type of soil} = \text{medium}$$

$$\text{Zone factor } Z = 0.36$$

$$\text{Importance factor } I = 1.2$$

$$\text{Horizontal seismic coeff. -Long., } A_{hL} = (Z/2)*(I)*(Sa/g)_{(Long.)} = 0.20$$

$$\text{Horizontal seismic coeff. -Trans., } A_{hT} = (Z/2)*(I)*(Sa/g)_{(Trans.)} = 0.20$$

$$\text{Vertical seismic coeff. } A_v = 2/3 A_h = 0.14$$

$$\text{Response Reduction Factor, } R_{long.} = 3$$

$$\text{Response Reduction Factor, } R_{trans.} = 1$$

$$\text{Response Reduction Factor, } R_{vert.} = 3$$

$$\text{Design Horizontal Longitudinal seismic coeff., } A_{hL} = A_h'/R_{(Long.)} = 0.06761$$

$$\text{Design Horizontal Transverse seismic coeff., } A_{hT} = A_h'/R_{(Trans.)} = 0.2034$$

$$\text{Design Vertical Seismic Coefficient - } A_v = A_v'/R_{(vert.)} = 0.0452$$

## DYNAMIC EARTH PRESSURE CALCULATION FOR OVER-TURNING & SLIDING :

### A) Non-Seismic Case :

Coefficient of Active Earth Pressure

$$K_a \text{ Dry} = 0.297$$

$$K_a' \text{ Submerged} = 0.308$$

Backfill Soil Parameter

|                             |   |                    |   |               |
|-----------------------------|---|--------------------|---|---------------|
| $\phi$                      | = | 30 °               | = | 0.524 Radians |
| $\delta$                    | = | 20 °               | = | 0.349 Radians |
| $\delta_{\text{submerged}}$ | = | 10 °               | = | 0.175 Radians |
| $i$                         | = | 0 °                | = | 0.000 Radians |
| $\alpha$                    | = | 90 °               | = | 1.571 Radians |
| $\gamma_{\text{dry}}$       | = | 2 t/m <sup>3</sup> |   |               |
| $\gamma_{\text{sat}}$       | = | 2 t/m <sup>3</sup> |   |               |
| $\gamma_{\text{sub}}$       | = | 1 t/m <sup>3</sup> |   |               |

$$\text{LL surcharge intensity } q = 2.4 \text{ t/m}^2$$

$$\text{Abutment Length } L = 12 \text{ m}$$

$$\text{Footing Base width } B = 3.9 \text{ m}$$

$$C_a = \frac{(1 \pm \alpha_v) * \sin^2(\alpha + \phi - \lambda)}{\cos \lambda * \sin^2 \alpha \cdot \sin(\alpha - \delta - \lambda) \cdot \left[ 1 + \sqrt{\frac{\sin(\phi + \delta) \cdot \sin(\phi - i - \lambda)}{\sin(\alpha - \delta - \lambda) \cdot \sin(\alpha + i)}} \right]^2}$$

$$\alpha_h = 0.06761$$

$$\alpha_v = 0.0452$$

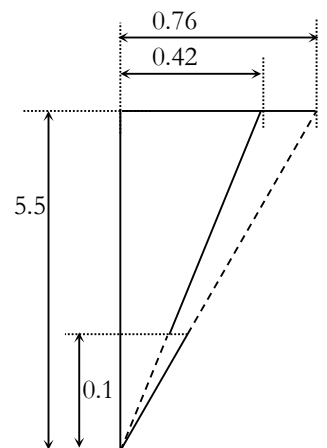
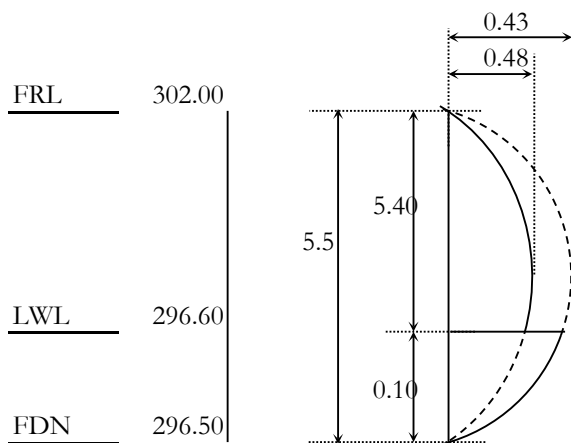
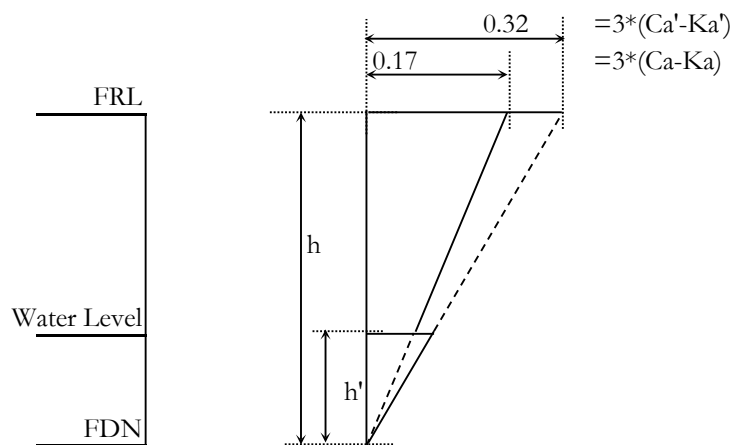
| $\lambda$                    | Formula used  | For | $+\alpha_v$ | $-\alpha_v$ |     |
|------------------------------|---|-----|-------------|-------------|-----|
| $\lambda_{\text{dry}}$       | $= \tan^{-1} \frac{\alpha_h}{1 \pm \alpha_v}$   |     | 3.70        | 4.05        | deg |
| $\lambda_{\text{submerged}}$ | $= \tan^{-1} \frac{\gamma_{\text{sat}} * \alpha_h}{(\gamma_{\text{sat}} - 1) (1 \pm \alpha_v)}$ |     | 7.37        | 8.06        | deg |

| $+\alpha_v$ | $-\alpha_v$ |         |
|-------------|-------------|---------|
| 0.06        | 0.07        | Radians |
| 0.13        | 0.14        | Radians |

| Seismic case (Coefficient of Earth Pressure) |         |       |
|--|---------|-------|
| For Seismic downward dry condition           | $C_a$   | 0.355 |
| For Seismic downward submerged condition     | $C_a'$  | 0.413 |
| For Seismic upward dry condition             | $C_a-$  | 0.329 |
| For Seismic upward submerged condition       | $C_a-'$ | 0.387 |

### 1) LWL Seismic Downward

|                             |   |                      |
|-----------------------------|---|----------------------|
| $K_a$                       | = | 0.297                |
| $K_a'$                      | = | 0.308                |
| $C_a$                       | = | 0.355                |
| $C_a'$                      | = | 0.413                |
| $\gamma_{\text{dry}}$       | = | 2 t/m <sup>3</sup>   |
| $\gamma_{\text{sat}}$       | = | 2 t/m <sup>3</sup>   |
| $\gamma_{\text{sub}}$       | = | 1 t/m <sup>3</sup>   |
| $\delta$                    | = | 20 deg               |
| $\delta_{\text{submerged}}$ | = | 10 deg               |
| $q$                         | = | 2.4 t/m <sup>2</sup> |
| $L$                         | = | 12 m                 |
| $B$                         | = | 3.9 m                |



#### Dyanmic Earth Pressure Calculation

Parabola above Water Level

|                         |   |                       |
|-------------------------|---|-----------------------|
| p <sub>mid_height</sub> | = | 0.48 t/m <sup>2</sup> |
| h                       | = | 5.5 m                 |
| y                       | = | 2.65 m                |
| L                       | = | 12 m                  |

Parabola below Water Level

|                         |   |                       |
|-------------------------|---|-----------------------|
| p <sub>mid_height</sub> | = | 0.43 t/m <sup>2</sup> |
| h                       | = | 5.5 m                 |
| y                       | = | -2.65 m               |
| L                       | = | 12 m                  |

| Dyanmic Earth Pressure              | Pa          | δ    | Pa*Cosδ     | ey         | Pa*Sinδ    | ex          |
|-------------------------------------|-------------|------|-------------|------------|------------|-------------|
|                                     | T           | deg. | T           | m          | T          | m           |
| Parabola above Water Level          | 21.1        | 20   | 19.8        | 2.8        | 7.2        | -3.9        |
| Parabola below Water Level          | 0.0         | 10   | 0.0         | 0.1        | 0.0        | -3.9        |
| <b>Total Dynamic Earth Pressure</b> | <b>21.1</b> |      | <b>19.8</b> | <b>2.8</b> | <b>7.2</b> | <b>-3.9</b> |

|                                     |   |                    |
|-------------------------------------|---|--------------------|
| <b>Total Dynamic Earth Pressure</b> | = | <b>21.12 Tonne</b> |
| <b>Horizontal Component</b>         | = | <b>19.85</b>       |
| <b>Lever arm</b>                    | = | <b>2.75</b>        |
| <b>Moment M<sub>TT</sub></b>        | = | <b>54.58 Tm</b>    |
| <b>Vertical Component</b>           | = | <b>7.22</b>        |
| <b>Lever arm</b>                    | = | <b>-3.90 m</b>     |
| <b>Moment M<sub>TT</sub></b>        | = | <b>-28.1568 Tm</b> |
| <b>Net Moment M<sub>TT</sub></b>    | = | <b>26.42 Tm</b>    |

#### Dyanmic Surcharge Pressure Calculation

Pressure Distribution above water level

|                          |   |                       |
|--------------------------|---|-----------------------|
| Intensity at top         | = | 0.42 t/m <sup>2</sup> |
| Intensity at water Level | = | 0.01 t/m <sup>2</sup> |
| h-h'                     | = | 5.40 m                |
| L                        | = | 12 m                  |

Pressure Distribution below water level

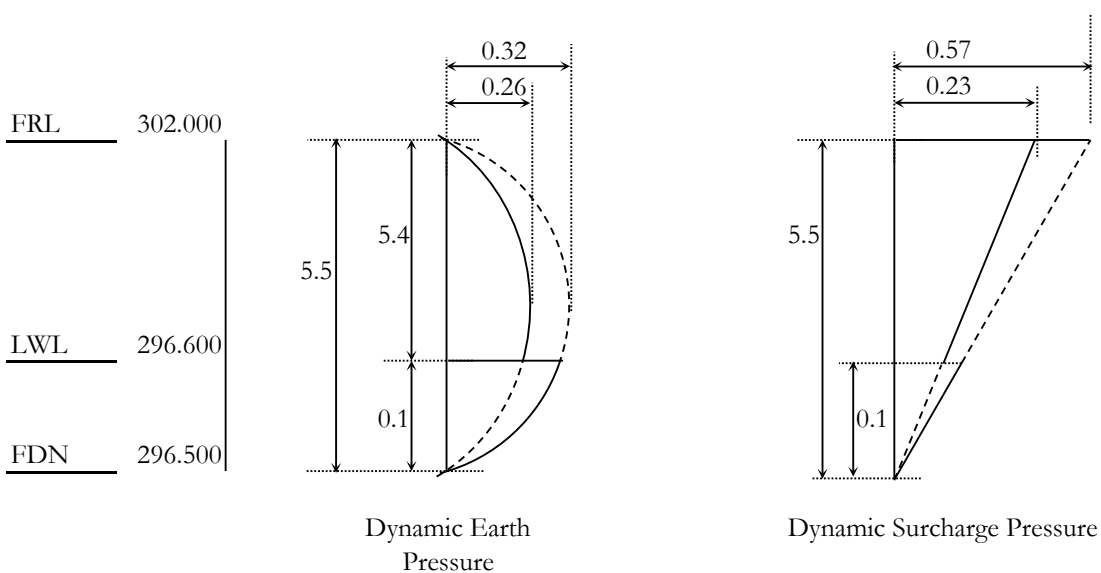
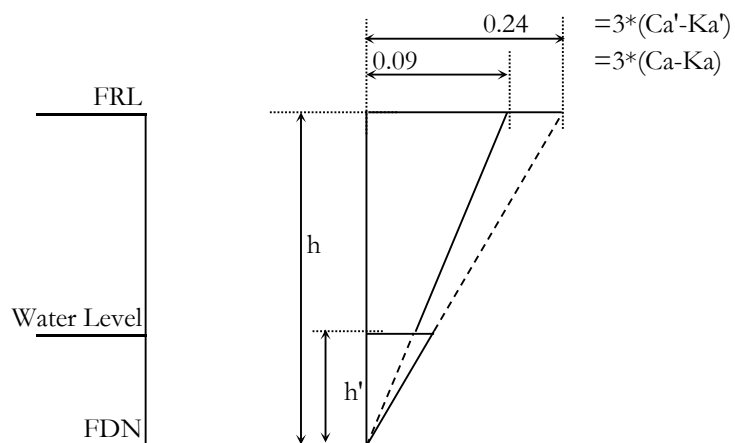
|                          |   |                       |
|--------------------------|---|-----------------------|
| Intensity at water Level | = | 0.01 t/m <sup>2</sup> |
| Intensity at base        | = | 0 t/m <sup>2</sup>    |
| h                        | = | 0.1 m                 |
| L                        | = | 12 m                  |

| Dyanmic Surcharge Pressure              | Pa           | Lever arm above Base |
|---|--------------|----------------------|
|   | T/m          | m                    |
| Trapezodial Portion above water Level   | 13.82        | 3.67                 |
| Traingular Portion below water Level    | 0.01         | 0.07                 |
| <b>Total Dynamic Surcharge Pressure</b> | <b>13.83</b> | <b>3.67</b>          |

|                                 |   |                    |
|---------------------------------|---|--------------------|
| <b>Total Surcharge Pressure</b> | = | <b>13.83 Tonne</b> |
| <b>Levera arm above base</b>    | = | <b>3.67 m</b>      |
| <b>Moment M<sub>TT</sub></b>    | = | <b>50.69 Tm</b>    |

## 2) LWL Seismic Upward

|                             |   |                      |
|-----------------------------|---|----------------------|
| $K_a$                       | = | 0.297                |
| $K_a'$                      | = | 0.308                |
| $C_a$                       | = | 0.329                |
| $C_a'$                      | = | 0.387                |
| $\gamma_{\text{dry}}$       | = | 2 t/m <sup>3</sup>   |
| $\gamma_{\text{sat}}$       | = | 2 t/m <sup>3</sup>   |
| $\gamma_{\text{sub}}$       | = | 1 t/m <sup>3</sup>   |
| $\delta$                    | = | 20 deg               |
| $\delta_{\text{submerged}}$ | = | 10 deg               |
| $q$                         | = | 2.4 t/m <sup>2</sup> |
| $L$                         | = | 12 m                 |
| $B$                         | = | 3.9 m                |



#### Dyanmic Earth Pressure Calculation

##### Parabola above Water Level

|                         |   |                       |
|-------------------------|---|-----------------------|
| p <sub>mid_height</sub> | = | 0.26 t/m <sup>2</sup> |
| h                       | = | 5.5 m                 |
| y                       | = | 2.65 m                |
| L                       | = | 12 m                  |

##### Parabola below Water Level

|                         |   |                       |
|-------------------------|---|-----------------------|
| p <sub>mid_height</sub> | = | 0.32 t/m <sup>2</sup> |
| h                       | = | 5.5 m                 |
| y                       | = | -2.65 m               |
| L                       | = | 12 m                  |

| Dyanmic Earth Pressure              | Pa          | δ    | Pa*Cosδ     | ey         | Pa*Sinδ    | ex          |
|-------------------------------------|-------------|------|-------------|------------|------------|-------------|
|                                     | T           | deg. | T           | m          | T          | m           |
| Parabola above Water Level          | 11.5        | 20   | 10.8        | 2.8        | 3.9        | -3.9        |
| Parabola below Water Level          | 0.0         | 10   | 0.0         | 0.1        | 0.0        | -3.9        |
| <b>Total Dynamic Earth Pressure</b> | <b>11.5</b> |      | <b>10.8</b> | <b>2.7</b> | <b>3.9</b> | <b>-3.9</b> |

|                                     |   |                    |
|-------------------------------------|---|--------------------|
| <b>Total Dynamic Earth Pressure</b> | = | <b>11.48 Tonne</b> |
| <b>Horizontal Component</b>         | = | <b>10.79</b>       |
| <b>Lever arm</b>                    | = | <b>2.75</b>        |
| <b>Moment M<sub>TT</sub></b>        | = | <b>29.67 Tm</b>    |
| <b>Vertical Component</b>           | = | <b>3.93</b>        |
| <b>Lever arm</b>                    | = | <b>-3.90 m</b>     |
| <b>Moment M<sub>TT</sub></b>        | = | <b>-15.3104 Tm</b> |
| <b>Net Moment M<sub>TT</sub></b>    | = | <b>14.36 Tm</b>    |

#### Dyanmic Surcharge Pressure Calculation

##### Pressure Distribution above water level

|                          |   |                        |
|--------------------------|---|------------------------|
| Intensity at top         | = | 0.23 t/m <sup>2</sup>  |
| Intensity at water Level | = | 0.004 t/m <sup>2</sup> |
| h-h'                     | = | 5.4 m                  |
| L                        | = | 12 m                   |

##### Pressure Distribution below water level

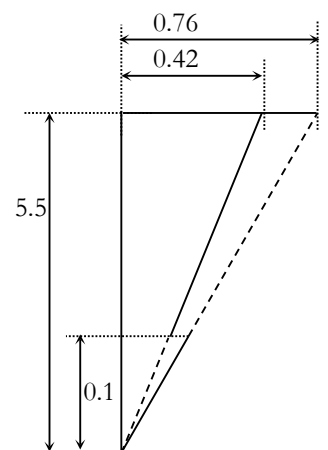
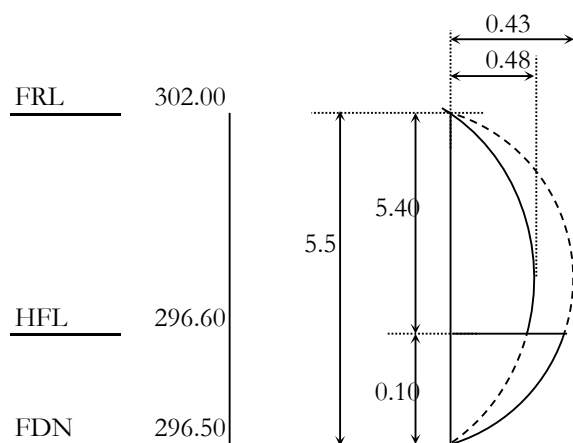
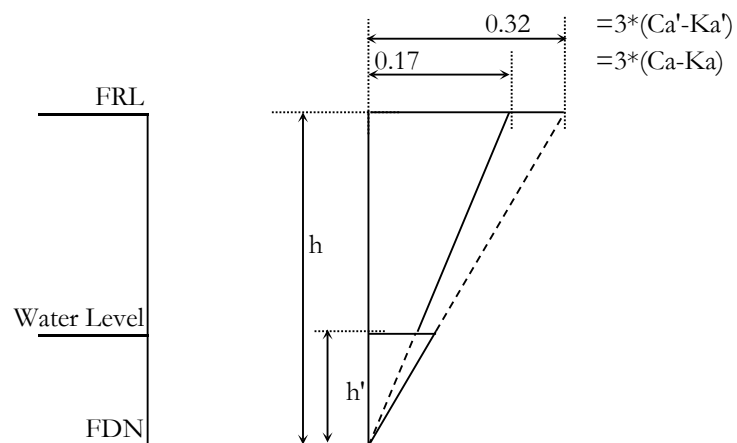
|                          |   |                       |
|--------------------------|---|-----------------------|
| Intensity at water Level | = | 0.01 t/m <sup>2</sup> |
| Intensity at base        | = | 0 t/m <sup>2</sup>    |
| h                        | = | 0.1 m                 |
| L                        | = | 12 m                  |

| Dyanmic Surcharge Pressure              | Pa          | Lever arm above Base |
|---|-------------|----------------------|
|   | T/m         | m                    |
| Trapezoidal Portion above water Level   | 7.51        | 3.67                 |
| Triangular Portion below water Level    | 0.01        | 0.07                 |
| <b>Total Dynamic Surcharge Pressure</b> | <b>7.52</b> | <b>3.66</b>          |

|                                 |   |                   |
|---------------------------------|---|-------------------|
| <b>Total Surcharge Pressure</b> | = | <b>7.52 Tonne</b> |
| <b>Lever arm above base</b>     | = | <b>3.66 m</b>     |
| <b>Moment M<sub>TT</sub></b>    | = | <b>27.56 Tm</b>   |

### 3) HFL Seismic Downward

|                      |   |                      |
|----------------------|---|----------------------|
| $K_a$                | = | 0.297                |
| $K_a'$               | = | 0.308                |
| $C_a$                | = | 0.355                |
| $C_a'$               | = | 0.413                |
| $\gamma_{dry}$       | = | 2 t/m <sup>3</sup>   |
| $\gamma_{sat}$       | = | 2 t/m <sup>3</sup>   |
| $\gamma_{sub}$       | = | 1 t/m <sup>3</sup>   |
| $\delta$             | = | 20 deg               |
| $\delta_{submerged}$ | = | 10 deg               |
| $q$                  | = | 2.4 t/m <sup>2</sup> |
| $L$                  | = | 12 m                 |
| $B$                  | = | 3.9 m                |





#### Dyanmic Earth Pressure Calculation

Parabola above Water Level

|                         |   |                       |
|-------------------------|---|-----------------------|
| p <sub>mid_height</sub> | = | 0.48 t/m <sup>2</sup> |
| h                       | = | 5.5 m                 |
| y                       | = | 2.65 m                |
| L                       | = | 12 m                  |

Parabola below Water Level

|                         |   |                       |
|-------------------------|---|-----------------------|
| p <sub>mid_height</sub> | = | 0.43 t/m <sup>2</sup> |
| h                       | = | 5.5 m                 |
| y                       | = | -2.65 m               |
| L                       | = | 12 m                  |

| Dyanmic Earth Pressure              | Pa          | δ    | Pa*Cosδ     | ey         | Pa*Sinδ    | ex          |
|-------------------------------------|-------------|------|-------------|------------|------------|-------------|
|                                     | T           | deg. | T           | m          | T          | m           |
| Parabola above Water Level          | 21.1        | 20   | 19.8        | 2.8        | 7.2        | -3.9        |
| Parabola below Water Level          | 0.0         | 10   | 0.0         | 0.1        | 0.0        | -3.9        |
| <b>Total Dynamic Earth Pressure</b> | <b>21.1</b> |      | <b>19.8</b> | <b>2.8</b> | <b>7.2</b> | <b>-3.9</b> |

|                                     |   |                    |
|-------------------------------------|---|--------------------|
| <b>Total Dynamic Earth Pressure</b> | = | <b>21.12 Tonne</b> |
| <b>Horizontal Component</b>         | = | <b>19.85</b>       |
| <b>Lever arm</b>                    | = | <b>2.75</b>        |
| <b>Moment M<sub>TT</sub></b>        | = | <b>54.58 Tm</b>    |
| <b>Vertical Component</b>           | = | <b>7.22</b>        |
| <b>Lever arm</b>                    | = | <b>-3.90 m</b>     |
| <b>Moment M<sub>TT</sub></b>        | = | <b>-28.1568 Tm</b> |
| <b>Net Moment M<sub>TT</sub></b>    | = | <b>26.42 Tm</b>    |

#### Dyanmic Surcharge Pressure Calculation

Pressure Distribution above water level

|                          |   |                        |
|--------------------------|---|------------------------|
| Intensity at top         | = | 0.42 t/m <sup>2</sup>  |
| Intensity at water Level | = | 0.008 t/m <sup>2</sup> |
| h-h'                     | = | 5.4 m                  |
| L                        | = | 12 m                   |

Pressure Distribution below water level

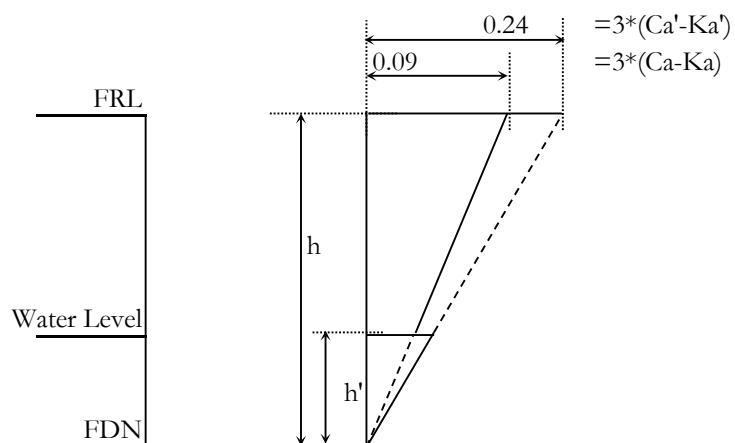
|                          |   |                       |
|--------------------------|---|-----------------------|
| Intensity at water Level | = | 0.01 t/m <sup>2</sup> |
| Intensity at base        | = | 0 t/m <sup>2</sup>    |
| h                        | = | 0.1 m                 |
| L                        | = | 12 m                  |

| Dyanmic Surcharge Pressure              | Pa           | Lever arm above Base |
|---|--------------|----------------------|
|   | T/m          | m                    |
| Trapezoidal Portion above water Level   | 13.82        | 3.67                 |
| Triangular Portion below water Level    | 0.01         | 0.07                 |
| <b>Total Dynamic Surcharge Pressure</b> | <b>13.83</b> | <b>3.67</b>          |

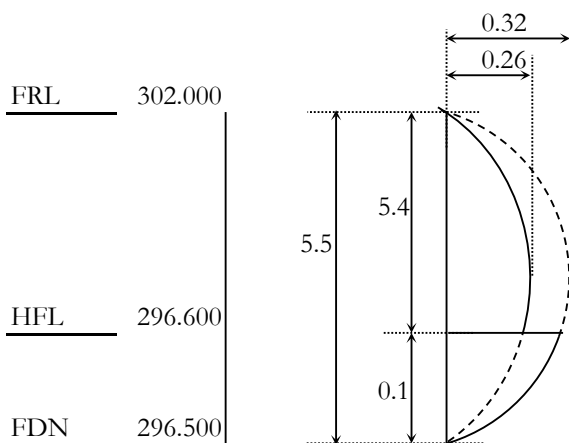
|                                 |   |                    |
|---------------------------------|---|--------------------|
| <b>Total Surcharge Pressure</b> | = | <b>13.83 Tonne</b> |
| <b>Lever arm above base</b>     | = | <b>3.67 m</b>      |
| <b>Moment M<sub>TT</sub></b>    | = | <b>50.69 Tm</b>    |

#### 4) HFL Seismic Upward

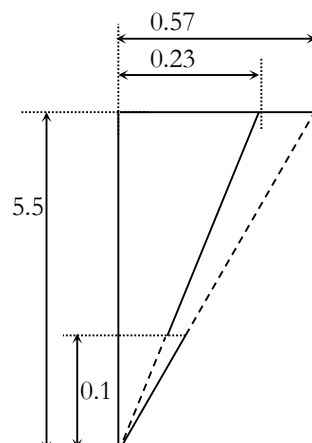
|                             |   |                      |
|-----------------------------|---|----------------------|
| $K_a$                       | = | 0.297                |
| $K_a'$                      | = | 0.308                |
| $C_a$                       | = | 0.329                |
| $C_a'$                      | = | 0.387                |
| $\gamma_{\text{dry}}$       | = | 2 t/m <sup>3</sup>   |
| $\gamma_{\text{sat}}$       | = | 2 t/m <sup>3</sup>   |
| $\gamma_{\text{sub}}$       | = | 1 t/m <sup>3</sup>   |
| $\delta$                    | = | 20 deg               |
| $\delta_{\text{submerged}}$ | = | 10 deg               |
| $q$                         | = | 2.4 t/m <sup>2</sup> |
| $L$                         | = | 12 m                 |
| $B$                         | = | 3.9 m                |



Dynamic Earth Pressure Coeff. Variation



Dynamic Earth Pressure



Dynamic Surcharge Pressure

#### Dyanmic Earth Pressure Calculation

Parabola above Water Level

|                         |   |                       |
|-------------------------|---|-----------------------|
| p <sub>mid_height</sub> | = | 0.26 t/m <sup>2</sup> |
| h                       | = | 5.5 m                 |
| y                       | = | 2.65 m                |
| L                       | = | 12 m                  |

Parabola below Water Level

|                         |   |                       |
|-------------------------|---|-----------------------|
| p <sub>mid_height</sub> | = | 0.32 t/m <sup>2</sup> |
| h                       | = | 5.5 m                 |
| y                       | = | -2.65 m               |
| L                       | = | 12 m                  |

| Dyanmic Earth Pressure              | Pa          | δ    | Pa*cosδ     | ey         | Pa*sinδ    | ex          |
|-------------------------------------|-------------|------|-------------|------------|------------|-------------|
|                                     | T           | deg. | T           | m          | T          | m           |
| Parabola above Water Level          | 11.5        | 20   | 10.8        | 2.8        | 3.9        | -3.9        |
| Parabola below Water Level          | 0.0         | 10   | 0.0         | 0.1        | 0.0        | -3.9        |
| <b>Total Dynamic Earth Pressure</b> | <b>11.5</b> |      | <b>10.8</b> | <b>2.7</b> | <b>3.9</b> | <b>-3.9</b> |

|                                     |   |                    |
|-------------------------------------|---|--------------------|
| <b>Total Dynamic Earth Pressure</b> | = | <b>11.48 Tonne</b> |
| <b>Horizontal Component</b>         | = | <b>10.79</b>       |
| <b>Lever arm</b>                    | = | <b>2.75</b>        |
| <b>Moment M<sub>TT</sub></b>        | = | <b>29.67 Tm</b>    |
| <b>Vertical Component</b>           | = | <b>3.93</b>        |
| <b>Lever arm</b>                    | = | <b>-3.90 m</b>     |
| <b>Moment M<sub>TT</sub></b>        | = | <b>-15.3104 Tm</b> |
| <b>Net Moment M<sub>TT</sub></b>    | = | <b>14.36 Tm</b>    |

#### Dyanmic Surcharge Pressure Calculation

Pressure Distribution above water level

|                          |   |                        |
|--------------------------|---|------------------------|
| Intensity at top         | = | 0.23 t/m <sup>2</sup>  |
| Intensity at water Level | = | 0.004 t/m <sup>2</sup> |
| h-h'                     | = | 5.4 m                  |
| L                        | = | 12 m                   |

Pressure Distribution below water level

|                          |   |                       |
|--------------------------|---|-----------------------|
| Intensity at water Level | = | 0.01 t/m <sup>2</sup> |
| Intensity at base        | = | 0 t/m <sup>2</sup>    |
| h                        | = | 0.1 m                 |
| L                        | = | 12 m                  |

| Dyanmic Surcharge Pressure              | Pa          | Lever arm above Base |
|---|-------------|----------------------|
|   | T/m         | m                    |
| Trapezoidal Portion above water Level   | 7.51        | 3.67                 |
| Triangular Portion below water Level    | 0.01        | 0.07                 |
| <b>Total Dynamic Surcharge Pressure</b> | <b>7.52</b> | <b>3.66</b>          |

|                                 |   |                   |
|---------------------------------|---|-------------------|
| <b>Total Surcharge Pressure</b> | = | <b>7.52 Tonne</b> |
| <b>Lever arm above base</b>     | = | <b>3.66 m</b>     |
| <b>Moment M<sub>TT</sub></b>    | = | <b>27.56 Tm</b>   |

**1) SUMMARY DYNAMIC PRESSURE FOR OVERTURNING & SLIDING:**

**a) EARTH PRESSURE FOR OVERTURNING & SLIDING:**

| Description   | Dynamic Earth Pressure       |                        |              |                        |
|---|------------------------------|------------------------|--------------|------------------------|
|   | Horizontal (H <sub>L</sub> ) | M <sub>TT</sub> (Dest) | Vertical (V) | M <sub>TT</sub> (Steb) |
|   | Tonne                        | Tm                     | Tonne        | Tm                     |
| 1) LWL Seismic Downward<br>Horizontal Component<br>Vertical Component | 19.85                        | 54.58                  | 7.22         | -28.16                 |
| 2) LWL Seismic Upward<br>Horizontal Component<br>Vertical Component   | 10.79                        | 29.67                  | 3.93         | -15.31                 |
| 3) HFL Seismic Downward<br>Horizontal Component<br>Vertical Component | 19.85                        | 54.58                  | 7.22         | -28.16                 |
| 4) HFL Seismic Upward<br>Horizontal Component<br>Vertical Component   | 10.79                        | 29.67                  | 3.93         | -15.31                 |

**b) SURCHARGE PRESSURE FOR OVERTURNING & SLIDING:**

| Description             | Dynamic Surcharge Pressure   |                        |
|-------------------------|------------------------------|------------------------|
|                         | Horizontal (H <sub>L</sub> ) | M <sub>TT</sub> (Dest) |
|                         | Tonne                        | Tm                     |
| 1) LWL Seismic Downward | 13.83                        | 50.69                  |
| 2) LWL Seismic Upward   | 7.52                         | 27.56                  |
| 3) HFL Seismic Downward | 13.83                        | 50.69                  |
| 4) HFL Seismic Upward   | 7.52                         | 27.56                  |

**2) SUMMARY DYNAMIC PRESSURE FOR BASE PRESSURE:**

Total base width = 3.9 m  
Distance from toe to shaft back = 2.4 m

| <b><i>a) EARTH PRESSURE FOR BASE PRESSURE:</i></b>                    |                        |                 |              |                 |
|---|------------------------|-----------------|--------------|-----------------|
| Description   | Dynamic Earth Pressure |                 |              |                 |
|   | Horizontal ( $H_L$ )   | $M_{TT (Dest)}$ | Vertical (V) | $M_{TT (Steb)}$ |
|   | Tonne                  | Tm              | Tonne        | Tm              |
| 1) LWL Seismic Downward<br>Horizontal Component<br>Vertical Component | 19.85                  | 54.58           | 7.22         | -17.33          |
| 2) LWL Seismic Upward<br>Horizontal Component<br>Vertical Component   | 10.79                  | 29.67           | 3.93         | -9.42           |
| 3) HFL Seismic Downward<br>Horizontal Component<br>Vertical Component | 19.85                  | 54.58           | 7.22         | -17.33          |
| 4) HFL Seismic Upward<br>Horizontal Component<br>Vertical Component   | 10.79                  | 29.67           | 3.93         | -9.42           |

***b) SURCHARGE PRESSURE FOR BASE PRESSURE:***

| Description             | Dynamic Surcharge Pressure |                 |
|-------------------------|----------------------------|-----------------|
|                         | Horizontal ( $H_L$ )       | $M_{TT (Dest)}$ |
|                         | Tonne                      | Tm              |
| 1) LWL Seismic Downward | 13.83                      | 50.69           |
| 2) LWL Seismic Upward   | 7.52                       | 27.56           |
| 3) HFL Seismic Downward | 13.83                      | 50.69           |
| 4) HFL Seismic Upward   | 7.52                       | 27.56           |

**SEISMIC COMPONENT OF SUPER-STRUCTURE DL & SIDL :**

|   |          |   |         |
|---|----------|---|---------|
| Longitudinal Horizontal seismic coefficient | $A_{hL}$ | = | 0.06761 |
| Transverse Horizontal seismic coefficient   | $A_{hT}$ | = | 0.2034  |
| Vertical seismic coefficient                | $A_V$    | = | 0.0452  |

Loads & Their Lever arm from base slab bottom

| Description                |   | W     | ey   |
|----------------------------|---|-------|------|
|                            |   | Tonne | m    |
| Total Super-Structure DL   | = | 310.3 | 5.36 |
| Total Super-Structure SIDL | = | 91.6  | 5.74 |
| Total Surfacing weight     | = | 26.7  | 5.47 |
| Total                      |   | 428.5 | 5.5  |

W = Weight of super-structure

ey = Cg. above base slab in vertical direction

Distance From base slab bottom to bearing top = 4.435 m

Distance from toe tip to c/L of brg = -1.575 m

**SEISMIC LONGITUDINAL :**

|  |          |   |             |
|--|----------|---|-------------|
| Longitudinal seismic coefficient         | $A_{hL}$ | = | 0.06761     |
| Total weight of sup DL, SIDL & surfacing |          | = | 428.5 Tonne |

***Forces at fixed end***

|                                |  |   |            |
|--------------------------------|--|---|------------|
| Seismic Component              |  | = | 29.0 Tonne |
| Lever arm above base slab      |  | = | 4.4 m      |
| Moment about T-T axis $M_{TT}$ |  | = | 128.5 Tm   |

***Forces at free end***

|                                |  |   |           |
|--------------------------------|--|---|-----------|
| Seismic Component              |  | = | 0.0 Tonne |
| Lever arm above base slab      |  | = | 0.0 m     |
| Moment about T-T axis $M_{TT}$ |  | = | 0.0 Tm    |

**SEISMIC TRANSVERSE :**

|  |          |   |             |
|--|----------|---|-------------|
| Horizontal seismic coefficient           | $A_{hT}$ | = | 0.2034      |
| Total weight of sup DL, SIDL & surfacing |          | = | 428.5 Tonne |

***Forces at fixed end***

|                               |  |   |            |
|-------------------------------|--|---|------------|
| Seismic Component             |  | = | 43.6 Tonne |
| Lever arm above base slab     |  | = | 5.5 m      |
| Moment about LL axis $M_{LL}$ |  | = | 237.6 Tm   |

***Forces at free end***

|                               |  |   |            |
|-------------------------------|--|---|------------|
| Seismic Component             |  | = | 43.6 Tonne |
| Lever arm above base slab     |  | = | 5.5 m      |
| Moment about LL axis $M_{LL}$ |  | = | 237.6 Tm   |

**SEISMIC VERTICAL :**

|  |       |   |             |
|--|-------|---|-------------|
| Horizontal seismic coefficient           | $A_v$ | = | 0.0452      |
| Total weight of sup DL, SIDL & surfacing |       | = | 428.5 Tonne |

***Forces at fixed end***

|                                |  |   |           |
|--------------------------------|--|---|-----------|
| Seismic Component              |  | = | 9.7 Tonne |
| Lever arm from toe             |  | = | -1.6 m    |
| Moment about T-T axis $M_{TT}$ |  | = | -15.3 Tm  |

***Forces at free end***

|                                |  |   |           |
|--------------------------------|--|---|-----------|
| Seismic Component              |  | = | 9.7 Tonne |
| Lever arm from toe             |  | = | -1.6 m    |
| Moment about T-T axis $M_{TT}$ |  | = | -15.3 Tm  |

**Summary of Permanent Load (DL+SIDL+SURFACING) seismic Component :**

| At Fixed End, Force about toe | V<br>T | $H_L$<br>T | $H_T$<br>T | ey<br>m | $e_L$<br>m | $M_{LL}$<br>Tm | $M_{TT}$<br>Tm |
|-------------------------------|--------|------------|------------|---------|------------|----------------|----------------|
| Seismic Longitudinal          |        | 29.0       |            | 4.4     |            | 128.5          |                |
| Seismic Transverse            |        |            | 43.6       | 5.5     |            | 237.6          |                |
| Seismic Vertical              | 9.7    |            |            |         | -1.6       |                | -15.3          |

**SEISMIC COMPONENT OF LIVE LOAD :**

|   |          |   |         |
|---|----------|---|---------|
| Longitudinal Horizontal seismic coefficient | $A_{hL}$ | = | 0.06761 |
| Transverse Horizontal seismic coefficient   | $A_{hT}$ | = | 0.2034  |
| Vertical seismic coefficient                | $A_v$    | = | 0.0452  |

Loads & Their Lever arm from base slab bottom

| Description         | W     | ey  |
|---------------------|-------|-----|
|                     | Tonne | m   |
| Maximum Live Load = | 89.9  | 6.7 |
| Minimum Live Load   | 45.3  | 6.7 |

W = Live Load Reaction

ey = Cg. above base slab in vertical direction

Distance From base slab bottom to bearing top = 4.5 m

Distance from toe tip to c/L of brg. = -1.575 m

**SEISMIC LONGITUDINAL :**

No Live Load seismic component is considered in longitudinal direction

**SEISMIC TRANSVERSE :**

Horizontal seismic coefficient  $A_{hT}$  = 0.2034

**Max Live Load Reaction Case :**

|                               |   |             |
|-------------------------------|---|-------------|
| Maximum Live Load reaction    | = | 89.87 Tonne |
| Seismic Component             | = | 18.28 Tonne |
| Lever arm above base slab     | = | 6.70 m      |
| Moment about LL axis $M_{LL}$ | = | 122.47 Tm   |

**Min Live Load Reaction Case :**

|                               |   |             |
|-------------------------------|---|-------------|
| Minimum Live Load reaction    | = | 45.33 Tonne |
| Seismic Component             | = | 9.22 Tonne  |
| Lever arm above base slab     | = | 6.70 m      |
| Moment about LL axis $M_{LL}$ | = | 61.78 Tm    |



**SEISMIC VERTICAL :**

Vertical seismic coefficient  $A_{hT}$  = 0.0452

**Max Live Load Reaction Case :**

Maximum Live Load reaction = 89.87 Tonne  
 Seismic Component = 4.06 Tonne  
 Lever arm from toe = -1.58 m  
 Moment about LL axis  $M_{LL}$  = -6.40 Tm

**Min Live Load Reaction Case :**

Minimum Live Load reaction = 45.33 Tonne  
 Seismic Component = 2.05 Tonne  
 Lever arm from toe = -1.58 m  
 Moment about LL axis  $M_{LL}$  = -3.23 Tm

**Summary of LL seismic component transferred from super-structure :****Max Live Load Reaction Case :**

| At Fixed/ Free End   | V<br>T | $H_L$<br>T | $H_T$<br>T | $e_y$<br>m | $e_L$<br>m | $M_{LL}$<br>Tm | $M_{TT}$<br>Tm |
|----------------------|--------|------------|------------|------------|------------|----------------|----------------|
| Seismic Longitudinal |        | 0.0        |            | 0.0        |            |                | 0.0            |
| Seismic Transverse   |        |            | 18.3       | 6.70       |            | 122.5          |                |
| Seismic Vertical     | 4.1    |            |            | -1.58      |            |                | -6.4           |

**Min Live Load Reaction Case :**

| At Fixed/ Free End   | V<br>T | $H_L$<br>T | $H_T$<br>T | $e_y$<br>m | $e_L$<br>m | $M_{LL}$<br>Tm | $M_{TT}$<br>Tm |
|----------------------|--------|------------|------------|------------|------------|----------------|----------------|
| Seismic Longitudinal |        | 0.0        |            | 0.0        |            |                | 0.0            |
| Seismic Transverse   |        |            | 9.2        | 6.70       |            | 61.8           |                |
| Seismic Vertical     | 2.0    |            |            | -1.58      |            |                | -3.2           |

**SEISMIC COMPONENT OF SUB-STRUCTURE & BACKFILL :**

|   |          |   |         |
|---|----------|---|---------|
| Longitudinal Horizontal seismic coefficient | $A_{hL}$ | = | 0.06761 |
| Transverse Horizontal seismic coefficient   | $A_{hT}$ | = | 0.2034  |
| Vertical seismic coefficient                | $A_v$    | = | 0.0452  |

**Sub-structure Vertical load**

| Description     | W     | ey  | ex   |
|-----------------|-------|-----|------|
|                 | Tonne | m   | m    |
| Sub-structure = | 133.2 | 2.8 | -1.9 |
| Return wall =   | 46.3  | 4.4 | -3.2 |
| Total           | 179.5 | 3.2 | -2.2 |

W = Weight of super-structure

ey = Cg. above base slab in vertical direction

**Backfill Vertical load**

| Description       | W     | ey  | ex   |
|-------------------|-------|-----|------|
|                   | Tonne | m   | m    |
| Backfill Weight = | 162.1 | 2.7 | -3.2 |
| Total             | 162.1 | 2.7 | -3.2 |

**SEISMIC LONGITUDINAL :**

|                                  |          |   |               |
|----------------------------------|----------|---|---------------|
|                                  |          |   | Sub-Structure |
| Longitudinal seismic coefficient | $A_{hL}$ | = | 0.06761       |
| Total weight of Sub-structure    |          | = | 179.5 Tonne   |
| Seismic Component                |          | = | 12.1 Tonne    |
| Lever arm above base slab        |          | = | 3.2 m         |
| Moment about T-T axis $M_{TT}$   |          | = | 38.7 Tm       |

**SEISMIC TRANSVERSE :**

|                                |          |   |             |
|--------------------------------|----------|---|-------------|
| Horizontal seismic coefficient | $A_{hT}$ | = | 0.2034      |
| Total weight of Sub-structure  |          | = | 179.5 Tonne |
| Seismic Component              |          | = | 36.5 Tonne  |
| Lever arm above base slab      |          | = | 3.2 m       |
| Moment about LL axis $M_{LL}$  |          | = | 116.3 Tm    |

**SEISMIC VERTICAL :**

|                                |       |   |             |
|--------------------------------|-------|---|-------------|
| Horizontal seismic coefficient | $A_v$ | = | 0.0452      |
| Total weight of Sub-structure  |       | = | 179.5 Tonne |
| Seismic Component              |       | = | 8.1 Tonne   |
| Lever arm from toe             |       | = | -2.2 m      |
| Moment about T-T axis $M_{TT}$ |       | = | -17.9 Tm    |

**Summery of Sub-structure seismic component :**

| At Fixed End         | V<br>T | $H_L$<br>T | $H_T$<br>T | $M_{LL}$<br>Tm | $M_{TT}$<br>Tm |
|----------------------|--------|------------|------------|----------------|----------------|
| Seismic Longitudinal |        | 12.1       |            |                | 38.7           |
| Seismic Transverse   |        |            | 36.5       | 116.3          |                |
| Seismic Vertical     | 8.1    |            |            |                | -17.9          |

**SEISMIC COMPONENT OF BACK FILL :****SEISMIC LONGITUDINAL :**

Earth Fill

|                                  |          |   |             |
|----------------------------------|----------|---|-------------|
| Longitudinal seismic coefficient | $A_{hL}$ | = | 0.06761     |
| Total weight of Sub-structure    |          | = | 162.1 Tonne |
| Seismic Component                |          | = | 11.0 Tonne  |
| Lever arm above base slab        |          | = | 2.7 m       |
| Moment about T-T axis $M_{TT}$   |          | = | 29.4 Tm     |

**SEISMIC TRANSVERSE :**

|                                |          |   |             |
|--------------------------------|----------|---|-------------|
| Horizontal seismic coefficient | $A_{hT}$ | = | 0.2034      |
| Total weight of Sub-structure  |          | = | 162.1 Tonne |
| Seismic Component              |          | = | 33.0 Tonne  |
| Lever arm above base slab      |          | = | 2.7 m       |
| Moment about LL axis $M_{LL}$  |          | = | 88.5 Tm     |

**SEISMIC VERTICAL :**

|                                |       |   |             |
|--------------------------------|-------|---|-------------|
| Horizontal seismic coefficient | $A_v$ | = | 0.0452      |
| Total weight of Sub-structure  |       | = | 162.1 Tonne |
| Seismic Component              |       | = | 7.3 Tonne   |
| Lever arm from toe             |       | = | -3.2 m      |
| Moment about T-T axis $M_{TT}$ |       | = | -23.1 Tm    |

***Summery of Earthfill seismic component :***

| At Fixed End         | V   | H <sub>L</sub> | H <sub>T</sub> | M <sub>LL</sub> | M <sub>TT</sub> |
|----------------------|-----|----------------|----------------|-----------------|-----------------|
|                      | T   | T              | T              | Tm              | Tm              |
| Seismic Longitudinal |     | 11.0           |                |                 | 29.4            |
| Seismic Transverse   |     |                | 33.0           | 88.5            |                 |
| Seismic Vertical     | 7.3 |                |                |                 | -23.1           |





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LOAD COMBINATION  
FOR BASE PRESSURE CHECK

| LC-1  | NS, LWL, Span dislodge, FP  | Forces about toe |                |                |                 |                 |  | LC-1 |
|-------|-----------------------------|------------------|----------------|----------------|-----------------|-----------------|--|------|
| S.N.  | Description                 | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |  |      |
|       |                             | Tonne            | Tonne          | Tonne          | Tm              | Tm              |  |      |
| 1)    | Sub-structure & Foundation  | 236.7            |                |                | -507.8          | 0.0             |  | 0.95 |
| 2)    | Backfill                    | 162.1            |                |                | -511.8          | 0.0             |  | 0.95 |
| 9)    | Fluid Pressure              |                  | 0.03           |                | 0.00            |                 |  | 1.5  |
| 10.1) | Surcharge Pressure LWL(O/S) |                  | 47.1           |                | 129.4           |                 |  | 1.2  |

| S.N. | Description                | Forces about toe |                |                |                       |                       |                       |                       |
|------|----------------------------|------------------|----------------|----------------|-----------------------|-----------------------|-----------------------|-----------------------|
|      |                            | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT(Dest)</sub> | M <sub>TT(Steb)</sub> | M <sub>LL(Dest)</sub> | M <sub>LL(Steb)</sub> |
|      |                            | Tonne            | Tonne          | Tonne          | Tm                    | Tm                    | Tm                    | Tm                    |
| LC-1 | NS, LWL, Span dislodge, FP | 378.828          | 56.535         | 0              | 155.251               | -968.651              | 0                     | 0                     |

| LC-2  | NS, LWL, Span dislodge, EP  | Forces about toe |                |                |                 |                 |  | LC-2 |
|-------|-----------------------------|------------------|----------------|----------------|-----------------|-----------------|--|------|
| S.N.  | Description                 | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |  |      |
|       |                             | Tonne            | Tonne          | Tonne          | Tm              | Tm              |  |      |
| 1)    | Sub-structure & Foundation  | 236.7            |                |                | -507.8          | 0.0             |  | 0.95 |
| 2)    | Backfill                    | 162.1            |                |                | -511.8          | 0.0             |  | 0.95 |
| 9.1)  | Earth Pressure LWL (O/S)    |                  |                |                |                 |                 |  | 1.5  |
|       | Horizontal Component        |                  | 101.5          |                | 231.4           |                 |  | 1.5  |
|       | Vertical Component          | 36.2             |                |                | -141.2          |                 |  | 1.5  |
| 10.1) | Surcharge Pressure LWL(O/S) |                  | 47.1           |                | 129.4           |                 |  | 1.2  |

| S.N. | Description                | Forces about toe |                |                |                       |                       |                       |                       |
|------|----------------------------|------------------|----------------|----------------|-----------------------|-----------------------|-----------------------|-----------------------|
|      |                            | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT(Dest)</sub> | M <sub>TT(Steb)</sub> | M <sub>LL(Dest)</sub> | M <sub>LL(Steb)</sub> |
|      |                            | Tonne            | Tonne          | Tonne          | Tm                    | Tm                    | Tm                    | Tm                    |
| LC-2 | NS, LWL, Span dislodge, EP | 433.152          | 208.693        | 0              | 502.419               | -1180.52              | 0                     | 0                     |

| LC-3 | NS, LWL, Min LL Lead, FP             | Forces about toe |                |                |                 |                 |  | LC-3 |
|------|--------------------------------------|------------------|----------------|----------------|-----------------|-----------------|--|------|
| S.N. | Description                          | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |  |      |
|      |                                      | Tonne            | Tonne          | Tonne          | Tm              | Tm              |  |      |
| 1)   | Sub-structure & Foundation           | 236.7            |                |                | -507.8          | 0.0             |  | 0.95 |
| 2)   | Backfill                             | 162.1            |                |                | -511.8          | 0.0             |  | 0.95 |
| 3)   | Super-structure DL                   | 155.1            |                |                | -244.3          | 0.0             |  | 0.95 |
| 4)   | SIDL (excluding surfacing)           | 45.8             |                |                | -72.2           | 0.0             |  | 0.95 |
| 5)   | Surfacing                            | 13.3             |                |                | -21.0           | -3.3            |  | 1    |
| 6.2) | Live Load Vertical Load Min Reaction | 45.3             |                |                | -71.4           | 131.9           |  | 1.5  |
| 7)   | Live Load Horizontal Forces          |                  | 26.6           |                | 117.9           |                 |  | 1.5  |
| 9)   | Fluid Pressure                       |                  | 0.03           |                | 0.00            |                 |  | 1.5  |

|       |                             |  |      |  |       |  |  |     |
|-------|-----------------------------|--|------|--|-------|--|--|-----|
| 10.1) | Surcharge Pressure LWL(O/S) |  | 47.1 |  | 129.4 |  |  | 1.2 |
|-------|-----------------------------|--|------|--|-------|--|--|-----|

| S.N. | Description              | Forces about toe |                |                |                       |                       |                       |                       |
|------|--------------------------|------------------|----------------|----------------|-----------------------|-----------------------|-----------------------|-----------------------|
|      |                          | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT(Dest)</sub> | M <sub>TT(Steb)</sub> | M <sub>LL(Dest)</sub> | M <sub>LL(Steb)</sub> |
|      |                          | Tonne            | Tonne          | Tonne          | Tm                    | Tm                    | Tm                    | Tm                    |
| LC-3 | NS, LWL, Min LL Lead, FP | 651.048          | 96.4226        | 0              | 332.153               | -1397.4               | 197.88                | -3.33145              |

| S.N.  | Description                          | Forces about toe |                |                |                 |                 | LC-4 |
|-------|--------------------------------------|------------------|----------------|----------------|-----------------|-----------------|------|
|       |                                      | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |      |
|       |                                      | Tonne            | Tonne          | Tonne          | Tm              | Tm              |      |
| 1)    | Sub-structure & Foundation           | 236.7            |                |                | -507.8          | 0.0             | 0.95 |
| 2)    | Backfill                             | 162.1            |                |                | -511.8          | 0.0             | 0.95 |
| 3)    | Super-structure DL                   | 155.1            |                |                | -244.3          | 0.0             | 0.95 |
| 4)    | SIDL (excluding surfacing)           | 45.8             |                |                | -72.2           | 0.0             | 0.95 |
| 5)    | Surfacing                            | 13.3             |                |                | -21.0           | -3.3            | 1    |
| 6.2)  | Live Load Vertical Load Min Reaction | 45.3             |                |                | -71.4           | 131.9           | 1.5  |
| 7)    | Live Load Horizontal Forces          |                  | 26.6           |                | 117.9           |                 | 1.5  |
| 9.1)  | Earth Pressure LWL (O/S)             |                  |                |                |                 |                 | 1.5  |
|       | Horizontal Component                 |                  | 101.5          |                | 231.4           |                 | 1.5  |
|       | Vertical Component                   | 36.2             |                |                | -141.2          |                 | 1.5  |
| 10.1) | Surcharge Pressure LWL(O/S)          |                  | 47.1           |                | 129.4           |                 | 1.2  |

| S.N. | Description              | Forces about toe |                |                |                       |                       |                       |                       |
|------|--------------------------|------------------|----------------|----------------|-----------------------|-----------------------|-----------------------|-----------------------|
|      |                          | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT(Dest)</sub> | M <sub>TT(Steb)</sub> | M <sub>LL(Dest)</sub> | M <sub>LL(Steb)</sub> |
|      |                          | Tonne            | Tonne          | Tonne          | Tm                    | Tm                    | Tm                    | Tm                    |
| LC-4 | NS, LWL, Min LL Lead, EP | 705.373          | 248.581        | 0              | 679.32                | -1609.26              | 197.88                | -3.33145              |

| S.N.                        | Description                                     | Forces about toe |                |                |                 |                 | LC-5  |
|-----------------------------|---|------------------|----------------|----------------|-----------------|-----------------|-------|
|                             |   | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |       |
|                             |   | Tonne            | Tonne          | Tonne          | Tm              | Tm              |       |
| 1)                          | Sub-structure & Foundation                      | 236.7            |                |                | -507.8          | 0.0             | 0.95  |
| 2)                          | Backfill  | 162.1            |                |                | -511.8          | 0.0             | 0.95  |
| 9.1)                        | Earth Pressure LWL (O/S)                        |                  |                |                |                 |                 | 1     |
|                             | Horizontal Component                            |                  | 101.5          |                | 231.4           |                 | 1     |
|                             | Vertical Component                              | 36.2             |                |                | -141.2          |                 | 1     |
| <b>Seismic Longitudinal</b> |   |                  |                |                |                 |                 | 0.75  |
| 11)                         | Sub-structure Component                         |                  | 12.1           |                | 38.7            |                 | 0.75  |
| 12)                         | Earth fill component                            |                  | 11.0           |                | 29.4            |                 | 0.75  |
| 12)                         | Super-Structure DL, SIDL, & Surfacing Component |                  | 29.0           |                | 128.5           |                 | 0.75  |
| 13)                         | Dynamic Earth Pressure LWL                      |                  |                |                |                 |                 | 0.75  |
| 13.1)                       | LWL Seismic Downward_O/S                        |                  |                |                |                 |                 | 0.75  |
|                             | Horizontal Component                            |                  | 19.8           |                | 54.6            |                 | 0.75  |
|                             | Vertical Component                              | 7.2              |                |                | -28.2           |                 | 0.75  |
| <b>Seismic Transverses</b>  |   |                  |                |                |                 |                 | 0.225 |
| 15)                         | Sub-structure Component                         |                  |                | 36.5           |                 | 116.3           | 0.225 |
| 17)                         | Super-Structure DL, SIDL, & Surfacing Component |                  |                | 43.6           |                 | 237.6           | 0.225 |



|                                  |                                       |         |  |     |          |      |  |       |
|----------------------------------|---------------------------------------|---------|--|-----|----------|------|--|-------|
| 18.2)                            | Live Load Component (Min. Reaction)   |         |  | 9.2 |          | 61.8 |  | 0.045 |
| <b>Seismic Vertical Downward</b> |                                       |         |  |     |          |      |  | 0.225 |
| 19)                              | Sub-structure Component               | 8.11393 |  |     | -17.9354 |      |  | 0.225 |
| 20)                              | Earthfill component                   | 7.3     |  |     | -23.1    |      |  | 0.225 |
| 21)                              | Super-Structure DL, SIDL, & Surfacing | 9.68496 |  |     | -15.2538 |      |  | 0.225 |
| 22.2)                            | Live Load Component (Min. Reaction)   | 2.04908 |  |     | -3.2273  |      |  | 0.045 |

| S.N. | Description                            | Forces about toe |                |                |                       |                       |                       |                       |
|------|--|------------------|----------------|----------------|-----------------------|-----------------------|-----------------------|-----------------------|
|      |  | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT(Dest)</sub> | M <sub>TT(Steb)</sub> | M <sub>LL(Dest)</sub> | M <sub>LL(Steb)</sub> |
|      |  | Tonne            | Tonne          | Tonne          | Tm                    | Tm                    | Tm                    | Tm                    |
| LC-5 | SIS,LWL, Span dislodge ,Seismic Sx=1,S | 426.204          | 155.402        | 18.4363        | 419.801               | -1143.83              | 82.4117               | 0                     |

| LC-6                             | SIS, LWL,Span dislodge ,Seismic Sx=1,S          | Forces about toe |                |                |                 |                 |  | LC-6   |
|----------------------------------|---|------------------|----------------|----------------|-----------------|-----------------|--|--------|
| S.N.                             | Description                                     | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |  |        |
|                                  |   | Tonne            | Tonne          | Tonne          | Tm              | Tm              |  |        |
| 1)                               | Sub-structure & Foundation                      | 236.7            |                |                | -507.8          | 0.0             |  | 0.95   |
| 2)                               | Backfill  | 162.1            |                |                | -511.8          | 0.0             |  | 0.95   |
| 9.1)                             | Earth Pressure LWL (O/S)                        |                  |                |                |                 |                 |  | 1      |
|                                  | Horizontal Component                            |                  | 101.5          |                | 231.4           |                 |  | 1      |
|                                  | Vertical Component                              | 36.2             |                |                | -141.2          |                 |  | 1      |
| <b>Seismic Longitudinal</b>      |   |                  |                |                |                 |                 |  | 0.75   |
| 11)                              | Sub-structure Component                         |                  | 12.1           |                | 38.7            |                 |  | 0.75   |
| 12)                              | Earth fill component                            |                  | 11.0           |                | 29.4            |                 |  | 0.75   |
| 12)                              | Super-Structure DL, SIDL, & Surfacing Component |                  | 29.0           |                | 128.5           |                 |  | 0.75   |
| 13)                              | Dynamic Earth Pressure LWL                      |                  |                |                |                 |                 |  | 0.75   |
| 13.2)                            | LWL Seismic Upward_O/S                          |                  |                |                |                 |                 |  | 0.75   |
|                                  | Horizontal Component                            |                  | 10.8           |                | 29.7            |                 |  | 0.75   |
|                                  | Vertical Component                              | 3.9              |                |                | -15.3           |                 |  | 0.75   |
| <b>Seismic Transveres</b>        |   |                  |                |                |                 |                 |  | 0.225  |
| 15)                              | Sub-structure Component                         |                  |                | 36.5           |                 | 116.3           |  | 0.225  |
| 17)                              | Super-Structure DL, SIDL, & Surfacing Component |                  |                | 43.6           |                 | 237.6           |  | 0.225  |
| 18.2)                            | Live Load Component (Min. Reaction)             |                  |                | 9.2            |                 | 61.8            |  | 0.045  |
| <b>Seismic Vertical Downward</b> |   |                  |                |                |                 |                 |  | 0.225  |
| 19)                              | Sub-structure Component                         | 8.11393          |                |                | -17.9354        |                 |  | -0.225 |
| 21)                              | Super-Structure DL, SIDL, & Surfacing           | 9.68496          |                |                | -15.2538        |                 |  | -0.225 |
| 22.2)                            | Live Load Component (Min. Reaction)             | 2.04908          |                |                | -3.2273         |                 |  | -0.045 |

| S.N. | Description                            | Forces about toe |                |                |                       |                       |                       |                       |
|------|--|------------------|----------------|----------------|-----------------------|-----------------------|-----------------------|-----------------------|
|      |  | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT(Dest)</sub> | M <sub>TT(Steb)</sub> | M <sub>LL(Dest)</sub> | M <sub>LL(Steb)</sub> |
|      |  | Tonne            | Tonne          | Tonne          | Tm                    | Tm                    | Tm                    | Tm                    |
| LC-6 | SIS, LWL,Span dislodge ,Seismic Sx=1,S | 413.891          | 148.613        | 18.4363        | 408.734               | -1121.38              | 82.4117               | 0                     |

| LC-7 | SIS,LWL,Min LL Acc,Seismic Sx=1,Sz= | Forces about toe |                |                |                 |                 |  | LC-7 |
|------|-------------------------------------|------------------|----------------|----------------|-----------------|-----------------|--|------|
| S.N. | Description                         | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |  |      |
|      |                                     | Tonne            | Tonne          | Tonne          | Tm              | Tm              |  |      |
| 1)   | Sub-structure & Foundation          | 236.7            |                |                | -507.8          | 0.0             |  | 0.95 |

|                                  |   |         |       |      |          |       |      |
|----------------------------------|---|---------|-------|------|----------|-------|------|
| 2)                               | Backfill  | 162.1   |       |      | -511.8   | 0.0   | 0.95 |
| 3)                               | Super-structure DL                              | 155.1   |       |      | -244.3   | 0.0   | 0.95 |
| 4)                               | SIDL (excluding surfacing)                      | 45.8    |       |      | -72.2    | 0.0   | 0.95 |
| 5)                               | Surfacing                                       | 13.3    |       |      | -21.0    | -3.3  | 1    |
| 6.2)                             | Live Load Vertical Load Min Reaction            | 45.3    |       |      | -71.4    | 131.9 | 0.2  |
| 7)                               | Live Load Horizontal Forces                     |         | 26.6  |      | 117.9    |       | 0.2  |
| 9.1)                             | Earth Pressure LWL (O/S)                        |         |       |      |          |       | 1    |
|                                  | Horizontal Component                            |         | 101.5 |      | 231.4    |       | 1    |
|                                  | Vertical Component                              | 36.2    |       |      | -141.2   |       | 1    |
| <b>Seismic Longitudinal</b>      |   |         |       |      |          |       | 1.5  |
| 11)                              | Sub-structure Component                         |         | 12.1  |      | 38.7     |       | 1.5  |
| 12)                              | Earth fill component                            |         | 11.0  |      | 29.4     |       | 1.5  |
| 12)                              | Super-Structure DL, SIDL, & Surfacing Component |         | 29.0  |      | 128.5    |       | 1.5  |
| 13)                              | Dynamic Earth Pressure LWL                      |         |       |      |          |       | 1.5  |
| 13.1)                            | LWL Seismic Downward_O/S                        |         |       |      |          |       | 1.5  |
|                                  | Horizontal Component                            |         | 19.8  |      | 54.6     |       | 1.5  |
|                                  | Vertical Component                              | 7.2     |       |      | -28.2    |       | 1.5  |
| <b>Seismic Transverses</b>       |   |         |       |      |          |       | 0.45 |
| 15)                              | Sub-structure Component                         |         |       | 36.5 |          | 116.3 | 0.45 |
| 17)                              | Super-Structure DL, SIDL, & Surfacing Component |         |       | 43.6 |          | 237.6 | 0.45 |
| 18.2)                            | Live Load Component (Min. Reaction)             |         |       | 9.2  |          | 61.8  | 0.09 |
| <b>Seismic Vertical Downward</b> |   |         |       |      |          |       | 0.45 |
| 19)                              | Sub-structure Component                         | 8.11393 |       |      | -17.9354 |       | 0.45 |
| 20)                              | Earthfill component                             | 7.3     |       |      | -23.1    |       | 0.45 |
| 21)                              | Super-Structure DL, SIDL, & Surfacing           | 9.68496 |       |      | -15.2538 |       | 0.45 |
| 22.2)                            | Live Load Component (Min. Reaction)             | 2.04908 |       |      | -3.2273  |       | 0.09 |

| S.N. | Description                         | Forces about toe |                |                |                       |                       |                       |                       |
|------|-------------------------------------|------------------|----------------|----------------|-----------------------|-----------------------|-----------------------|-----------------------|
|      |                                     | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT(Dest)</sub> | M <sub>TT(Steb)</sub> | M <sub>LL(Dest)</sub> | M <sub>LL(Steb)</sub> |
|      |                                     | Tonne            | Tonne          | Tonne          | Tm                    | Tm                    | Tm                    | Tm                    |
| LC-7 | SIS,LWL,Min LL Acc,Seismic Sx=1,Sz= | 650.652          | 214.655        | 36.8726        | 631.742               | -1513.69              | 191.207               | -3.33145              |

| S.N.                        | Description                                     | Forces about toe |                |                |                 |                 | LC-8 |
|-----------------------------|---|------------------|----------------|----------------|-----------------|-----------------|------|
|                             |   | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |      |
|                             |   | Tonne            | Tonne          | Tonne          | Tm              | Tm              |      |
| 1)                          | Sub-structure & Foundation                      | 236.7            |                |                | -507.8          | 0.0             | 0.95 |
| 2)                          | Backfill  | 162.1            |                |                | -511.8          | 0.0             | 0.95 |
| 3)                          | Super-structure DL                              | 155.1            |                |                | -244.3          | 0.0             | 0.95 |
| 4)                          | SIDL (excluding surfacing)                      | 45.8             |                |                | -72.2           | 0.0             | 0.95 |
| 5)                          | Surfacing                                       | 13.3             |                |                | -21.0           | -3.3            | 1    |
| 6.2)                        | Live Load Vertical Load Min Reaction            | 45.3             |                |                | -71.4           | 131.9           | 0.2  |
| 7)                          | Live Load Horizontal Forces                     |                  | 26.6           |                | 117.9           |                 | 0.2  |
| 9.1)                        | Earth Pressure LWL (O/S)                        |                  |                |                |                 |                 | 1    |
|                             | Horizontal Component                            |                  | 101.5          |                | 231.4           |                 | 1    |
|                             | Vertical Component                              | 36.2             |                |                | -141.2          |                 | 1    |
| <b>Seismic Longitudinal</b> |   |                  |                |                |                 |                 | 1.5  |
| 11)                         | Sub-structure Component                         |                  | 12.1           |                | 38.7            |                 | 1.5  |
| 12)                         | Earth fill component                            |                  | 11.0           |                | 29.4            |                 | 1.5  |
| 12)                         | Super-Structure DL, SIDL, & Surfacing Component |                  | 29.0           |                | 128.5           |                 | 1.5  |
| 13)                         | Dynamic Earth Pressure LWL                      |                  |                |                |                 |                 | 1.5  |

|   |         |      |      |          |       |  |       |
|---|---------|------|------|----------|-------|--|-------|
| 13.2) LWL Seismic Upward_O/S                        |         |      |      |          |       |  | 1.5   |
| Horizontal Component                                |         | 10.8 |      | 29.7     |       |  | 1.5   |
| Vertical Component                                  | 3.9     |      |      | -15.3    |       |  | 1.5   |
| <b>Seismic Transverses</b>                          |         |      |      |          |       |  |       |
| 15) Sub-structure Component                         |         |      | 36.5 |          | 116.3 |  | 0.45  |
| 17) Super-Structure DL, SIDL, & Surfacing Component |         |      | 43.6 |          | 237.6 |  | 0.45  |
| 18.2) Live Load Component (Min. Reaction)           |         |      | 9.2  |          | 61.8  |  | 0.09  |
| <b>Seismic Vertical Downward</b>                    |         |      |      |          |       |  |       |
| 19) Sub-structure Component                         | 8.11393 |      |      | -17.9354 |       |  | -0.45 |
| 21) Super-Structure DL, SIDL, & Surfacing           | 9.68496 |      |      | -15.2538 |       |  | -0.45 |
| 22.2) Live Load Component (Min. Reaction)           | 2.04908 |      |      | -3.2273  |       |  | -0.09 |

| S.N. | Description                             | Forces about toe |                |                |                        |                        |                        |                        |
|------|---|------------------|----------------|----------------|------------------------|------------------------|------------------------|------------------------|
|      |   | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> (Dest) | M <sub>TT</sub> (Steb) | M <sub>LL</sub> (Dest) | M <sub>LL</sub> (Steb) |
|      |   | Tonne            | Tonne          | Tonne          | Tm                     | Tm                     | Tm                     | Tm                     |
| LC-8 | SIS, LWL, Min LL Acc, Seismic Sx=1, Sz= | 626.026          | 201.076        | 36.8726        | 609.609                | -1468.79               | 191.207                | -3.33145               |

| S.N.  | Description                 | Forces about toe |                |                |                 |                 | LC-9 |
|-------|-----------------------------|------------------|----------------|----------------|-----------------|-----------------|------|
|       |                             | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |      |
|       |                             | Tonne            | Tonne          | Tonne          | Tm              | Tm              |      |
| 1)    | Sub-structure & Foundation  | 236.7            |                |                | -507.8          | 0.0             | 0.95 |
| 2)    | Backfill                    | 162.1            |                |                | -511.8          | 0.0             | 0.95 |
| 8)    | Buoyancy                    | -10.6            |                |                | 9.1             | 0.0             | 1    |
| 9.1)  | Earth Pressure HFL (O/S)    |                  |                |                |                 |                 | 1.5  |
|       | Horizontal Component        |                  | 101.5          |                | 231.4           |                 | 1.5  |
|       | Vertical Component          | 36.2             |                |                | -141.2          |                 | 1.5  |
| 10.1) | Surcharge Pressure HFL(O/S) |                  | 47.1           |                | 129.4           |                 | 1.2  |

| S.N. | Description                | Forces about toe |                |                |                        |                        |                        |                        |
|------|----------------------------|------------------|----------------|----------------|------------------------|------------------------|------------------------|------------------------|
|      |                            | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> (Dest) | M <sub>TT</sub> (Steb) | M <sub>LL</sub> (Dest) | M <sub>LL</sub> (Steb) |
|      |                            | Tonne            | Tonne          | Tonne          | Tm                     | Tm                     | Tm                     | Tm                     |
| LC-9 | NS, HFL, Span dislodge, EP | 422.592          | 208.693        | 0              | 511.545                | -1180.52               | 0                      | 0                      |

| S.N. | Description                          | Forces about toe |                |                |                 |                 | LC-10 |
|------|--------------------------------------|------------------|----------------|----------------|-----------------|-----------------|-------|
|      |                                      | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |       |
|      |                                      | Tonne            | Tonne          | Tonne          | Tm              | Tm              |       |
| 1)   | Sub-structure & Foundation           | 236.7            |                |                | -507.8          | 0.0             | 0.95  |
| 2)   | Backfill                             | 162.1            |                |                | -511.8          | 0.0             | 0.95  |
| 3)   | Super-structure DL                   | 155.1            |                |                | -244.3          | 0.0             | 0.95  |
| 4)   | SIDL (excluding surfacing)           | 45.8             |                |                | -72.2           | 0.0             | 0.95  |
| 5)   | Surfacing                            | 13.3             |                |                | -21.0           | -3.3            | 1     |
| 6.2) | Live Load Vertical Load Min Reaction | 45.3             |                |                | -71.4           | 131.9           | 1.5   |
| 7)   | Live Load Horizontal Forces          |                  | 26.6           |                | 117.9           |                 | 1.5   |
| 8)   | Buoyancy                             | -10.6            |                |                | 9.1             | 0.0             | 1     |
| 9.1) | Earth Pressure HFL (O/S)             |                  |                |                |                 |                 | 1.5   |
|      | Horizontal Component                 |                  | 101.5          |                | 231.4           |                 | 1.5   |

|       |                             |      |      |  |        |  |  |     |
|-------|-----------------------------|------|------|--|--------|--|--|-----|
| 10.1) | Vertical Component          | 36.2 |      |  | -141.2 |  |  | 1.5 |
|       | Surcharge Pressure HFL(O/S) |      | 47.1 |  | 129.4  |  |  | 1.2 |

| S.N.  | Description              | Forces about toe |                |                |                       |                       |                       |                       |
|-------|--------------------------|------------------|----------------|----------------|-----------------------|-----------------------|-----------------------|-----------------------|
|       |                          | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT(Dest)</sub> | M <sub>TT(Steb)</sub> | M <sub>LL(Dest)</sub> | M <sub>LL(Steb)</sub> |
|       |                          | Tonne            | Tonne          | Tonne          | Tm                    | Tm                    | Tm                    | Tm                    |
| LC-10 | NS, HFL, Min LL Lead, EP | 694.813          | 248.581        | 0              | 688.446               | -1609.26              | 197.88                | -3.33145              |

| S.N.                             | Description                                     | Forces about toe |                |                |                 |                 | LC-11 |
|----------------------------------|---|------------------|----------------|----------------|-----------------|-----------------|-------|
|                                  |   | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |       |
|                                  |   | Tonne            | Tonne          | Tonne          | Tm              | Tm              |       |
| 1)                               | Sub-structure & Foundation                      | 236.7            |                |                | -507.8          | 0.0             | 0.95  |
| 2)                               | Backfill  | 162.1            |                |                | -511.8          | 0.0             | 0.95  |
| 8)                               | Buoyancy  | -10.6            |                |                | 9.1             | 0.0             | 1     |
| 9.1)                             | Earth Pressure HFL (O/S)                        |                  |                |                |                 |                 | 1     |
|                                  | Horizontal Component                            |                  | 101.5          |                | 231.4           |                 | 1     |
|                                  | Vertical Component                              | 36.2             |                |                | -141.2          |                 | 1     |
| <b>Seismic Longitudinal</b>      |   |                  |                |                |                 |                 | 0.75  |
| 11)                              | Sub-structure Component                         |                  | 12.1           |                | 38.7            |                 | 0.75  |
| 12)                              | Earth fill component                            |                  | 11.0           |                | 29.4            |                 | 0.75  |
| 12)                              | Super-Structure DL, SIDL, & Surfacing Component |                  | 29.0           |                | 128.5           |                 | 0.75  |
| 13)                              | Dynamic Earth Pressure HFL                      |                  |                |                |                 |                 | 0.75  |
| 13.1)                            | HFL Seismic Downward_O/S                        |                  |                |                |                 |                 | 0.75  |
|                                  | Horizontal Component                            |                  | 19.8           |                | 54.6            |                 | 0.75  |
|                                  | Vertical Component                              | 7.2              |                |                | -28.2           |                 | 0.75  |
| <b>Seismic Transveres</b>        |   |                  |                |                |                 |                 | 0.225 |
| 15)                              | Sub-structure Component                         |                  |                | 36.5           |                 | 116.3           | 0.225 |
| 17)                              | Super-Structure DL, SIDL, & Surfacing Component |                  |                | 43.6           |                 | 237.6           | 0.225 |
| 18.2)                            | Live Load Component (Min. Reaction)             |                  |                | 9.2            |                 | 61.8            | 0.045 |
| <b>Seismic Vertical Downward</b> |   |                  |                |                |                 |                 | 0.225 |
| 19)                              | Sub-structure Component                         | 8.11393          |                |                | -17.9354        |                 | 0.225 |
| 20)                              | Earthfill component                             | 7.3              |                |                | -23.1           |                 | 0.225 |
| 21)                              | Super-Structure DL, SIDL, & Surfacing           | 9.68496          |                |                | -15.2538        |                 | 0.225 |
| 22.2)                            | Live Load Component (Min. Reaction)             | 2.04908          |                |                | -3.2273         |                 | 0.045 |

| S.N.  | Description                            | Forces about toe |                |                |                       |                       |                       |                       |
|-------|--|------------------|----------------|----------------|-----------------------|-----------------------|-----------------------|-----------------------|
|       |  | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT(Dest)</sub> | M <sub>TT(Steb)</sub> | M <sub>LL(Dest)</sub> | M <sub>LL(Steb)</sub> |
|       |  | Tonne            | Tonne          | Tonne          | Tm                    | Tm                    | Tm                    | Tm                    |
| LC-11 | SIS,HFL, Span dislodge ,Seismic Sx=1,S | 415.644          | 155.402        | 18.4363        | 428.927               | -1143.83              | 82.4117               | 0                     |

| S.N. | Description                | Forces about toe |                |                |                 |                 | LC-12 |
|------|----------------------------|------------------|----------------|----------------|-----------------|-----------------|-------|
|      |                            | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |       |
|      |                            | Tonne            | Tonne          | Tonne          | Tm              | Tm              |       |
| 1)   | Sub-structure & Foundation | 236.7            |                |                | -507.8          | 0.0             | 0.95  |
| 2)   | Backfill                   | 162.1            |                |                | -511.8          | 0.0             | 0.95  |
| 8)   | Buoyancy                   | -10.6            |                |                | 9.1             | 0.0             | 1     |

|                                  |   |         |       |      |          |       |        |
|----------------------------------|---|---------|-------|------|----------|-------|--------|
| 9.1)                             | Earth Pressure HFL (O/S)                        |         |       |      |          |       | 1      |
|                                  | Horizontal Component                            |         | 101.5 |      | 231.4    |       | 1      |
|                                  | Vertical Component                              | 36.2    |       |      | -141.2   |       | 1      |
| <b>Seismic Longitudinal</b>      |   |         |       |      |          |       | 0.75   |
| 11)                              | Sub-structure Component                         |         | 12.1  |      | 38.7     |       | 0.75   |
| 12)                              | Earth fill component                            |         | 11.0  |      | 29.4     |       | 0.75   |
| 12)                              | Super-Structure DL, SIDL, & Surfacing Component |         | 29.0  |      | 128.5    |       | 0.75   |
| 13)                              | Dynamic Earth Pressure HFL                      |         |       |      |          |       | 0.75   |
|                                  | 13.2) HFL Seismic Upward_O/S                    |         |       |      |          |       | 0.75   |
|                                  | Horizontal Component                            |         | 10.8  |      | 29.7     |       | 0.75   |
|                                  | Vertical Component                              | 3.9     |       |      | -15.3    |       | 0.75   |
| <b>Seismic Transverses</b>       |   |         |       |      |          |       | 0.225  |
| 15)                              | Sub-structure Component                         |         |       | 36.5 |          | 116.3 | 0.225  |
| 17)                              | Super-Structure DL, SIDL, & Surfacing Component |         |       | 43.6 |          | 237.6 | 0.225  |
| 18.2)                            | Live Load Component (Min. Reaction)             |         |       | 9.2  |          | 61.8  | 0.045  |
| <b>Seismic Vertical Downward</b> |   |         |       |      |          |       | 0.225  |
| 19)                              | Sub-structure Component                         | 8.11393 |       |      | -17.9354 |       | -0.225 |
| 21)                              | Super-Structure DL, SIDL, & Surfacing           | 9.68496 |       |      | -15.2538 |       | -0.225 |
| 22.2)                            | Live Load Component (Min. Reaction)             | 2.04908 |       |      | -3.2273  |       | -0.045 |

| S.N.  | Description                               | Forces about toe |                         |                         |                             |                             |                             |                             |
|-------|---|------------------|-------------------------|-------------------------|-----------------------------|-----------------------------|-----------------------------|-----------------------------|
|       |   | V<br>Tonne       | H <sub>L</sub><br>Tonne | H <sub>T</sub><br>Tonne | M <sub>TT(Dest)</sub><br>Tm | M <sub>TT(Steb)</sub><br>Tm | M <sub>LL(Dest)</sub><br>Tm | M <sub>LL(Steb)</sub><br>Tm |
| LC-12 | SIS, HFL, Span dislodge ,Seismic Sx=1,Sz= | 403.331          | 148.613                 | 18.4363                 | 417.86                      | -1121.38                    | 82.4117                     | 0                           |

| S.N.                        | Description                                     | Forces about toe |                         |                         |                       |                       | LC-13 |
|-----------------------------|---|------------------|-------------------------|-------------------------|-----------------------|-----------------------|-------|
|                             |   | V<br>Tonne       | H <sub>L</sub><br>Tonne | H <sub>T</sub><br>Tonne | M <sub>TT</sub><br>Tm | M <sub>LL</sub><br>Tm |       |
| 1)                          | Sub-structure & Foundation                      | 236.7            |                         |                         | -507.8                | 0.0                   | 0.95  |
| 2)                          | Backfill  | 162.1            |                         |                         | -511.8                | 0.0                   | 0.95  |
| 3)                          | Super-structure DL                              | 155.1            |                         |                         | -244.3                | 0.0                   | 0.95  |
| 4)                          | SIDL (excluding surfacing)                      | 45.8             |                         |                         | -72.2                 | 0.0                   | 0.95  |
| 5)                          | Surfacing                                       | 13.3             |                         |                         | -21.0                 | -3.3                  | 1     |
| 6.2)                        | Live Load Vertical Load Min Reaction            | 45.3             |                         |                         | -71.4                 | 131.9                 | 0.2   |
| 7)                          | Live Load Horizontal Forces                     |                  | 26.6                    |                         | 117.9                 |                       | 0.2   |
| 8)                          | Buoyancy  | -10.6            |                         |                         | 9.1                   | 0.0                   | 1     |
| 9.1)                        | Earth Pressure HFL (O/S)                        |                  |                         |                         |                       |                       | 1     |
|                             | Horizontal Component                            |                  | 101.5                   |                         | 231.4                 |                       | 1     |
|                             | Vertical Component                              | 36.2             |                         |                         | -141.2                |                       | 1     |
| <b>Seismic Longitudinal</b> |   |                  |                         |                         |                       |                       | 1.5   |
| 11)                         | Sub-structure Component                         |                  | 12.1                    |                         | 38.7                  |                       | 1.5   |
| 12)                         | Earth fill component                            |                  | 11.0                    |                         | 29.4                  |                       | 1.5   |
| 12)                         | Super-Structure DL, SIDL, & Surfacing Component |                  | 29.0                    |                         | 128.5                 |                       | 1.5   |
| 13)                         | Dynamic Earth Pressure HFL                      |                  |                         |                         |                       |                       | 1.5   |
|                             | 13.1) HFL Seismic Downward_O/S                  |                  |                         |                         |                       |                       | 1.5   |
|                             | Horizontal Component                            |                  | 19.8                    |                         | 54.6                  |                       | 1.5   |
|                             | Vertical Component                              | 7.2              |                         |                         | -28.2                 |                       | 1.5   |
| <b>Seismic Transverses</b>  |   |                  |                         |                         |                       |                       | 0.45  |
| 15)                         | Sub-structure Component                         |                  |                         | 36.5                    |                       | 116.3                 | 0.45  |
| 17)                         | Super-Structure DL, SIDL, & Surfacing Component |                  |                         | 43.6                    |                       | 237.6                 | 0.45  |

|                                  |                                       |         |  |     |          |      |  |      |
|----------------------------------|---------------------------------------|---------|--|-----|----------|------|--|------|
| 18.2)                            | Live Load Component (Min. Reaction)   |         |  | 9.2 |          | 61.8 |  | 0.09 |
| <b>Seismic Vertical Downward</b> |                                       |         |  |     |          |      |  | 0.45 |
| 19)                              | Sub-structure Component               | 8.11393 |  |     | -17.9354 |      |  | 0.45 |
| 20)                              | Earthfill component                   | 7.3     |  |     | -23.1    |      |  | 0.45 |
| 21)                              | Super-Structure DL, SIDL, & Surfacing | 9.68496 |  |     | -15.2538 |      |  | 0.45 |
| 22.2)                            | Live Load Component (Min. Reaction)   | 2.04908 |  |     | -3.2273  |      |  | 0.09 |

| S.N.  | Description                         | Forces about toe |                |                |                       |                       |                       |                       |
|-------|-------------------------------------|------------------|----------------|----------------|-----------------------|-----------------------|-----------------------|-----------------------|
|       |                                     | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT(Dest)</sub> | M <sub>TT(Steb)</sub> | M <sub>LL(Dest)</sub> | M <sub>LL(Steb)</sub> |
|       |                                     | Tonne            | Tonne          | Tonne          | Tm                    | Tm                    | Tm                    | Tm                    |
| LC-13 | SIS,HFL,Min LL Acc,Seismic Sx=1,Sz= | 640.092          | 214.655        | 36.8726        | 640.868               | -1513.69              | 191.207               | -3.33145              |

| S.N.                             | Description                                     | Forces about toe |                |                |                 |                 | LC-14 |
|----------------------------------|---|------------------|----------------|----------------|-----------------|-----------------|-------|
|                                  |   | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |       |
|                                  |   | Tonne            | Tonne          | Tonne          | Tm              | Tm              |       |
| 1)                               | Sub-structure & Foundation                      | 236.7            |                |                | -507.8          | 0.0             | 0.95  |
| 2)                               | Backfill  | 162.1            |                |                | -511.8          | 0.0             | 0.95  |
| 3)                               | Super-structure DL                              | 155.1            |                |                | -244.3          | 0.0             | 0.95  |
| 4)                               | SIDL (excluding surfacing)                      | 45.8             |                |                | -72.2           | 0.0             | 0.95  |
| 5)                               | Surfacing                                       | 13.3             |                |                | -21.0           | -3.3            | 1     |
| 6.2)                             | Live Load Vertical Load Min Reaction            | 45.3             |                |                | -71.4           | 131.9           | 0.2   |
| 7)                               | Live Load Horizontal Forces                     |                  | 26.6           |                | 117.9           |                 | 0.2   |
| 8)                               | Buoyancy  | -10.6            |                |                | 9.1             | 0.0             | 1     |
| 9.1)                             | Earth Pressure HFL (O/S)                        |                  |                |                |                 |                 | 1     |
|                                  | Horizontal Component                            |                  | 101.5          |                | 231.4           |                 | 1     |
|                                  | Vertical Component                              | 36.2             |                |                | -141.2          |                 | 1     |
| <b>Seismic Longitudinal</b>      |   |                  |                |                |                 |                 | 1.5   |
| 11)                              | Sub-structure Component                         |                  | 12.1           |                | 38.7            |                 | 1.5   |
| 12)                              | Earth fill component                            |                  | 11.0           |                | 29.4            |                 | 1.5   |
| 12)                              | Super-Structure DL, SIDL, & Surfacing Component |                  | 29.0           |                | 128.5           |                 | 1.5   |
| 13)                              | Dynamic Earth Pressure HFL                      |                  |                |                |                 |                 | 1.5   |
| 13.2)                            | HFL Seismic Upward_O/S                          |                  |                |                |                 |                 | 1.5   |
|                                  | Horizontal Component                            |                  | 10.8           |                | 29.7            |                 | 1.5   |
|                                  | Vertical Component                              | 3.9              |                |                | -15.3           |                 | 1.5   |
| <b>Seismic Transveres</b>        |   |                  |                |                |                 |                 | 0.45  |
| 15)                              | Sub-structure Component                         |                  |                | 36.5           |                 | 116.3           | 0.45  |
| 17)                              | Super-Structure DL, SIDL, & Surfacing Component |                  |                | 43.6           |                 | 237.6           | 0.45  |
| 18.2)                            | Live Load Component (Min. Reaction)             |                  |                | 9.2            |                 | 61.8            | 0.09  |
| <b>Seismic Vertical Downward</b> |   |                  |                |                |                 |                 | 0.45  |
| 19)                              | Sub-structure Component                         | 8.11393          |                |                | -17.9354        |                 | -0.45 |
| 21)                              | Super-Structure DL, SIDL, & Surfacing           | 9.68496          |                |                | -15.2538        |                 | -0.45 |
| 22.2)                            | Live Load Component (Min. Reaction)             | 2.04908          |                |                | -3.2273         |                 | -0.09 |

| S.N.  | Description                          | Forces about toe |                |                |                       |                       |                       |                       |
|-------|--------------------------------------|------------------|----------------|----------------|-----------------------|-----------------------|-----------------------|-----------------------|
|       |                                      | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT(Dest)</sub> | M <sub>TT(Steb)</sub> | M <sub>LL(Dest)</sub> | M <sub>LL(Steb)</sub> |
|       |                                      | Tonne            | Tonne          | Tonne          | Tm                    | Tm                    | Tm                    | Tm                    |
| LC-14 | SIS, HFL,Min LL Acc,Seismic Sx=1,Sz= | 615.466          | 201.076        | 36.8726        | 618.735               | -1468.79              | 191.207               | -3.33145              |

**VERIFICATION of EQUILIBRIUM (OVERTURNING & SLIDING):**

$$FOS|_{\text{sliding}} = \frac{(\mu \cdot \Sigma V + \Sigma H_{\text{restoring}})}{\Sigma H_{\text{sliding}}} \geq 1$$

$$\mu = 0.80$$

$$FOS|_{\text{overturning}} = \frac{\Sigma M_{\text{restoring}}}{\Sigma M_{\text{overturning}}} \geq 1$$

**SUMMARY OF FORCES:**

| S.N.  | Description                            | Forces about toe |                         |                         |                             |                             |                             |                             |
|-------|--|------------------|-------------------------|-------------------------|-----------------------------|-----------------------------|-----------------------------|-----------------------------|
|       |  | V<br>Tonne       | H <sub>L</sub><br>Tonne | H <sub>T</sub><br>Tonne | M <sub>TT(Dest)</sub><br>Tm | M <sub>TT(Steb)</sub><br>Tm | M <sub>LL(Dest)</sub><br>Tm | M <sub>LL(Steb)</sub><br>Tm |
| LC-1  | NS, LWL, Span dislodge, FP             | 378.828          | 56.535                  | 0                       | 155.251                     | -968.651                    | 0                           | 0                           |
| LC-2  | NS, LWL, Span dislodge, EP             | 433.152          | 208.693                 | 0                       | 502.419                     | -1180.52                    | 0                           | 0                           |
| LC-3  | NS, LWL, Min LL Lead, FP               | 651.048          | 96.4226                 | 0                       | 332.153                     | -1397.4                     | 197.88                      | -3.33145                    |
| LC-4  | NS, LWL, Min LL Lead, EP               | 705.373          | 248.581                 | 0                       | 679.32                      | -1609.26                    | 197.88                      | -3.33145                    |
|       |  |                  |                         |                         |                             |                             |                             |                             |
| LC-5  | SIS,LWL, Span dislodge ,Seismic Sx=1,S | 426.204          | 155.402                 | 18.4363                 | 419.801                     | -1143.83                    | 82.4117                     | 0                           |
| LC-6  | SIS, LWL,Span dislodge ,Seismic Sx=1,S | 413.891          | 148.613                 | 18.4363                 | 408.734                     | -1121.38                    | 82.4117                     | 0                           |
| LC-7  | SIS,LWL,Min LL Acc,Seismic Sx=1,Sz=    | 650.652          | 214.655                 | 36.8726                 | 631.742                     | -1513.69                    | 191.207                     | -3.33145                    |
| LC-8  | SIS, LWL,Min LL Acc,Seismic Sx=1,Sz=   | 626.026          | 201.076                 | 36.8726                 | 609.609                     | -1468.79                    | 191.207                     | -3.33145                    |
|       |  |                  |                         |                         |                             |                             |                             |                             |
| LC-9  | NS, HFL, Span dislodge, EP             | 422.592          | 208.693                 | 0                       | 511.545                     | -1180.52                    | 0                           | 0                           |
| LC-10 | NS, HFL, Min LL Lead, EP               | 694.813          | 248.581                 | 0                       | 688.446                     | -1609.26                    | 197.88                      | -3.33145                    |
|       |  |                  |                         |                         |                             |                             |                             |                             |
| LC-11 | SIS,HFL, Span dislodge ,Seismic Sx=1,S | 415.644          | 155.402                 | 18.4363                 | 428.927                     | -1143.83                    | 82.4117                     | 0                           |
| LC-12 | SIS, HFL,Span dislodge ,Seismic Sx=1,S | 403.331          | 148.613                 | 18.4363                 | 417.86                      | -1121.38                    | 82.4117                     | 0                           |
| LC-13 | SIS,HFL,Min LL Acc,Seismic Sx=1,Sz=    | 640.092          | 214.655                 | 36.8726                 | 640.868                     | -1513.69                    | 191.207                     | -3.33145                    |
| LC-14 | SIS, HFL,Min LL Acc,Seismic Sx=1,Sz=   | 615.466          | 201.076                 | 36.8726                 | 618.735                     | -1468.79                    | 191.207                     | -3.33145                    |
|       |  |                  |                         |                         |                             |                             |                             |                             |

| Along Long. Dir <sup>n</sup> |       |
|------------------------------|-------|
| FOS<br> <br>sliding          | Check |
| 5.36                         | OK    |
| 1.66                         | OK    |
| 5.40                         | OK    |
| 2.27                         | OK    |
| 2.19                         | OK    |
| 2.23                         | OK    |
| 2.42                         | OK    |
| 2.49                         | OK    |
| 1.62                         | OK    |
| 2.24                         | OK    |
| 2.14                         | OK    |
| 2.17                         | OK    |
| 2.39                         | OK    |
| 2.45                         | OK    |





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LOAD COMBINATION  
FOR FOOTING DESIGN

| LC-1  | NS, LWL, Span dislodge, FP     | Forces about toe |                |                |                 |                 |  | LC-1 |
|-------|--------------------------------|------------------|----------------|----------------|-----------------|-----------------|--|------|
| S.N.  | Description                    | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |  |      |
|       |                                | Tonne            | Tonne          | Tonne          | Tm              | Tm              |  |      |
| 1)    | Sub-structure & Foundation     | 236.7            |                |                | -507.8          | 0.0             |  | 1    |
| 2)    | Backfill                       | 162.1            |                |                | -511.8          | 0.0             |  | 1    |
| 9)    | Fluid Pressure                 |                  | 0.03           |                | 0.00            |                 |  | 1    |
| 10.3) | Surcharge Pressure LWL(BP, SD) |                  | 47.1           |                | 129.4           |                 |  | 1    |

| S.N. | Description                | Forces about toe |                |                |                 |                 |
|------|----------------------------|------------------|----------------|----------------|-----------------|-----------------|
|      |                            | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|      |                            | Tonne            | Tonne          | Tonne          | Tm              | Tm              |
| LC-1 | NS, LWL, Span dislodge, FP | 398.766          | 47.11          | 0              | -890.257        | 0               |

| LC-2        | NS, LWL, Span dislodge, EP     | Forces about toe |                |                |                 |                 |  | LC-2 |
|-------------|--------------------------------|------------------|----------------|----------------|-----------------|-----------------|--|------|
| S.N.        | Description                    | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |  |      |
|             |                                | Tonne            | Tonne          | Tonne          | Tm              | Tm              |  |      |
| 1)          | Sub-structure & Foundation     | 236.7            |                |                | -507.8          | 0.0             |  | 1    |
| 2)          | Backfill                       | 162.1            |                |                | -511.8          | 0.0             |  | 1    |
| <b>9.3)</b> | Earth Pressure LWL (BP, SD)    |                  |                |                |                 |                 |  | 1    |
|             | Horizontal Component           |                  | 101.5          |                | 231.4           |                 |  | 1    |
|             | Vertical Component             | 36.2             |                |                | -86.9           |                 |  | 1    |
| 10.3)       | Surcharge Pressure LWL(BP, SD) |                  | 47.1           |                | 129.4           |                 |  | 1    |

| S.N. | Description                | Forces about toe |                |                |                 |                 |
|------|----------------------------|------------------|----------------|----------------|-----------------|-----------------|
|      |                            | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|      |                            | Tonne            | Tonne          | Tonne          | Tm              | Tm              |
| LC-2 | NS, LWL, Span dislodge, EP | 434.982          | 148.54         | 0              | -745.731        | 0               |

| LC-3 | NS, LWL, Max LL, FP                  | Forces about toe |                |                |                 |                 |  | LC-3 |
|------|--------------------------------------|------------------|----------------|----------------|-----------------|-----------------|--|------|
| S.N. | Description                          | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |  |      |
|      |                                      | Tonne            | Tonne          | Tonne          | Tm              | Tm              |  |      |
| 1)   | Sub-structure & Foundation           | 236.7            |                |                | -507.8          | 0.0             |  | 1    |
| 2)   | Backfill                             | 162.1            |                |                | -511.8          | 0.0             |  | 1    |
| 3)   | Super-structure DL                   | 155.1            |                |                | -244.3          | 0.0             |  | 1    |
| 4)   | SIDL (excluding surfacing)           | 45.8             |                |                | -72.2           | 0.0             |  | 1    |
| 5)   | Surfacing                            | 13.3             |                |                | -21.0           | -3.3            |  | 1    |
| 6.1) | Live Load Vertical Load Max Reaction | 89.9             |                |                | -141.5          | 261.5           |  | 1    |

|       |                                |  |      |  |       |  |  |   |
|-------|--------------------------------|--|------|--|-------|--|--|---|
| 7)    | Live Load Horizontal Forces    |  | 26.6 |  | 117.9 |  |  | 1 |
| 9)    | Fluid Pressure                 |  | 0.03 |  | 0.00  |  |  | 1 |
| 10.3) | Surcharge Pressure LWL(BP, SD) |  | 47.1 |  | 129.4 |  |  | 1 |

| S.N. | Description         | Forces about toe |                |                |                 |                 |
|------|---------------------|------------------|----------------|----------------|-----------------|-----------------|
|      |                     | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|      |                     | Tonne            | Tonne          | Tonne          | Tm              | Tm              |
| LC-3 | NS, LWL, Max LL, FP | 702.901          | 73.70          | 0              | -1251.33        | 258.181         |

| LC-4  | NS, LWL, Max LL, EP                  | Forces about toe |                |                |                 |                 |  | LC-4 |
|-------|--------------------------------------|------------------|----------------|----------------|-----------------|-----------------|--|------|
| S.N.  | Description                          | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |  |      |
|       |                                      | Tonne            | Tonne          | Tonne          | Tm              | Tm              |  |      |
| 1)    | Sub-structure & Foundation           | 236.7            |                |                | -507.8          | 0.0             |  | 1    |
| 2)    | Backfill                             | 162.1            |                |                | -511.8          | 0.0             |  | 1    |
| 3)    | Super-structure DL                   | 155.1            |                |                | -244.3          | 0.0             |  | 1    |
| 4)    | SIDL (excluding surfacing)           | 45.8             |                |                | -72.2           | 0.0             |  | 1    |
| 5)    | Surfacing                            | 13.3             |                |                | -21.0           | -3.3            |  | 1    |
| 6.1)  | Live Load Vertical Load Max Reaction | 89.9             |                |                | -141.5          | 261.5           |  | 1    |
| 7)    | Live Load Horizontal Forces          |                  | 26.6           |                | 117.9           |                 |  | 1    |
| 9.3)  | Earth Pressure LWL (BP, SD)          |                  |                |                |                 |                 |  | 1    |
|       | Horizontal Component                 |                  | 101.5          |                | 231.4           |                 |  | 1    |
|       | Vertical Component                   | 36.2             |                |                | -86.9           |                 |  | 1    |
| 10.3) | Surcharge Pressure LWL(BP, SD)       |                  | 47.1           |                | 129.4           |                 |  | 1    |

| S.N. | Description         | Forces about toe |                |                |                 |                 |
|------|---------------------|------------------|----------------|----------------|-----------------|-----------------|
|      |                     | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|      |                     | Tonne            | Tonne          | Tonne          | Tm              | Tm              |
| LC-4 | NS, LWL, Max LL, EP | 739.117          | 175.14         | 0              | -1106.81        | 258.181         |

| LC-5                        | SIS,LWL, Span dislodge ,Seismic Sx=1,S        | Forces about toe |                |                |                 |                 |  | LC-5 |
|-----------------------------|---|------------------|----------------|----------------|-----------------|-----------------|--|------|
| S.N.                        | Description                                   | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |  |      |
|                             |   | Tonne            | Tonne          | Tonne          | Tm              | Tm              |  |      |
| 1)                          | Sub-structure & Foundation                    | 236.7            |                |                | -507.8          | 0.0             |  | 1    |
| 2)                          | Backfill                                      | 162.1            |                |                | -511.8          | 0.0             |  | 1    |
| 9.3)                        | Earth Pressure LWL (BP, SD)                   |                  |                |                |                 |                 |  | 1    |
|                             | Horizontal Component                          |                  | 101.5          |                | 231.4           |                 |  | 1    |
|                             | Vertical Component                            | 36.2             |                |                | -86.9           |                 |  | 1    |
| 10.3)                       | Surcharge Pressure LWL(BP, SD)                |                  | 47.1           |                | 129.4           |                 |  | 0.2  |
| <b>Seismic Longitudinal</b> |   |                  |                |                |                 |                 |  | 0.5  |
| 11)                         | Sub-structure Component                       |                  | 12.1           |                | 38.7            |                 |  | 0.5  |
| 12)                         | Earth fill component                          |                  | 11.0           |                | 29.4            |                 |  | 0.5  |
| 12)                         | Super-Structure DL, SIDL, & Surfacing Compone |                  | 29.0           |                | 128.5           |                 |  | 0.5  |
| 13)                         | Dynamic Earth Pressure LWL                    |                  |                |                |                 |                 |  | 0.5  |

|                                  |   |         |      |      |          |       |      |
|----------------------------------|---|---------|------|------|----------|-------|------|
| 13)                              | 13.5)LWL Seismic Downward_BP/SD                 |         |      |      |          |       | 0.5  |
|                                  | Horizontal Component                            |         | 19.8 |      | 54.6     |       | 0.5  |
|                                  | Vertical Component                              | 7.2     |      |      | -17.3    |       | 0.5  |
| 14)                              | 14.2) Dynamic Surcharge Pressure BP/SD          |         |      |      |          |       | 0.2  |
|                                  | LWL Seismic Downward                            |         | 13.8 |      | 50.7     |       | 0.2  |
| <b>Seismic Transverses</b>       |   |         |      |      |          |       | 0.15 |
| 15)                              | Sub-structure Component                         |         |      | 36.5 |          | 116.3 | 0.15 |
| 17)                              | Super-Structure DL, SIDL, & Surfacing Component |         |      | 43.6 |          | 237.6 | 0.15 |
| <b>Seismic Vertical Downward</b> |   |         |      |      |          |       | 0.15 |
| 19)                              | Sub-structure Component                         | 8.11393 |      |      | -17.9354 |       | 0.15 |
| 20)                              | Earth fill                                      | 7.3     |      |      | -23.1    |       | 0.15 |
| 21)                              | Super-Structure DL, SIDL, & Surfacing           | 9.68496 |      |      | -15.2538 |       | 0.15 |

| S.N. | Description                             | Forces about toe |                |                |                 |                 |
|------|---|------------------|----------------|----------------|-----------------|-----------------|
|      |   | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|      |   | Tonne            | Tonne          | Tonne          | Tm              | Tm              |
| LC-5 | SIS,LWL, Span dislodge ,Seismic Sx=1,\$ | 442.361          | 149.60         | 12.0143        | -730.636        | 53.0877         |

| LC-6                             | SIS, LWL,Span dislodge ,Seismic Sx=1,\$         | Forces about toe |                |                |                 |                 | LC-6  |
|----------------------------------|---|------------------|----------------|----------------|-----------------|-----------------|-------|
| S.N.                             | Description                                     | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |       |
|                                  |   | Tonne            | Tonne          | Tonne          | Tm              | Tm              |       |
| 1)                               | Sub-structure & Foundation                      | 236.7            |                |                | -507.8          | 0.0             | 1     |
| 2)                               | Backfill  | 162.1            |                |                | -511.8          | 0.0             | 1     |
| 9.3)                             | Earth Pressure LWL (BP, SD)                     |                  |                |                |                 |                 | 1     |
|                                  | Horizontal Component                            |                  | 101.5          |                | 231.4           |                 | 1     |
|                                  | Vertical Component                              | 36.2             |                |                | -86.9           |                 | 1     |
| 10.3)                            | Surcharge Pressure LWL(BP, SD)                  |                  | 47.1           |                | 129.4           |                 | 0.2   |
| <b>Seismic Longitudinal</b>      |   |                  |                |                |                 |                 | 0.5   |
| 11)                              | Sub-structure Component                         |                  | 12.1           |                | 38.7            |                 | 0.5   |
| 12)                              | Earth fill component                            |                  | 11.0           |                | 29.4            |                 | 0.5   |
| 12)                              | Super-Structure DL, SIDL, & Surfacing Compone   |                  | 29.0           |                | 128.5           |                 | 0.5   |
| 13)                              | Dynamic Earth Pressure LWL                      |                  |                |                |                 |                 | 0.5   |
|                                  | 13.6) LWL Seismic Upward_BP/SD                  |                  |                |                |                 |                 | 0.5   |
|                                  | Horizontal Component                            |                  | 10.8           |                | 29.7            |                 | 0.5   |
|                                  | Vertical Component                              | 3.9              |                |                | -9.4            |                 | 0.5   |
| 14)                              | 14.2) Dynamic Surcharge Pressure BP/SD          |                  |                |                |                 |                 | 0.2   |
|                                  | LWL Seismic Upward                              |                  | 7.5            |                | 27.6            |                 | 0.2   |
| <b>Seismic Transverses</b>       |   |                  |                |                |                 |                 | 0.15  |
| 15)                              | Sub-structure Component                         |                  |                | 36.5           |                 | 116.3           | 0.15  |
| 17)                              | Super-Structure DL, SIDL, & Surfacing Component |                  |                | 43.6           |                 | 237.6           | 0.15  |
| <b>Seismic Vertical Downward</b> |   |                  |                |                |                 |                 | 0.15  |
| 19)                              | Sub-structure Component                         | 8.11393          |                |                | -17.9354        |                 | -0.15 |
| 21)                              | Super-Structure DL, SIDL, & Surfacing           | 9.68496          |                |                | -15.2538        |                 | -0.15 |

| S.N. | Description | Forces about toe |                |                |                 |                 |
|------|-------------|------------------|----------------|----------------|-----------------|-----------------|
|      |             | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |

|      |   | Tonne   | Tonne  | Tonne   | Tm       | Tm      |
|------|---|---------|--------|---------|----------|---------|
| LC-6 | SIS, LWL, Span dislodge ,Seismic Sx=1,Sz=0.3, | 434.275 | 143.82 | 12.0143 | -730.335 | 53.0877 |

| LC-7                             | SIS,LWL,Max LL,Seismic Sx=1,Sz=0.3,             | Forces about toe |                |                |                 |                 | LC-7 |
|----------------------------------|---|------------------|----------------|----------------|-----------------|-----------------|------|
| S.N.                             | Description                                     | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |      |
|                                  |   | Tonne            | Tonne          | Tonne          | Tm              | Tm              |      |
| 1)                               | Sub-structure & Foundation                      | 236.7            |                |                | -507.8          | 0.0             | 1    |
| 2)                               | Backfill  | 162.1            |                |                | -511.8          | 0.0             | 1    |
| 3)                               | Super-structure DL                              | 155.1            |                |                | -244.3          | 0.0             | 1    |
| 4)                               | SIDL (excluding surfacing)                      | 45.8             |                |                | -72.2           | 0.0             | 1    |
| 5)                               | Surfacing                                       | 13.3             |                |                | -21.0           | -3.3            | 1    |
| 6.1)                             | Live Load Vertical Load Max Reaction            | 89.9             |                |                | -141.5          | 261.5           | 0.2  |
| 7)                               | Live Load Horizontal Forces                     |                  | 26.6           |                | 117.9           |                 | 0.2  |
| 9.3)                             | Earth Pressure LWL (BP, SD)                     |                  |                |                |                 |                 | 1    |
|                                  | Horizontal Component                            |                  | 101.5          |                | 231.4           |                 | 1    |
|                                  | Vertical Component                              | 36.2             |                |                | -86.9           |                 | 1    |
| 10.3)                            | Surcharge Pressure LWL(BP, SD)                  |                  | 47.1           |                | 129.4           |                 | 0.2  |
| <b>Seismic Longitudinal</b>      |   |                  |                |                |                 |                 | 1    |
| 11)                              | Sub-structure Component                         |                  | 12.1           |                | 38.7            |                 | 1    |
| 12)                              | Earth fill component                            |                  | 11.0           |                | 29.4            |                 | 1    |
| 12)                              | Super-Structure DL, SIDL, & Surfacing Component |                  | 29.0           |                | 128.5           |                 | 1    |
| 13)                              | Dynamic Earth Pressure LWL                      |                  |                |                |                 |                 | 1    |
| 13)                              | 13.5)LWL Seismic Downward_BP/SD                 |                  |                |                |                 |                 | 1    |
|                                  | Horizontal Component                            |                  | 19.8           |                | 54.6            |                 | 1    |
|                                  | Vertical Component                              | 7.2              |                |                | -17.3           |                 | 1    |
| 14)                              | 14.2) Dynamic Surcharge Pressure BP/SD          |                  |                |                |                 |                 | 0.2  |
|                                  | LWL Seismic Downward                            |                  | 13.8           |                | 50.7            |                 | 0.2  |
| <b>Seismic Transveres</b>        |   |                  |                |                |                 |                 | 0.3  |
| 15)                              | Sub-structure Component                         |                  |                | 36.5           |                 | 116.3           | 0.3  |
| 17)                              | Super-Structure DL, SIDL, & Surfacing Component |                  |                | 43.6           |                 | 237.6           | 0.3  |
| 18.1)                            | Live Load Component (Max. Reaction)             |                  |                | 18.279         |                 | 122.469         | 0.06 |
| <b>Seismic Vertical Downward</b> |   |                  |                |                |                 |                 | 0.3  |
| 19)                              | Sub-structure Component                         | 8.11393          |                |                | -17.9354        |                 | 0.3  |
| 20)                              | Earth fill                                      | 7.3              |                |                | -23.1           |                 | 0.3  |
| 21)                              | Super-Structure DL, SIDL, & Surfacing           | 9.68496          |                |                | -15.2538        |                 | 0.3  |
| 22.1)                            | Live Load Component (Max. Reaction)             | 4.1              |                |                | -6.4            |                 | 0.06 |

| S.N. | Description                         | Forces about toe |                |                |                 |                 |
|------|-------------------------------------|------------------|----------------|----------------|-----------------|-----------------|
|      |                                     | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|      |                                     | Tonne            | Tonne          | Tonne          | Tm              | Tm              |
| LC-7 | SIS,LWL,Max LL,Seismic Sx=1,Sz=0.3, | 682.225          | 190.88         | 25.1252        | -964.755        | 162.495         |

| LC-8 | SIS, LWL,Max LL,Seismic Sx=1,Sz=0.3, | Forces about toe |                |                |                 |                 | LC-8 |
|------|--------------------------------------|------------------|----------------|----------------|-----------------|-----------------|------|
| S.N. | Description                          | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |      |

|                                  |   | Tonne   | Tonne  | Tonne  | Tm       | Tm      |  |       |
|----------------------------------|---|---------|--------|--------|----------|---------|--|-------|
| 1)                               | Sub-structure & Foundation                      | 236.7   |        |        | -507.8   | 0.0     |  | 1     |
| 2)                               | Backfill  | 162.1   |        |        | -511.8   | 0.0     |  | 1     |
| 3)                               | Super-structure DL                              | 155.1   |        |        | -244.3   | 0.0     |  | 1     |
| 4)                               | SIDL (excluding surfacing)                      | 45.8    |        |        | -72.2    | 0.0     |  | 1     |
| 5)                               | Surfacing                                       | 13.3    |        |        | -21.0    | -3.3    |  | 1     |
| 6.1)                             | Live Load Vertical Load Max Reaction            | 89.9    |        |        | -141.5   | 261.5   |  | 0.2   |
| 7)                               | Live Load Horizontal Forces                     |         | 26.6   |        | 117.9    |         |  | 0.2   |
| 10.1)                            | Surcharge Pressure LWL(O/S)                     |         | 47.076 |        | 129.375  |         |  | 0.2   |
| 9.3)                             | Earth Pressure LWL (BP, SD)                     |         |        |        |          |         |  | 1     |
|                                  | Horizontal Component                            |         | 101.5  |        | 231.4    |         |  | 1     |
|                                  | Vertical Component                              | 36.2    |        |        | -86.9    |         |  | 1     |
| 10.3)                            | Surcharge Pressure LWL(BP, SD)                  |         | 47.1   |        | 129.4    |         |  | 0.2   |
| <b>Seismic Longitudinal</b>      |   |         |        |        |          |         |  | 1     |
| 11)                              | Sub-structure Component                         |         | 12.1   |        | 38.7     |         |  | 1     |
| 12)                              | Earth fill component                            |         | 11.0   |        | 29.4     |         |  | 1     |
| 12)                              | Super-Structure DL, SIDL, & Surfacing Component |         | 29.0   |        | 128.5    |         |  | 1     |
| 13)                              | Dynamic Earth Pressure LWL                      |         |        |        |          |         |  | 1     |
|                                  | 13.6) LWL Seismic Upward_BP/SD                  |         |        |        |          |         |  | 1     |
|                                  | Horizontal Component                            |         | 10.8   |        | 29.7     |         |  | 1     |
|                                  | Vertical Component                              | 3.9     |        |        | -9.4     |         |  | 1     |
| 14)                              | 14.2) Dynamic Surcharge Pressure BP/SD          |         |        |        |          |         |  | 0.2   |
|                                  | LWL Seismic Upward                              |         | 7.5    |        | 27.6     |         |  | 0.2   |
| <b>Seismic Transverses</b>       |   |         |        |        |          |         |  | 0.3   |
| 15)                              | Sub-structure Component                         |         |        | 36.5   |          | 116.3   |  | 0.3   |
| 17)                              | Super-Structure DL, SIDL, & Surfacing Component |         |        | 43.6   |          | 237.6   |  | 0.3   |
| 18.1)                            | Live Load Component (Max. Reaction)             |         |        | 18.279 |          | 122.469 |  | 0.06  |
| <b>Seismic Vertical Downward</b> |   |         |        |        |          |         |  | 0.3   |
| 19)                              | Sub-structure Component                         | 8.11393 |        |        | -17.9354 |         |  | -0.3  |
| 21)                              | Super-Structure DL, SIDL, & Surfacing           | 9.68496 |        |        | -15.2538 |         |  | -0.3  |
| 22.1)                            | Live Load Component (Max. Reaction)             | 4.1     |        |        | -6.4     |         |  | -0.06 |

| S.N. | Description                         | Forces about toe |                |                |                 |                 |
|------|-------------------------------------|------------------|----------------|----------------|-----------------|-----------------|
|      |                                     | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|      |                                     | Tonne            | Tonne          | Tonne          | Tm              | Tm              |
| LC-8 | SIS, LWL,Max LL,Seismic Sx=1,Sz=0.3 | 665.566          | 189.98         | 25.1252        | -932.885        | 162.495         |

| S.N.  | Description                    | Forces about toe |                |                |                 |                 |  | LC-9 |
|-------|--------------------------------|------------------|----------------|----------------|-----------------|-----------------|--|------|
|       |                                | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |  |      |
|       |                                | Tonne            | Tonne          | Tonne          | Tm              | Tm              |  |      |
| 1)    | Sub-structure & Foundation     | 236.7            |                |                | -507.8          | 0.0             |  | 1    |
| 2)    | Backfill                       | 162.1            |                |                | -511.8          | 0.0             |  | 1    |
| 8)    | Buoyancy                       | -10.6            |                |                | 9.1             | 0.0             |  | 1    |
| 9.3)  | Earth Pressure HFL (BP, SD)    |                  |                |                |                 |                 |  | 1    |
|       | Horizontal Component           |                  | 101.5          |                | 231.4           |                 |  | 1    |
|       | Vertical Component             | 36.2             |                |                | -86.9           |                 |  | 1    |
| 10.3) | Surcharge Pressure HFL(BP, SD) |                  | 47.1           |                | 129.4           |                 |  | 1    |

| S.N. | Description                | Forces about toe |                |                |                 |                 |
|------|----------------------------|------------------|----------------|----------------|-----------------|-----------------|
|      |                            | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|      |                            | Tonne            | Tonne          | Tonne          | Tm              | Tm              |
| LC-9 | NS, HFL, Span dislodge, EP | 424.422          | 148.54         | 0              | -736.605        | 0               |

| S.N.  | Description                          | Forces about toe |                |                |                 |                 | LC-10 |
|-------|--------------------------------------|------------------|----------------|----------------|-----------------|-----------------|-------|
|       |                                      | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |       |
|       |                                      | Tonne            | Tonne          | Tonne          | Tm              | Tm              |       |
| 1)    | Sub-structure & Foundation           | 236.7            |                |                | -507.8          | 0.0             | 1     |
| 2)    | Backfill                             | 162.1            |                |                | -511.8          | 0.0             | 1     |
| 3)    | Super-structure DL                   | 155.1            |                |                | -244.3          | 0.0             | 1     |
| 4)    | SIDL (excluding surfacing)           | 45.8             |                |                | -72.2           | 0.0             | 1     |
| 5)    | Surfacing                            | 13.3             |                |                | -21.0           | -3.3            | 1     |
| 6.1)  | Live Load Vertical Load Max Reaction | 89.9             |                |                | -141.5          | 261.5           | 1     |
| 7)    | Live Load Horizontal Forces          |                  | 26.6           |                | 117.9           |                 | 1     |
| 8)    | Buoyancy                             | -10.6            |                |                | 9.1             | 0.0             | 1     |
| 9.3)  | Earth Pressure HFL (BP, SD)          |                  |                |                |                 |                 | 1     |
|       | Horizontal Component                 |                  | 101.5          |                | 231.4           |                 | 1     |
|       | Vertical Component                   | 36.2             |                |                | -86.9           |                 | 1     |
| 10.3) | Surcharge Pressure HFL(BP, SD)       |                  | 47.1           |                | 129.4           |                 | 1     |

| S.N.  | Description         | Forces about toe |                |                |                 |                 |
|-------|---------------------|------------------|----------------|----------------|-----------------|-----------------|
|       |                     | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|       |                     | Tonne            | Tonne          | Tonne          | Tm              | Tm              |
| LC-10 | NS, HFL, Max LL, EP | 728.557          | 175.14         | 0              | -1097.68        | 258.181         |

| S.N.                        | Description                                     | Forces about toe |                |                |                 |                 | LC-11 |
|-----------------------------|---|------------------|----------------|----------------|-----------------|-----------------|-------|
|                             |   | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |       |
|                             |   | Tonne            | Tonne          | Tonne          | Tm              | Tm              |       |
| 1)                          | Sub-structure & Foundation                      | 236.7            |                |                | -507.8          | 0.0             | 1     |
| 2)                          | Backfill  | 162.1            |                |                | -511.8          | 0.0             | 1     |
| 8)                          | Buoyancy  | -10.6            |                |                | 9.1             | 0.0             | 1     |
| 9.3)                        | Earth Pressure HFL (BP, SD)                     |                  |                |                |                 |                 | 1     |
|                             | Horizontal Component                            |                  | 101.5          |                | 231.4           |                 | 1     |
|                             | Vertical Component                              | 36.2             |                |                | -86.9           |                 | 1     |
| 10.3)                       | Surcharge Pressure HFL(BP, SD)                  |                  | 47.1           |                | 129.4           |                 | 0.2   |
| <b>Seismic Longitudinal</b> |   |                  |                |                |                 |                 | 0.5   |
| 11)                         | Sub-structure Component                         |                  | 12.1           |                | 38.7            |                 | 0.5   |
| 12)                         | Earth fill component                            |                  | 11.0           |                | 29.4            |                 | 0.5   |
| 12)                         | Super-Structure DL, SIDL, & Surfacing Component |                  | 29.0           |                | 128.5           |                 | 0.5   |
| 13)                         | Dynamic Earth Pressure HFL                      |                  |                |                |                 |                 | 0.5   |
| 13)                         | 13.5)HFL Seismic Downward_BP/SD                 |                  |                |                |                 |                 | 0.5   |
|                             | Horizontal Component                            |                  | 19.8           |                | 54.6            |                 | 0.5   |

|                                  |   |         |      |      |          |       |      |
|----------------------------------|---|---------|------|------|----------|-------|------|
|                                  | Vertical Component                              | 7.2     |      |      | -17.3    |       | 0.5  |
| 14)                              | 14.2) Dynamic Surcharge Pressure BP/SD          |         |      |      |          |       | 0.2  |
|                                  | HFL Seismic Downward                            |         | 13.8 |      | 50.7     |       | 0.2  |
| <b>Seismic Transverses</b>       |   |         |      |      |          |       |      |
| 15)                              | Sub-structure Component                         |         |      | 36.5 |          | 116.3 | 0.15 |
| 17)                              | Super-Structure DL, SIDL, & Surfacing Component |         |      | 43.6 |          | 237.6 | 0.15 |
| <b>Seismic Vertical Downward</b> |   |         |      |      |          |       |      |
| 19)                              | Sub-structure Component                         | 8.11393 |      |      | -17.9354 |       | 0.15 |
| 20)                              | Earth fill                                      | 7.3     |      |      | -23.1    |       | 0.15 |
| 21)                              | Super-Structure DL, SIDL, & Surfacing           | 9.68496 |      |      | -15.2538 |       | 0.15 |

| S.N.  | Description                            | Forces about toe |                |                |                 |                 |
|-------|--|------------------|----------------|----------------|-----------------|-----------------|
|       |  | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|       |  | Tonne            | Tonne          | Tonne          | Tm              | Tm              |
| LC-11 | SIS,HFL, Span dislodge ,Seismic Sx=1,S | 431.801          | 149.60         | 12.0143        | -721.51         | 53.0877         |

| LC-12                            | SIS, HFL,Span dislodge ,Seismic Sx=1,S          | Forces about toe |                |                |                 |                 |  | LC-12 |
|----------------------------------|---|------------------|----------------|----------------|-----------------|-----------------|--|-------|
| S.N.                             | Description                                     | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |  |       |
|                                  |   | Tonne            | Tonne          | Tonne          | Tm              | Tm              |  |       |
| 1)                               | Sub-structure & Foundation                      | 236.7            |                |                | -507.8          | 0.0             |  | 1     |
| 2)                               | Backfill  | 162.1            |                |                | -511.8          | 0.0             |  | 1     |
| 8)                               | Buoyancy  | -10.6            |                |                | 9.1             | 0.0             |  | 1     |
| 9.3)                             | Earth Pressure HFL (BP, SD)                     |                  |                |                |                 |                 |  | 1     |
|                                  | Horizontal Component                            |                  | 101.5          |                | 231.4           |                 |  | 1     |
|                                  | Vertical Component                              | 36.2             |                |                | -86.9           |                 |  | 1     |
| 10.3)                            | Surcharge Pressure HFL(BP, SD)                  |                  | 47.1           |                | 129.4           |                 |  | 0.2   |
| <b>Seismic Longitudinal</b>      |   |                  |                |                |                 |                 |  | 0.5   |
| 11)                              | Sub-structure Component                         |                  | 12.1           |                | 38.7            |                 |  | 0.5   |
| 12)                              | Earth fill component                            |                  | 11.0           |                | 29.4            |                 |  | 0.5   |
| 12)                              | Super-Structure DL, SIDL, & Surfacing Compone   |                  | 29.0           |                | 128.5           |                 |  | 0.5   |
| 13)                              | Dynamic Earth Pressure HFL                      |                  |                |                |                 |                 |  | 0.5   |
|                                  | 13.6) HFL Seismic Upward_BP/SD                  |                  |                |                |                 |                 |  | 0.5   |
|                                  | Horizontal Component                            |                  | 10.8           |                | 29.7            |                 |  | 0.5   |
|                                  | Vertical Component                              | 3.9              |                |                | -9.4            |                 |  | 0.5   |
| 14)                              | 14.2) Dynamic Surcharge Pressure BP/SD          |                  |                |                |                 |                 |  | 0.2   |
|                                  | HFL Seismic Upward                              |                  | 7.5            |                | 27.6            |                 |  | 0.2   |
| <b>Seismic Transverses</b>       |   |                  |                |                |                 |                 |  | 0.15  |
| 15)                              | Sub-structure Component                         |                  |                | 36.5           |                 | 116.3           |  | 0.15  |
| 17)                              | Super-Structure DL, SIDL, & Surfacing Component |                  |                | 43.6           |                 | 237.6           |  | 0.15  |
| <b>Seismic Vertical Downward</b> |   |                  |                |                |                 |                 |  | 0.15  |
| 19)                              | Sub-structure Component                         | 8.11393          |                |                | -17.9354        |                 |  | -0.15 |
| 21)                              | Super-Structure DL, SIDL, & Surfacing           | 9.68496          |                |                | -15.2538        |                 |  | -0.15 |

| S.N. | Description | Forces about toe |                |                |                 |                 |
|------|-------------|------------------|----------------|----------------|-----------------|-----------------|
|      |             | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|      |             | Tonne            | Tonne          | Tonne          | Tm              | Tm              |

|       |   |         |        |         |          |         |
|-------|---|---------|--------|---------|----------|---------|
| LC-12 | SIS, HFL,Span dislodge ,Seismic Sx=1,Sz=0.3 | 423.715 | 143.82 | 12.0143 | -721.209 | 53.0877 |
|-------|---|---------|--------|---------|----------|---------|

| LC-13                            | SIS,HFL,Max LL,Seismic Sx=1,Sz=0.3              | Forces about toe |                |                |                 |                 | LC-13 |
|----------------------------------|---|------------------|----------------|----------------|-----------------|-----------------|-------|
| S.N.                             | Description                                     | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |       |
|                                  |   | Tonne            | Tonne          | Tonne          | Tm              | Tm              |       |
| 1)                               | Sub-structure & Foundation                      | 236.7            |                |                | -507.8          | 0.0             | 1     |
| 2)                               | Backfill  | 162.1            |                |                | -511.8          | 0.0             | 1     |
| 3)                               | Super-structure DL                              | 155.1            |                |                | -244.3          | 0.0             | 1     |
| 4)                               | SIDL (excluding surfacing)                      | 45.8             |                |                | -72.2           | 0.0             | 1     |
| 5)                               | Surfacing                                       | 13.3             |                |                | -21.0           | -3.3            | 1     |
| 6.1)                             | Live Load Vertical Load Max Reaction            | 89.9             |                |                | -141.5          | 261.5           | 0.2   |
| 7)                               | Live Load Horizontal Forces                     |                  | 26.6           |                | 117.9           |                 | 0.2   |
| 8)                               | Buoyancy  | -10.6            |                |                | 9.1             | 0.0             | 1     |
| 9.3)                             | Earth Pressure HFL (BP, SD)                     |                  |                |                |                 |                 | 1     |
|                                  | Horizontal Component                            |                  | 101.5          |                | 231.4           |                 | 1     |
|                                  | Vertical Component                              | 36.2             |                |                | -86.9           |                 | 1     |
| 10.3)                            | Surcharge Pressure HFL(BP, SD)                  |                  | 47.1           |                | 129.4           |                 | 0.2   |
| <b>Seismic Longitudinal</b>      |   |                  |                |                |                 |                 | 1     |
| 11)                              | Sub-structure Component                         |                  | 12.1           |                | 38.7            |                 | 1     |
| 12)                              | Earth fill component                            |                  | 11.0           |                | 29.4            |                 | 1     |
| 12)                              | Super-Structure DL, SIDL, & Surfacing Component |                  | 29.0           |                | 128.5           |                 | 1     |
| 13)                              | Dynamic Earth Pressure HFL                      |                  |                |                |                 |                 | 1     |
| 13)                              | 13.5)HFL Seismic Downward_BP/SD                 |                  |                |                |                 |                 | 1     |
|                                  | Horizontal Component                            |                  | 19.8           |                | 54.6            |                 | 1     |
|                                  | Vertical Component                              | 7.2              |                |                | -17.3           |                 | 1     |
| 14)                              | 14.2) Dynamic Surcharge Pressure BP/SD          |                  |                |                |                 |                 | 0.2   |
|                                  | HFL Seismic Downward                            |                  | 13.8           |                | 50.7            |                 | 0.2   |
| <b>Seismic Transveres</b>        |   |                  |                |                |                 |                 | 0.3   |
| 15)                              | Sub-structure Component                         |                  |                | 36.5           |                 | 116.3           | 0.3   |
| 17)                              | Super-Structure DL, SIDL, & Surfacing Component |                  |                | 43.6           |                 | 237.6           | 0.3   |
| 18.1)                            | Live Load Component (Max. Reaction)             |                  |                | 18.279         |                 | 122.469         | 0.06  |
| <b>Seismic Vertical Downward</b> |   |                  |                |                |                 |                 | 0.3   |
| 19)                              | Sub-structure Component                         | 8.11393          |                |                | -17.9354        |                 | 0.3   |
| 20)                              | Earth fill                                      | 7.3              |                |                | -23.1           |                 | 0.3   |
| 21)                              | Super-Structure DL, SIDL, & Surfacing           | 9.68496          |                |                | -15.2538        |                 | 0.3   |
| 22.1)                            | Live Load Component (Max. Reaction)             | 4.1              |                |                | -6.4            |                 | 0.06  |

| S.N.  | Description                        | Forces about toe |                |                |                 |                 |
|-------|------------------------------------|------------------|----------------|----------------|-----------------|-----------------|
|       |                                    | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|       |                                    | Tonne            | Tonne          | Tonne          | Tm              | Tm              |
| LC-13 | SIS,HFL,Max LL,Seismic Sx=1,Sz=0.3 | 671.665          | 190.88         | 25.1252        | -955.629        | 162.495         |

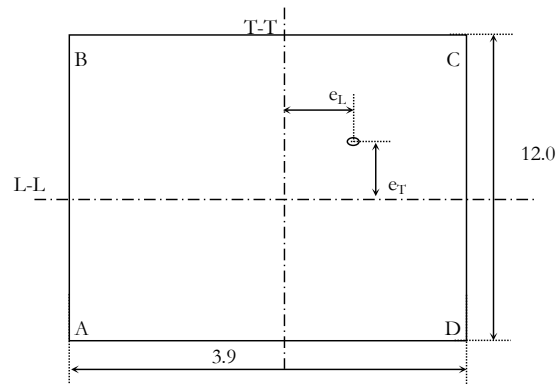
| LC-14 | SIS, HFL,Max LL,Seismic Sx=1,Sz=0.3 | Forces about toe |                |                |                 |                 | LC-14 |
|-------|-------------------------------------|------------------|----------------|----------------|-----------------|-----------------|-------|
| S.N.  | Description                         | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |       |



|                                  |   | Tonne   | Tonne | Tonne  | Tm       | Tm      |  |       |
|----------------------------------|---|---------|-------|--------|----------|---------|--|-------|
| 1)                               | Sub-structure & Foundation                      | 236.7   |       |        | -507.8   | 0.0     |  | 1     |
| 2)                               | Backfill  | 162.1   |       |        | -511.8   | 0.0     |  | 1     |
| 3)                               | Super-structure DL                              | 155.1   |       |        | -244.3   | 0.0     |  | 1     |
| 4)                               | SIDL (excluding surfacing)                      | 45.8    |       |        | -72.2    | 0.0     |  | 1     |
| 5)                               | Surfacing                                       | 13.3    |       |        | -21.0    | -3.3    |  | 1     |
| 6.1)                             | Live Load Vertical Load Max Reaction            | 89.9    |       |        | -141.5   | 261.5   |  | 0.2   |
| 7)                               | Live Load Horizontal Forces                     |         | 26.6  |        | 117.9    |         |  | 0.2   |
| 8)                               | Buoyancy  | -10.6   |       |        | 9.1      | 0.0     |  | 1     |
| 10.1)                            | Surcharge Pressure HFL(O/S)                     |         | 47.1  |        | 129.4    |         |  | 0.2   |
| 9.3)                             | Earth Pressure HFL (BP, SD)                     |         |       |        |          |         |  | 1     |
|                                  | Horizontal Component                            |         | 101.5 |        | 231.4    |         |  | 1     |
|                                  | Vertical Component                              | 36.2    |       |        | -86.9    |         |  | 1     |
| 10.3)                            | Surcharge Pressure HFL(BP, SD)                  |         | 47.1  |        | 129.4    |         |  | 0.2   |
| <b>Seismic Longitudinal</b>      |   |         |       |        |          |         |  | 1     |
| 11)                              | Sub-structure Component                         |         | 12.1  |        | 38.7     |         |  | 1     |
| 12)                              | Earth fill component                            |         | 11.0  |        | 29.4     |         |  | 1     |
| 12)                              | Super-Structure DL, SIDL, & Surfacing Component |         | 29.0  |        | 128.5    |         |  | 1     |
| 13)                              | Dynamic Earth Pressure HFL                      |         |       |        |          |         |  | 1     |
|                                  | 13.6) HFL Seismic Upward_BP/SD                  |         |       |        |          |         |  | 1     |
|                                  | Horizontal Component                            |         | 10.8  |        | 29.7     |         |  | 1     |
|                                  | Vertical Component                              | 3.9     |       |        | -9.4     |         |  | 1     |
| 14)                              | 14.2) Dynamic Surcharge Pressure BP/SD          |         |       |        |          |         |  | 0.2   |
|                                  | HFL Seismic Upward                              |         | 7.5   |        | 27.6     |         |  | 0.2   |
| <b>Seismic Transverses</b>       |   |         |       |        |          |         |  | 0.3   |
| 15)                              | Sub-structure Component                         |         |       | 36.5   |          | 116.3   |  | 0.3   |
| 17)                              | Super-Structure DL, SIDL, & Surfacing Component |         |       | 43.6   |          | 237.6   |  | 0.3   |
| 18.1)                            | Live Load Component (Max. Reaction)             |         |       | 18.279 |          | 122.469 |  | 0.06  |
| <b>Seismic Vertical Downward</b> |   |         |       |        |          |         |  | 0.3   |
| 19)                              | Sub-structure Component                         | 8.11393 |       |        | -17.9354 |         |  | -0.3  |
| 21)                              | Super-Structure DL, SIDL, & Surfacing           | 9.68496 |       |        | -15.2538 |         |  | -0.3  |
| 22.1)                            | Live Load Component (Max. Reaction)             | 4.1     |       |        | -6.4     |         |  | -0.06 |

| S.N.  | Description                         | Forces about toe |                |                |                 |                 |
|-------|-------------------------------------|------------------|----------------|----------------|-----------------|-----------------|
|       |                                     | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|       |                                     | Tonne            | Tonne          | Tonne          | Tm              | Tm              |
| LC-14 | SIS, HFL,Max LL,Seismic Sx=1,Sz=0.3 | 655.006          | 189.98         | 25.1252        | -923.759        | 162.495         |

**CHECK FOR MAXIMUM BASE PRESSRE**  
**LOAD COMBINATION FOR MAXIMUM BASE PRESSURE**



| Coordinates of basecorner |        |        |
|---------------------------|--------|--------|
| Edges                     | x (m)  | z (m)  |
| A                         | -1.950 | 6.000  |
| B                         | -1.950 | -6.000 |
| C                         | 1.950  | -6.000 |
| D                         | 1.950  | 6.000  |

| Properties of Base |                         |   |                       |
|--------------------|-------------------------|---|-----------------------|
| Area               | 3.9x12                  | = | 46.8 m <sup>2</sup>   |
| I <sub>TT</sub>    | 12x3.9 <sup>3</sup> /12 | = | 59.319 m <sup>4</sup> |
| I <sub>LL</sub>    | 3.9x12 <sup>3</sup> /12 | = | 561.6 m <sup>4</sup>  |

| Maximum Base Pressure |               | Heel side |     | Toe Side |       | Bearing Capacity | Check |
|-----------------------|---------------|-----------|-----|----------|-------|------------------|-------|
| Non-Seismic case      | LWL Condition | 5.9       | 5.9 | 12.7     | 12.66 | 60.0             | OK    |
| Seismic Case          | LWL Condition | 7.6       | 2.0 | 29.5     | 12.5  | 75.0             | OK    |
| Non-Seismic case      | HFL Condition | 4.0       | 0.5 | 28.0     | 24.5  | 60.0             | OK    |
| Seismic Case          | HFL Condition | 7.7       | 2.2 | 28.9     | 11.9  | 75.0             | OK    |

**CHECK FOR MAXIMUM BASE PRESSRE**

**SUMMARY OF FORCES :**

|       |  |                  |                |                |                 |                 | <i>Eccentricity of Vertical load from toe point</i> |                     | <i>Eccentricity of Vertical load wrt cg of base</i> |                 | <i>Moment and forces at cg of base</i> |                  | <i>Base Pressure = <math>P/A \pm M_{TT} *x / I_{TT} \pm M_{LL} *z / I_{LL}</math></i> |                  |                  |                  |
|-------|--|------------------|----------------|----------------|-----------------|-----------------|---|---------------------|---|-----------------|--|------------------|---|------------------|------------------|------------------|
| S.N.  | Description                            | Forces about toe |                |                |                 |                 | e <sub>L1</sub>                                     | e <sub>T1</sub>     | e <sub>L</sub>                                      | e <sub>T</sub>  | M <sub>TT</sub>                        | M <sub>LL</sub>  | <i>base pressure at footing corners</i>   |                  |                  |                  |
|       |  | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> | M <sub>TT</sub> / V                                 | M <sub>LL</sub> / V | B/2-e <sub>L1</sub>                                 | e <sub>T1</sub> | V*e <sub>L</sub>                       | V*e <sub>T</sub> | A   | B                | C                | D                |
|       |  | Tonne            | Tonne          | Tonne          | Tm              | Tm              | m   | m                   | m   | m               | Tm                                     | Tm               | T/m <sup>2</sup>  | T/m <sup>2</sup> | T/m <sup>2</sup> | T/m <sup>2</sup> |
| LC-2  | NS, LWL, Span dislodge, EP             | 434.982          | 148.544        | 0              | -745.731        | 0               | -1.71   | 0.00                | 0.24  | 0.00            | 102.5                                  | 0.0              | 5.9   | 5.9              | 12.7             | 12.7             |
| LC-3  | NS, LWL, Max LL, FP                    | 702.901          | 73.697         | 0              | -1251.33        | 258.181         | -1.78   | 0.37                | 0.17  | 0.37            | 119.3                                  | 258.2            | 13.9  | 8.3              | 16.2             | 21.7             |
| LC-4  | NS, LWL, Max LL, EP                    | 739.117          | 175.136        | 0              | -1106.81        | 258.181         | -1.50   | 0.35                | 0.45  | 0.35            | 334.5                                  | 258.2            | 7.6   | 2.0              | 24.0             | 29.5             |
| LC-5  | SIS,LWL, Span dislodge ,Seismic Sx=1,S | 442.361          | 149.605        | 12.0143        | -730.636        | 53.0877         | -1.65   | 0.12                | 0.30  | 0.12            | 132.0                                  | 53.1             | 5.7   | 4.5              | 13.2             | 14.4             |
| LC-6  | SIS, LWL,Span dislodge ,Seismic Sx=1,S | 434.275          | 143.817        | 12.0143        | -730.335        | 53.0877         | -1.68   | 0.12                | 0.27  | 0.12            | 116.5                                  | 53.1             | 6.0   | 4.9              | 12.5             | 13.7             |
| LC-7  | SIS,LWL,Max LL,Seismic Sx=1,Sz=0.3,S   | 682.225          | 190.879        | 25.1252        | -964.755        | 162.495         | -1.41   | 0.24                | 0.54  | 0.24            | 365.6                                  | 162.5            | 4.3   | 0.8              | 24.9             | 28.3             |
| LC-8  | SIS, LWL,Max LL,Seismic Sx=1,Sz=0.3,S  | 665.566          | 189.98         | 25.1252        | -932.885        | 162.495         | -1.40   | 0.24                | 0.55  | 0.24            | 365.0                                  | 162.5            | 4.0   | 0.5              | 24.5             | 28.0             |
| LC-9  | NS, HFL, Span dislodge, EP             | 424.422          | 148.544        | 0              | -736.605        | 0               | -1.74   | 0.00                | 0.21  | 0.00            | 91.0                                   | 0.0              | 6.1   | 6.1              | 12.1             | 12.1             |
| LC-10 | NS, HFL, Max LL, EP                    | 728.557          | 175.136        | 0              | -1097.68        | 258.181         | -1.51   | 0.35                | 0.44  | 0.35            | 323.0                                  | 258.2            | 7.7   | 2.2              | 23.4             | 28.9             |
| LC-11 | SIS,HFL, Span dislodge ,Seismic Sx=1,S | 431.801          | 149.605        | 12.0143        | -721.51         | 53.0877         | -1.67   | 0.12                | 0.28  | 0.12            | 120.5                                  | 53.1             | 5.8   | 4.7              | 12.6             | 13.8             |
| LC-12 | SIS, HFL,Span dislodge ,Seismic Sx=1,S | 423.715          | 143.817        | 12.0143        | -721.209        | 53.0877         | -1.70   | 0.13                | 0.25  | 0.13            | 105.0                                  | 53.1             | 6.2   | 5.0              | 11.9             | 13.1             |
| LC-13 | SIS,HFL,Max LL,Seismic Sx=1,Sz=0.3,S   | 671.665          | 190.879        | 25.1252        | -955.629        | 162.495         | -1.42   | 0.24                | 0.53  | 0.24            | 354.1                                  | 162.5            | 4.4   | 1.0              | 24.3             | 27.7             |
| LC-14 | SIS, HFL,Max LL,Seismic Sx=1,Sz=0.3,S  | 655.006          | 189.98         | 25.1252        | -923.759        | 162.495         | -1.41   | 0.25                | 0.54  | 0.25            | 353.5                                  | 162.5            | 4.1   | 0.6              | 23.9             | 27.4             |



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DESIGN OF FOUNDATION  
ULS LOAD COMBINATION

| LC-2        | NS(1), LWL, Span dislodge, EP  | Forces about toe |                |                |                 |                 |  | LC-2 |
|-------------|--------------------------------|------------------|----------------|----------------|-----------------|-----------------|--|------|
| S.N.        | Description                    | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |  |      |
|             |                                | Tonne            | Tonne          | Tonne          | Tm              | Tm              |  |      |
| 1)          | Sub-structure & Foundation     | 236.7            |                |                | -507.798        | 0               |  | 1.35 |
| 2)          | Backfill                       | 162.1            |                |                | -511.835        | 0               |  | 1.35 |
| <b>9.3)</b> | Earth Pressure LWL (BP, SD)    |                  |                |                |                 |                 |  | 1.5  |
|             | Horizontal Component           |                  | 101.47         |                | 231.45          |                 |  | 1.5  |
|             | Vertical Component             | 36.22            |                |                | -86.92          |                 |  | 1.5  |
| 10.3)       | Surcharge Pressure LWL(BP, SD) |                  | 47.08          |                | 129.37          |                 |  | 1.2  |

| S.N. | Description                   | Forces about toe |                |                |                 |                 |
|------|-------------------------------|------------------|----------------|----------------|-----------------|-----------------|
|      |                               | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|      |                               | Tonne            | Tonne          | Tonne          | Tm              | Tm              |
| LC-2 | NS(1), LWL, Span dislodge, EP | 592.659          | 208.693        | 0              | -1004.46        | 0               |

| LC-4        | NS(1), LWL, Min LL acomp, EP         | Forces about toe |                |                |                 |                 |  | LC-4 |
|-------------|--------------------------------------|------------------|----------------|----------------|-----------------|-----------------|--|------|
| S.N.        | Description                          | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |  |      |
|             |                                      | Tonne            | Tonne          | Tonne          | Tm              | Tm              |  |      |
| 1)          | Sub-structure & Foundation           | 236.7            |                |                | -507.798        | 0               |  | 1.35 |
| 2)          | Backfill                             | 162.1            |                |                | -511.835        | 0               |  | 1.35 |
| 3)          | Super-structure DL                   | 155.1            |                |                | -244.322        | 0               |  | 1.35 |
| 4)          | SIDL (excluding surfacing)           | 45.8             |                |                | -72.1621        | 0               |  | 1.35 |
| 5)          | Surfacing                            | 13.3             |                |                | -20.9882        | -3.33145        |  | 1.75 |
| 6.2)        | Live Load Vertical Load Min Reaction | 45.3             |                |                | -71.40          | 131.92          |  | 1.15 |
| 7)          | Live Load Horizontal Forces          |                  | 26.6           |                | 117.93          |                 |  | 1.15 |
| <b>9.3)</b> | Earth Pressure LWL (BP, SD)          |                  |                |                |                 |                 |  | 1.5  |
|             | Horizontal Component                 |                  | 101.47         |                | 231.45          |                 |  | 1.5  |
|             | Vertical Component                   | 36.22            |                |                | -86.92          |                 |  | 1.5  |
| 10.3)       | Surcharge Pressure LWL(BP, SD)       |                  | 47.08          |                | 129.37          |                 |  | 1.2  |

| S.N. | Description                  | Forces about toe |                |                |                 |                 |
|------|------------------------------|------------------|----------------|----------------|-----------------|-----------------|
|      |                              | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|      |                              | Tonne            | Tonne          | Tonne          | Tm              | Tm              |
| LC-4 | NS(1), LWL, Min LL acomp, EP | 939.384          | 239.274        | 0              | -1414.93        | 145.878         |

| LC-6        | NS(1), LWL, Max LL Lead, EP          | Forces about toe |                |                |                 |                 |  | LC-6 |
|-------------|--------------------------------------|------------------|----------------|----------------|-----------------|-----------------|--|------|
| S.N.        | Description                          | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |  |      |
|             |                                      | Tonne            | Tonne          | Tonne          | Tm              | Tm              |  |      |
| 1)          | Sub-structure & Foundation           | 236.7            |                |                | -507.798        | 0               |  | 1.35 |
| 2)          | Backfill                             | 162.1            |                |                | -511.835        | 0               |  | 1.35 |
| 3)          | Super-structure DL                   | 155.1            |                |                | -244.322        | 0               |  | 1.35 |
| 4)          | SIDL (excluding surfacing)           | 45.8             |                |                | -72.1621        | 0               |  | 1.35 |
| 5)          | Surfacing                            | 13.3             |                |                | -20.9882        | -3.33145        |  | 1.75 |
| 6.1)        | Live Load Vertical Load Max Reaction | 89.9             |                |                | -141.54         | 261.51          |  | 1.5  |
| 7)          | Live Load Horizontal Forces          |                  | 26.6           |                | 117.93          |                 |  | 1.5  |
| <b>9.3)</b> | Earth Pressure LWL (BP, SD)          |                  |                |                |                 |                 |  | 1    |
|             | Horizontal Component                 |                  | 101.47         |                | 231.45          |                 |  | 1    |
|             | Vertical Component                   | 36.22            |                |                | -86.92          |                 |  | 1    |
| 10.3)       | Surcharge Pressure LWL(BP, SD)       |                  | 47.08          |                | 129.37          |                 |  | 1.2  |

| S.N. | Description                 | Forces about toe |                |                |                 |                 |
|------|-----------------------------|------------------|----------------|----------------|-----------------|-----------------|
|      |                             | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|      |                             | Tonne            | Tonne          | Tonne          | Tm              | Tm              |
| LC-6 | NS(1), LWL, Max LL Lead, EP | 1003.94          | 197.847        | 0              | -1576.12        | 386.438         |

| LC-8        | NS(2), LWL, Span dislodge, EP  | Forces about toe |                |                |                 |                 |  | LC-8 |
|-------------|--------------------------------|------------------|----------------|----------------|-----------------|-----------------|--|------|
| S.N.        | Description                    | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |  |      |
|             |                                | Tonne            | Tonne          | Tonne          | Tm              | Tm              |  |      |
| 1)          | Sub-structure & Foundation     | 236.7            |                |                | -507.798        | 0               |  | 1    |
| 2)          | Backfill                       | 162.1            |                |                | -511.835        | 0               |  | 1    |
| <b>9.3)</b> | Earth Pressure LWL (BP, SD)    |                  |                |                |                 |                 |  | 1.3  |
|             | Horizontal Component           |                  | 101.47         |                | 231.45          |                 |  | 1.3  |
|             | Vertical Component             | 36.22            |                |                | -86.92          |                 |  | 1.3  |
| 10.3)       | Surcharge Pressure LWL(BP, SD) |                  | 47.08          |                | 129.37          |                 |  | 1    |

| S.N. | Description                   | Forces about toe |                |                |                 |                 |
|------|-------------------------------|------------------|----------------|----------------|-----------------|-----------------|
|      |                               | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|      |                               | Tonne            | Tonne          | Tonne          | Tm              | Tm              |
| LC-8 | NS(2), LWL, Span dislodge, EP | 445.847          | 178.984        | 0              | -702.373        | 0               |

| LC-10       | NS(2), LWL, Min LL acom, EP          | Forces about toe |                |                |                 |                 |  | LC-10 |
|-------------|--------------------------------------|------------------|----------------|----------------|-----------------|-----------------|--|-------|
| S.N.        | Description                          | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |  |       |
|             |                                      | Tonne            | Tonne          | Tonne          | Tm              | Tm              |  |       |
| 1)          | Sub-structure & Foundation           | 236.7            |                |                | -507.798        | 0               |  | 1     |
| 2)          | Backfill                             | 162.1            |                |                | -511.835        | 0               |  | 1     |
| 3)          | Super-structure DL                   | 155.1            |                |                | -244.322        | 0               |  | 1     |
| 4)          | SIDL (excluding surfacing)           | 45.8             |                |                | -72.1621        | 0               |  | 1     |
| 5)          | Surfacing                            | 13.3             |                |                | -20.9882        | -3.33145        |  | 1     |
| 6.2)        | Live Load Vertical Load Min Reaction | 45.3             |                |                | -71.40          | 131.92          |  | 1     |
| 7)          | Live Load Horizontal Forces          |                  | 26.6           |                | 117.93          |                 |  | 1     |
| <b>9.3)</b> | Earth Pressure LWL (BP, SD)          |                  |                |                |                 |                 |  | 1.3   |
|             | Horizontal Component                 |                  | 101.47         |                | 231.45          |                 |  | 1.3   |
|             | Vertical Component                   | 36.22            |                |                | -86.92          |                 |  | 1.3   |
| 10.3)       | Surcharge Pressure LWL(BP, SD)       |                  | 47.08          |                | 129.37          |                 |  | 1     |

| S.N.  | Description                 | Forces about toe |                |                |                 |                 |
|-------|-----------------------------|------------------|----------------|----------------|-----------------|-----------------|
|       |                             | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|       |                             | Tonne            | Tonne          | Tonne          | Tm              | Tm              |
| LC-10 | NS(2), LWL, Min LL acom, EP | 705.449          | 205.576        | 0              | -993.311        | 128.589         |

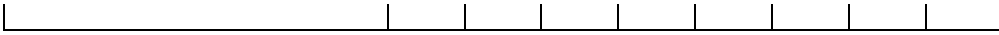
| S.N.  | Description                          | Forces about toe |                |                |                 |                 | LC-12 |
|-------|--------------------------------------|------------------|----------------|----------------|-----------------|-----------------|-------|
|       |                                      | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |       |
|       |                                      | Tonne            | Tonne          | Tonne          | Tm              | Tm              |       |
| 1)    | Sub-structure & Foundation           | 236.7            |                |                | -507.798        | 0               | 1     |
| 2)    | Backfill                             | 162.1            |                |                | -511.835        | 0               | 1     |
| 3)    | Super-structure DL                   | 155.1            |                |                | -244.322        | 0               | 1     |
| 4)    | SIDL (excluding surfacing)           | 45.8             |                |                | -72.1621        | 0               | 1     |
| 5)    | Surfacing                            | 13.3             |                |                | -20.9882        | -3.33145        | 1     |
| 6.1)  | Live Load Vertical Load Max Reaction | 89.9             |                |                | -141.54         | 261.51          | 1.3   |
| 7)    | Live Load Horizontal Forces          |                  | 26.6           |                | 117.93          |                 | 1.3   |
| 9.3)  | Earth Pressure LWL (BP, SD)          |                  |                |                |                 |                 | 0.85  |
|       | Horizontal Component                 |                  | 101.47         |                | 231.45          |                 | 0.85  |
|       | Vertical Component                   | 36.22            |                |                | -86.92          |                 | 0.85  |
| 10.3) | Surcharge Pressure LWL(BP, SD)       |                  | 47.08          |                | 129.37          |                 | 1     |

| S.N.  | Description                 | Forces about toe |                |                |                 |                 |
|-------|-----------------------------|------------------|----------------|----------------|-----------------|-----------------|
|       |                             | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|       |                             | Tonne            | Tonne          | Tonne          | Tm              | Tm              |
| LC-12 | NS(2), LWL, Max LL Lead, EP | 760.645          | 167.893        | 0              | -1135.57        | 336.634         |

| S.N.  | Description                    | Forces about toe |                |                |                 |                 | LC-19 |
|-------|--------------------------------|------------------|----------------|----------------|-----------------|-----------------|-------|
|       |                                | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |       |
|       |                                | Tonne            | Tonne          | Tonne          | Tm              | Tm              |       |
| 1)    | Sub-structure & Foundation     | 236.7            |                |                | -507.798        | 0               | 1.35  |
| 2)    | Backfill                       | 162.1            |                |                | -511.835        | 0               | 1.35  |
| 8)    | Buoyancy                       | -10.6            |                |                | 9.1             | 0.0             | 0.15  |
| 9.3)  | Earth Pressure HFL (BP, SD)    |                  |                |                |                 |                 | 1.5   |
|       | Horizontal Component           |                  | 101.5          |                | 231.4           |                 | 1.5   |
|       | Vertical Component             | 36.2             |                |                | -86.9           |                 | 1.5   |
| 10.3) | Surcharge Pressure HFL(BP, SD) |                  | 47.1           |                | 129.4           |                 | 1.2   |

| S.N.  | Description                   | Forces about toe |                |                |                 |                 |
|-------|-------------------------------|------------------|----------------|----------------|-----------------|-----------------|
|       |                               | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|       |                               | Tonne            | Tonne          | Tonne          | Tm              | Tm              |
| LC-19 | NS(1), HFL, Span dislodge, EP | 591.075          | 208.693        | 0              | -1003.1         | 0               |

| S.N.  | Description                          | Forces about toe |                |                |                 |                 | LC-20 |
|-------|--------------------------------------|------------------|----------------|----------------|-----------------|-----------------|-------|
|       |                                      | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |       |
|       |                                      | Tonne            | Tonne          | Tonne          | Tm              | Tm              |       |
| 1)    | Sub-structure & Foundation           | 236.7            |                |                | -507.798        | 0               | 1.35  |
| 2)    | Backfill                             | 162.1            |                |                | -511.835        | 0               | 1.35  |
| 3)    | Super-structure DL                   | 155.1            |                |                | -244.322        | 0               | 1.35  |
| 4)    | SIDL (excluding surfacing)           | 45.8             |                |                | -72.1621        | 0               | 1.35  |
| 5)    | Surfacing                            | 13.3             |                |                | -20.9882        | -3.33145        | 1.75  |
| 6.2)  | Live Load Vertical Load Min Reaction | 45.3             |                |                | -71.40          | 131.92          | 1.15  |
| 7)    | Live Load Horizontal Forces          |                  | 26.6           |                | 117.93          |                 | 1.15  |
| 8)    | Buoyancy                             | -10.6            |                |                | 9.1             | 0.0             | 0.15  |
| 9.3)  | Earth Pressure HFL (BP, SD)          |                  |                |                |                 |                 | 1.5   |
|       | Horizontal Component                 |                  | 101.5          |                | 231.4           |                 | 1.5   |
|       | Vertical Component                   | 36.2             |                |                | -86.9           |                 | 1.5   |
| 10.3) | Surcharge Pressure HFL(BP, SD)       |                  | 47.1           |                | 129.4           |                 | 1.2   |



| S.N.  | Description                  | Forces about toe |                |                |                 |                 |
|-------|------------------------------|------------------|----------------|----------------|-----------------|-----------------|
|       |                              | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|       |                              | Tonne            | Tonne          | Tonne          | Tm              | Tm              |
| LC-20 | NS(1), HFL, Min LL acomp, EP | 937.8            | 239.274        | 0              | -1413.56        | 145.878         |

| S.N.  | Description                          | Forces about toe |                |                |                 |                 |  | LC-21 |
|-------|--------------------------------------|------------------|----------------|----------------|-----------------|-----------------|--|-------|
|       |                                      | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |  |       |
|       |                                      | Tonne            | Tonne          | Tonne          | Tm              | Tm              |  |       |
| 1)    | Sub-structure & Foundation           | 236.7            |                |                | -507.798        | 0               |  | 1.35  |
| 2)    | Backfill                             | 162.1            |                |                | -511.835        | 0               |  | 1.35  |
| 3)    | Super-structure DL                   | 155.1            |                |                | -244.322        | 0               |  | 1.35  |
| 4)    | SIDL (excluding surfacing)           | 45.8             |                |                | -72.1621        | 0               |  | 1.35  |
| 5)    | Surfacing                            | 13.3             |                |                | -20.9882        | -3.33145        |  | 1.75  |
| 6.1)  | Live Load Vertical Load Max Reaction | 89.9             |                |                | -141.54         | 261.51          |  | 1.5   |
| 7)    | Live Load Horizontal Forces          |                  | 26.6           |                | 117.93          |                 |  | 1.5   |
| 8)    | Buoyancy                             | -10.6            |                |                | 9.1             | 0.0             |  | 0.15  |
| 9.3)  | Earth Pressure HFL (BP, SD)          |                  |                |                |                 |                 |  | 1     |
|       | Horizontal Component                 |                  | 101.5          |                | 231.4           |                 |  | 1     |
|       | Vertical Component                   | 36.2             |                |                | -86.9           |                 |  | 1     |
| 10.3) | Surcharge Pressure HFL(BP, SD)       |                  | 47.1           |                | 129.4           |                 |  | 1.2   |

| S.N.  | Description                 | Forces about toe |                |                |                 |                 |
|-------|-----------------------------|------------------|----------------|----------------|-----------------|-----------------|
|       |                             | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|       |                             | Tonne            | Tonne          | Tonne          | Tm              | Tm              |
| LC-21 | NS(1), HFL, Max LL Lead, EP | 1002.36          | 197.847        | 0              | -1574.75        | 386.438         |

| S.N.  | Description                    | Forces about toe |                |                |                 |                 |  | LC-22 |
|-------|--------------------------------|------------------|----------------|----------------|-----------------|-----------------|--|-------|
|       |                                | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |  |       |
|       |                                | Tonne            | Tonne          | Tonne          | Tm              | Tm              |  |       |
| 1)    | Sub-structure & Foundation     | 236.7            |                |                | -507.798        | 0               |  | 1     |
| 2)    | Backfill                       | 162.1            |                |                | -511.835        | 0               |  | 1     |
| 8)    | Buoyancy                       | -10.6            |                |                | 9.1             | 0.0             |  | 0.15  |
| 9.3)  | Earth Pressure HFL (BP, SD)    |                  |                |                |                 |                 |  | 1.3   |
|       | Horizontal Component           |                  | 101.5          |                | 231.4           |                 |  | 1.3   |
|       | Vertical Component             | 36.2             |                |                | -86.9           |                 |  | 1.3   |
| 10.3) | Surcharge Pressure HFL(BP, SD) |                  | 47.1           |                | 129.4           |                 |  | 1     |

| S.N.  | Description                   | Forces about toe |                |                |                 |                 |
|-------|-------------------------------|------------------|----------------|----------------|-----------------|-----------------|
|       |                               | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|       |                               | Tonne            | Tonne          | Tonne          | Tm              | Tm              |
| LC-22 | NS(2), HFL, Span dislodge, EP | 444.263          | 178.984        | 0              | -701.004        | 0               |

| S.N. | Description                          | Forces about toe |                |                |                 |                 |  | LC-23 |
|------|--------------------------------------|------------------|----------------|----------------|-----------------|-----------------|--|-------|
|      |                                      | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |  |       |
|      |                                      | Tonne            | Tonne          | Tonne          | Tm              | Tm              |  |       |
| 1)   | Sub-structure & Foundation           | 236.7            |                |                | -507.798        | 0               |  | 1     |
| 2)   | Backfill                             | 162.1            |                |                | -511.835        | 0               |  | 1     |
| 3)   | Super-structure DL                   | 155.1            |                |                | -244.322        | 0               |  | 1     |
| 4)   | SIDL (excluding surfacing)           | 45.8             |                |                | -72.1621        | 0               |  | 1     |
| 5)   | Surfacing                            | 13.3             |                |                | -20.9882        | -3.33145        |  | 1     |
| 6.2) | Live Load Vertical Load Min Reaction | 45.3             |                |                | -71.40          | 131.92          |  | 1     |
| 7)   | Live Load Horizontal Forces          |                  | 26.6           |                | 117.93          |                 |  | 1     |
| 8)   | Buoyancy                             | -10.6            |                |                | 9.1             | 0.0             |  | 0.15  |
| 9.3) | Earth Pressure HFL (BP, SD)          |                  |                |                |                 |                 |  | 1.3   |
|      | Horizontal Component                 |                  | 101.5          |                | 231.4           |                 |  | 1.3   |
|      | Vertical Component                   | 36.2             |                |                | -86.9           |                 |  | 1.3   |



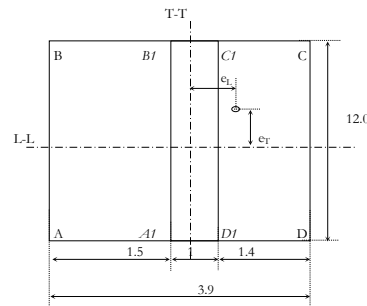
|       |                                |  |      |  |       |  |  |   |
|-------|--------------------------------|--|------|--|-------|--|--|---|
| 10.3) | Surcharge Pressure HFL(BP, SD) |  | 47.1 |  | 129.4 |  |  | 1 |
|-------|--------------------------------|--|------|--|-------|--|--|---|

| S.N.  | Description                 | Forces about toe |                |                |                 |                 |
|-------|-----------------------------|------------------|----------------|----------------|-----------------|-----------------|
|       |                             | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|       |                             | Tonne            | Tonne          | Tonne          | Tm              | Tm              |
| LC-23 | NS(2), HFL, Min LL acom, EP | 703.865          | 205.576        | 0              | -991.942        | 128.589         |

| S.N.  | Description                          | Forces about toe |                |                |                 |                 | LC-24 |
|-------|--------------------------------------|------------------|----------------|----------------|-----------------|-----------------|-------|
|       |                                      | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |       |
|       |                                      | Tonne            | Tonne          | Tonne          | Tm              | Tm              |       |
| LC-24 | NS(2), HFL, Max LL Lead, EP          |                  |                |                |                 |                 |       |
| 1)    | Sub-structure & Foundation           | 236.7            |                |                | -507.798        | 0               | 1     |
| 2)    | Backfill                             | 162.1            |                |                | -511.835        | 0               | 1     |
| 3)    | Super-structure DL                   | 155.1            |                |                | -244.322        | 0               | 1     |
| 4)    | SIDL (excluding surfacing)           | 45.8             |                |                | -72.1621        | 0               | 1     |
| 5)    | Surfacing                            | 13.3             |                |                | -20.9882        | -3.33145        | 1     |
| 6.1)  | Live Load Vertical Load Max Reaction | 89.9             |                |                | -141.54         | 261.51          | 1.3   |
| 7)    | Live Load Horizontal Forces          |                  | 26.6           |                | 117.93          |                 | 1.3   |
| 8)    | Buoyancy                             | -10.6            |                |                | 9.1             | 0.0             | 0.15  |
| 9.3)  | Earth Pressure HFL (BP, SD)          |                  |                |                |                 |                 | 0.85  |
|       | Horizontal Component                 |                  | 101.5          |                | 231.4           |                 | 0.85  |
|       | Vertical Component                   | 36.2             |                |                | -86.9           |                 | 0.85  |
| 10.3) | Surcharge Pressure HFL(BP, SD)       |                  | 47.1           |                | 129.4           |                 | 1     |

| S.N.  | Description                 | Forces about toe |                |                |                 |                 |
|-------|-----------------------------|------------------|----------------|----------------|-----------------|-----------------|
|       |                             | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|       |                             | Tonne            | Tonne          | Tonne          | Tm              | Tm              |
| LC-24 | NS(2), HFL, Max LL Lead, EP | 759.061          | 167.893        | 0              | -1134.2         | 336.634         |

**BASE PRESSRE CALCULATION**  
**ULS LOAD COMBINATIONS**



| Coordinates of basecorner |        |        |
|---------------------------|--------|--------|
| Edges                     | x (m)  | z (m)  |
| A                         | -1.950 | 6.000  |
| B                         | -1.950 | -6.000 |
| C                         | 1.950  | -6.000 |
| D                         | 1.950  | 6.000  |

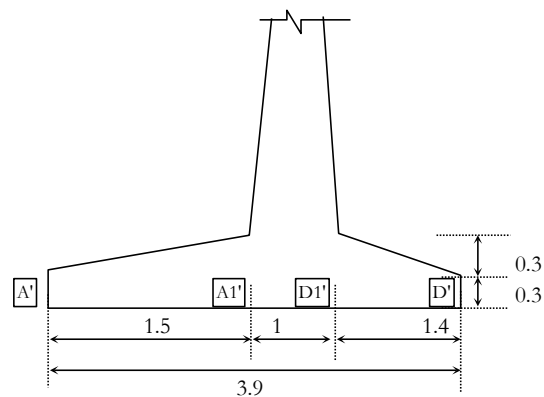
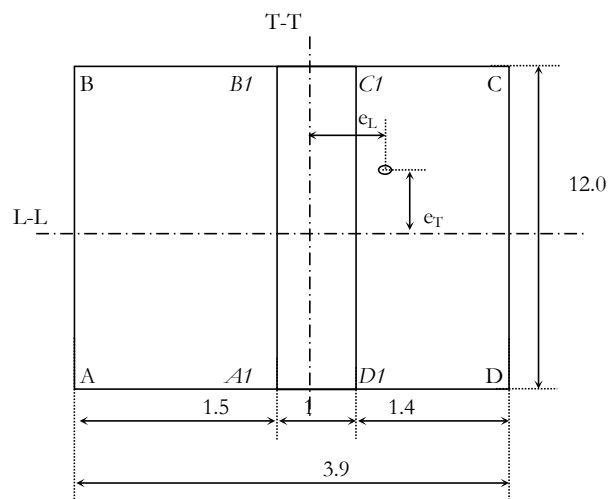
| Properties of Base |                         |   |                       |
|--------------------|-------------------------|---|-----------------------|
| Area               | 3.9x12                  | = | 46.8 m <sup>2</sup>   |
| I <sub>TT</sub>    | 12x3.9 <sup>3</sup> /12 | = | 59.319 m <sup>4</sup> |
| I <sub>LL</sub>    | 3.9x12 <sup>3</sup> /12 | = | 561.6 m <sup>4</sup>  |

**CHECK FOR MAXIMUM BASE PRESSRE**

| SUMMARY OF FORCES : |  |                  |                |                |                 |                 | Eccentricity of Vertical load from toe point |                     | Eccentricity of Vertical load wrt cg of base |                | Moment and forces at cg of base |                  | Gross Base Pressure = $P/A \pm M_{TT} * x / I_{TT} \pm M_{LL} * z / I_{LL}$ |                  |                  |                  |
|---------------------|--|------------------|----------------|----------------|-----------------|-----------------|--|---------------------|--|----------------|---------------------------------|------------------|---|------------------|------------------|------------------|
| S.N.                | Description                              | Forces about toe |                |                |                 |                 | e <sub>L</sub>                               | e <sub>T</sub>      | e <sub>L</sub>                               | e <sub>T</sub> | M <sub>TT</sub>                 | M <sub>LL</sub>  | base pressure at footing corners  |                  |                  |                  |
|                     |  | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> | M <sub>TT</sub> / V                          | M <sub>LL</sub> / V | B/2-e <sub>L</sub>                           | e <sub>T</sub> | V*e <sub>L</sub>                | V*e <sub>T</sub> | A   | B                | C                | D                |
|                     |  | Tonne            | Tonne          | Tonne          | Tm              | Tm              | m  | m                   | m  | m              | Tm                              | Tm               | T/m <sup>2</sup>  | T/m <sup>2</sup> | T/m <sup>2</sup> | T/m <sup>2</sup> |
| LC-1                | NS(1), LWL, Span dislodge, FP            | 538.334          |                |                |                 |                 |  |                     |  |                |                                 |                  |   |                  |                  |                  |
| LC-2                | NS(1), LWL, Span dislodge, EP            | 592.659          | 208.693        | 0              | -1004.5         | 0               | -1.69  | 0.00                | 0.26   | 0.00           | 151.2                           | 0.0              | 7.7   | 7.7              | 17.6             | 17.6             |
| LC-3                | NS(1), LWL, Min LL acomp, FP             |                  |                |                |                 |                 |  |                     |  |                |                                 |                  |   |                  |                  |                  |
| LC-4                | NS(1), LWL, Min LL acomp, EP             | 939.384          | 239.274        | 0              | -1414.9         | 145.878         | -1.51  | 0.16                | 0.44   | 0.16           | 416.9                           | 145.9            | 7.9   | 4.8              | 32.2             | 35.3             |
| LC-5                | NS(1), LWL, Max LL Lead, FP              |                  |                |                |                 |                 |  |                     |  |                |                                 |                  |   |                  |                  |                  |
| LC-6                | NS(1), LWL, Max LL Lead, EP              | 1003.94          | 197.847        | 0              | -1576.1         | 386.438         | -1.57  | 0.38                | 0.38   | 0.38           | 381.6                           | 386.4            | 13.0  | 4.8              | 29.9             | 38.1             |
| LC-7                | NS(2), LWL, Span dislodge, FP            |                  |                |                |                 |                 |  |                     |  |                |                                 |                  |   |                  |                  |                  |
| LC-8                | NS(2), LWL, Span dislodge, EP            | 445.847          | 178.984        | 0              | -702.37         | 0               | -1.58  | 0.00                | 0.37   | 0.00           | 167.0                           | 0.0              | 4.0   | 4.0              | 15.0             | 15.0             |
| LC-9                | NS(2), LWL, Min LL acomp, FP             |                  |                |                |                 |                 |  |                     |  |                |                                 |                  |   |                  |                  |                  |
| LC-10               | NS(2), LWL, Min LL acomp, EP             | 705.449          | 205.576        | 0              | -993.31         | 128.589         | -1.41  | 0.18                | 0.54   | 0.18           | 382.3                           | 128.6            | 3.9   | 1.1              | 26.3             | 29.0             |
| LC-11               | NS(2), LWL, Max LL Lead, FP              |                  |                |                |                 |                 |  |                     |  |                |                                 |                  |   |                  |                  |                  |
| LC-12               | NS(2), LWL, Max LL Lead, EP              | 760.645          | 167.893        | 0              | -1135.6         | 336.634         | -1.49  | 0.44                | 0.46   | 0.44           | 347.7                           | 336.6            | 8.4   | 1.2              | 24.1             | 31.3             |
| LC-13               | SIS,LWL, Span dislodge ,Seismic Sx=1,Sz= | 588.795          | 187.428        | 24.889         | -971.17         | 111.256         | -1.65  | 0.19                | 0.30   | 0.19           | 177.0                           | 111.3            | 8.0   | 5.6              | 17.2             | 19.6             |
| LC-14               | SIS, LWL,Span dislodge ,Seismic Sx=1,Sz= | 572.994          | 176.559        | 24.889         | -968.86         | 111.256         | -1.69  | 0.19                | 0.26   | 0.19           | 148.5                           | 111.3            | 8.6   | 6.2              | 15.9             | 18.3             |
| LC-15               | SIS,LWL,Min LL Acc,Seismic Sx=1,Sz=      | 908.342          | 265.558        | 49.7781        | -1208.2         | 243.065         | -1.33  | 0.27                | 0.62   | 0.27           | 563.0                           | 243.1            | 3.5   | -1.7             | 35.3             | 40.5             |
| LC-16               | SIS, LWL,Min LL Acc,Seismic Sx=1,Sz=     | 875.097          | 245.523        | 49.7781        | -1193.7         | 243.065         | -1.36  | 0.28                | 0.59   | 0.28           | 512.7                           | 243.1            | 4.4   | -0.8             | 33.0             | 38.1             |
| LC-17               | SIS,LWL,Max LL Acc,Seismic Sx=1,Sz=      | 917.493          | 265.558        | 50.8786        | -1222.6         | 276.358         | -1.33  | 0.30                | 0.62   | 0.30           | 566.5                           | 276.4            | 3.9   | -2.0             | 35.3             | 41.2             |
| LC-18               | SIS, LWL,Max LL Acc,Seismic Sx=1,Sz=     | 883.759          | 245.523        | 50.8786        | -1207.4         | 276.358         | -1.37  | 0.31                | 0.58   | 0.31           | 515.9                           | 276.4            | 4.9   | -1.0             | 32.9             | 38.8             |
| LC-19               | NS(1), HFL, Span dislodge, EP            | 591.075          | 208.693        | 0              | -1003.1         | 0               | -1.70  | 0.00                | 0.25   | 0.00           | 149.5                           | 0.0              | 7.7   | 7.7              | 17.5             | 17.5             |
| LC-20               | NS(1), HFL, Min LL acomp, EP             | 937.8            | 239.274        | 0              | -1413.6         | 145.878         | -1.51  | 0.16                | 0.44   | 0.16           | 415.1                           | 145.9            | 7.9   | 4.8              | 32.1             | 35.2             |
| LC-21               | NS(1), HFL, Max LL Lead, EP              | 1002.36          | 197.847        | 0              | -1574.7         | 386.438         | -1.57  | 0.39                | 0.38   | 0.39           | 379.8                           | 386.4            | 13.1  | 4.8              | 29.8             | 38.0             |
| LC-22               | NS(2), HFL, Span dislodge, EP            | 444.263          | 178.984        | 0              | -701            | 0               | -1.58  | 0.00                | 0.37   | 0.00           | 165.3                           | 0.0              | 4.1   | 4.1              | 14.9             | 14.9             |
| LC-23               | NS(2), HFL, Min LL acomp, EP             | 703.865          | 205.576        | 0              | -991.94         | 128.589         | -1.41  | 0.18                | 0.54   | 0.18           | 380.6                           | 128.6            | 3.9   | 1.2              | 26.2             | 28.9             |
| LC-24               | NS(2), HFL, Max LL Lead, EP              | 759.061          | 167.893        | 0              | -1134.2         | 336.634         | -1.49  | 0.44                | 0.46   | 0.44           | 346.0                           | 336.6            | 8.4   | 1.2              | 24.0             | 31.2             |
| LC-25               | SIS,HFL, Span dislodge ,Seismic Sx=1,Sz= | 587.211          | 187.428        | 24.889         | -969.8          | 111.256         | -1.65  | 0.19                | 0.30   | 0.19           | 175.3                           | 111.3            | 8.0   | 5.6              | 17.1             | 19.5             |
| LC-26               | SIS, HFL,Span dislodge ,Seismic Sx=1,Sz= | 571.41           | 176.559        | 24.889         | -967.49         | 111.256         | -1.69  | 0.19                | 0.26   | 0.19           | 146.8                           | 111.3            | 8.6   | 6.2              | 15.8             | 18.2             |
| LC-27               | SIS,HFL,Min LL Acc,Seismic Sx=1,Sz=      | 906.758          | 265.558        | 49.7781        | -1206.9         | 243.065         | -1.33  | 0.27                | 0.62   | 0.27           | 561.3                           | 243.1            | 3.5   | -1.7             | 35.2             | 40.4             |
| LC-28               | SIS, HFL,Min LL Acc,Seismic Sx=1,Sz=     | 873.513          | 245.523        | 49.7781        | -1192.4         | 243.065         | -1.37  | 0.28                | 0.58   | 0.28           | 511.0                           | 243.1            | 4.5   | -0.7             | 32.9             | 38.1             |
| LC-29               | SIS,HFL,Max LL Acc,Seismic Sx=1,Sz=      | 915.909          | 265.558        | 50.8786        | -1221.3         | 276.358         | -1.33  | 0.30                | 0.62   | 0.30           | 564.7                           | 276.4            | 4.0   | -1.9             | 35.2             | 41.1             |
| LC-30               | SIS, HFL,Max LL Acc,Seismic Sx=1,Sz=     | 882.175          | 245.523        | 50.8786        | -1206           | 276.358         | -1.37  | 0.31                | 0.58   | 0.31           | 514.2                           | 276.4            | 4.9   | -1.0             | 32.8             | 38.7             |

### NET BASE PRESSRE CALCULATION

### ULS LOAD COMBINATIONS



Deduction due to overburden pressure LWL:

| LWL        | A'    | A1'   | D'   | D1'  | Comb-1 | Comb-2 | Comb-3 |
|------------|-------|-------|------|------|--------|--------|--------|
| Earth fill | 10.4  | 9.8   | 0    | 0    | 1.35   | 1      | 1.35   |
| footing    | 0.75  | 1.5   | 0.75 | 1.5  | 1.35   | 1      | 1.35   |
| Comb-1     | 15.05 | 15.26 | 1.01 | 2.03 |        |        |        |
| Comb-2     | 11.15 | 11.30 | 0.75 | 1.50 |        |        |        |
| Comb-3     | 15.05 | 15.26 | 1.01 | 2.03 |        |        |        |

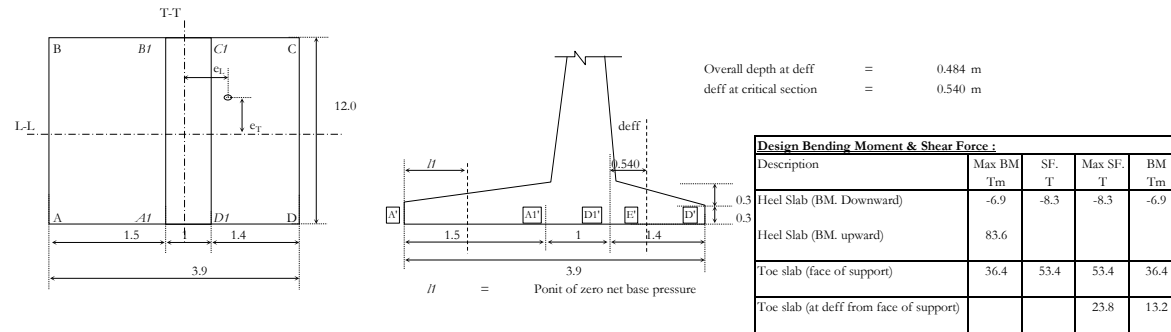
Deduction due to overburden pressure HFL:

| LWL           | A'           | A1'          | D'          | D1'         | Comb-1 | Comb-2 | Comb-3 |
|---------------|--------------|--------------|-------------|-------------|--------|--------|--------|
| Earth fill    | 10.4         | 9.8          | 0           | 0           | 1.35   | 1      | 1.35   |
| footing       | 0.75         | 1.5          | 0.75        | 1.5         | 1.35   | 1      | 1.35   |
| Bouency       | -0.1         | -0.1         | -0.3        | -0.6        | 0.15   | 0.15   | 0.15   |
| <b>Comb-1</b> | <b>15.04</b> | <b>15.24</b> | <b>0.97</b> | <b>1.94</b> |        |        |        |
| <b>Comb-2</b> | <b>11.14</b> | <b>11.29</b> | <b>0.71</b> | <b>1.41</b> |        |        |        |
| <b>Comb-3</b> | <b>15.04</b> | <b>15.24</b> | <b>0.97</b> | <b>1.94</b> |        |        |        |

**DESIGN OF HEEL SLAB**

| <b>SUMMARY OF FORCES :</b> |   | <b>Gross Base Pressure = <math>P/A \pm M_{TT} *x / I_{TT} \pm M_{LL} *z / I_{LL}</math></b> |                        |                        |                        | <b>Average Gross Base Pressure at Critical points</b> |                        |                        |                        | <b>NET BASE PRESSURE</b>                |                        |                        |                        |
|----------------------------|---|---|------------------------|------------------------|------------------------|---|------------------------|------------------------|------------------------|---|------------------------|------------------------|------------------------|
| <b>S.No.</b>               | <b>Description</b>                        | <b>base pressure at footing corners</b>   |                        |                        |                        | <b>base pressure at footing corners</b>               |                        |                        |                        | <b>base pressure at footing corners</b> |                        |                        |                        |
|                            |   | <b>A</b>  | <b>B</b>               | <b>C</b>               | <b>D</b>               | <b>A'</b>   | <b>A1'</b>             | <b>D'</b>              | <b>D1'</b>             | <b>A'</b>                               | <b>A1'</b>             | <b>D'</b>              | <b>D1'</b>             |
|                            |   | <b>T/m<sup>2</sup></b>  | <b>T/m<sup>2</sup></b> | <b>T/m<sup>2</sup></b> | <b>T/m<sup>2</sup></b> | <b>T/m<sup>2</sup></b>                                | <b>T/m<sup>2</sup></b> | <b>T/m<sup>2</sup></b> | <b>T/m<sup>2</sup></b> | <b>T/m<sup>2</sup></b>                  | <b>T/m<sup>2</sup></b> | <b>T/m<sup>2</sup></b> | <b>T/m<sup>2</sup></b> |
| LC-1                       | NS(1), LWL, Span dislodge, FP             | 0.0   | 0.0                    | 0.0                    | 0.0                    | 0.0   | 0.0                    | 0.0                    | 0.0                    |   |                        |                        |                        |
| LC-2                       | NS(1), LWL, Span dislodge, EP             | 7.7   | 7.7                    | 17.6                   | 17.6                   | 7.7   | 11.5                   | 17.6                   | 14.1                   | -7.4                                    | -3.7                   | 16.6                   | 12.0                   |
| LC-3                       | NS(1), LWL, Min LL acomp, FP              | 0.0   | 0.0                    | 0.0                    | 0.0                    | 0.0   | 0.0                    | 0.0                    | 0.0                    |   |                        |                        |                        |
| LC-4                       | NS(1), LWL, Min LL acomp, EP              | 7.9   | 4.8                    | 32.2                   | 35.3                   | 6.4   | 16.9                   | 33.8                   | 23.9                   | -8.7                                    | 1.7                    | 32.8                   | 21.9                   |
| LC-5                       | NS(1), LWL, Max LL Lead, FP               | 0.0   | 0.0                    | 0.0                    | 0.0                    | 0.0   | 0.0                    | 0.0                    | 0.0                    | -15.1                                   | -15.3                  | -1.0                   | -2.0                   |
| LC-6                       | NS(1), LWL, Max LL Lead, EP               | 13.0  | 4.8                    | 29.9                   | 38.1                   | 8.9   | 18.6                   | 34.0                   | 25.0                   | -6.1                                    | 3.3                    | 33.0                   | 23.0                   |
| LC-7                       | NS(2), LWL, Span dislodge, FP             | 0.0   | 0.0                    | 0.0                    | 0.0                    | 0.0   | 0.0                    | 0.0                    | 0.0                    | -11.2                                   | -11.3                  | -0.8                   | -1.5                   |
| LC-8                       | NS(2), LWL, Span dislodge, EP             | 4.0   | 4.0                    | 15.0                   | 15.0                   | 4.0   | 8.3                    | 15.0                   | 11.1                   | -7.1                                    | -3.0                   | 14.3                   | 9.6                    |
| LC-9                       | NS(2), LWL, Min LL acomp, FP              | 0.0   | 0.0                    | 0.0                    | 0.0                    | 0.0   | 0.0                    | 0.0                    | 0.0                    | -11.2                                   | -11.3                  | -0.8                   | -1.5                   |
| LC-10                      | NS(2), LWL, Min LL acom, EP               | 3.9   | 1.1                    | 26.3                   | 29.0                   | 2.5   | 12.2                   | 27.6                   | 18.6                   | -8.6                                    | 0.9                    | 26.9                   | 17.1                   |
| LC-11                      | NS(2), LWL, Max LL Lead, FP               | 0.0   | 0.0                    | 0.0                    | 0.0                    | 0.0   | 0.0                    | 0.0                    | 0.0                    | -11.2                                   | -11.3                  | -0.8                   | -1.5                   |
| LC-12                      | NS(2), LWL, Max LL Lead, EP               | 8.4   | 1.2                    | 24.1                   | 31.3                   | 4.8   | 13.6                   | 27.7                   | 19.5                   | -6.3                                    | 2.3                    | 26.9                   | 18.0                   |
| LC-13                      | SIS,LWL, Span dislodge ,Seismic Sx=1,Sz=0 | 8.0   | 5.6                    | 17.2                   | 19.6                   | 6.8   | 11.2                   | 18.4                   | 14.2                   | -4.4                                    | -0.1                   | 17.6                   | 12.7                   |
| LC-14                      | SIS, LWL,Span dislodge ,Seismic Sx=1,Sz=0 | 8.6   | 6.2                    | 15.9                   | 18.3                   | 7.4   | 11.1                   | 17.1                   | 13.6                   | -3.8                                    | -0.2                   | 16.4                   | 12.1                   |
| LC-15                      | SIS,LWL,Min LL Acc,Seismic Sx=1,Sz=0      | 3.5   | -1.7                   | 35.3                   | 40.5                   | 0.9   | 15.1                   | 37.9                   | 24.6                   | -10.2                                   | 3.8                    | 37.2                   | 23.1                   |
| LC-16                      | SIS, LWL,Min LL Acc,Seismic Sx=1,Sz=0     | 4.4   | -0.8                   | 33.0                   | 38.1                   | 1.8   | 14.8                   | 35.6                   | 23.5                   | -9.3                                    | 3.5                    | 34.8                   | 22.0                   |
| LC-17                      | SIS,LWL,Max LL Acc,Seismic Sx=1,Sz=0      | 3.9   | -2.0                   | 35.3                   | 41.2                   | 1.0   | 15.3                   | 38.2                   | 24.9                   | -10.2                                   | 4.0                    | 37.5                   | 23.4                   |
| LC-18                      | SIS, LWL,Max LL Acc,Seismic Sx=1,Sz=0     | 4.9   | -1.0                   | 32.9                   | 38.8                   | 1.9   | 15.0                   | 35.8                   | 23.7                   | -9.2                                    | 3.7                    | 35.1                   | 22.2                   |
| LC-19                      | NS(1), HFL, Span dislodge, EP             | 7.7   | 7.7                    | 17.5                   | 17.5                   | 7.7   | 11.5                   | 17.5                   | 14.0                   | -7.3                                    | -3.7                   | 16.6                   | 12.1                   |
| LC-20                      | NS(1), HFL, Min LL acomp, EP              | 7.9   | 4.8                    | 32.1                   | 35.2                   | 6.4   | 16.9                   | 33.7                   | 23.9                   | -8.6                                    | 1.6                    | 32.7                   | 22.0                   |
| LC-21                      | NS(1), HFL, Max LL Lead, EP               | 13.1  | 4.8                    | 29.8                   | 38.0                   | 8.9   | 18.5                   | 33.9                   | 24.9                   | -6.1                                    | 3.3                    | 32.9                   | 23.0                   |
| LC-22                      | NS(2), HFL, Span dislodge, EP             | 4.1   | 4.1                    | 14.9                   | 14.9                   | 4.1   | 8.2                    | 14.9                   | 11.0                   | -7.1                                    | -3.0                   | 14.2                   | 9.6                    |
| LC-23                      | NS(2), HFL, Min LL acom, EP               | 3.9   | 1.2                    | 26.2                   | 28.9                   | 2.5   | 12.2                   | 27.6                   | 18.6                   | -8.6                                    | 0.9                    | 26.8                   | 17.2                   |
| LC-24                      | NS(2), HFL, Max LL Lead, EP               | 8.4   | 1.2                    | 24.0                   | 31.2                   | 4.8   | 13.6                   | 27.6                   | 19.4                   | -6.3                                    | 2.3                    | 26.9                   | 18.0                   |
| LC-25                      | SIS,HFL, Span dislodge ,Seismic Sx=1,Sz=0 | 8.0   | 5.6                    | 17.1                   | 19.5                   | 6.8   | 11.2                   | 18.3                   | 14.2                   | -4.4                                    | -0.1                   | 17.6                   | 12.7                   |
| LC-26                      | SIS, HFL,Span dislodge ,Seismic Sx=1,Sz=0 | 8.6   | 6.2                    | 15.8                   | 18.2                   | 7.4   | 11.1                   | 17.0                   | 13.6                   | -3.8                                    | -0.2                   | 16.3                   | 12.1                   |
| LC-27                      | SIS,HFL,Min LL Acc,Seismic Sx=1,Sz=0      | 3.5   | -1.7                   | 35.2                   | 40.4                   | 0.9   | 15.1                   | 37.8                   | 24.6                   | -10.2                                   | 3.8                    | 37.1                   | 23.1                   |
| LC-28                      | SIS, HFL,Min LL Acc,Seismic Sx=1,Sz=0     | 4.5   | -0.7                   | 32.9                   | 38.1                   | 1.9   | 14.8                   | 35.5                   | 23.4                   | -9.3                                    | 3.5                    | 34.7                   | 21.9                   |
| LC-29                      | SIS,HFL,Max LL Acc,Seismic Sx=1,Sz=0      | 4.0   | -1.9                   | 35.2                   | 41.1                   | 1.0   | 15.3                   | 38.1                   | 24.8                   | -10.1                                   | 4.0                    | 37.4                   | 23.3                   |
| LC-30                      | SIS, HFL,Max LL Acc,Seismic Sx=1,Sz=0     | 4.9   | -1.0                   | 32.8                   | 38.7                   | 1.9   | 14.9                   | 35.8                   | 23.6                   | -9.2                                    | 3.6                    | 35.0                   | 22.1                   |

**FINDING BENDING MOMENT & SHEAR FORCE AT CRITICAL SECTION  
ULS LOAD COMBINATIONS**



**DESIGN OF HEEL SLAB**

**SUMMARY OF FORCES :**

|       |  | NET BASE PRESSURE                |                  |                  |                  |                  | Point of<br>zero net<br>base<br>pressure | Point of<br>zero base<br>pressure | BENDING MOMENT & SHEAR FORCE |      |          |                      |                      |                      |                      |   |    |
|-------|--|----------------------------------|------------------|------------------|------------------|------------------|--|-----------------------------------|------------------------------|------|----------|----------------------|----------------------|----------------------|----------------------|---|----|
| S.N.  | Description                              | base pressure at footing corners |                  |                  |                  |                  |  |                                   | Heel Slab                    |      | Toe Slab |                      |                      |                      |                      |   |    |
|       |  | A'                               | A1'              | D'               | D1'              | E1'              |  |                                   | BM                           | SF   |          | BM   <sub>face</sub> | SF   <sub>face</sub> | SF   <sub>deff</sub> | BM   <sub>deff</sub> |   |    |
|       |  | T/m <sup>2</sup>                 | T/m <sup>2</sup> | T/m <sup>2</sup> | T/m <sup>2</sup> | T/m <sup>2</sup> |  |                                   | l'                           | BM   | BM       | T                    |                      | Tm                   | T                    | T | Tm |
|       |  |                                  |                  |                  |                  |                  |  | m                                 | Tm                           |      |          |                      |                      |                      |                      |   |    |
| LC-1  | NS(1), LWL, Span dislodge, FP            |                                  |                  |                  |                  |                  |  |                                   |                              |      |          |                      |                      |                      |                      |   |    |
| LC-2  | NS(1), LWL, Span dislodge, EP            | -7.4                             | -3.7             | 16.6             | 12.0             | 14.9             | 0.00                                     | 0.00                              | -6.9                         | -8.3 | 14.8     | 20.1                 | 11.6                 | 5.9                  |                      |   |    |
| LC-3  | NS(1), LWL, Min LL accomp, FP            |                                  |                  |                  |                  |                  |  |                                   |                              |      |          |                      |                      |                      |                      |   |    |
| LC-4  | NS(1), LWL, Min LL accomp, EP            | -8.7                             | 1.7              | 32.8             | 21.9             | 28.6             | 0.00                                     | 0.00                              | -5.9                         | -5.3 | 28.6     | 38.3                 | 21.7                 | 11.6                 |                      |   |    |
| LC-5  | NS(1), LWL, Max LL Lead, FP              |                                  |                  |                  |                  |                  |  |                                   |                              |      |          |                      |                      |                      |                      |   |    |
| LC-6  | NS(1), LWL, Max LL Lead, EP              | -6.1                             | 3.3              | 33.0             | 23.0             | 29.1             | 0.00                                     | 0.00                              | -3.4                         | -2.1 | 29.1     | 39.2                 | 22.4                 | 11.7                 |                      |   |    |
| LC-7  | NS(2), LWL, Span dislodge, FP            |                                  |                  |                  |                  |                  |  |                                   |                              |      |          |                      |                      |                      |                      |   |    |
| LC-8  | NS(2), LWL, Span dislodge, EP            | -7.1                             | -3.0             | 14.3             | 9.6              | 12.5             | 0.00                                     | 0.00                              | -6.5                         | -7.6 | 12.4     | 16.7                 | 9.5                  | 5.1                  |                      |   |    |
| LC-9  | NS(2), LWL, Min LL accomp, FP            |                                  |                  |                  |                  |                  |  |                                   |                              |      |          |                      |                      |                      |                      |   |    |
| LC-10 | NS(2), LWL, Min LL accomp, EP            | -8.6                             | 0.9              | 26.9             | 17.1             | 23.1             | 0.00                                     | 0.00                              | -6.2                         | -5.8 | 23.2     | 30.8                 | 17.3                 | 9.5                  |                      |   |    |
| LC-11 | NS(2), LWL, Max LL Lead, FP              |                                  |                  |                  |                  |                  |  |                                   |                              |      |          |                      |                      |                      |                      |   |    |
| LC-12 | NS(2), LWL, Max LL Lead, EP              | -6.3                             | 2.3              | 26.9             | 18.0             | 23.5             | 0.00                                     | 0.00                              | -3.9                         | -3.0 | 23.5     | 31.4                 | 17.8                 | 9.5                  |                      |   |    |
| LC-13 | SIS,LWL, Span dislodge ,Seismic Sx=1,Sz= | -4.4                             | -0.1             | 17.6             | 12.7             | 15.7             | 0  | 0                                 | -3.3                         | -3.3 | 15.7     | 21.3                 | 12.2                 | 6.3                  |                      |   |    |
| LC-14 | SIS, LWL,Span dislodge ,Seismic Sx=1,Sz= | -3.8                             | -0.2             | 16.4             | 12.1             | 14.7             | 0  | 0                                 | -2.9                         | -3.0 | 14.7     | 19.9                 | 11.5                 | 5.9                  |                      |   |    |
| LC-15 | SIS,LWL,Min LL Acc,Seismic Sx=1,Sz=      | -10.2                            | 3.8              | 37.2             | 23.1             | 31.8             | 0  | 0                                 | -6.2                         | -4.8 | 31.8     | 42.2                 | 23.6                 | 13.1                 |                      |   |    |
| LC-16 | SIS, LWL,Min LL Acc,Seismic Sx=1,Sz=     | -9.3                             | 3.5              | 34.8             | 22.0             | 29.8             | 0  | 0                                 | -5.7                         | -4.3 | 29.9     | 39.7                 | 22.3                 | 12.3                 |                      |   |    |
| LC-17 | SIS,LWL,Max LL Acc,Seismic Sx=1,Sz=      | -10.2                            | 4.0              | 37.5             | 23.4             | 32.0             | 0  | 0                                 | -6.1                         | -4.6 | 32.1     | 42.6                 | 23.8                 | 13.2                 |                      |   |    |
| LC-18 | SIS, LWL,Max LL Acc,Seismic Sx=1,Sz=     | -9.2                             | 3.7              | 35.1             | 22.2             | 30.1             | 0  | 0                                 | -5.5                         | -4.2 | 30.2     | 40.1                 | 22.5                 | 12.4                 |                      |   |    |
| LC-19 | NS(1), HFL, Span dislodge, EP            | -7.3                             | -3.7             | 16.6             | 12.1             | 14.8             | 0.00                                     | 0.00                              | -6.9                         | -8.3 | 14.8     | 20.1                 | 11.6                 | 5.9                  |                      |   |    |
| LC-20 | NS(1), HFL, Min LL accomp, EP            | -8.6                             | 1.6              | 32.7             | 22.0             | 28.6             | 0.00                                     | 0.00                              | -5.9                         | -5.2 | 28.5     | 38.3                 | 21.7                 | 11.6                 |                      |   |    |
| LC-21 | NS(1), HFL, Max LL Lead, EP              | -6.1                             | 3.3              | 32.9             | 23.0             | 29.1             | 0.00                                     | 0.00                              | -3.3                         | -2.1 | 29.0     | 39.2                 | 22.4                 | 11.7                 |                      |   |    |
| LC-22 | NS(2), HFL, Span dislodge, EP            | -7.1                             | -3.0             | 14.2             | 9.6              | 12.4             | 0.00                                     | 0.00                              | -6.4                         | -7.6 | 12.4     | 16.7                 | 9.5                  | 5.0                  |                      |   |    |
| LC-23 | NS(2), HFL, Min LL accomp, EP            | -8.6                             | 0.9              | 26.8             | 17.2             | 23.1             | 0.00                                     | 0.00                              | -6.1                         | -5.8 | 23.1     | 30.8                 | 17.3                 | 9.5                  |                      |   |    |
| LC-24 | NS(2), HFL, Max LL Lead, EP              | -6.3                             | 2.3              | 26.9             | 18.0             | 23.5             | 0.00                                     | 0.00                              | -3.9                         | -3.0 | 23.5     | 31.4                 | 17.8                 | 9.5                  |                      |   |    |
| LC-25 | SIS,HFL, Span dislodge ,Seismic Sx=1,Sz= | 8.0                              | 5.6              | 17.1             | 19.5             | 6.8              | 5.03                                     | 67.30                             | 8.1                          | 10.2 | 17.6     | 25.6                 | 11.3                 | 5.1                  |                      |   |    |
| LC-26 | SIS, HFL,Span dislodge ,Seismic Sx=1,Sz= | 8.6                              | 6.2              | 15.8             | 18.2             | 7.4              | 5.41                                     | 83.65                             | 8.8                          | 11.1 | 16.3     | 23.8                 | 11.0                 | 4.8                  |                      |   |    |
| LC-27 | SIS,HFL,Min LL Acc,Seismic Sx=1,Sz=      | 3.5                              | -1.7             | 35.2             | 40.4             | 0.9              | 1.02                                     | 1.21                              | 2.0                          | 1.4  | 36.2     | 53.0                 | 17.8                 | 8.8                  |                      |   |    |
| LC-28 | SIS, HFL,Min LL Acc,Seismic Sx=1,Sz=     | 4.5                              | -0.7             | 32.9             | 38.1             | 1.9              | 1.29                                     | 2.47                              | 3.1                          | 2.8  | 33.9     | 49.6                 | 17.2                 | 8.3                  |                      |   |    |
| LC-29 | SIS,HFL,Max LL Acc,Seismic Sx=1,Sz=      | 4.0                              | -1.9             | 35.2             | 41.1             | 1.0              | 1.01                                     | 1.33                              | 2.2                          | 1.5  | 36.4     | 53.4                 | 18.1                 | 8.8                  |                      |   |    |
| LC-30 | SIS, HFL,Max LL Acc,Seismic Sx=1,Sz=     | 4.9                              | -1.0             | 32.8             | 38.7             | 1.9              | 1.24                                     | 2.53                              | 3.3                          | 2.9  | 34.1     | 50.1                 | 17.5                 | 8.3                  |                      |   |    |

## DESIGN OF TOE SLAB :

### (ULS) CHECK FOR BENDING MOMENT

Design Bending Moment  $M_{ED}$  = 36.4 Tm

$a_l$  = d (shifting moment curve by a distance  $a_l$ )

D = 0.6 m \*/ overall depth at face of support

d = 0.515 m \*/ deff at face of support

D' = 0.490 m \*/ overall depth at d from face of support

d' = 0.405 m \*/ deff at d from face of support

Clear Cover = 75 mm

Ast Provided = 20  $\phi$  @ 130 c/c  
+ 0  $\phi$  @ 130 c/c LAYER-2  
= 2417 mm<sup>2</sup>/m

Grade of Concrete fck = 35 Mpa

Grade of steel fyk = 500 Mpa

xu = 0.87 fyk Ast / 0.362 fck b  
= 83 mm

x<sub>u\_max</sub> = 0.456 d'  
= 185 mm UNDER REINFORCED

Ast calculated = M / 0.87 fyk (d' - 0.416 xu)

= 2261 mm<sup>2</sup>/m

Ast minimum = 0.15% \* b \* d

= 773 mm<sup>2</sup>/m

Ast required = Max( 2261 , 773 )

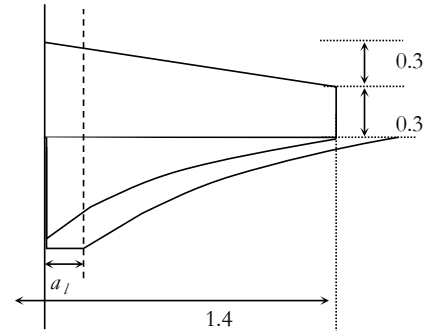
= 2261 mm<sup>2</sup>/m < 2417 mm<sup>2</sup>/m OK

Distribution steel = 20% of Ast.main (Refer clause 16.6.1 of IRC :112-2011)

= 483 mm<sup>2</sup>/m

Provide distribution steel as 16  $\phi$  @ 150 c/c

1340 mm<sup>2</sup>/m OK



|                       |   |         |
|-----------------------|---|---------|
| fyk                   | = | 500 Mpa |
| ε <sub>uk</sub>       | = | 0.0025  |
| ε <sub>ud</sub>       | = | 0.00225 |
| fck                   | = | 35 Mpa  |
| ε <sub>cu2</sub>      | = | 0.0035  |
| x <sub>u_max</sub> /d | = | 0.4560  |

**(SLS) CHECK FOR STRESSES (RARE & QUASI PERMANENT LOAD COMBINATIONS)**

$$\begin{aligned}
 \text{Design Bending Moment } M_{\text{RARE}} &= 22.06 \text{ Tm} \\
 M_{\text{QP}} &= 13.93 \text{ Tm} \\
 M_{\text{ST}} &= M_{\text{RARE}} - M_{\text{QP}} \quad (\text{Bending Moment due to short term loading}) \\
 &= 8.13 \text{ Tm}
 \end{aligned}$$

$$\begin{aligned}
 \text{Modulus of Elasticity for Concrete} \\
 \text{For short term loading } E_{\text{cm}} &= 32308 \text{ Mpa} \\
 \text{Creep coefficient } \phi &= 1 \\
 \text{For long term loading } E_{\text{cm}}' &= 16154 \text{ Mpa}
 \end{aligned}$$

$$\text{Reinf. modulus of elasticity } E_s = 200000 \text{ N/mm}^2$$

$$\text{Modular ratio for QP Combination} = E_s / E_{\text{cm}}' = 12.38$$

Equavelent Modulus of Elasticity for Rare Combination :

$$E_{\text{c,eq}} = \frac{E_{\text{cm}} * (M_{\text{QP}} + M_{\text{ST}})}{M_{\text{ST}} + (1 + \phi) * M_{\text{QP}}} = 19806 \text{ MPa}$$

$$\text{Modular ratio for Rare Combination} = E_s / E_{\text{c,eq}} = 10.10$$

| Formula used for calculation of stress    |   |
|---|---|
| dc (depth of neutral axis)                | $= \frac{-m * A_s + \sqrt{(m^2 * A_s^2 + 2 * m * A_s * b * d)}}{b}$ |
| $I_{\text{NA}}$ (Transformed)             | $= b * dc^3 / 3 + m * A_s * (d - dc)^2$                             |
| Compressive stress in concrete $\sigma_c$ | $= M_{\text{RARE}} * dc / I_{\text{NA}}$                            |
| Tensile stress in steel $\sigma_s$        | $= m * M_{\text{RARE}} * (d - dc) / I_{\text{NA}}$                  |

| <i>Description</i>                        | <i>Stress Check For Rare Combination</i> | <i>Stress Check For QP Combination</i> |
|---|--|--|
| Design Moment                             | = 22.06 Tm                               | = 13.93 Tm                             |
| Total Depth at section                    | = 0.6 m                                  | = 0.6 m                                |
| deff                                      | = 0.515 m                                | = 0.515 m                              |
| width b                                   | = 1 m                                    | = 1 m                                  |
| $A_{\text{st, provided}}$                 | = 2417 mm <sup>2</sup> /m                | = 2417 mm <sup>2</sup> /m              |
| Modular ratio                             | = 10.10                                  | = 12.38                                |
| dc (depth of neutral axis)                | = 136 mm                                 | = 148 mm                               |
| $I_{\text{NA}}$ (Transformed)             | = 4.34E+09 mm <sup>4</sup>               | = 5.11E+09 mm <sup>4</sup>             |
| Compressive stress in concrete $\sigma_c$ | = 6.91 N/mm <sup>2</sup>                 | = 4.04 N/mm <sup>2</sup>               |
| Permissible Compressive stress            | = 16.8 N/mm <sup>2</sup> OK              | = 12.6 N/mm <sup>2</sup> OK            |
| Tensile stress in steel $\sigma_s$        | = 194 N/mm <sup>2</sup>                  | = 124 N/mm <sup>2</sup>                |
| Permissible tensile stress                | = 300 N/mm <sup>2</sup> OK               | = 400 N/mm <sup>2</sup> OK             |

**(SLS) CHECK FOR CRACK WIDTH (QUASI PERMANENT LOAD COMBINATIONS)**

Minimum Reinforcement for crack control :

$$A_{s,min} = k_c k f_{ct,eff} A_{ct} / \sigma_s \quad (IRC 112 / clause 12.3.3 (2))$$

For Web

$$k_c = 0.4 \text{ For Bending member}$$

$$h = 0.6 \text{ m}, \quad b = 1 \text{ m}$$

$$k = 0.79$$

$$f_{ct,eff} = f_{ctm} = 2.77 \text{ Mpa}$$

$A_{ct}$  = Area of concrete within tensile zone just before the first crack form, section behaves elastically until the tensile fiber stress reaches  $f_{ctm}$ . hence Neutral axis depth will be considered for gross section

$$A_{ct} = b * h / 2 = 0.3 \text{ m}^2$$

$$\sigma_s = \text{Maximum stress permitted in reinf. Immediately after formation of crack} = f_{yk} = 500 \text{ Mpa}$$

$$A_{s,min} = 525 \text{ mm}^2/\text{m} < 2417 \text{ mm}^2/\text{m} \quad \text{OK}$$

Calculation of crack width : (IRC 112 / clause 12.3.4)

$$w_{k,max} = 0.3 \text{ mm}$$

$$\text{Clear cover } c = 75 \text{ mm}$$

$$\text{Bar dia } \phi_{eq} = 20.00 \text{ mm}$$

$$5(c + \phi_{eq}/2) = 425 \text{ mm}$$

$$\text{Spacing b/w bars} = 130 \text{ mm} < 425 \text{ mm}$$

$$s_{rmax} = \text{Maximum crack spacing} = 3.4c + 0.17 \phi / \rho_{Peff} = 466.903 \text{ mm}$$

The Following formula can be used for calculation of maximum crack spacing.

$$h_{c,eff} = \text{Min} \begin{cases} 2.5 (h - d) \\ (h - x)/3 \\ h/2 \end{cases} = 0.15061 \text{ m}$$

|     |     |  |
|-----|-----|--|
| $h$ | $=$ | $0.6 \text{ m}$  |
| $d$ | $=$ | $0.515 \text{ m}$  |
| $x$ | $=$ | $0.14815969 \text{ m} \quad */ \text{ (for Quasi Permanent Load combination)}$ |

$$\text{width } b = 1 \text{ m}$$

$$A_{c,eff} = h_{c,eff} * b = 0.15061 \text{ m}^2$$



$$\begin{aligned}
\rho_{p,eff} &= A_s / A_{c,eff} \\
&= 2417 / 150613 \\
&= 0.0160 \\
\sigma_{sc} &= \text{Stress in tension Reinforcement assuming cracked section} \\
&= 123.76 \text{ Mpa} \quad */ \text{ (for Quasi Permanent Load combination)} \\
E_s &= 200000 \text{ Mpa} \\
E_{cm}' &= 16154 \text{ Mpa} \quad */ \text{ (for Long term loading)} \\
\alpha_e &= E_s / E_{cm} \\
\alpha_e &= 12.38 \\
k_t &= 0.5 \quad (\text{factor dependent on duration of load}) \\
\varepsilon_{sm} - \varepsilon_{cm} &= \text{Max} \left\{ \begin{array}{l} \frac{\sigma_{sc} - k_t f_{ct,eff} (1 + \alpha_e \rho_{p,eff}) / \rho_{p,eff}}{E_s} \\ 0.6 \sigma_{sc} / E_s \end{array} \right. \\
&= 0.00037 \\
w_k &= s_{rmax} (\varepsilon_{sm} - \varepsilon_{cm}) \\
&= 0.173 \text{ mm} < 0.300 \text{ mm} \quad \text{OK}
\end{aligned}$$

**(ULS) CHECK FOR SHEAR FORCE** (Section At deff from face of Support)

$$\begin{aligned}
\text{Factored Shear Force } V_{ED} &= 23.82 \text{ T} \\
\text{Corresponding BM } M_{ED} &= 13.19 \text{ Tm}
\end{aligned}$$

$$\begin{aligned}
V_{CCD} &= \text{Reductin in Shear force due to inclined compression chord} \\
&= M_{ED} / d * \sin\beta
\end{aligned}$$

$$\beta = 12.095 \text{ deg} \quad */ \text{Inclination angle of compression chord.}$$

$$V_{CCD} = 6.829 \text{ T}$$

$$\begin{aligned}
\text{Design Shear Force } V_{NS} &= V_{ED} - V_{CCD} \\
&= 16.99 \text{ Tonne}
\end{aligned}$$

Reduction in Design Shear For Within Zone (  $a_v = 0.5d$  to  $2d$ )

$$a_v = 0.515 \text{ m}$$

$$\begin{aligned}
\text{Reduction factor } \beta_1 &= a_v / 2d \\
&= 0.5
\end{aligned}$$

$$\begin{aligned}
\text{Design Shear Force } V_{NS}' &= \beta_1 * V_{NS} \\
&= 8.49 \text{ Tonne}
\end{aligned}$$

**Max Shear Capacity of section**

$$v = 0.6 * (1 - f_{ck} / 310) \quad \text{*/ } f_{ck} \text{ in Mpa}$$

$$= 0.5323$$

$$f_{cd} = 0.447 * f_{ck}$$

$$= 15.63 \text{ Mpa}$$

$$V_{RDC, \max} = 0.5 b_w d v f_{cd}$$

$$= 168 \text{ Tonne} > 8.49 \text{ Tonne} \quad \text{OK}$$

$$D' = 0.490 \text{ m} \quad \text{*/ overall depth at face of support}$$

$$d' = 0.405 \text{ m} \quad \text{*/ deff at face of support}$$

**Check for Design Shear Reinforcement :**

$$k = \text{Min} \left\{ \begin{array}{l} 1 + \sqrt{200/d} \\ 2 \end{array} \right. \quad d \text{ is depth in mm}$$

$$k = 1.703$$

$$\rho_1 = \text{Min} \left\{ \begin{array}{l} A_{sl} / b_w d \\ 0.02 \end{array} \right.$$

$$\rho_1 = 0.00597$$

$$\sigma_{cp} = 0 \text{ Mpa}$$

$$v_{\min} = 0.031 k^{3/2} f_{ck}^{1/2}$$

$$= 0.408$$

$$V_{Rdc} = \text{Max} \left\{ \begin{array}{l} (0.12 k (80 \rho_1 f_{ck})^{0.33} + 0.15 \sigma_{cp}) b_w d \\ (v_{\min} + 0.15 \sigma_{cp}) b_w d \end{array} \right. \quad (IRC 112 / \text{ clause } 10.3.2 (2))$$

$$= 20.95 \text{ Tonne} > 8.49 \text{ Tonne} \quad \text{NO SHEAR REINFORCEMENT REQUIRED}$$

## DESIGN OF HEEL SLAB :

### (ULS) CHECK FOR BENDING MOMENT

Design Bending Moment  $M_{ED}$  = 6.92 Tm

$a_l$  = d (shifting moment curve by a distance  $a_l$ )

D = 0.6 m \*/ overall depth at face of support

d = 0.517 m \*/ deff at face of support

D' = 0.497 m \*/ overall depth at d from face of support

d' = 0.414 m \*/ deff at d from face of support

Clear Cover = 75 mm

Ast Provided = 16  $\phi$  @ 150 c/c  
 + 0  $\phi$  @ 150 c/c  
 = 1340 mm<sup>2</sup>/m

Grade of Concrete fck = 35 Mpa

Grade of steel fyk = 500 Mpa

xu = 0.87 fyk Ast / 0.362 fck b  
 = 46 mm

$x_{u_{max}}$  = 0.609 d  
 = 252 mm UNDER REINFORCED

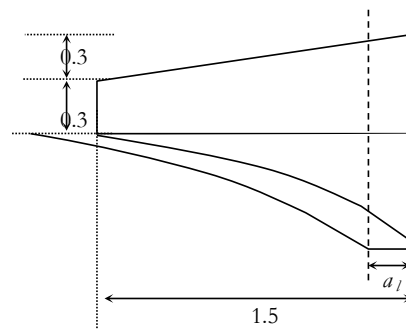
Ast calculated = M / 0.87 fyk (d - 0.416 xu)  
 = 403 mm<sup>2</sup>/m

Ast minimum = 0.15% \* b \* d  
 = 776 mm<sup>2</sup>/m

Ast required = Max( 403 , 776 )  
 = 776 mm<sup>2</sup>/m < 1340 mm<sup>2</sup>/m OK

Distribution steel = 20% of Ast.main (Refer clause 16.6.1 of IRC :112-2011)  
 = 268 mm<sup>2</sup>/m

Provide distribution steel as 16  $\phi$  @ 150 c/c  
 1340 mm<sup>2</sup>/m OK



ALTERNATE

|                  |   |         |
|------------------|---|---------|
| fyk              | = | 500 Mpa |
| $\epsilon_{uk}$  | = | 0.0025  |
| $\epsilon_{ud}$  | = | 0.00225 |
| fck              | = | 35 Mpa  |
| $\epsilon_{cu2}$ | = | 0.0035  |
| $xu_{max}/d$     | = | 0.6087  |

**(ULS) CHECK FOR SHEAR FORCE**

(Section At Face of Support)

$$\text{Factored Shear Force } V_{ED} = 8.32 \text{ T}$$

$$\text{Corresponding BM } M_{ED} = 6.92 \text{ Tm}$$

$$V_{CCD} = \text{Reduction in Shear force due to inclined compression chord}$$

$$= M_{ED} / d * \sin \beta$$

$$\beta = 11.310 \text{ deg} \quad */ \text{Inclination angle of compression chord.}$$

$$V_{CCD} = 2.626 \text{ T}$$

$$\text{Design Shear Force } V_{NS} = V_{ED} - V_{CCD}$$

$$= 5.70 \text{ Tonne}$$

Reduction in Design Shear For Within Zone ( $a_v = 0.5d$  to 0)

$$\text{Reduction factor } \beta_1 = 0.5$$

$$\text{Design Shear Force } V_{NS}' = \beta_1 * V_{NS}$$

$$= 2.85 \text{ Tonne}$$

**Max Shear Capacity of section**

$$v = 0.6 * (1 - f_{ck} / 310) \quad */ f_{ck} \text{ in Mpa}$$

$$= 0.532$$

$$f_{cd} = 0.447 * f_{ck}$$

$$= 15.63 \text{ Mpa}$$

$$V_{RDC, \max} = 0.5 b_w d v f_{cd}$$

$$= 215 \text{ Tonne} > 2.85 \text{ Tonne} \quad \text{OK}$$

$$D = 0.600 \text{ m} \quad */ \text{overall depth at face of support}$$

$$d = 0.517 \text{ m} \quad */ \text{deff at face of support}$$

**Check for Design Shear Reinforcement :**

$$k = \text{Min} \left\{ \begin{array}{l} 1 + \sqrt{200/d} \\ 2 \end{array} \right. \quad d \text{ is depth in mm}$$

$$k = 1.622$$

$$\rho_1 = \text{Min} \left\{ \begin{array}{l} A_{sl} / b_w d \\ 0.02 \end{array} \right.$$

$$\rho_1 = 0.00259$$

$$\sigma_{cp} = 0 \text{ Mpa}$$

$$v_{\min} = 0.031 k^{3/2} f_{ck}^{1/2}$$

$$= 0.379$$

r

$$V_{Rdc} = \text{Max} \left\{ \begin{array}{l} (0.12 k (80 \rho_1 f_{ck})^{0.33} + 0.15 \sigma_{cp}) b w d \\ (v_{min} + 0.15 \sigma_{cp}) b w d \end{array} \right. \quad (\text{IRC 112 / clause 10.3.2 (2)})$$

$$= 20 \text{ Tonne} > 2.8 \text{ Tonne} \quad \text{NO SHEAR REINFORCEMENT REQUIRED}$$

#### (SLS) CHECK FOR STRESSES (RARE & QUASI PERMANENT LOAD COMBINATIONS)

Design Bending Moment

$$\begin{aligned} M_{RARE} &= 4.25 \text{ Tm} \\ M_{QP} &= 0.00 \text{ Tm} \\ M_{ST} &= M_{RARE} - M_{QP} \quad (\text{Bending Moment due to short term loading}) \\ &= 4.25 \text{ Tm} \end{aligned}$$

Modulus of Elasticity for Concrete

For short term loading  $E_{cm} = 32308 \text{ Mpa}$

Creep coefficient  $\phi = 1$

For long term loading  $E_{cm}' = 16154 \text{ Mpa}$

Reinf. modulus of elasticity  $E_s = 200000 \text{ N/mm}^2$

Modular ratio for QP Combination  $= E_s / E_{cm} = 6.190$

Equavelent Modulus of Elasticity for Rare Combination :

$$E_{c,eq} = \frac{E_{cm} * (M_{QP} + M_{ST})}{M_{ST} + (1 + \phi) * M_{QP}} = 32308 \text{ MPa}$$

Modular ratio for Rare Combination  $= E_s / E_{c,eq} = 6.19$

| Formula used for calculation of stress    |   |
|---|---|
| dc (depth of neutral axis)                | $= \frac{-m * A_s + \sqrt{(m^2 * A_s^2 + 2 * m * A_s * b * d)}}{b}$ |
| $I_{NA}$ (Transformed)                    | $= b * dc^3 / 3 + m * A_s * (d - dc)^2$                             |
| Compressive stress in concrete $\sigma_c$ | $= M_{RARE} * dc / I_{NA}$  |
| Tensile stress in steel $\sigma_s$        | $= m * M_{RARE} * (d - dc) / I_{NA}$                                |

| Description                               | Stress Check For Rare Combination | Stress Check For QP Combination |
|---|-----------------------------------|---------------------------------|
| Design Moment                             | = 4.25 Tm                         | = 0.00 Tm                       |
| Total Depth at section                    | = 0.6 m                           | = 0.6 m                         |
| deff                                      | = 0.517 m                         | = 0.517 m                       |
| width b                                   | = 1 m                             | = 1 m                           |
| $A_{st, provided}$                        | = 1340.41 mm <sup>2</sup> /m      | = 1340.41 mm <sup>2</sup> /m    |
| Modular ratio                             | = 6.19                            | = 6.19                          |
| dc (depth of neutral axis)                | = 84.70 mm                        | = 84.70 mm                      |
| $I_{NA}$ (Transformed)                    | = 1.75E+09 mm <sup>4</sup>        | = 1.75E+09 mm <sup>4</sup>      |
| Compressive stress in concrete $\sigma_c$ | = 2.05 N/mm <sup>2</sup>          | = 0.00 N/mm <sup>2</sup>        |
| Permissible Compressive stress            | = 16.8 N/mm <sup>2</sup> OK       | = 12.6 N/mm <sup>2</sup> OK     |
| Tensile stress in steel $\sigma_s$        | = 64.88 N/mm <sup>2</sup>         | = 0.00 N/mm <sup>2</sup>        |
| Permissible tensile stress                | = 300 N/mm <sup>2</sup> OK        | = 400 N/mm <sup>2</sup> OK      |



**(SLS) CHECK FOR CRACK WIDTH (QUASI PERMANENT LOAD COMBINATIONS)**

**Minimum Reinforcement for crack control:**

$$\begin{aligned}
 A_{s,min} &= k_c k f_{ct,eff} A_{ct} / \sigma_s && (IRC 112 / \text{clause } 12.3.3 (2)) \\
 k_c &= 0.4 \text{ For Bending member} \\
 h &= 0.6 \text{ m} , && b = 1 \text{ m} \\
 k &= 0.79 \\
 f_{ct,eff} &= f_{ctm} = 2.77 \text{ Mpa} \\
 A_{ct} &= b * h / 2 = 0.3 \text{ m}^2 \\
 \sigma_s &= f_{yk} = 500 \text{ Mpa} \\
 A_{s,min} &= 525 \text{ mm}^2/\text{m} < 1340 \text{ mm}^2/\text{m} \text{ OK}
 \end{aligned}$$

**Calculation of crack width:** (IRC 112 / clause 12.3.4)

$$\begin{aligned}
 w_{k,max} &= 0.3 \text{ mm} \\
 \text{Clear cover } c &= 75 \text{ mm} \\
 \text{Bar dia } \phi_{eq} &= 16.00 \text{ mm} \\
 5 (c + \phi_{eq}/2) &= 415 \text{ mm} \\
 \text{Spacing b/w bars} &= 75 \text{ mm} < 415 \text{ mm}
 \end{aligned}$$

The Following formula can be used for calculation of maximum crack spacing.

$$\begin{aligned}
 s_{rmax} &= \text{Maximum crack spacing} \\
 &= 3.4c + 0.17 \phi / \rho_{Peff} \\
 &= 603.553 \text{ mm}
 \end{aligned}$$

$$\begin{aligned}
 h_{c,eff} &= \text{Min} \begin{cases} 2.5 (h - d) \\ (h - x)/3 \\ h/2 \end{cases} \\
 &= 0.172 \text{ m}
 \end{aligned}$$

|   |   |              |
|---|---|--------------|
| h | = | 0.6 m        |
| d | = | 0.517 m      |
| x | = | 0.08470032 m |

\*/ (for Quasi Permanent Load combination)

$$\text{width } b = 1 \text{ m}$$

$$A_{c,eff} = h_{c,eff} * b = 0.17177 \text{ m}^2$$

$$\begin{aligned}
 \rho_{P,eff} &= A_s / A_{c,eff} \\
 &= 1340.41 / 171767 \\
 &= 0.0078
 \end{aligned}$$

$$\begin{aligned}
 \sigma_{sc} &= \text{Stress in tension Reinforcement assuming cracked section} \\
 &= 0.00 \text{ Mpa} \quad */ \text{ (for Quasi Permanent Load combination)}
 \end{aligned}$$

$$\begin{aligned}
 E_s &= 200000 \text{ Mpa} \\
 E_{cm}' &= 16154.1 \text{ Mpa} \quad */ \text{ (for Long term loading)} \\
 \alpha_c &= E_s / E_{cm}' \\
 \alpha_c &= 12.3807
 \end{aligned}$$

$$kt = 0.5 \quad (\text{factor dependent on duration of load})$$

$$\begin{aligned}
 \epsilon_{sm} - \epsilon_{cm} &= \text{Max} \left\{ \begin{array}{l} \cdot (1 + \alpha_e \rho_{P,eff}) / \rho_{P,eff} \\ E_s \\ 0.6 \sigma_{sc} / E_s \end{array} \right. \\
 &= 0 \\
 w_k &= s_{rmax} (\epsilon_{sm} - \epsilon_{cm}) \\
 &= 0.000 \text{ mm} < 0.300 \text{ mm} \quad \text{OK}
 \end{aligned}$$





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DESIGN OF FOUNDATION  
SLS LOAD COMBINATION

| LC-2        | QP, LWL, EP                 | Forces about toe |                |                |                 |                 |  | LC-2 |
|-------------|-----------------------------|------------------|----------------|----------------|-----------------|-----------------|--|------|
| S.N.        | Description                 | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |  |      |
|             |                             | Tonne            | Tonne          | Tonne          | Tm              | Tm              |  |      |
| 1)          | Sub-structure & Foundation  | 236.66084        |                |                | -507.7978       | 0               |  | 1    |
| 2)          | Backfill                    | 162.105          |                |                | -511.8345       | 0               |  | 1    |
| 3)          | Super-structure DL          | 155.125          |                |                | -244.3219       | 0               |  | 1    |
| 4)          | SIDL (excluding surfacing)  | 45.817188        |                |                | -72.16207       | 0               |  | 1    |
| 5)          | Surfacing                   | 13.325813        |                |                | -20.98815       | -3.331453       |  | 1    |
| <b>9.3)</b> | Earth Pressure LWL (BP, SD) |                  |                |                |                 |                 |  | 1    |
|             | Horizontal Component        |                  | 101.47         |                | 231.45          |                 |  | 1    |
|             | Vertical Component          | 36.216469        |                |                | -86.92          |                 |  | 1    |

| S.N. | Description | Forces about toe |                |                |                 |                 |
|------|-------------|------------------|----------------|----------------|-----------------|-----------------|
|      |             | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|      |             | Tonne            | Tonne          | Tonne          | Tm              | Tm              |
| LC-2 | QP, LWL, EP | 649.25031        | 101.46756      | 0              | -1212.578       | -3.331453       |

| LC-4        | RARE, LWL, Span dislodge EP    | Forces about toe |                |                |                 |                 |  | LC-4 |
|-------------|--------------------------------|------------------|----------------|----------------|-----------------|-----------------|--|------|
| S.N.        | Description                    | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |  |      |
|             |                                | Tonne            | Tonne          | Tonne          | Tm              | Tm              |  |      |
| 1)          | Sub-structure & Foundation     | 236.66084        |                |                | -507.7978       | 0               |  | 1    |
| 2)          | Backfill                       | 162.105          |                |                | -511.8345       | 0               |  | 1    |
| <b>9.3)</b> | Earth Pressure LWL (BP, SD)    |                  |                |                |                 |                 |  | 1    |
|             | Horizontal Component           |                  | 101.47         |                | 231.45          |                 |  | 1    |
|             | Vertical Component             | 36.216469        |                |                | -86.92          |                 |  | 1    |
| 10.3)       | Surcharge Pressure LWL(BP, SD) |                  | 47.08          |                | 129.37          |                 |  | 0.8  |

| S.N. | Description                 | Forces about toe |                |                |                 |                 |
|------|-----------------------------|------------------|----------------|----------------|-----------------|-----------------|
|      |                             | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|      |                             | Tonne            | Tonne          | Tonne          | Tm              | Tm              |
| LC-4 | RARE, LWL, Span dislodge EP | 434.98231        | 139.12875      | 0              | -771.606        | 0               |

| LC-6        | RARE, LWL, Min LL acomp, EP          | Forces about toe |                |                |                 |                 |  | LC-6 |
|-------------|--------------------------------------|------------------|----------------|----------------|-----------------|-----------------|--|------|
| S.N.        | Description                          | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |  |      |
|             |                                      | Tonne            | Tonne          | Tonne          | Tm              | Tm              |  |      |
| 1)          | Sub-structure & Foundation           | 236.66084        |                |                | -507.7978       | 0               |  | 1    |
| 2)          | Backfill                             | 162.105          |                |                | -511.8345       | 0               |  | 1    |
| 3)          | Super-structure DL                   | 155.125          |                |                | -244.3219       | 0               |  | 1    |
| 4)          | SIDL (excluding surfacing)           | 45.817188        |                |                | -72.16207       | 0               |  | 1    |
| 5)          | Surfacing                            | 13.325813        |                |                | -20.98815       | -3.331453       |  | 1    |
| 6.2)        | Live Load Vertical Load Min Reaction | 45.333333        |                |                | -71.40          | 131.92          |  | 0.75 |
| 7)          | Live Load Horizontal Forces          |                  | 26.592         |                | 117.93434       |                 |  | 0.75 |
| <b>9.3)</b> | Earth Pressure LWL (BP, SD)          |                  |                |                |                 |                 |  | 1    |
|             | Horizontal Component                 |                  | 101.47         |                | 231.45          |                 |  | 1    |
|             | Vertical Component                   | 36.216469        |                |                | -86.92          |                 |  | 1    |
| 10.3)       | Surcharge Pressure LWL(BP, SD)       |                  | 47.08          |                | 129.37          |                 |  | 0.8  |

|  |  |  |  |  |  |  |  |
|--|--|--|--|--|--|--|--|
|  |  |  |  |  |  |  |  |
|--|--|--|--|--|--|--|--|

| S.N. | Description                 | Forces about toe |                |                |                 |                 |
|------|-----------------------------|------------------|----------------|----------------|-----------------|-----------------|
|      |                             | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|      |                             | Tonne            | Tonne          | Tonne          | Tm              | Tm              |
| LC-6 | RARE, LWL, Min LL acomp, EP | 683.25031        | 159.07255      | 0              | -1074.177       | 95.608547       |

| S.N.  | Description                          | Forces about toe |                |                |                 |                 | LC-8 |
|-------|--------------------------------------|------------------|----------------|----------------|-----------------|-----------------|------|
|       |                                      | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |      |
|       |                                      | Tonne            | Tonne          | Tonne          | Tm              | Tm              |      |
| LC-8  | RARE, LWL, Max LL lead, EP           |                  |                |                |                 |                 |      |
| 1)    | Sub-structure & Foundation           | 236.66084        |                |                | -507.7978       | 0               | 1    |
| 2)    | Backfill                             | 162.105          |                |                | -511.8345       | 0               | 1    |
| 3)    | Super-structure DL                   | 155.125          |                |                | -244.3219       | 0               | 1    |
| 4)    | SIDL (excluding surfacing)           | 45.817188        |                |                | -72.16207       | 0               | 1    |
| 5)    | Surfacing                            | 13.325813        |                |                | -20.98815       | -3.331453       | 1    |
| 6.1)  | Live Load Vertical Load Max Reaction | 89.866667        |                |                | -141.54         | 261.51          | 1    |
| 7)    | Live Load Horizontal Forces          |                  | 26.592         |                | 117.93434       |                 | 1    |
| 9.3)  | Earth Pressure LWL (BP, SD)          |                  |                |                |                 |                 | 1    |
|       | Horizontal Component                 |                  | 101.47         |                | 231.45          |                 | 1    |
|       | Vertical Component                   | 36.216469        |                |                | -86.92          |                 | 1    |
| 10.3) | Surcharge Pressure LWL(BP, SD)       |                  | 47.08          |                | 129.37          |                 | 0.8  |

| S.N. | Description                | Forces about toe |                |                |                 |                 |
|------|----------------------------|------------------|----------------|----------------|-----------------|-----------------|
|      |                            | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|      |                            | Tonne            | Tonne          | Tonne          | Tm              | Tm              |
| LC-8 | RARE, LWL, Max LL lead, EP | 739.11697        | 165.72048      | 0              | -1132.684       | 258.18055       |

| S.N. | Description                 | Forces about toe |                |                |                 |                 | LC-9 |
|------|-----------------------------|------------------|----------------|----------------|-----------------|-----------------|------|
|      |                             | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |      |
|      |                             | Tonne            | Tonne          | Tonne          | Tm              | Tm              |      |
| LC-9 | QP, HFL, EP                 |                  |                |                |                 |                 |      |
| 1)   | Sub-structure & Foundation  | 236.66084        |                |                | -507.7978       | 0               | 1    |
| 2)   | Backfill                    | 162.105          |                |                | -511.8345       | 0               | 1    |
| 3)   | Super-structure DL          | 155.125          |                |                | -244.3219       | 0               | 1    |
| 4)   | SIDL (excluding surfacing)  | 45.817188        |                |                | -72.16207       | 0               | 1    |
| 5)   | Surfacing                   | 13.325813        |                |                | -20.98815       | -3.331453       | 1    |
| 8)   | Buoyancy                    | -10.6            |                |                | 9.1             | 0.0             | 0.15 |
| 9.3) | Earth Pressure HFL (BP, SD) |                  |                |                |                 |                 | 1    |
|      | Horizontal Component        |                  | 101.5          |                | 231.4           |                 | 1    |
|      | Vertical Component          | 36.2             |                |                | -86.9           |                 | 1    |

| S.N. | Description | Forces about toe |                |                |                 |                 |
|------|-------------|------------------|----------------|----------------|-----------------|-----------------|
|      |             | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|      |             | Tonne            | Tonne          | Tonne          | Tm              | Tm              |
| LC-9 | QP, HFL, EP | 647.66631        | 101.46756      | 0              | -1211.209       | -3.331453       |

| S.N.  | Description                 | Forces about toe |                |                |                 |                 | LC-10 |
|-------|-----------------------------|------------------|----------------|----------------|-----------------|-----------------|-------|
|       |                             | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |       |
|       |                             | Tonne            | Tonne          | Tonne          | Tm              | Tm              |       |
| LC-10 | RARE, HFL, Span dislodge EP |                  |                |                |                 |                 |       |
| 1)    | Sub-structure & Foundation  | 236.66084        |                |                | -507.7978       | 0               | 1     |

|       |                                |         |       |  |           |     |  |      |
|-------|--------------------------------|---------|-------|--|-----------|-----|--|------|
| 2)    | Backfill                       | 162.105 |       |  | -511.8345 | 0   |  | 1    |
| 8)    | Buoyancy                       | -10.6   |       |  | 9.1       | 0.0 |  | 0.15 |
| 9.3)  | Earth Pressure HFL (BP, SD)    |         |       |  |           |     |  | 1    |
|       | Horizontal Component           |         | 101.5 |  | 231.4     |     |  | 1    |
|       | Vertical Component             | 36.2    |       |  | -86.9     |     |  | 1    |
| 10.3) | Surcharge Pressure HFL(BP, SD) |         | 47.1  |  | 129.4     |     |  | 0.8  |

| S.N.  | Description                 | Forces about toe |                |                |                 |                 |
|-------|-----------------------------|------------------|----------------|----------------|-----------------|-----------------|
|       |                             | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|       |                             | Tonne            | Tonne          | Tonne          | Tm              | Tm              |
| LC-10 | RARE, HFL, Span dislodge EP | 433.39831        | 139.12875      | 0              | -770.2371       | 0               |

| S.N.  | Description                          | Forces about toe |                |                |                 |                 | LC-11 |
|-------|--------------------------------------|------------------|----------------|----------------|-----------------|-----------------|-------|
|       |                                      | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |       |
|       |                                      | Tonne            | Tonne          | Tonne          | Tm              | Tm              |       |
| 1)    | Sub-structure & Foundation           | 236.66084        |                |                | -507.7978       | 0               | 1     |
| 2)    | Backfill                             | 162.105          |                |                | -511.8345       | 0               | 1     |
| 3)    | Super-structure DL                   | 155.125          |                |                | -244.3219       | 0               | 1     |
| 4)    | SIDL (excluding surfacing)           | 45.817188        |                |                | -72.16207       | 0               | 1     |
| 5)    | Surfacing                            | 13.325813        |                |                | -20.98815       | -3.331453       | 1     |
| 6.2)  | Live Load Vertical Load Min Reaction | 45.333333        |                |                | -71.40          | 131.92          | 0.75  |
| 7)    | Live Load Horizontal Forces          |                  | 26.592         |                | 117.93434       |                 | 0.75  |
| 8)    | Buoyancy                             | -10.6            |                |                | 9.1             | 0.0             | 0.15  |
| 9.3)  | Earth Pressure HFL (BP, SD)          |                  |                |                |                 |                 | 1     |
|       | Horizontal Component                 |                  | 101.5          |                | 231.4           |                 | 1     |
|       | Vertical Component                   | 36.2             |                |                | -86.9           |                 | 1     |
| 10.3) | Surcharge Pressure HFL(BP, SD)       |                  | 47.1           |                | 129.4           |                 | 0.8   |

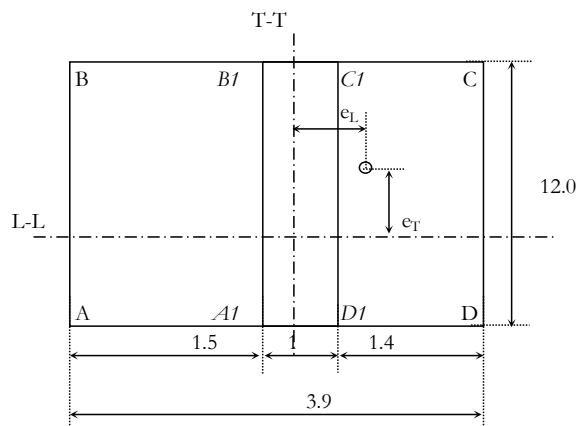
| S.N.  | Description                 | Forces about toe |                |                |                 |                 |
|-------|-----------------------------|------------------|----------------|----------------|-----------------|-----------------|
|       |                             | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|       |                             | Tonne            | Tonne          | Tonne          | Tm              | Tm              |
| LC-11 | RARE, HFL, Min LL acomp, EP | 681.66631        | 159.07255      | 0              | -1072.808       | 95.608547       |

| S.N.  | Description                          | Forces about toe |                |                |                 |                 | LC-12 |
|-------|--------------------------------------|------------------|----------------|----------------|-----------------|-----------------|-------|
|       |                                      | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |       |
|       |                                      | Tonne            | Tonne          | Tonne          | Tm              | Tm              |       |
| 1)    | Sub-structure & Foundation           | 236.66084        |                |                | -507.7978       | 0               | 1     |
| 2)    | Backfill                             | 162.105          |                |                | -511.8345       | 0               | 1     |
| 3)    | Super-structure DL                   | 155.125          |                |                | -244.3219       | 0               | 1     |
| 4)    | SIDL (excluding surfacing)           | 45.817188        |                |                | -72.16207       | 0               | 1     |
| 5)    | Surfacing                            | 13.325813        |                |                | -20.98815       | -3.331453       | 1     |
| 6.1)  | Live Load Vertical Load Max Reaction | 89.866667        |                |                | -141.54         | 261.51          | 1     |
| 7)    | Live Load Horizontal Forces          |                  | 26.592         |                | 117.93434       |                 | 1     |
| 8)    | Buoyancy                             | -10.6            |                |                | 9.1             | 0.0             | 0.15  |
| 9.3)  | Earth Pressure HFL (BP, SD)          |                  |                |                |                 |                 | 1     |
|       | Horizontal Component                 |                  | 101.5          |                | 231.4           |                 | 1     |
|       | Vertical Component                   | 36.2             |                |                | -86.9           |                 | 1     |
| 10.3) | Surcharge Pressure HFL(BP, SD)       |                  | 47.1           |                | 129.4           |                 | 0.8   |

| S.N.  | Description                | Forces about toe |                |                |                 |                 |
|-------|----------------------------|------------------|----------------|----------------|-----------------|-----------------|
|       |                            | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|       |                            | Tonne            | Tonne          | Tonne          | Tm              | Tm              |
| LC-12 | RARE, HFL, Max LL lead, EP | 737.53297        | 165.72048      | 0              | -1131.315       | 258.18055       |

# BASE PRESSRE CALCULATION

## SLS LOAD COMBINATIONS



| Coordinates of basecorner |        |        |
|---------------------------|--------|--------|
| Edges                     | x (m)  | z (m)  |
| A                         | -1.950 | 6.000  |
| B                         | -1.950 | -6.000 |
| C                         | 1.950  | -6.000 |
| D                         | 1.950  | 6.000  |

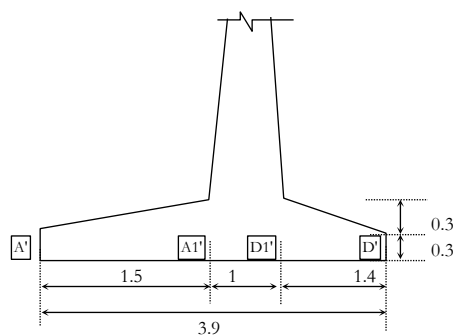
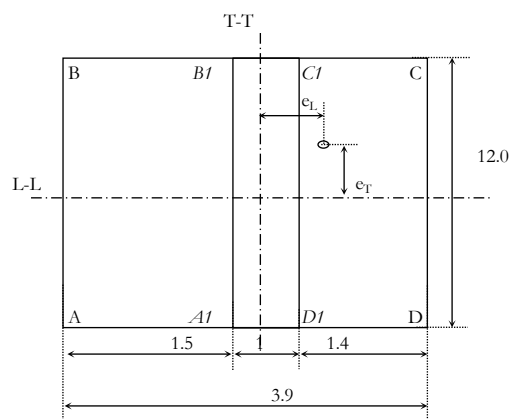
| Properties of Base |                         |   |                       |
|--------------------|-------------------------|---|-----------------------|
| Area               | 3.9x12                  | = | 46.8 m <sup>2</sup>   |
| I <sub>TT</sub>    | 12x3.9 <sup>3</sup> /12 | = | 59.32 m <sup>4</sup>  |
| I <sub>LL</sub>    | 3.9x12 <sup>3</sup> /12 | = | 561.60 m <sup>4</sup> |

## CHECK FOR MAXIMUM BASE PRESSRE

### SUMMARY OF FORCES :

|       |                             |                  |                |                |                 |                 | <i>Eccentricity of Vertical load from toe point</i> |                     | <i>Eccentricity of Vertical load wrt cg of base</i> |                 | <i>Moment and forces at cg of base</i> |                  | <i>Gross Base Pressure = P/ A ± M<sub>TT</sub> *x / I<sub>TT</sub> ± M<sub>LL</sub> *z / I<sub>LL</sub></i> |                  |                  |                  |
|-------|-----------------------------|------------------|----------------|----------------|-----------------|-----------------|---|---------------------|---|-----------------|--|------------------|---|------------------|------------------|------------------|
| S.N.  | Description                 | Forces about toe |                |                |                 |                 | e <sub>L1</sub>                                     | e <sub>T1</sub>     | e <sub>L</sub>                                      | e <sub>T</sub>  | M <sub>TT</sub>                        | M <sub>LL</sub>  | <i>base pressure at footing corners</i>   |                  |                  |                  |
|       |                             | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> | M <sub>TT</sub> / V                                 | M <sub>LL</sub> / V | B/2-e <sub>L1</sub>                                 | e <sub>T1</sub> | V*e <sub>L</sub>                       | V*e <sub>T</sub> | A   | B                | C                | D                |
|       |                             | Tonne            | Tonne          | Tonne          | Tm              | Tm              | m   | m                   | m   | m               | Tm                                     | Tm               | T/m <sup>2</sup>  | T/m <sup>2</sup> | T/m <sup>2</sup> | T/m <sup>2</sup> |
| LC-1  | QP, LWL, FP                 | 613.034          | 0.0288         | 0              | -1357.1         | -3.3315         |   |                     |   |                 |  |                  |   |                  |                  |                  |
| LC-2  | QP, LWL, EP                 | 649.25           | 101.468        | 0              | -1212.6         | -3.3315         | -1.87   | -0.01               | 0.08  | -0.01           | 53.5                                   | -3.3             | 12.1  | 12.2             | 15.7             | 15.6             |
| LC-3  | RARE, LWL, Span dislodge FP | 398.766          | 37.69          | 0              | -916.13         | 0               |   |                     |   |                 |  |                  |   |                  |                  |                  |
| LC-4  | RARE, LWL, Span dislodge EP | 434.982          | 139.129        | 0              | -771.61         | 0               | -1.77   | 0.00                | 0.18  | 0.00            | 76.6                                   | 0.0              | 6.8   | 6.8              | 11.8             | 11.8             |
| LC-5  | RARE, LWL, Min LL acomp, FP | 647.034          | 57.6338        | 0              | -1218.7         | 95.6085         |   |                     |   |                 |  |                  |   |                  |                  |                  |
| LC-6  | RARE, LWL, Min LL acomp, EP | 683.25           | 159.073        | 0              | -1074.2         | 95.6085         | -1.57   | 0.14                | 0.38  | 0.14            | 258.2                                  | 95.6             | 7.1   | 5.1              | 22.1             | 24.1             |
| LC-7  | RARE, LWL, Max LL lead, FP  | 702.901          | 64.2817        | 0              | -1277.2         | 258.181         |   |                     |   |                 |  |                  |   |                  |                  |                  |
| LC-8  | RARE, LWL, Max LL lead, EP  | 739.117          | 165.72         | 0              | -1132.7         | 258.181         | -1.53   | 0.35                | 0.42  | 0.35            | 308.6                                  | 258.2            | 8.4   | 2.9              | 23.2             | 28.7             |
| LC-9  | QP, HFL, EP                 | 647.666          | 101.468        | 0              | -1211.2         | -3.3315         | -1.87   | -0.01               | 0.08  | -0.01           | 51.7                                   | -3.3             | 12.1  | 12.2             | 15.6             | 15.5             |
| LC-10 | RARE, HFL, Span dislodge EP | 433.398          | 139.129        | 0              | -770.24         | 0               | -1.78   | 0.00                | 0.17  | 0.00            | 74.9                                   | 0.0              | 6.8   | 6.8              | 11.7             | 11.7             |
| LC-11 | RARE, HFL, Min LL acomp, EP | 681.666          | 159.073        | 0              | -1072.8         | 95.6085         | -1.57   | 0.14                | 0.38  | 0.14            | 256.4                                  | 95.6             | 7.2   | 5.1              | 22.0             | 24.0             |
| LC-12 | RARE, HFL, Max LL lead, EP  | 737.533          | 165.72         | 0              | -1131.3         | 258.181         | -1.53   | 0.35                | 0.42  | 0.35            | 306.9                                  | 258.2            | 8.4   | 2.9              | 23.1             | 28.6             |

**NET BASE PRESSRE CALCULATION**  
**SLS LOAD COMBINATIONS**



Deduction due to over burden LWL

| LWL           | A'           | A1'          | D'          | D1'         | Comb-1 |
|---------------|--------------|--------------|-------------|-------------|--------|
| Earth fill    | 10.4         | 9.8          | 0           | 0           | 1      |
| footing       | 0.75         | 1.5          | 0.75        | 1.5         | 1      |
| <b>Comb-1</b> | <b>11.15</b> | <b>11.30</b> | <b>0.75</b> | <b>1.50</b> |        |

Deduction due to over burden HFL

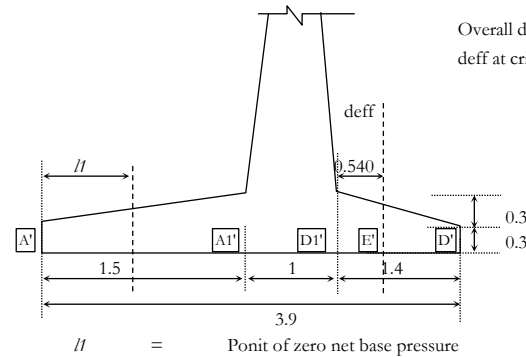
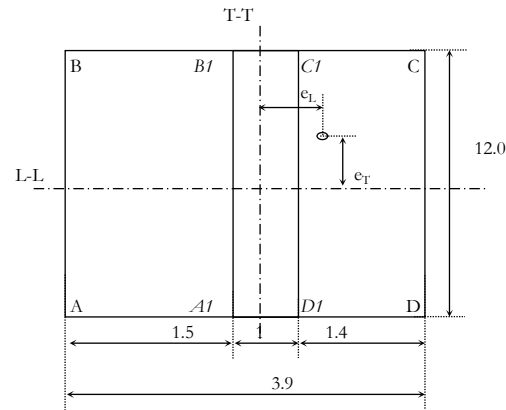
| LWL           | A'           | A1'          | D'          | D1'         | Comb-1 |
|---------------|--------------|--------------|-------------|-------------|--------|
| Earth fill    | 10.4         | 9.8          | 0           | 0           | 1      |
| footing       | 0.75         | 1.5          | 0.75        | 1.5         | 1      |
| Buoyancy      | -0.1         | -0.1         | -0.3        | -0.6        | 0.15   |
| <b>Comb-1</b> | <b>11.14</b> | <b>11.29</b> | <b>0.71</b> | <b>1.41</b> |        |

**DESIGN FORCES FOR BASE SLAB**

| <b>SUMMARY OF FORCES :</b> |                             | <b>Gross Base Pressure = <math>P/A \pm M_{TT} *x / I_{TT} \pm M_{LL} *z / I_{LL}</math></b> |                  |                  |                  | <b>Average Gross Base Pressure at Critical points</b> |                  |                  |                  | <b>NET BASE PRESSURE</b>                |                  |                  |                  |
|----------------------------|-----------------------------|---|------------------|------------------|------------------|---|------------------|------------------|------------------|---|------------------|------------------|------------------|
| S.N.                       | Description                 | <b>base pressure at footing corners</b>   |                  |                  |                  | <b>base pressure at footing corners</b>               |                  |                  |                  | <b>base pressure at footing corners</b> |                  |                  |                  |
|                            |                             | A   | B                | C                | D                | A'  | A1'              | D'               | D1'              | A'                                      | A1'              | D'               | D1'              |
|                            |                             | T/m <sup>2</sup>  | T/m <sup>2</sup> | T/m <sup>2</sup> | T/m <sup>2</sup> | T/m <sup>2</sup>                                      | T/m <sup>2</sup> | T/m <sup>2</sup> | T/m <sup>2</sup> | T/m <sup>2</sup>                        | T/m <sup>2</sup> | T/m <sup>2</sup> | T/m <sup>2</sup> |
| LC-1                       | QP, LWL, FP                 |   |                  |                  |                  |   |                  |                  |                  |   |                  |                  |                  |
| LC-2                       | QP, LWL, EP                 | 12.1  | 12.2             | 15.7             | 15.6             | 12.1  | 13.5             | 15.6             | 14.37            | 1.0                                     | 2.2              | 14.9             | 12.9             |
| LC-3                       | RARE, LWL, Span dislodge FP |   |                  |                  |                  |   |                  |                  |                  |   |                  |                  |                  |
| LC-4                       | RARE, LWL, Span dislodge EP | 6.8   | 6.8              | 11.8             | 11.8             | 6.8   | 8.7              | 11.8             | 10.00            | -4.4                                    | -2.6             | 11.1             | 8.5              |
| LC-5                       | RARE, LWL, Min LL acomp, FP |   |                  |                  |                  |   |                  |                  |                  |   |                  |                  |                  |
| LC-6                       | RARE, LWL, Min LL acomp, EP | 7.1   | 5.1              | 22.1             | 24.1             | 6.1   | 12.6             | 23.1             | 16.99            | -5.0                                    | 1.3              | 22.3             | 15.5             |
| LC-7                       | RARE, LWL, Max LL lead, FP  |   |                  |                  |                  |   |                  |                  |                  |   |                  |                  |                  |
| LC-8                       | RARE, LWL, Max LL lead, EP  | 8.4   | 2.9              | 23.2             | 28.7             | 5.6   | 13.5             | 25.9             | 18.65            | -5.5                                    | 2.2              | 25.2             | 17.2             |
| LC-9                       | QP, HFL, EP                 | 12.1  | 12.2             | 15.6             | 15.5             | 12.1  | 13.4             | 15.5             | 14.32            | 1.0                                     | 2.2              | 14.8             | 12.9             |
| LC-10                      | RARE, HFL, Span dislodge EP | 6.8   | 6.8              | 11.7             | 11.7             | 6.8   | 8.7              | 11.7             | 9.96             | -4.3                                    | -2.6             | 11.0             | 8.5              |
| LC-11                      | RARE, HFL, Min LL acomp, EP | 7.2   | 5.1              | 22.0             | 24.0             | 6.1   | 12.6             | 23.0             | 16.94            | -5.0                                    | 1.3              | 22.3             | 15.5             |
| LC-12                      | RARE, HFL, Max LL lead, EP  | 8.4   | 2.9              | 23.1             | 28.6             | 5.7   | 13.4             | 25.8             | 18.60            | -5.5                                    | 2.1              | 25.1             | 17.2             |



**FINDING BENDING MOMENT & SHEAR FORCE AT CRITICAL SECTION**  
**SLS LOAD COMBINATIONS**



| Design Bending Moment & Shear Force : |     |            |          |
|---------------------------------------|-----|------------|----------|
| Description                           |     | Rare<br>Tm | QS<br>Tm |
| Heel Slab (BM. Downward)              | LWL | -4.3       | 0.0      |
| Toe slab (face of support)            | LWL | 22.1       | 13.9     |

**DESIGN FORCES FOR BASE SLAB**

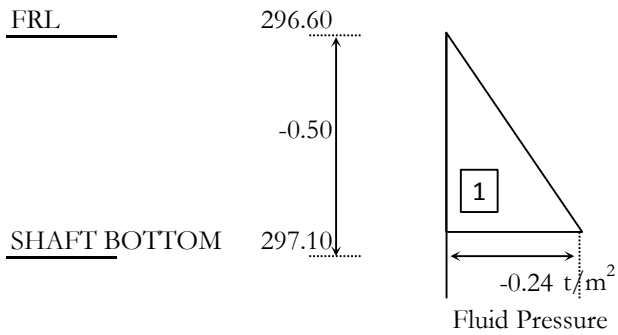
| SUMMARY OF FORCES : |                             | NET BASE PRESSURE                |                  |                  |                  |                  |
|---------------------|-----------------------------|----------------------------------|------------------|------------------|------------------|------------------|
| S.N.                | Description                 | base pressure at footing corners |                  |                  |                  |                  |
|                     |                             | A'                               | A1'              | D'               | D1'              | E1'              |
|                     |                             | T/m <sup>2</sup>                 | T/m <sup>2</sup> | T/m <sup>2</sup> | T/m <sup>2</sup> | T/m <sup>2</sup> |
| LC-1                | QP, LWL, FP                 | 0.0                              | 0.0              | 0.0              | 0.0              | 0                |
| LC-2                | QP, LWL, EP                 | 1.0                              | 2.2              | 14.9             | 12.9             | 14.1043          |
| LC-4                | RARE, LWL, Span dislodge EP | -4.4                             | -2.6             | 11.1             | 8.5              | 10.0762          |
| LC-6                | RARE, LWL, Min LL acomp, EP | -5.0                             | 1.3              | 22.3             | 15.5             | 19.6965          |
| LC-8                | RARE, LWL, Max LL lead, EP  | -5.5                             | 2.2              | 25.2             | 17.2             | 22.089           |
| LC-9                | QP, HFL, EP                 | 1.0                              | 2.2              | 14.8             | 12.9             | 14.0919          |
| LC-10               | RARE, HFL, Span dislodge EP | -4.3                             | -2.6             | 11.0             | 8.5              | 10.0638          |
| LC-11               | RARE, HFL, Min LL acomp, EP | -5.0                             | 1.3              | 22.3             | 15.5             | 19.6841          |
| LC-12               | RARE, HFL, Max LL lead, EP  | -5.5                             | 2.1              | 25.1             | 17.2             | 22.0767          |

| Point of<br>zero net<br>base<br>pressure | BM at<br>Point of<br>zero base<br>pressure |
|--|--|
| $l/l$                                    | BM   |
| m  | Tm   |
| 0.00                                     | 0.00                                       |
| -1.20                                    | 0.47                                       |
| 0.00                                     | 0.00                                       |
| 0.00                                     | 0.00                                       |
| 0.00                                     | 0.00                                       |
| -1.30                                    | 0.56                                       |
| 0.00                                     | 0.00                                       |
| 0.00                                     | 0.00                                       |
| 0.00                                     | 0  |

| BENDING MOMENT & SHEAR FORCE |      |          |           |           |           |           |
|------------------------------|------|----------|-----------|-----------|-----------|-----------|
| Heel Slab                    |      | Toe Slab |           |           |           |           |
| BM                           | SF   |          | BM   face | SF   face | SF   deff | BM   deff |
| Tm                           | T    |          | Tm        | T         | T         | Tm        |
| 0.0                          | 0.0  |          | 0.0       | 0.0       | 0.00      | 0.00      |
| 1.5                          | 2.3  |          | 13.9      | 19.4      | 11.60     | 5.41      |
| -4.3                         | -5.2 |          | 10.0      | 13.7      | 7.99      | 3.97      |
| -3.3                         | -2.8 |          | 19.7      | 26.5      | 15.13     | 7.93      |
| -3.3                         | -2.5 |          | 22.1      | 29.6      | 16.87     | 8.93      |
| 1.6                          | 2.4  |          | 13.9      | 19.4      | 11.61     | 5.39      |
| -4.2                         | -5.2 |          | 10.0      | 13.7      | 8.00      | 3.96      |
| -3.2                         | -2.7 |          | 19.6      | 26.5      | 15.14     | 7.92      |
| -3.3                         | -2.5 |          | 22.0      | 29.6      | 16.89     | 8.92      |

### FLUID PRESSURE CALCULATION FOR SHAFT DESIGN :

Fluid density = 0.48 t/m<sup>3</sup>  
 Abutment Length L = 12 m



Total Fluid Pressure

| Component | Factor | p                | h    | L  | F     | ey       |
|-----------|--------|------------------|------|----|-------|----------|
|           |        | T/m <sup>2</sup> | m    | m  | Tonne | m        |
| 1         | 0.5    | -0.24            | -0.5 | 12 | 0.72  | -0.16667 |
| Total     |        |                  |      |    | 0.72  | -0.167   |

**Total fluid Pressure** = **0.72 Tonne**  
**Lever arm** = **-0.17**  
**Moment M<sub>TT</sub>** = **-0.12 Tm**  
**Net Moment M<sub>TT</sub>** = **-0.12 Tm**

### SUMMARY FLUID PRESSURE :

| Description      | Fluid Pressure               |                        |
|------------------|------------------------------|------------------------|
|                  | Horizontal (H <sub>L</sub> ) | M <sub>TT</sub> (Dest) |
|                  | Tonne                        | Tm                     |
| 1) LWL Condition | 0.72                         | -0.12                  |

## **EARTH PRESSURE CALCULATION FOR SHAFT DESIGN :**

### **A) Non-Seismic Case :**

Coefficient of Active Earth Pressure

$$\text{Active earth pressure } Ka = \frac{\sin^2(\alpha + \phi)}{\sin^2 \alpha \cdot \sin(\alpha - \delta) \cdot \left[ 1 + \sqrt{\frac{\sin(\phi + \delta) \cdot \sin(\phi - i)}{\sin(\alpha - \delta) \cdot \sin(\alpha + i)}} \right]^2}$$

Backfill Soil Parameter

|                             |   |                    |   |               |
|-----------------------------|---|--------------------|---|---------------|
| $\phi$                      | = | 30 °               | = | 0.524 Radians |
| $\delta$                    | = | 20 °               | = | 0.349 Radians |
| $\delta_{\text{submerged}}$ | = | 10 °               | = | 0.175 Radians |
| $i$                         | = | 0 °                | = | 0 Radians     |
| $\alpha$                    | = | 90.00 °            | = | 1.571 Radians |
| $\gamma_{\text{dry}}$       | = | 2 t/m <sup>3</sup> |   |               |
| $\gamma_{\text{sat}}$       | = | 2 t/m <sup>3</sup> |   |               |
| $\gamma_{\text{sub}}$       | = | 1 t/m <sup>3</sup> |   |               |

|                        |   |   |                      |
|------------------------|---|---|----------------------|
| LL surcharge intensity | q | = | 2.4 t/m <sup>2</sup> |
|------------------------|---|---|----------------------|

|                 |   |   |      |
|-----------------|---|---|------|
| Abutment Length | L | = | 12 m |
|-----------------|---|---|------|

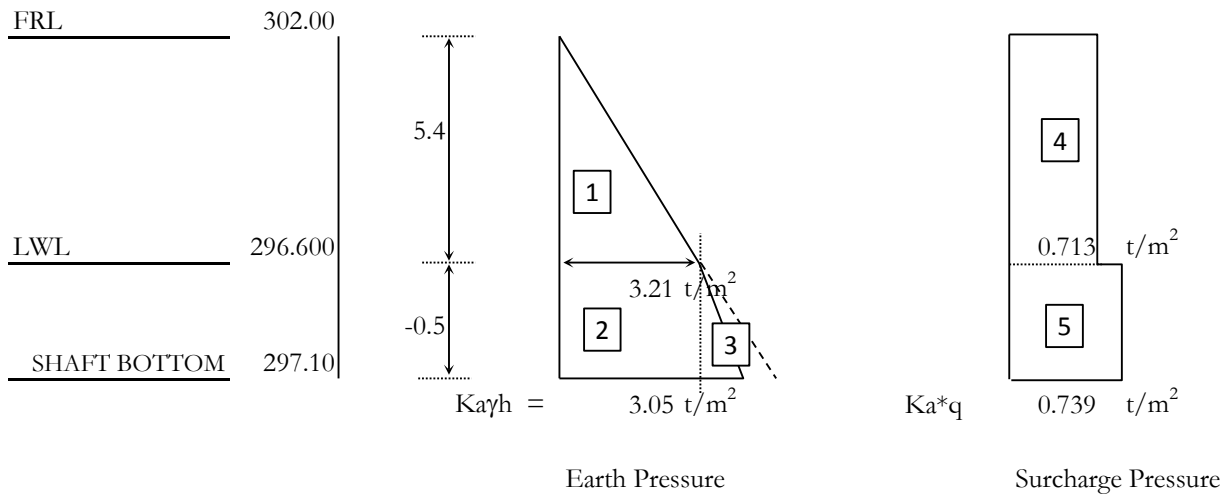
|             |   |   |     |
|-------------|---|---|-----|
| Shaft width | B | = | 1 m |
|-------------|---|---|-----|

|                   |   |       |
|-------------------|---|-------|
| $Ka_{\text{Dry}}$ | = | 0.297 |
|-------------------|---|-------|

|                          |   |       |
|--------------------------|---|-------|
| $Ka'_{\text{Submerged}}$ | = | 0.308 |
|--------------------------|---|-------|

### **1) LWL CONDITION**

|                             |   |                      |
|-----------------------------|---|----------------------|
| Ka                          | = | 0.297                |
| Ka'                         | = | 0.308                |
| $\gamma_{\text{dry}}$       | = | 2 t/m <sup>3</sup>   |
| $\gamma_{\text{sub}}$       | = | 1 t/m <sup>3</sup>   |
| $\delta$                    | = | 20 °                 |
| $\delta_{\text{submerged}}$ | = | 10 °                 |
| q                           | = | 2.4 t/m <sup>2</sup> |
| L                           | = | 12 m                 |
| B                           | = | 1 m                  |



Total Earth Pressure at rest

| Component | Factor | p                | h    | L  | F       | $\delta$ | $F \cdot \cos \delta$ | ey     | $F \cdot \sin \delta$ | ex   |
|-----------|--------|------------------|------|----|---------|----------|-----------------------|--------|-----------------------|------|
|           |        | T/m <sup>2</sup> | m    | m  | Tonne   | deg      | Tonne                 | m      | Tonne                 | m    |
| 1         | 0.5    | 3.2076           | 5.4  | 12 | 103.93  | 20       | 97.66                 | 1.768  | 35.54                 | -0.5 |
| 2         | 1      | 3.2076           | -0.5 | 12 | -19.25  | 10       | -18.95                | -0.25  | -3.34                 | -0.5 |
| 3         | 0.5    | -0.154           | -0.5 | 12 | 0.46    | 10       | 0.45                  | -0.167 | 0.08                  | -0.5 |
| Total     |        |                  |      |    | 85.1426 |          | 79.1605               | 2.083  | 32.28313              | -0.5 |

|                                       |   |                    |
|---------------------------------------|---|--------------------|
| <b>Total Earth Pressure at rest</b>   | = | <b>85.14 Tonne</b> |
| <b>Horizontal Component</b>           | = | <b>79.16</b>       |
| <b>Lever arm</b>                      | = | <b>2.08</b>        |
| <b>Moment <math>M_{TT}</math></b>     | = | <b>164.86 Tm</b>   |
| <b>Vertical Component</b>             | = | <b>32.28</b>       |
| <b>Lever arm</b>                      | = | <b>-0.50 m</b>     |
| <b>Moment <math>M_{TT}</math></b>     | = | <b>-16.14 Tm</b>   |
| <b>Net Moment <math>M_{TT}</math></b> | = | <b>148.72 Tm</b>   |

Total Surcharge pressure

| Component | Factor | p                | h    | L  | F       | ey      |
|-----------|--------|------------------|------|----|---------|---------|
|           |        | T/m <sup>2</sup> | m    | m  | Tonne   | m       |
| 4         | 1      | 0.7128           | 5.4  | 12 | 46.19   | 2.2     |
| 5         | 1      | 0.7392           | -0.5 | 12 | -4.4352 | -0.25   |
| Total     |        |                  |      |    | 41.7542 | 2.46024 |

|                                   |          |                    |
|-----------------------------------|----------|--------------------|
| <b>Total Surcharge Pressure</b>   | <b>=</b> | <b>41.75 Tonne</b> |
| <b>Lever arm above base</b>       | <b>=</b> | <b>2.46 m</b>      |
| <b>Moment <math>M_{TT}</math></b> | <b>=</b> | <b>102.73 Tm</b>   |

**SUMMARY EARTH PRESSURE :**

| Description      | Earth Pressure       |                 |                |                 |
|------------------|----------------------|-----------------|----------------|-----------------|
|                  | Horizontal ( $H_L$ ) | $M_{TT (Dest)}$ | Vertical ( V ) | $M_{TT (Steb)}$ |
|                  | Tonne                | Tm              | Tonne          | Tm              |
| 1) LWL Condition | 79.16                | 164.86          | 32.28          | -16.1           |

**SUMMARY SURCHARGE PRESSURE :**

| Description      | Surcharge Pressure   |                 |
|------------------|----------------------|-----------------|
|                  | Horizontal ( $H_L$ ) | $M_{TT (Dest)}$ |
|                  | Tonne                | Tm              |
| 1) LWL Condition | 41.75                | 102.73          |

## DYNAMIC EARTH PRESSURE CALCULATION FOR SHAFT DESIGN :

### A) Non-Seismic Case :

Coefficient of Earth Pressure at rest

$$K_o \text{ Dry} = 0.297$$

$$K_o' \text{ Submerged} = 0.308$$

Backfill Soil Parameter

|                             |   |                    |   |               |
|-----------------------------|---|--------------------|---|---------------|
| $\phi$                      | = | 30 °               | = | 0.524 Radians |
| $\delta$                    | = | 20 °               | = | 0.349 Radians |
| $\delta_{\text{submerged}}$ | = | 10 °               | = | 0.175 Radians |
| $i$                         | = | 0 °                | = | 0 Radians     |
| $\alpha$                    | = | 90 °               | = | 1.571 Radians |
| $\gamma_{\text{dry}}$       | = | 2 t/m <sup>3</sup> |   |               |
| $\gamma_{\text{sat}}$       | = | 2 t/m <sup>3</sup> |   |               |
| $\gamma_{\text{sub}}$       | = | 1 t/m <sup>3</sup> |   |               |

$$\text{LL surcharge intensity } q = 2.4 \text{ t/m}^2$$

$$\text{Abutment Length } (1 \pm \alpha_v) * \sin^2(\alpha + \phi - \lambda) = 12 \text{ m}$$

$$\text{Shaft width } = \frac{B}{1 + \frac{\cos \lambda * \sin^2 \alpha \cdot \sin(\alpha - \delta - \lambda)}{\sin(\phi + \delta) \cdot \sin(\phi - i - \lambda)}} = 1 \text{ m}$$

$$\alpha_h = 0.06761$$

$$\alpha_v = 0.0452$$

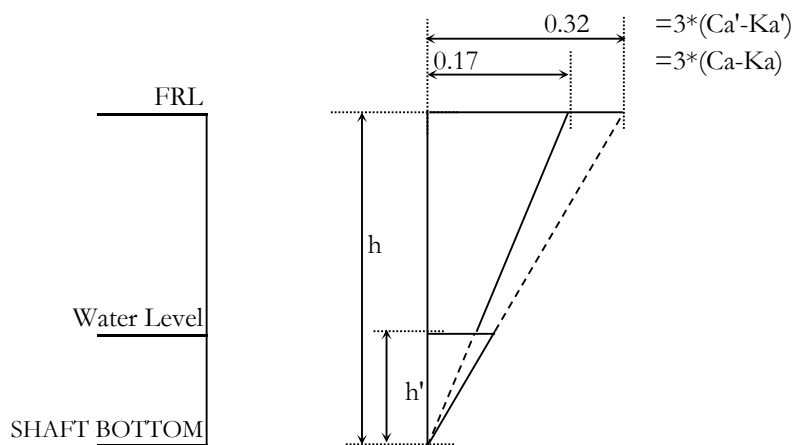
| $\lambda$                    | Formula used  | For | $+\alpha_v$ | $-\alpha_v$ |     |
|------------------------------|---|-----|-------------|-------------|-----|
| $\lambda_{\text{dry}}$       | $= \tan^{-1} \frac{\alpha_h}{1 \pm \alpha_v}$   |     | 3.70        | 4.05        | deg |
| $\lambda_{\text{submerged}}$ | $= \tan^{-1} \frac{\gamma_{\text{sat}} * \alpha_h}{(\gamma_{\text{sat}} - 1) (1 \pm \alpha_v)}$ |     | 7.37        | 8.060259    | deg |

| $+\alpha_v$ | $-\alpha_v$ |         |
|-------------|-------------|---------|
| 0.06        | 0.07        | Radians |
| 0.13        | 0.14        | Radians |

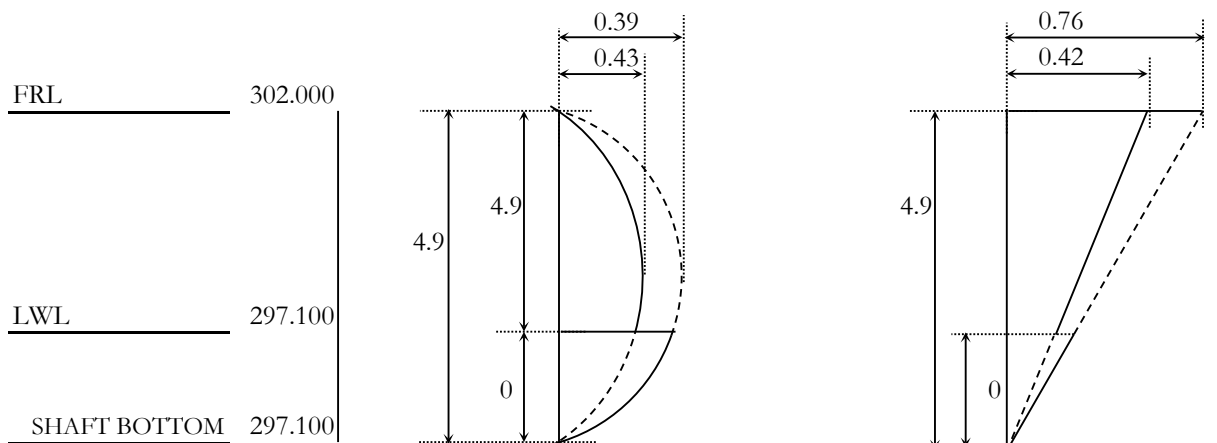
| Seismic case (Coefficient of Earth Pressure) |      |       |
|--|------|-------|
| For Seismic downward dry condition           | Ca   | 0.355 |
| For Seismic downward submerged condition     | Ca'  | 0.413 |
| For Seismic upward dry condition             | Ca-  | 0.329 |
| For Seismic upward submerged condition       | Ca-' | 0.387 |

### 1) LWL Seismic Downward

|                             |   |                      |
|-----------------------------|---|----------------------|
| $K_a$                       | = | 0.297                |
| $K_a'$                      | = | 0.308                |
| $C_a$                       | = | 0.355                |
| $C_a'$                      | = | 0.413                |
| $\gamma_{\text{dry}}$       | = | 2 t/m <sup>3</sup>   |
| $\gamma_{\text{sat}}$       | = | 2 t/m <sup>3</sup>   |
| $\gamma_{\text{sub}}$       | = | 1 t/m <sup>3</sup>   |
| $\delta$                    | = | 20 deg               |
| $\delta_{\text{submerged}}$ | = | 10 deg               |
| $q$                         | = | 2.4 t/m <sup>2</sup> |
| $L$                         | = | 12 m                 |
| $B$                         | = | 1 m                  |



Dynamic Earth Pressure Coeff. Variation



Dynamic Earth Pressure

Dynamic Surcharge Pressure

### Dyanmic Earth Pressure Calculation

#### Parabola above Water Level

|                         |   |                       |
|-------------------------|---|-----------------------|
| p <sub>mid_height</sub> | = | 0.43 t/m <sup>2</sup> |
| h                       | = | 4.9 m                 |
| y                       | = | 2.45 m                |
| L                       | = | 12 m                  |

#### Parabola below Water Level

|                         |   |                       |
|-------------------------|---|-----------------------|
| p <sub>mid_height</sub> | = | 0.39 t/m <sup>2</sup> |
| h                       | = | 4.9 m                 |
| y                       | = | -2.45 m               |
| L                       | = | 12 m                  |

| Dyanmic Earth Pressure              | Pa          | δ    | Pa*Cosδ     | ey         | Pa*Sinδ    | ex          |
|-------------------------------------|-------------|------|-------------|------------|------------|-------------|
|                                     | T           | deg. | T           | m          | T          | m           |
| Parabola above Water Level          | 16.8        | 20   | 15.8        | 2.4        | 5.7        | -0.5        |
| Parabola below Water Level          | 0.0         | 10   | 0.0         | 0.0        | 0.0        | -0.5        |
| <b>Total Dynamic Earth Pressure</b> | <b>16.8</b> |      | <b>15.8</b> | <b>2.4</b> | <b>5.7</b> | <b>-0.5</b> |

|                                     |   |                    |
|-------------------------------------|---|--------------------|
| <b>Total Dynamic Earth Pressure</b> | = | <b>16.76 Tonne</b> |
| <b>Horizontal Component</b>         | = | <b>15.75</b>       |
| <b>Lever arm</b>                    | = | <b>2.45</b>        |
| <b>Moment M<sub>TT</sub></b>        | = | <b>38.59 Tm</b>    |
| <b>Vertical Component</b>           | = | <b>5.73</b>        |
| <b>Lever arm</b>                    | = | <b>-0.50 m</b>     |
| <b>Moment M<sub>TT</sub></b>        | = | <b>-2.86673 Tm</b> |
| <b>Net Moment M<sub>TT</sub></b>    | = | <b>35.73 Tm</b>    |

### Dyanmic Surcharge Pressure Calculation

#### Pressure Distribution above water level

|                          |   |                        |
|--------------------------|---|------------------------|
| Intensity at top         | = | 0.42 t/m <sup>2</sup>  |
| Intensity at water Level | = | 0.000 t/m <sup>2</sup> |
| h-h'                     | = | 4.9 m                  |
| L                        | = | 12 m                   |

#### Pressure Distribution below water level

|                          |   |                       |
|--------------------------|---|-----------------------|
| Intensity at water Level | = | 0.00 t/m <sup>2</sup> |
| Intensity at base        | = | 0 t/m <sup>2</sup>    |
| h                        | = | 0 m                   |
| L                        | = | 12 m                  |

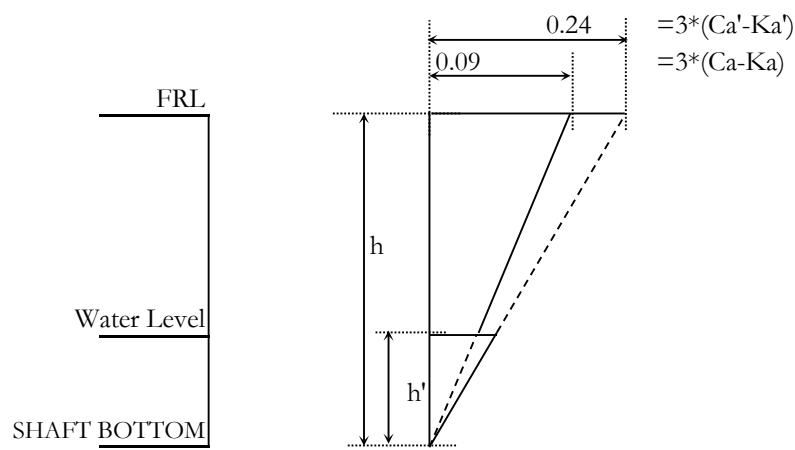
| Dyanmic Surcharge Pressure              | Pa           | Lever arm above Base |
|---|--------------|----------------------|
|   | T/m          | m                    |
| Trapezoidal Portion above water Level   | 12.32        | 3.26667              |
| Triangular Portion below water Level    | 0.00         | 0.00                 |
| <b>Total Dynamic Surcharge Pressure</b> | <b>12.32</b> | <b>3.27</b>          |

|                                 |   |                    |
|---------------------------------|---|--------------------|
| <b>Total Surcharge Pressure</b> | = | <b>12.32 Tonne</b> |
| <b>Lever arm above base</b>     | = | <b>3.27 m</b>      |
| <b>Moment M<sub>TT</sub></b>    | = | <b>40.23 Tm</b>    |

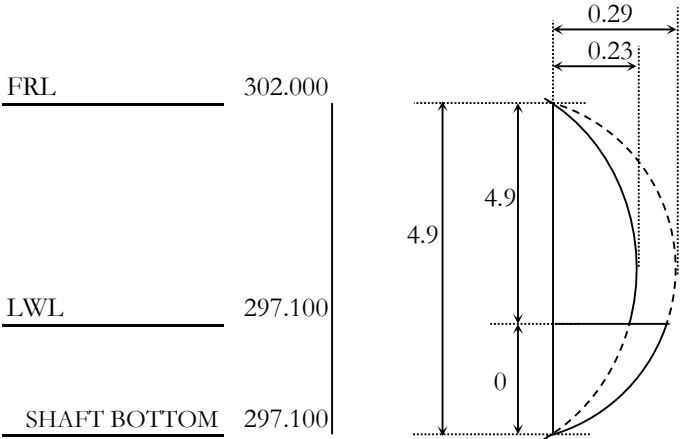


2) LWL Seismic Upward

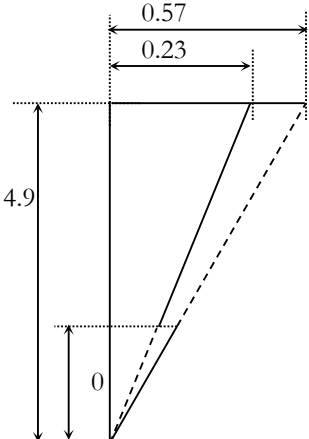
|                             |   |                      |
|-----------------------------|---|----------------------|
| Ka                          | = | 0.297                |
| Ka'                         | = | 0.308                |
| Ca-                         | = | 0.329                |
| Ca-'                        | = | 0.387                |
| $\gamma_{\text{dry}}$       | = | 2 t/m <sup>3</sup>   |
| $\gamma_{\text{sat}}$       | = | 2 t/m <sup>3</sup>   |
| $\gamma_{\text{sub}}$       | = | 1 t/m <sup>3</sup>   |
| $\delta$                    | = | 20 deg               |
| $\delta_{\text{submerged}}$ | = | 10 deg               |
| q                           | = | 2.4 t/m <sup>2</sup> |
| L                           | = | 12 m                 |
| B                           | = | 1 m                  |



Dynamic Earth Pressure Coeff. Variation



Dynamic Earth Pressure



Dynamic Surcharge Pressure

#### Dyanmic Earth Pressure Calculation

Parabola above Water Level

|                         |   |                       |
|-------------------------|---|-----------------------|
| p <sub>mid_height</sub> | = | 0.23 t/m <sup>2</sup> |
| h                       | = | 4.9 m                 |
| y                       | = | 2.45 m                |
| L                       | = | 12 m                  |

Parabola below Water Level

|                         |   |                       |
|-------------------------|---|-----------------------|
| p <sub>mid_height</sub> | = | 0.29 t/m <sup>2</sup> |
| h                       | = | 4.9 m                 |
| y                       | = | -2.45 m               |
| L                       | = | 12 m                  |

| Dyanmic Earth Pressure              | Pa         | δ    | Pa*cosδ    | ey         | Pa*sinδ    | ex          |
|-------------------------------------|------------|------|------------|------------|------------|-------------|
|                                     | T          | deg. | T          | m          | T          | m           |
| Parabola above Water Level          | 9.1        | 20   | 8.6        | 2.4        | 3.1        | -0.5        |
| Parabola below Water Level          | 0.0        | 10   | 0.0        | 0.0        | 0.0        | -0.5        |
| <b>Total Dynamic Earth Pressure</b> | <b>9.1</b> |      | <b>8.6</b> | <b>2.4</b> | <b>3.1</b> | <b>-0.5</b> |

|                                     |   |                    |
|-------------------------------------|---|--------------------|
| <b>Total Dynamic Earth Pressure</b> | = | <b>9.11 Tonne</b>  |
| <b>Horizontal Component</b>         | = | <b>8.56</b>        |
| <b>Lever arm</b>                    | = | <b>2.45</b>        |
| <b>Moment M<sub>TT</sub></b>        | = | <b>20.98 Tm</b>    |
| <b>Vertical Component</b>           | = | <b>3.12</b>        |
| <b>Lever arm</b>                    | = | <b>-0.50 m</b>     |
| <b>Moment M<sub>TT</sub></b>        | = | <b>-1.55853 Tm</b> |
| <b>Net Moment M<sub>TT</sub></b>    | = | <b>19.42 Tm</b>    |

#### Dyanmic Surcharge Pressure Calculation

Pressure Distribution above water level

|                          |   |                        |
|--------------------------|---|------------------------|
| Intensity at top         | = | 0.23 t/m <sup>2</sup>  |
| Intensity at water Level | = | 0.000 t/m <sup>2</sup> |
| h-h'                     | = | 4.9 m                  |
| L                        | = | 12 m                   |

Pressure Distribution below water level

|                          |   |                       |
|--------------------------|---|-----------------------|
| Intensity at water Level | = | 0.00 t/m <sup>2</sup> |
| Intensity at base        | = | 0 t/m <sup>2</sup>    |
| h                        | = | 0 m                   |
| L                        | = | 12 m                  |

| Dyanmic Surcharge Pressure              | Pa          | Lever arm above Base |
|---|-------------|----------------------|
|   | T/m         | m                    |
| Trapezoidal Portion above water Level   | 6.70        | 3.27                 |
| Triangular Portion below water Level    | 0.00        | 0.00                 |
| <b>Total Dynamic Surcharge Pressure</b> | <b>6.70</b> | <b>3.27</b>          |

|                                 |   |                   |
|---------------------------------|---|-------------------|
| <b>Total Surcharge Pressure</b> | = | <b>6.70 Tonne</b> |
| <b>Lever arm above base</b>     | = | <b>3.27 m</b>     |
| <b>Moment M<sub>TT</sub></b>    | = | <b>21.87 Tm</b>   |

***SUMMARY DYNAMIC EARTH PRESSURE :***

| Description   | Dynamic Earth Pressure |                         |              |                         |
|---|------------------------|-------------------------|--------------|-------------------------|
|   | Horizontal ( $H_L$ )   | $M_{TT} \text{ (Dest)}$ | Vertical (V) | $M_{TT} \text{ (Steb)}$ |
|   | Tonne                  | Tm                      | Tonne        | Tm                      |
| 1) LWL Seismic Downward<br>Horizontal Component<br>Vertical Component | 0.00                   | 0.00                    | 0.00         | 0                       |
| 2) LWL Seismic Upward<br>Horizontal Component<br>Vertical Component   | 0.00                   | 0.00                    | 0.00         | 0.00                    |

**SUMMARY DYNAMIC SURCHARGE PRESSURE :**

| Description             | Dynamic Surcharge Pressure |                         |
|-------------------------|----------------------------|-------------------------|
|                         | Horizontal ( $H_L$ )       | $M_{TT} \text{ (Dest)}$ |
|                         | Tonne                      | Tm                      |
| 1) LWL Seismic Downward | 0.00                       | 0.00                    |
| 2) LWL Seismic Upward   | 0.00                       | 0.00                    |

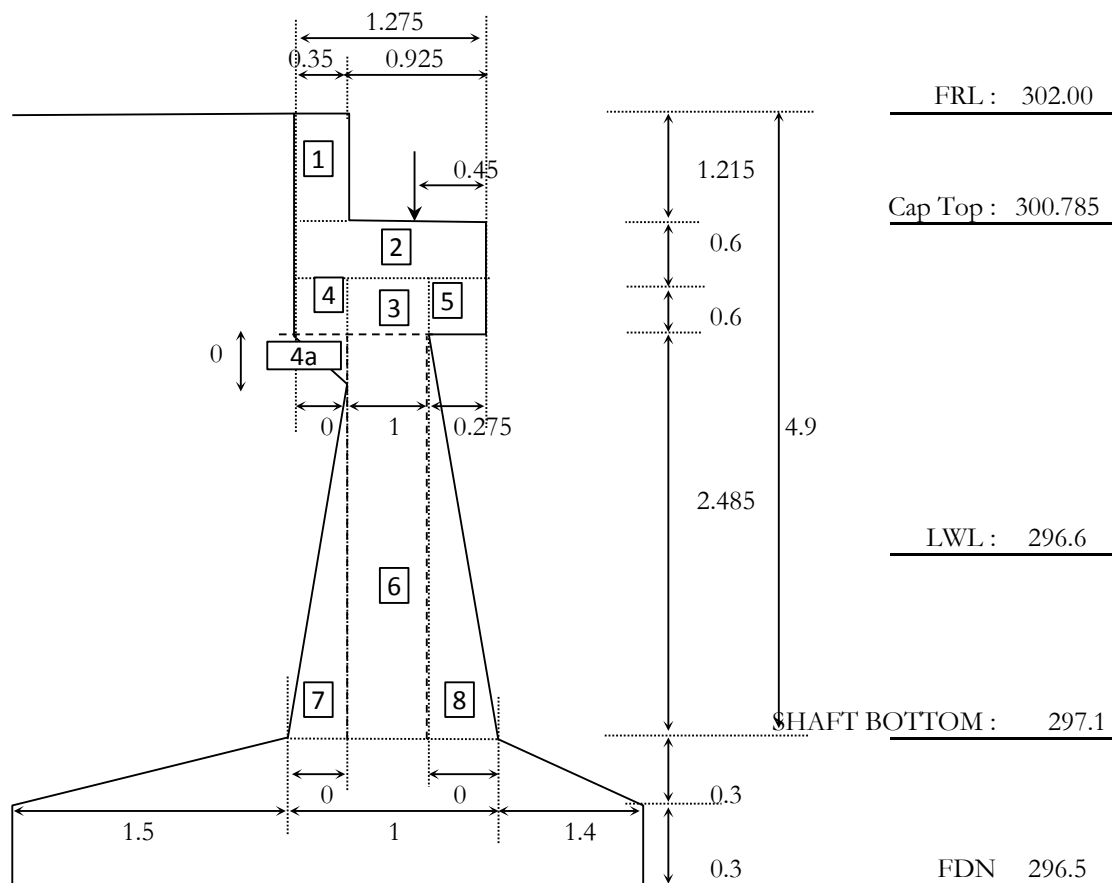
## UNFACTORED FORCES FOR DESIGN OF SHAFT :

### SELFWEIGHT OF ABUTMENT

|                           |                           |       |                  |
|---------------------------|---------------------------|-------|------------------|
| RCC Density               | =                         | 2.5   | t/m <sup>3</sup> |
| water density             | $\gamma_{\text{water}}$ = | 1     | t/m <sup>3</sup> |
| Soil Density              | $\gamma_{\text{soil}}$ =  | 2     | t/m <sup>3</sup> |
| Thickness of wearing coat | =                         | 0.065 | m                |
| Depth of super-structure  | =                         | 1     | m                |

### ABUTMENT COMPONENT :-

Length of Abutment = 12 m



### Calculating Selfweight of Sub-structure :

Forces @ Base of abutment shaft

$e_L$  = Cg. w.r.t. c/L of shaft, at bottom of abutment shaft.  
 $e_Y$  = Cg. From base of abutment shaft.

| Element                                  | Area Factor | B     | H   | L  | V              | W     | e <sub>Y</sub> | e <sub>L</sub> |
|--|-------------|-------|---|----|----------------|-------|----------------|----------------|
|  |             | m     | m   | m  | m <sup>3</sup> | Tonne | m              | m              |
| Dirt Wall & Abutment Cap                 |             |       |   |    |                |       |                |                |
| 1  | 1           | 0.35  | 1.215   | 12 | 5.11           | 12.76 | 4.29           | -0.325         |
| 2  | 1           | 1.275 | 0.6   | 12 | 9.18           | 22.95 | 3.38           | 0.1375         |
| 3  | 1           | 1.275 | 0.6   | 12 | 9.18           | 22.95 | 3.38           | 0.1375         |
| 4  | 0           | 0     | 0.6   | 12 | 0.00           | 0.00  | 2.88           | -0.5           |
| 4a                                       | 0           | 0     | 0   | 12 | 0.00           | 0.00  | 2.48           | -0.5           |
| 5  | 0           | 0.275 | 0.6   | 12 | 0.00           | 0.00  | 2.88           | 0.592          |
|  | Total       |       |   |    | 23.47          | 58.66 | 3.58           | 0.04           |
| */ Increase Abutment cap weight by       |             |       | 20% on account of bearing, bearing pedestal, stopper etc. |    |                |       |                |                |
| <i>Abutment Cap weight Considered</i>    |             |       |   |    | 28.16          | 70.40 | 3.58           | 0.04           |
| Abutment Shaft                           |             |       |   |    |                |       |                |                |
| 6  | 1           | 1     | 2.48  | 12 | 29.81          | 74.5  | 1.24           | 0              |
| 7  | 0.5         | 0     | 2.48  | 12 | 0.00           | 0.0   | 0.83           | -0.5           |
| 8  | 0.5         | 0     | 2.48  | 12 | 0.00           | 0.0   | 0.83           | 0.500          |
| <i>Abutment shaft weight considered.</i> |             |       |   |    | 29.81          | 74.54 | 1.24           | 0.00           |

|   |              |               |             |             |
|---|--------------|---------------|-------------|-------------|
| <b>Total Sub-structure self weight at base of shaft</b> | <b>57.97</b> | <b>144.93</b> | <b>2.38</b> | <b>0.02</b> |
|---|--------------|---------------|-------------|-------------|

|   |          |                   |
|---|----------|-------------------|
| <b>Total Weight of sub-structure &amp; foundation</b> | <b>=</b> | <b>144.93 T</b>   |
| <b>Lever arm about toe (along L-L axis)</b>           | <b>=</b> | <b>0.02 m</b>     |
| <b>Moment M<sub>TT</sub></b>                          | <b>=</b> | <b>2.59603 Tm</b> |

***Forces due to Super-Structure DL, at Shaft Bottom:***

|   |   |              |
|---|---|--------------|
| Vertical Load (Sup DL Reaction)           | = | 155.13 Tonne |
| Cg. From Deck Top                         | = | 0.07 m       |
| Lever arm about toe (along L-L axis)      | = | 0.325 m      |
| Moment M <sub>TT</sub>                    | = | 50.4156 Tm   |
| Lever arm about c/L base (along T-T axis) | = | 0.00 m       |
| Moment M <sub>LL</sub>                    | = | 0 Tm         |
| Cg. From base slab bottom                 | = | 4.763 m      |

***Forces due to Super-Structure SIDL, at Shaft Bottom:***

|   |   |             |
|---|---|-------------|
| Vertical Load (Sup SIDL Reaction)         | = | 45.82 Tonne |
| Cg. above Deck Top                        | = | 0.31 m      |
| Lever arm about toe (along L-L axis)      | = | 0.325 m     |
| Moment $M_{TT}$                           | = | 14.8906 Tm  |
| Lever arm about c/L base (along T-T axis) | = | 0.00 m      |
| Moment $M_{LL}$                           | = | 0.00 Tm     |
| Cg. From base Slab bottom                 | = | 5.145 m     |

***Forces due to Super-Structure Surfacing , at Shaft Bottom:***

|   |   |             |
|---|---|-------------|
| Vertical Load (Sup Surfacing Reaction)    | = | 13.33 Tonne |
| Cg. above Deck Top                        | = | 0.03 m      |
| Lever arm about toe (along L-L axis)      | = | 0.325 m     |
| Moment $M_{TT}$                           | = | 4.33089 Tm  |
| Lever arm about c/L base (along T-T axis) | = | -0.25 m     |
| Moment $M_{LL}$                           | = | -3.33 Tm    |
| Cg. From base Slab bottom                 | = | 4.867 m     |

| <b>Forces due to LL , at Shaft Bottom:</b> |   | <b>Max Reaction</b> | <b>Min Reaction</b> |
|--|---|---------------------|---------------------|
| Vertical Load (CW LL Reaction)             | = | 89.87 Tonne         | 45.33 Tonne         |
| Lever arm about toe (along L-L axis)       | = | 0.325 m             | 0.325 m             |
| Moment $M_{TT}$                            | = | 29.2067 Tm          | 14.7333 Tm          |
| Lever arm about c/L base (along T-T axis)  | = | 2.91 m              | 2.91 m              |
| Moment $M_{LL}$                            | = | 261.51 Tm           | 131.92 Tm           |

| <b>Forces due to LL Longitudinal Forces, at Shaft Bottom:</b> |   |                   |
|---|---|-------------------|
| Longitudinal Force  | = | <b>26.6 Tonne</b> |
| Lever arm from footing base                                   | = | 3.835 m           |
| Moment in about transverse axis $M_{TT}$                      | = | <b>102.0 tm</b>   |

**Seismic Component of Permanent Load (DL+SIDL+SURFACING), at Shaft Bottom:**

| At Fixed End, Force about toe | V<br>T | $H_L$<br>T | $H_T$<br>T | ey<br>m | $e_L$<br>m | $M_{LL}$<br>Tm | $M_{TT}$<br>Tm |
|-------------------------------|--------|------------|------------|---------|------------|----------------|----------------|
| Seismic Longitudinal          |        | 29.0       |            | 3.835   |            |                | 111.1          |
| Seismic Transverse            |        |            | 43.6       | 4.851   |            | 211.4          |                |
| Seismic Vertical              | 9.7    |            |            |         | 0.325      |                | 3.1            |

**Summery of LL seismic component transferred from super-structure, at Shaft Bottom:**

**Max Live Load Reaction Case :**

| At Fixed/ Free End   | V<br>T | $H_L$<br>T | $H_T$<br>T | ey<br>m | $e_L$<br>m | $M_{LL}$<br>Tm | $M_{TT}$<br>Tm |
|----------------------|--------|------------|------------|---------|------------|----------------|----------------|
| Seismic Longitudinal |        | 0.0        |            | 0.0     |            |                | 0.0            |
| Seismic Transverse   |        |            | 18.3       | 6.100   |            | 111.5          |                |
| Seismic Vertical     | 4.1    |            |            |         | 0.3        |                | 1.3            |

Min Live Load Reaction Case :

| At Fixed/ Free End   | V<br>T | H <sub>L</sub><br>T | H <sub>T</sub><br>T | ey<br>m | e <sub>L</sub><br>m | M <sub>LL</sub><br>Tm | M <sub>TT</sub><br>Tm |
|----------------------|--------|---------------------|---------------------|---------|---------------------|-----------------------|-----------------------|
| Seismic Longitudinal |        | 0.0                 |                     | 0.0     |                     |                       | 0.0                   |
| Seismic Transverse   |        |                     | 9.2                 | 6.100   |                     | 56.2                  |                       |
| Seismic Vertical     | 2.0    |                     |                     | 0.3     |                     |                       | 0.7                   |

**SEISMIC COMPONENT OF SUB-STRUCTURE :**

Longitudinal Horizontal seismic coefficient       $A_{hL}$       =      0.06761

Transverse Horizontal seismic coefficient       $A_{hT}$       =      0.2034

Vertical seismic coefficient       $A_V$       =      0.0452

**Sub-structure seismic component :**

Sub-structure seismic component:

|                 |       |     |     |    |   |                                      |
|-----------------|-------|-----|-----|----|---|--------------------------------------|
| Description     | W     | ey  | ex  | W  | = | Weight of sub-structure              |
|                 | Tonne | m   | m   | ey | = | Cg. above base slab in vertical dir. |
| Sub-structure = | 144.9 | 2.4 | 0.0 |    |   |                                      |

|                      |     |                |                |     |                |                 |                 |
|----------------------|-----|----------------|----------------|-----|----------------|-----------------|-----------------|
| Seismic Component    | V   | H <sub>L</sub> | H <sub>T</sub> | ey  | e <sub>L</sub> | M <sub>LL</sub> | M <sub>TT</sub> |
|                      | T   | T              | T              | m   | m              | Tm              | Tm              |
| Seismic Longitudinal |     | 9.8            |                | 2.4 |                |                 | 23.3            |
| Seismic Transverse   |     |                | 29.5           | 2.4 |                | 70.1            |                 |
| Seismic Vertical     | 6.6 |                |                |     | 0.0            |                 | 0.1             |



**SUMMARY OF FORCES :**

| S.N.  | Description                          | Forces about toe |                |                |                 |                 |
|-------|--------------------------------------|------------------|----------------|----------------|-----------------|-----------------|
|       |                                      | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|       |                                      | Tonne            | Tonne          | Tonne          | Tm              | Tm              |
| 1)    | Sub-structure                        | 144.9            |                |                | 2.6             | 0.0             |
| 3)    | Super-structure DL                   | 155.1            |                |                | 50.4            | 0.0             |
| 4)    | SIDL (excluding surfacing)           | 45.8             |                |                | 14.9            | 0.0             |
| 5)    | Surfacing                            | 13.3             |                |                | 4.3             | -3.3            |
| 6.1)  | Live Load Vertical Load Max Reaction | 89.9             |                |                | 29.2            | 261.5           |
| 6.2)  | Live Load Vertical Load Min Reaction | 45.3             |                |                | 14.7            | 131.9           |
| 7)    | Live Load Horizontal Forces          |                  | 26.6           |                | 102.0           |                 |
| 9)    | Fluid Pressure                       |                  | 0.72           |                | -0.1            |                 |
| 9.1)  | Earth Pressure LWL                   |                  |                |                |                 |                 |
|       | Horizontal Component                 |                  | 79.2           |                | 164.9           |                 |
|       | Vertical Component                   | 32.3             |                |                | -16.1           |                 |
| 10.1) | Surcharge Pressure LWL               |                  | 41.8           |                | 102.7           |                 |



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LOAD COMBINATION  
FOR DESIGN OF PIER SHAFT

| LC-1  | NS, LWL, Span dislodge, FP | Forces about toe |                |                |                 |                 | LC-1 |
|-------|----------------------------|------------------|----------------|----------------|-----------------|-----------------|------|
| S.N.  | Description                | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |      |
|       |                            | Tonne            | Tonne          | Tonne          | Tm              | Tm              |      |
| 1)    | Sub-structure              | 144.93           |                |                | 2.596           | 0               | 1.35 |
| 9)    | Fluid Pressure             |                  | 0.72           |                | -0.12           |                 | 1.5  |
| 10.1) | Surcharge Pressure LWL     |                  | 41.754         |                | 102.73          |                 | 1.2  |

| S.N. | Description                | Forces at bottom of abutment shaft |                |                |                 |                 |
|------|----------------------------|------------------------------------|----------------|----------------|-----------------|-----------------|
|      |                            | V                                  | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|      |                            | Tonne                              | Tonne          | Tonne          | Tm              | Tm              |
| LC-1 | NS, LWL, Span dislodge, FP | 195.66                             | 51.185         | 0              | 126.6           | 0               |

| LC-2  | NS, LWL, Span dislodge, EP | Forces about toe |                |                |                 |                 | LC-2 |
|-------|----------------------------|------------------|----------------|----------------|-----------------|-----------------|------|
| S.N.  | Description                | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |      |
|       |                            | Tonne            | Tonne          | Tonne          | Tm              | Tm              |      |
| 1)    | Sub-structure              | 144.93           |                |                | 2.596           | 0               | 1.35 |
| 9.1)  | Earth Pressure LWL         |                  |                |                |                 |                 | 1.5  |
|       | Horizontal Component       |                  | 79.16          |                | 164.86          |                 | 1.5  |
| 10.1) | Surcharge Pressure LWL     |                  | 41.754         |                | 102.73          |                 | 1.2  |

| S.N. | Description                | Forces at bottom of abutment shaft |                |                |                 |                 |
|------|----------------------------|------------------------------------|----------------|----------------|-----------------|-----------------|
|      |                            | V                                  | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|      |                            | Tonne                              | Tonne          | Tonne          | Tm              | Tm              |
| LC-2 | NS, LWL, Span dislodge, EP | 195.66                             | 168.85         | 0              | 374.07          | 0               |

| LC-3 | NS, LWL, Min LL Lead, FP   | Forces about toe |                |                |                 |                 | LC-3 |
|------|----------------------------|------------------|----------------|----------------|-----------------|-----------------|------|
| S.N. | Description                | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |      |
|      |                            | Tonne            | Tonne          | Tonne          | Tm              | Tm              |      |
| 1)   | Sub-structure              | 144.93           |                |                | 2.596           | 0               | 1.35 |
| 3)   | Super-structure DL         | 155.13           |                |                | 50.416          | 0               | 1.35 |
| 4)   | SIDL (excluding surfacing) | 45.817           |                |                | 14.891          | 0               | 1.35 |
| 5)   | Surfacing                  | 13.326           |                |                | 4.3309          | -3.331          | 1.75 |

|       |                                   |        |        |  |        |        |  |      |
|-------|-----------------------------------|--------|--------|--|--------|--------|--|------|
| 6.2)  | Live Load Vertical Load Min React | 45.333 |        |  | 14.733 | 131.92 |  | 1.15 |
| 7)    | Live Load Horizontal Forces       |        | 26.592 |  | 101.98 |        |  | 1.15 |
| 9)    | Fluid Pressure                    |        | 0.72   |  | -0.12  |        |  | 1.5  |
| 10.1) | Surcharge Pressure LWL            |        | 41.754 |  | 102.73 |        |  | 1.2  |

| S.N. | Description              | Forces at bottom of abutment shaft |                |                |                 |                 |
|------|--------------------------|------------------------------------|----------------|----------------|-----------------|-----------------|
|      |                          | V                                  | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|      |                          | Tonne                              | Tonne          | Tonne          | Tm              | Tm              |
| LC-3 | NS, LWL, Min LL Lead, FP | 542.38                             | 81.766         | 0              | 356.56          | 145.88          |

| LC-4  | NS, LWL, Min LL Lead, EP          | Forces about toe |                |                |                 |                 |  | LC-4 |
|-------|-----------------------------------|------------------|----------------|----------------|-----------------|-----------------|--|------|
| S.N.  | Description                       | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |  |      |
|       |                                   | Tonne            | Tonne          | Tonne          | Tm              | Tm              |  |      |
| 1)    | Sub-structure                     | 144.93           |                |                | 2.596           | 0               |  | 1.35 |
| 3)    | Super-structure DL                | 155.13           |                |                | 50.416          | 0               |  | 1.35 |
| 4)    | SIDL (excluding surfacing)        | 45.817           |                |                | 14.891          | 0               |  | 1.35 |
| 5)    | Surfacing                         | 13.326           |                |                | 4.3309          | -3.331          |  | 1.75 |
| 6.2)  | Live Load Vertical Load Min React | 45.333           |                |                | 14.733          | 131.92          |  | 1.15 |
| 7)    | Live Load Horizontal Forces       |                  | 26.592         |                | 101.98          |                 |  | 1.15 |
| 9.1)  | Earth Pressure LWL                |                  |                |                |                 |                 |  | 1.5  |
|       | Horizontal Component              |                  | 79.16          |                | 164.86          |                 |  | 1.5  |
| 10.1) | Surcharge Pressure LWL            |                  | 41.754         |                | 102.73          |                 |  | 1.2  |

| S.N. | Description              | Forces at bottom of abutment shaft |                |                |                 |                 |
|------|--------------------------|------------------------------------|----------------|----------------|-----------------|-----------------|
|      |                          | V                                  | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|      |                          | Tonne                              | Tonne          | Tonne          | Tm              | Tm              |
| LC-4 | NS, LWL, Min LL Lead, EP | 542.38                             | 199.43         | 0              | 604.03          | 145.88          |

| LC-5 | NS, LWL, Max LL, FP               | Forces about toe |                |                |                 |                 |  | LC-5 |
|------|-----------------------------------|------------------|----------------|----------------|-----------------|-----------------|--|------|
| S.N. | Description                       | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |  |      |
|      |                                   | Tonne            | Tonne          | Tonne          | Tm              | Tm              |  |      |
| 1)   | Sub-structure                     | 144.93           |                |                | 2.596           | 0               |  | 1.35 |
| 3)   | Super-structure DL                | 155.13           |                |                | 50.416          | 0               |  | 1.35 |
| 4)   | SIDL (excluding surfacing)        | 45.817           |                |                | 14.891          | 0               |  | 1.35 |
| 5)   | Surfacing                         | 13.326           |                |                | 4.3309          | -3.331          |  | 1.75 |
| 6.1) | Live Load Vertical Load Max React | 89.867           |                |                | 29.207          | 261.51          |  | 1.5  |
| 7)   | Live Load Horizontal Forces       |                  | 26.592         |                | 101.98          |                 |  | 1.5  |
| 9)   | Fluid Pressure                    |                  | 0.72           |                | -0.12           |                 |  | 1    |

|       |                        |  |        |  |        |  |     |
|-------|------------------------|--|--------|--|--------|--|-----|
| 10.1) | Surcharge Pressure LWL |  | 41.754 |  | 102.73 |  | 1.2 |
|-------|------------------------|--|--------|--|--------|--|-----|

| S.N. | Description         | Forces at bottom of abutment shaft |                |                |                 |                 |
|------|---------------------|------------------------------------|----------------|----------------|-----------------|-----------------|
|      |                     | V                                  | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|      |                     | Tonne                              | Tonne          | Tonne          | Tm              | Tm              |
| LC-5 | NS, LWL, Max LL, FP | 625.05                             | 90.713         | 0              | 419.18          | 386.44          |

| LC-6        | NS, LWL, Max LL, EP              | Forces about toe |                |                |                 |                 | LC-6 |
|-------------|----------------------------------|------------------|----------------|----------------|-----------------|-----------------|------|
| S.N.        | Description                      | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |      |
|             |                                  | Tonne            | Tonne          | Tonne          | Tm              | Tm              |      |
| 1)          | Sub-structure                    | 144.93           |                |                | 2.596           | 0               | 1.35 |
| 3)          | Super-structure DL               | 155.13           |                |                | 50.416          | 0               | 1.35 |
| 4)          | SIDL (excluding surfacing)       | 45.817           |                |                | 14.891          | 0               | 1.35 |
| 5)          | Surfacing                        | 13.326           |                |                | 4.3309          | -3.331          | 1.75 |
| 6.1)        | Live Load Vertical Load Max Reac | 89.867           |                |                | 29.207          | 261.51          | 1.5  |
| 7)          | Live Load Horizontal Forces      |                  | 26.592         |                | 101.98          |                 | 1.5  |
| <b>9.1)</b> | Earth Pressure LWL               |                  |                |                |                 |                 | 1    |
|             | Horizontal Component             |                  | 79.16          |                | 164.86          |                 | 1    |
| 10.1)       | Surcharge Pressure LWL           |                  | 41.754         |                | 102.73          |                 | 1.2  |

| S.N. | Description         | Forces at bottom of abutment shaft |                |                |                 |                 |
|------|---------------------|------------------------------------|----------------|----------------|-----------------|-----------------|
|      |                     | V                                  | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|      |                     | Tonne                              | Tonne          | Tonne          | Tm              | Tm              |
| LC-6 | NS, LWL, Max LL, EP | 625.05                             | 169.15         | 0              | 584.16          | 386.44          |

| LC-7                        | SIS,LWL, Span dislodge ,Seismic S         | Forces about toe |                |                |                 |                 | LC-7 |
|-----------------------------|---|------------------|----------------|----------------|-----------------|-----------------|------|
| S.N.                        | Description                               | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |      |
|                             |   | Tonne            | Tonne          | Tonne          | Tm              | Tm              |      |
| 1)                          | Sub-structure                             | 144.93           |                |                | 2.596           | 0               | 1.35 |
| <b>9.1)</b>                 | Earth Pressure LWL                        |                  |                |                |                 |                 | 1    |
|                             | Horizontal Component                      |                  | 79.16          |                | 164.86          |                 | 1    |
| 10.1)                       | Surcharge Pressure LWL                    |                  | 41.754         |                | 102.73          |                 | 0.2  |
| <b>Seismic Longitudinal</b> |   |                  |                |                |                 |                 | 0.75 |
| 11)                         | Sub-structure Component                   |                  | 9.7982         |                | 23.307          |                 | 0.75 |
| <b>12)</b>                  | Backfill                                  |                  | 11.246         |                | 36.737          |                 | 0.75 |
| 12)                         | Super-Structure DL, SIDL, & Surfacing Cor |                  | 28.972         |                | 111.11          |                 | 0.75 |
| <b>13)</b>                  | Dynamic Earth Pressure                    |                  |                |                |                 |                 | 0.75 |
|                             | Horizontal Component                      |                  | 0              |                | 0               |                 | 0.75 |

|                                  |   |        |   |        |        |        |       |
|----------------------------------|---|--------|---|--------|--------|--------|-------|
| 14)                              | Dynamic Surcharge Pressure                      |        |   |        |        |        | 0.15  |
|                                  | 14.1) LWL Seismic Downward                      |        | 0 |        | 0      |        | 0.15  |
| <b>Seismic Transverses</b>       |   |        |   |        |        |        | 0.225 |
| 15)                              | Sub-structure Component                         |        |   | 29.479 |        | 70.122 | 0.225 |
| 17)                              | Super-Structure DL, SIDL, & Surfacing Component |        |   | 43.582 |        | 211.44 | 0.225 |
| <b>Seismic Vertical Downward</b> |   |        |   |        |        |        | 0.225 |
| 19)                              | Sub-structure Component                         | 6.5509 |   |        | 0.1173 |        | 0.225 |
| 21)                              | Super-Structure DL, SIDL, & Surf                | 9.685  |   |        | 3.1476 |        | 0.225 |

| S.N. | Description                       | Forces at bottom of abutment shaft |                |                |                 |                 |
|------|-----------------------------------|------------------------------------|----------------|----------------|-----------------|-----------------|
|      |                                   | V                                  | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|      |                                   | Tonne                              | Tonne          | Tonne          | Tm              | Tm              |
| LC-7 | SIS,LWL, Span dislodge ,Seismic S | 199.31                             | 125.02         | 16.439         | 318.01          | 63.351          |

|                                  |   |                  |                |                |                 |                 |        |
|----------------------------------|---|------------------|----------------|----------------|-----------------|-----------------|--------|
| LC-8                             | SIS, LWL,Span dislodge ,Seismic S               | Forces about toe |                |                |                 |                 | LC-8   |
| S.N.                             | Description                                     | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |        |
|                                  |   | Tonne            | Tonne          | Tonne          | Tm              | Tm              |        |
| 1)                               | Sub-structure                                   | 144.93           |                |                | 2.596           | 0               | 1.35   |
| 9.1)                             | Earth Pressure LWL                              |                  |                |                |                 |                 | 1      |
|                                  | Horizontal Component                            |                  | 79.16          |                | 164.86          |                 | 1      |
| 10.1)                            | Surcharge Pressure LWL                          |                  | 41.754         |                | 102.73          |                 | 0.2    |
| <b>Seismic Longitudinal</b>      |   |                  |                |                |                 |                 | 0.75   |
| 11)                              | Sub-structure Component                         |                  | 9.7982         |                | 23.307          |                 | 0.75   |
| 12)                              | Backfill  |                  | 11.246         |                | 36.737          |                 | 0.75   |
| 12)                              | Super-Structure DL, SIDL, & Surfacing Co        |                  | 28.972         |                | 111.11          |                 | 0.75   |
| 13)                              | Dynamic Earth Pressure                          |                  |                |                |                 |                 | 0.75   |
|                                  | Horizontal Component                            |                  | 0              |                | 0               |                 | 0.75   |
| 14)                              | Dynamic Surcharge Pressure                      |                  |                |                |                 |                 | 0.15   |
|                                  | 14.2) LWL Seismic Upward                        |                  | 0              |                | 0               |                 | 0.15   |
| <b>Seismic Transverses</b>       |   |                  |                |                |                 |                 | 0.225  |
| 15)                              | Sub-structure Component                         |                  |                | 29.479         |                 | 70.122          | 0.225  |
| 17)                              | Super-Structure DL, SIDL, & Surfacing Component |                  |                | 43.582         |                 | 211.44          | 0.225  |
| <b>Seismic Vertical Downward</b> |   |                  |                |                |                 |                 | 0.225  |
| 19)                              | Sub-structure Component                         | 6.5509           |                |                | 0.1173          |                 | -0.225 |
| 21)                              | Super-Structure DL, SIDL, & Surf                | 9.685            |                |                | 3.1476          |                 | -0.225 |

| S.N. | Description                       | Forces at bottom of abutment shaft |                |                |                 |                 |
|------|-----------------------------------|------------------------------------|----------------|----------------|-----------------|-----------------|
|      |                                   | V                                  | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|      |                                   | Tonne                              | Tonne          | Tonne          | Tm              | Tm              |
| LC-8 | SIS, LWL,Span dislodge ,Seismic S | 192                                | 125.02         | 16.439         | 316.54          | 63.351          |

|  |  |  |  |  |  |  |
|--|--|--|--|--|--|--|
|  |  |  |  |  |  |  |
|--|--|--|--|--|--|--|

| LC-9                             | SIS,LWL,Min LL Acc,Seismic Sx=                  | Forces about toe |                |                |                 |                 | LC-9 |
|----------------------------------|---|------------------|----------------|----------------|-----------------|-----------------|------|
| S.N.                             | Description                                     | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |      |
|                                  |   | Tonne            | Tonne          | Tonne          | Tm              | Tm              |      |
| 1)                               | Sub-structure                                   | 144.93           |                |                | 2.596           | 0               | 1.35 |
| 3)                               | Super-structure DL                              | 155.13           |                |                | 50.416          | 0               | 1.35 |
| 4)                               | SIDL (excluding surfacing)                      | 45.817           |                |                | 14.891          | 0               | 1.35 |
| 5)                               | Surfacing                                       | 13.326           |                |                | 4.3309          | -3.331          | 1.35 |
| 6.2)                             | Live Load Vertical Load Min React               | 45.333           |                |                | 14.733          | 131.92          | 0.2  |
| 7)                               | Live Load Horizontal Forces                     |                  | 26.592         |                | 101.98          |                 | 0.2  |
| 9.1)                             | Earth Pressure LWL                              |                  |                |                |                 |                 | 1    |
|                                  | Horizontal Component                            |                  | 79.16          |                | 164.86          |                 | 1    |
| 10.1)                            | Surcharge Pressure LWL                          |                  | 41.754         |                | 102.73          |                 | 0.2  |
| <b>Seismic Longitudinal</b>      |   |                  |                |                |                 |                 | 1.5  |
| 11)                              | Sub-structure Component                         |                  | 9.7982         |                | 23.307          |                 | 1.5  |
| 12)                              | Backfill  |                  | 11.246         |                | 36.737          |                 | 1.5  |
| 12)                              | Super-Structure DL, SIDL, & Surfacing Component |                  | 28.972         |                | 111.11          |                 | 1.5  |
| 13)                              | Dynamic Earth Pressure                          |                  |                |                |                 |                 | 1.5  |
|                                  | Horizontal Component                            |                  | 0              |                | 0               |                 | 1.5  |
| 14)                              | Dynamic Surcharge Pressure                      |                  |                |                |                 |                 | 0.3  |
|                                  | 14.1) LWL Seismic Downward                      |                  | 0              |                | 0               |                 | 0.3  |
| <b>Seismic Transverses</b>       |   |                  |                |                |                 |                 | 0.45 |
| 15)                              | Sub-structure Component                         |                  |                | 29.479         |                 | 70.122          | 0.45 |
| 17)                              | Super-Structure DL, SIDL, & Surfacing Component |                  |                | 43.582         |                 | 211.44          | 0.45 |
| 18.2)                            | Live Load Component (Min. Reaction)             |                  |                | 9.2208         |                 | 56.247          | 0.09 |
| <b>Seismic Vertical Downward</b> |   |                  |                |                |                 |                 | 0.45 |
| 19)                              | Sub-structure Component                         | 6.5509           |                |                | 0.1173          |                 | 0.45 |
| 21)                              | Super-Structure DL, SIDL, & Surfacing Component | 9.685            |                |                | 3.1476          |                 | 0.45 |
| 22.2)                            | Live Load Component (Min. Reaction)             | 2.0491           |                |                | 0.666           |                 | 0.09 |

| S.N. | Description                    | Forces at bottom of abutment shaft |                |                |                 |                 |
|------|--------------------------------|------------------------------------|----------------|----------------|-----------------|-----------------|
|      |                                | V                                  | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|      |                                | Tonne                              | Tonne          | Tonne          | Tm              | Tm              |
| LC-9 | SIS,LWL,Min LL Acc,Seismic Sx= | 501.47                             | 167.85         | 33.707         | 564.52          | 153.65          |

| LC-10 | SIS, LWL,Min LL Acc,Seismic Sx= | Forces about toe |                |                |                 |                 | LC-10 |
|-------|---------------------------------|------------------|----------------|----------------|-----------------|-----------------|-------|
| S.N.  | Description                     | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |       |
|       |                                 | Tonne            | Tonne          | Tonne          | Tm              | Tm              |       |
| 1)    | Sub-structure                   | 144.93           |                |                | 2.596           | 0               | 1.35  |
| 3)    | Super-structure DL              | 155.13           |                |                | 50.416          | 0               | 1.35  |
| 4)    | SIDL (excluding surfacing)      | 45.817           |                |                | 14.891          | 0               | 1.35  |

|                                  |   |        |        |        |        |        |  |       |
|----------------------------------|---|--------|--------|--------|--------|--------|--|-------|
| 5)                               | Surfacing                                       | 13.326 |        |        | 4.3309 | -3.331 |  | 1.35  |
| 6.2)                             | Live Load Vertical Load Min Reaction            | 45.333 |        |        | 14.733 | 131.92 |  | 0.2   |
| 7)                               | Live Load Horizontal Forces                     |        | 26.592 |        | 101.98 |        |  | 0.2   |
| 9.1)                             | Earth Pressure LWL                              |        |        |        |        |        |  | 1     |
|                                  | Horizontal Component                            |        | 79.16  |        | 164.86 |        |  | 1     |
| 10.1)                            | Surcharge Pressure LWL                          |        | 41.754 |        | 102.73 |        |  | 0.2   |
| <b>Seismic Longitudinal</b>      |   |        |        |        |        |        |  | 1.5   |
| 11)                              | Sub-structure Component                         |        | 9.7982 |        | 23.307 |        |  | 1.5   |
| 12)                              | Backfill  |        | 11.246 |        | 36.737 |        |  | 1.5   |
| 12)                              | Super-Structure DL, SIDL, & Surfacing Component |        | 28.972 |        | 111.11 |        |  | 1.5   |
| 13)                              | Dynamic Earth Pressure                          |        |        |        |        |        |  | 1.5   |
|                                  | Horizontal Component                            |        | 0      |        | 0      |        |  | 1.5   |
| 14)                              | Dynamic Surcharge Pressure                      |        |        |        |        |        |  | 0.3   |
|                                  | 14.2) LWL Seismic Upward                        |        | 0      |        | 0      |        |  | 0.3   |
| <b>Seismic Transverses</b>       |   |        |        |        |        |        |  | 0.45  |
| 15)                              | Sub-structure Component                         |        |        | 29.479 |        | 70.122 |  | 0.45  |
| 17)                              | Super-Structure DL, SIDL, & Surfacing Component |        |        | 43.582 |        | 211.44 |  | 0.45  |
| 18.2)                            | Live Load Component (Min. Reaction)             |        |        | 9.2208 |        | 56.247 |  | 0.09  |
| <b>Seismic Vertical Downward</b> |   |        |        |        |        |        |  | 0.45  |
| 19)                              | Sub-structure Component                         | 6.5509 |        |        | 0.1173 |        |  | -0.45 |
| 21)                              | Super-Structure DL, SIDL, & Surfacing Component | 9.685  |        |        | 3.1476 |        |  | -0.45 |
| 22.2)                            | Live Load Component (Min. Reaction)             | 2.0491 |        |        | 0.666  |        |  | -0.09 |

| S.N.  | Description                                    | Forces at bottom of abutment shaft |                |                |                 |                 |
|-------|--|------------------------------------|----------------|----------------|-----------------|-----------------|
|       |  | V                                  | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|       |  | Tonne                              | Tonne          | Tonne          | Tm              | Tm              |
| LC-10 | SIS, LWL, Min LL Acc, Seismic S <sub>x</sub> = | 486.49                             | 167.85         | 33.707         | 561.46          | 153.65          |

| S.N.                        | Description                          | Forces about toe |                |                |                 |                 | LC-11 |
|-----------------------------|--------------------------------------|------------------|----------------|----------------|-----------------|-----------------|-------|
|                             |                                      | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |       |
|                             |                                      | Tonne            | Tonne          | Tonne          | Tm              | Tm              |       |
| 1)                          | Sub-structure                        | 144.93           |                |                | 2.596           | 0               | 1.35  |
| 3)                          | Super-structure DL                   | 155.13           |                |                | 50.416          | 0               | 1.35  |
| 4)                          | SIDL (excluding surfacing)           | 45.817           |                |                | 14.891          | 0               | 1.35  |
| 5)                          | Surfacing                            | 13.326           |                |                | 4.3309          | -3.331          | 1.35  |
| 6.1)                        | Live Load Vertical Load Max Reaction | 89.867           |                |                | 29.207          | 261.51          | 0.2   |
| 7)                          | Live Load Horizontal Forces          |                  | 26.592         |                | 101.98          |                 | 0.2   |
| 9.1)                        | Earth Pressure LWL                   |                  |                |                |                 |                 | 1     |
|                             | Horizontal Component                 |                  | 79.16          |                | 164.86          |                 | 1     |
| 10.1)                       | Surcharge Pressure LWL               |                  | 41.754         |                | 102.73          |                 | 0.2   |
| <b>Seismic Longitudinal</b> |                                      |                  |                |                |                 |                 | 1.5   |
| 11)                         | Sub-structure Component              |                  | 9.7982         |                | 23.307          |                 | 1.5   |
| 12)                         | Backfill                             |                  | 11.246         |                | 36.737          |                 | 1.5   |



|                                  |   |        |        |        |        |      |
|----------------------------------|---|--------|--------|--------|--------|------|
| 12)                              | Super-Structure DL, SIDL, & Surfacing Component | 28.972 |        | 111.11 |        | 1.5  |
| 13)                              | Dynamic Earth Pressure                          |        |        |        |        | 1.5  |
|                                  | Horizontal Component                            | 0      |        | 0      |        | 1.5  |
| 14)                              | Dynamic Surcharge Pressure                      |        |        |        |        | 0.3  |
|                                  | 14.1) LWL Seismic Downward                      | 0      |        | 0      |        | 0.3  |
| <b>Seismic Transverses</b>       |   |        |        |        |        | 0.45 |
| 15)                              | Sub-structure Component                         |        | 29.479 |        | 70.122 | 0.45 |
| 17)                              | Super-Structure DL, SIDL, & Surfacing Component |        | 43.582 |        | 211.44 | 0.45 |
| 18.1)                            | Live Load Component (Max. Reaction)             |        | 18.279 |        | 111.5  | 0.09 |
| <b>Seismic Vertical Downward</b> |   |        |        |        |        | 0.45 |
| 19)                              | Sub-structure Component                         | 6.5509 |        | 0.1173 |        | 0.45 |
| 21)                              | Super-Structure DL, SIDL, & Surfacing Component | 9.685  |        | 3.1476 |        | 0.45 |
| 22.1)                            | Live Load Component (Max. Reaction)             | 4.062  |        | 1.3201 |        | 0.09 |

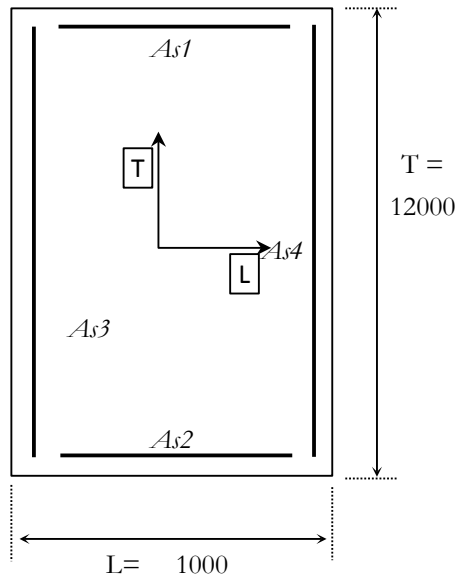
| S.N.  | Description                    | Forces at bottom of abutment shaft |                |                |                 |                 |
|-------|--------------------------------|------------------------------------|----------------|----------------|-----------------|-----------------|
|       |                                | V                                  | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|       |                                | Tonne                              | Tonne          | Tonne          | Tm              | Tm              |
| LC-11 | SIS,LWL,Max LL,Seismic Sx=1,Sz | 510.56                             | 167.85         | 34.523         | 567.48          | 184.54          |

| LC-12                       | SIS, LWL,Max LL,Seismic Sx=1,Sz                 | Forces about toe |                |                |                 |                 | LC-12 |
|-----------------------------|---|------------------|----------------|----------------|-----------------|-----------------|-------|
| S.N.                        | Description                                     | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |       |
|                             |   | Tonne            | Tonne          | Tonne          | Tm              | Tm              |       |
| 1)                          | Sub-structure                                   | 144.93           |                |                | 2.596           | 0               | 1.35  |
| 3)                          | Super-structure DL                              | 155.13           |                |                | 50.416          | 0               | 1.35  |
| 4)                          | SIDL (excluding surfacing)                      | 45.817           |                |                | 14.891          | 0               | 1.35  |
| 5)                          | Surfacing                                       | 13.326           |                |                | 4.3309          | -3.331          | 1.35  |
| 6.1)                        | Live Load Vertical Load Max Reaction            | 89.867           |                |                | 29.207          | 261.51          | 0.2   |
| 7)                          | Live Load Horizontal Forces                     |                  | 26.592         |                | 101.98          |                 | 0.2   |
| 9.1)                        | Earth Pressure LWL                              |                  |                |                |                 |                 | 1     |
|                             | Horizontal Component                            |                  | 79.16          |                | 164.86          |                 | 1     |
| 10.1)                       | Surcharge Pressure LWL                          |                  | 41.754         |                | 102.73          |                 | 0.2   |
| <b>Seismic Longitudinal</b> |   |                  |                |                |                 |                 | 1.5   |
| 11)                         | Sub-structure Component                         |                  | 9.7982         |                | 23.307          |                 | 1.5   |
| 12)                         | Backfill  |                  | 11.246         |                | 36.737          |                 | 1.5   |
| 12)                         | Super-Structure DL, SIDL, & Surfacing Component |                  | 28.972         |                | 111.11          |                 | 1.5   |
| 13)                         | Dynamic Earth Pressure                          |                  |                |                |                 |                 | 1.5   |
|                             | Horizontal Component                            |                  | 0              |                | 0               |                 | 1.5   |
| 14)                         | Dynamic Surcharge Pressure                      |                  |                |                |                 |                 | 0.3   |
|                             | 14.2) LWL Seismic Upward                        |                  | 0              |                | 0               |                 | 0.3   |
| <b>Seismic Transverses</b>  |   |                  |                |                |                 |                 | 0.45  |
| 15)                         | Sub-structure Component                         |                  |                | 29.479         |                 | 70.122          | 0.45  |
| 17)                         | Super-Structure DL, SIDL, & Surfacing Component |                  |                | 43.582         |                 | 211.44          | 0.45  |
| 18.1)                       | Live Load Component (Max. Reaction)             |                  |                | 18.279         |                 | 111.5           | 0.09  |

|                                  |                                  |        |  |  |        |       |
|----------------------------------|----------------------------------|--------|--|--|--------|-------|
| <b>Seismic Vertical Downward</b> |                                  |        |  |  |        | 0.45  |
| 19)                              | Sub-structure Component          | 6.5509 |  |  | 0.1173 | -0.45 |
| 21)                              | Super-Structure DL, SIDL, & Surf | 9.685  |  |  | 3.1476 | -0.45 |
| 22.1)                            | Live Load Component (Max. React  | 4.062  |  |  | 1.3201 | -0.09 |

| S.N.  | Description  | Forces at bottom of abutment shaft |                |                |                 |                 |
|-------|--|------------------------------------|----------------|----------------|-----------------|-----------------|
|       |  | V                                  | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|       |  | Tonne                              | Tonne          | Tonne          | Tm              | Tm              |
| LC-12 | SIS, LWL,Max LL,Seismic S <sub>x</sub> =1,S <sub>y</sub> | 495.22                             | 167.85         | 34.523         | 564.3           | 184.54          |

**ULS CHECK FOR ABUTMENT SHAFT :**



**Check For Biaxial Bending Moment**

$$N_{RD} = A_c f_{cd} + A_s f_{yd}$$

$$= 19861.5 \text{ Tonne}$$

$$\left( \frac{M_{EDT}}{M_{EDT}} \right)^\alpha + \left( \frac{M_{EDL}}{M_{RDL}} \right)^\alpha \leq 1$$

$$f_{ck} = 35 \text{ Mpa}$$

$$f_{cd} = 15.6 \text{ Mpa}$$

$$f_{yd} = 434.8 \text{ Mpa}$$

$$A_c = 12000000 \text{ mm}^2$$

$$A_s = 25333.8 \text{ mm}^2$$

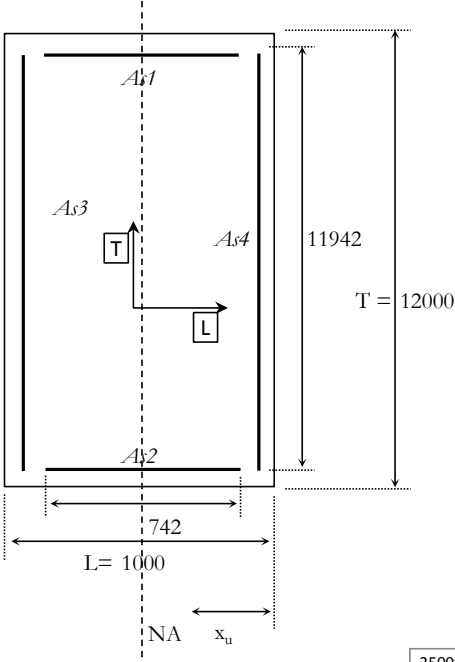
**ULS CHECK FOR ABUTMENT SHAFT :**

| S.N.  | Description                                      | Forces at bottom of abutment shaft |          |         |           |           | CHECK FOR MOMENT CAPACITY |          |           |           |   |
|-------|--|------------------------------------|----------|---------|-----------|-----------|---------------------------|----------|-----------|-----------|---|
|       |  | $N_{ED}$                           | $H_L$    | $H_T$   | $M_{ETT}$ | $M_{ELL}$ | $N_{ED}/N_{RD}$           | $\alpha$ | $M_{RIT}$ | $M_{RLL}$ | $(M_{EDT}/M_{RDT})^\alpha + (M_{EDL}/M_{RDL})^\alpha$ |
|       |  | Tonne                              | Tonne    | Tonne   | Tm        | Tm        |                           |          | Tm        | Tm        | Check   |
| LC-1  | NS, LWL, Span dislodge, FP                       | 195.656                            | 51.18509 | 0       | 126.595   | 0         |                           |          |           |           |   |
| LC-2  | NS, LWL, Span dislodge, EP                       | 195.656                            | 168.8458 | 0       | 374.072   | 0         | 0.0                       | 1        | 533.8     | 6456.2    | 0.70 OK   |
| LC-4  | NS, LWL, Min LL Lead, EP                         | 542.381                            | 199.4263 | 0       | 604.034   | 145.878   | 0.0                       | 1        | 680.4     | 8181.3    | 0.91 OK   |
| LC-6  | NS, LWL, Max LL, EP                              | 625.048                            | 169.1532 | 0       | 584.161   | 386.438   | 0.0                       | 1        | 715.3     | 8592.6    | 0.86 OK   |
|       |  |                                    |          |         |           |           |                           |          |           |           |   |
| LC-7  | SIS,LWL, Span dislodge ,Seismic $S_x=1, S_z=0.3$ | 199.309                            | 125.0233 | 16.4388 | 318.012   | 63.3507   | 0.0                       | 1        | 535.3     | 6474.4    | 0.60 OK   |
| LC-8  | SIS, LWL,Span dislodge ,Seismic $S_x=1, S_z=0.3$ | 192.003                            | 125.0233 | 16.4388 | 316.542   | 63.3507   | 0.0                       | 1        | 532.3     | 6438.1    | 0.60 OK   |
| LC-9  | SIS,LWL,Min LL Acc,Seismic $S_x=1, S_z=0.3$      | 501.475                            | 167.8536 | 33.7075 | 564.522   | 153.65    | 0.0                       | 1        | 663.1     | 7977.8    | 0.87 OK   |
| LC-10 | SIS, LWL,Min LL Acc,Seismic $S_x=1, S_z=0.3$     | 486.494                            | 167.8536 | 33.7075 | 561.463   | 153.65    | 0.0                       | 1        | 656.8     | 7903.2    | 0.87 OK   |
| LC-11 | SIS,LWL,Max LL,Seismic $S_x=1, S_z=0.3$          | 510.563                            | 167.8536 | 34.5227 | 567.475   | 184.541   | 0.0                       | 1        | 666.9     | 8023.0    | 0.87 OK   |

|       |                                     |         |          |         |         |         |     |   |       |        |      |    |
|-------|-------------------------------------|---------|----------|---------|---------|---------|-----|---|-------|--------|------|----|
| LC-12 | SIS, LWL,Max LL,Seismic Sx=1,Sz=0.3 | 495.219 | 167.8536 | 34.5227 | 564.299 | 184.541 | 0.0 | 1 | 660.5 | 7946.6 | 0.88 | OK |
|-------|-------------------------------------|---------|----------|---------|---------|---------|-----|---|-------|--------|------|----|

INTERACTION DIAGRAM : (P : M<sub>TT</sub>)

SECTION AT SHAFT BOTTOM



| xu/D  | Pu       | Mu       |
|-------|----------|----------|
|       | T        | Tm       |
| 1E-09 | -1102.02 | -14.8248 |
| 0.2   | 2970.42  | 1706.91  |
| 0.4   | 6033.18  | 2470.9   |
| 0.6   | 9174.61  | 2692.17  |
| 0.8   | 12544.1  | 2306.92  |
| 1     | 15808.8  | 1476.69  |
| 1.2   | 17525.4  | 858.002  |
| 1.4   | 18311.5  | 573.909  |
| 1.6   | 18738.7  | 419.12   |
| 1.8   | 18997.8  | 324.995  |
| 2     | 19167.5  | 263.201  |

Section Dimensions:

|   |   |       |    |
|---|---|-------|----|
| D | = | 1000  | mm |
| B | = | 12000 | mm |

Material Properties:

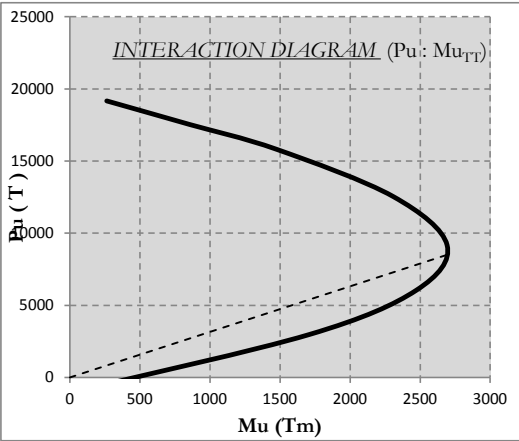
|     |   |        |                   |
|-----|---|--------|-------------------|
| fck | = | 35     | N/mm <sup>2</sup> |
| fyk | = | 500    | N/mm <sup>2</sup> |
| Es  | = | 200000 | N/mm <sup>2</sup> |

Reinforcement Details:

| Reinf.                                | Dia | Spacing | Cover | From | To    | Y_Cg  | Nos. | Spacing | Remark  |
|---------------------------------------|-----|---------|-------|------|-------|-------|------|---------|---------|
|                                       | mm  | mm      | mm    | m    | m     | m     |      |         |         |
| REINFORCEMENT ACROSS AXIS OF BENDING: |     |         |       |      |       |       |      |         |         |
| As1                                   | 16  | 200     | 50    | 323  | 742   | 5942  | 3    | 210     |         |
| As2                                   | 16  | 200     | 50    | 323  | 742   | -5942 | 3    | 210     |         |
| REINFORCEMENT ALONG AXIS OF BENDING:  |     |         |       |      |       |       |      |         |         |
| As3                                   | 16  | 200     | 75    | 58   | 11942 | -417  | 60   | 201     | LAYER-2 |
|                                       | 0   | 200     | 123   | 58   | 11942 | -377  | 60   | 201     |         |
| As4                                   | 16  | 200     | 50    | 58   | 11942 | 442   | 60   | 201     |         |

|                              |   |         |                 |
|------------------------------|---|---------|-----------------|
| As tension face (Length)     | = | 12063.7 | mm <sup>2</sup> |
| As Compression face (Length) | = | 12063.7 | mm <sup>2</sup> |
| As tension face (width)      | = | 603.186 | mm <sup>2</sup> |
| As Compression face (width)  | = | 603.186 | mm <sup>2</sup> |
| Total As                     | = | 25333.8 | mm <sup>2</sup> |
|                              | = | 0.21    | %               |

|                 |            |
|-----------------|------------|
| Balance Failure |            |
| d1              | 917 mm     |
| xu              | 566.049 mm |
| xu/D            | 0.56605    |
| Pu              | 8578.57 T  |
| Mu              | 2716.89 Tm |



**Formula Used In Construction of Intraction Diagram :**

$$P_u = C_c + C_s$$

$$M_u = M_c + M_s$$

$$C_c = \begin{cases} 0.361 * f_{ck} * x_u * b & x_u \leq D \\ 0.447 * f_{ck} * (1 - 4 * g / 21) * b * D & x_u > D \end{cases}$$

$$g = 16 / (7 x_u / D - 3)^2$$

$$C_s = \Sigma (f_{si} - f_{ci}) A_{si}$$

$$f_{ci} = \begin{cases} 0 & \epsilon_{si} \leq 0 \\ 0.447 f_{ck} & \epsilon_{si} \geq 0.002 \\ 0.447 f_{ck} [2 * (\epsilon_{si} / 0.002) - (\epsilon_{si} / 0.002)^2] & \text{otherwise} \end{cases}$$

$$f_{si} = \begin{cases} -0.87 f_y & \epsilon_{si} \leq -0.00217 \\ \epsilon_{si} * E_s & \epsilon_{si} > -0.00217 \\ 0.87 f_y & \epsilon_{si} > 0.00217 \end{cases} \quad \epsilon_{si} \leq 0.00217$$

$$M_c = C_c * (0.5D - x)$$

$$M_s = \Sigma C_{si} * y_i$$

$$x = \begin{cases} 0.416 x_u & x_u \leq D \\ (0.5 - 8 * g / 49) * \{D / (1 - 4 * g / 21)\} & x_u > D \end{cases}$$

$$x = \text{Centroid of stress blok area from most compressed edge}$$

$$\epsilon_{si} = \begin{cases} 0.0035 * \left[ \frac{x_u - D / 2 + y_i}{x_u} \right] & x_u \leq D \\ 0.002 * \left[ 1 + \frac{y_i - D / 14}{x_u - 3D / 7} \right] & x_u > D \end{cases}$$

| Pu      | Mu      |
|---------|---------|
| T       | Tm      |
| 195.656 | 126.595 |
| 195.656 | 374.072 |
| 542.381 | 356.557 |
| 542.381 | 604.034 |
| 625.048 | 584.161 |
| 0       | 0       |
| 199.309 | 318.012 |
| 192.003 | 316.542 |

**Reinforcement in Transverse Direction :**

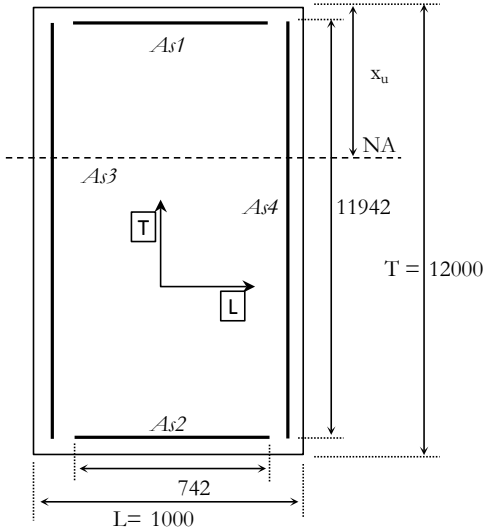
Total vertical reinf. = 25334 mm<sup>2</sup>  
Length of abutment = 12 m  
Reinf. /m length = 2111 mm<sup>2</sup>/m  
Reinforcement in transverse direction = 0.25 times vertical reinf  
= 528 mm<sup>2</sup>/m ( Total on both face)

Cross -sectional area Ac per meter length/ heighth = 1000000 mm<sup>2</sup> /m  
Minimum reinf. = 0.001 Ac  
= 1000 mm<sup>2</sup>/m

Reinforcement required = 1000 mm<sup>2</sup>/m (Total on both face)

Provide 20  $\phi$  @ 120 c/c on each face  
= 2618 mm<sup>2</sup>/m on each face  
 $\cong$  5236 mm<sup>2</sup>/m (total on both faces ) OK

INTRACTION DIAGRAM : (P : M<sub>LL</sub>)



| xu/D  | Pu       | Mu      |
|-------|----------|---------|
|       | T        | Tm      |
| 1E-09 | -1102.02 | 9.1E-05 |
| 0.2   | 2399.82  | 17422.5 |
| 0.4   | 5843.21  | 27323.5 |
| 0.6   | 9286.4   | 30052.2 |
| 0.8   | 12655.2  | 26165.9 |
| 1     | 15915.1  | 16603.7 |
| 1.2   | 17602.6  | 9396.98 |
| 1.4   | 18370.9  | 6117.34 |
| 1.6   | 18786    | 4345.49 |
| 1.8   | 19036.2  | 3276.59 |
| 2     | 19199.1  | 2580.01 |
| 100   | 19747    | 11.7577 |

SECTION AT SHAFT BOTTOM

Section Dimensions:

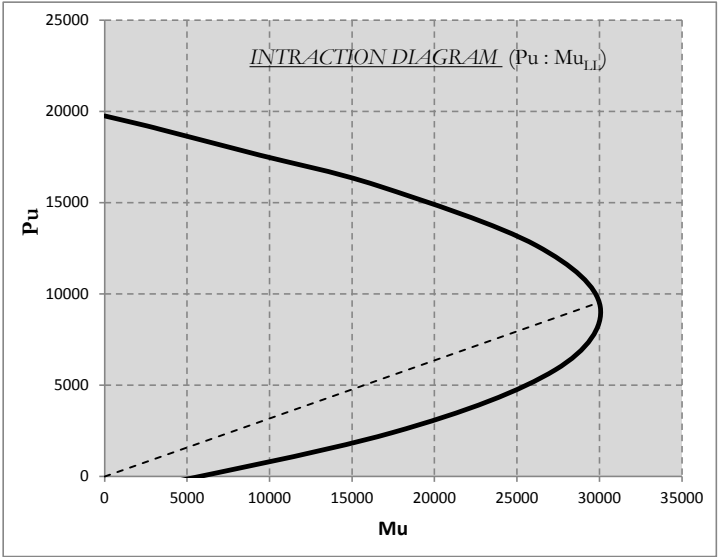
|   |   |       |    |
|---|---|-------|----|
| D | = | 12000 | mm |
| B | = | 1000  | mm |

Material Properties:

|                 |   |        |                   |
|-----------------|---|--------|-------------------|
| f <sub>ck</sub> | = | 35     | N/mm <sup>2</sup> |
| f <sub>yk</sub> | = | 500    | N/mm <sup>2</sup> |
| E <sub>s</sub>  | = | 200000 | N/mm <sup>2</sup> |

Reinforcement Details :

| Reinf.                                | Dia | Spacing | Cover | From | To    | Y_Cg  | Nos. | Spacing | Remark  |
|---------------------------------------|-----|---------|-------|------|-------|-------|------|---------|---------|
|                                       | mm  | mm      | mm    | m    | m     | m     |      |         |         |
| REINFORCEMENT ACROSS AXIS OF BENDING: |     |         |       |      |       |       |      |         |         |
| As3                                   | 16  | 200     | 75    | 58   | 11942 | -417  | 60   | 201.424 | LAYER-2 |
|                                       | 0   | 200     | 123   | 58   | 11942 | -377  | 60   | 201.424 |         |
| As4                                   | 16  | 200     | 50    | 58   | 11942 | 442   | 60   | 201.424 |         |
| REINFORCEMENT ALONG AXIS OF BENDING:  |     |         |       |      |       |       |      |         |         |
| As1                                   | 16  | 200     | 50    | 323  | 742   | 5942  | 3    | 209.5   |         |
| As2                                   | 16  | 200     | 50    | 323  | 742   | -5942 | 3    | 209.5   |         |



Balance Failure

|      |              |
|------|--------------|
| d1   | 11942        |
| xu   | 7371.6049 mm |
| xu/D | 0.6143004    |
| Pu   | 9532.5652 T  |
| Mu   | 29972.456 Tm |



**Confinement Reinforcement of Abutment:**

|   |    |   |  |
|---|----|---|--|
| Width of abutment shaft                               | b  | = | 1000 mm  |
| Length of abutment shaft                              | L  | = | 12000 mm   |
| Clear cover to earth face                             |    | = | 75 mm  |
| Clear cover to other face                             |    | = | 50 mm  |
| Confined area of concrete                             |    | = | 10412500 mm <sup>2</sup>   |
| $N_{ED}$  |    | = | 625 Tonne  |
| Ac  |    | = | 12000000 mm <sup>2</sup>   |
| fck   |    | = | 35 Mpa   |
| fcd   |    | = | 15.63 Mpa  |
| fyd   |    | = | 435 Mpa  |
| Normalized axial force                                |    |   |  |
| $\eta_k$  |    | = | Max $N_{ED}/Ac fck$  |
| $\eta_k$  |    | = | 0.015 < 0.08   |
|   |    | = | < 0.3  |
| Extent of confinement                                 |    | = | Depth of section within the plane of bending                               |
|   |    | = | 1 m  |
| Required volumetric ratio of transverse reinforcement |    |   |  |
| $\omega_{w,req}$                                      |    | = | 0.37 Ac/ Acc $\eta_k$ +0.13 fyd/fcd ( $\rho_L$ -0.01)                      |
| Ac  |    | = | Area of gross concrete section   |
|   |    | = | 12.00 m <sup>2</sup>   |
| Acc   |    | = | Confined core concrete area of the section within the outside dia of loop. |
|   |    | = | 10.41 m <sup>2</sup>   |
| $\rho_L$  |    | = | Reinforcement ratio of the longitudinal reinforcement                      |
|   |    | = | As/Acc   |
| Area of steel provided                                | As | = | 25334 mm <sup>2</sup>  |
| $\rho_L$  |    | = | 0.00243 mm <sup>2</sup>  |
| $\omega_{w,req}$                                      |    | = | 0.00635  |
| Minimum Confining Reinforcement                       |    |   |  |
| $\omega_{w,d}$  |    | = | Max(1.4* $\omega_{w,req}$ , 0.12)  |
|   |    | = | 0.12   |
| Volumetric ratio of transverse reinforcement          |    |   |  |
| $\rho_w$  |    | = | $\omega_{w,d}fcd/fyd$  |
|   |    | = | 0.00431  |

Volumetric ratio of transverse reinforcement

$$\rho_w = A_{sw} / b S_L$$

Area of the spiral or hoop bar

$$A_{sw} = \rho_w * b * S_L$$

$$b = \text{Dimension of the core perpendicular to the direction of confinement.} \\ = 875 \text{ mm}$$

$$S_L = \text{Spacing of hoops or ties in longitudinal direction (in vertical direction)} \\ \leq 1/5 * \text{smallest dimension of confined core} \\ = 0.2 \times 875 = 175 \text{ mm} \\ = 180 \text{ mm}$$

$$A_{sw} = 680 \text{ mm}^2$$

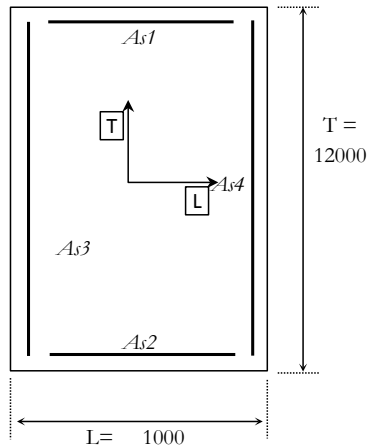
Provide 16 dia 20 Nos. @ 180 mm c/c

$$\text{Area of reinforcement provided at one section} = 4021 \text{ mm}^2 \quad \text{OK}$$

**Transverse distance b/w hoops legs or supplementary cross ties :**

$$S_T = \text{Min} \left\{ \begin{array}{l} 1/3 * \text{smallest dimension of confined core} \\ 200 \text{ mm} \end{array} \right. \\ = \text{Min} \left\{ \begin{array}{l} 0.33 \times 875 \\ 200 \text{ mm} \end{array} \right. = 292 \text{ mm} \\ = 200 \text{ mm}$$

# **ULS SHEAR CHECK FOR ABUTMENT SHAFT :**



|          |   |          |        |
|----------|---|----------|--------|
| $f_{ck}$ | = | 35       | Mpa    |
| $f_{cd}$ | = | 15.6333  | Mpa    |
| $f_{yk}$ | = | 500      | Mpa    |
| $A_c$    | = | 12000000 | $mm^2$ |
| $A_s$    | = | 25333.8  | $mm^2$ |

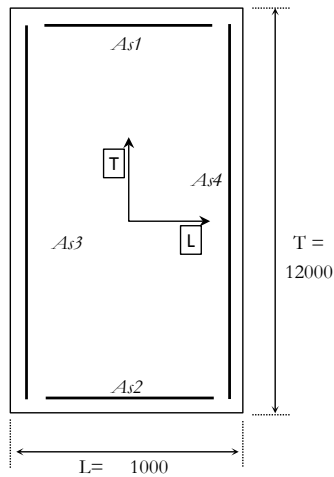
Reduction factor  $\beta$  = 0.5 for  $a_v < 0.5d$

|   |   |                                  |  |
|---|---|----------------------------------|--|
| <b>Design Shear Resitance</b> (IRC 112 / clause 10.3.2 (2)) |   |                                  |  |
| $k$   | = | Min                              | $\left\{ \begin{array}{l} 1 + \sqrt{200/d} \\ 2 \end{array} \right.$ d is depth in mm  |
| $k$   | = | 1.44721                          |  |
| $\rho_1$  | = | Min                              | $\left\{ \begin{array}{l} A_{s1}/bw \ d \\ 0.02 \end{array} \right.$   |
| $A_{s1}$  | = | 12063.7                          | $mm^2$ */ Reinforcement on tension face  |
| $\rho_1$  | = | 0.00101                          |  |
| $\sigma_{cp}$   | = | Axial stress                     |  |
| $v_{min}$   | = | $0.031 \ k^{3/2} \ f_{ck}^{1/2}$ |  |
|   | = | 0.3193                           |  |
| $V_{Rdc}$   | = | Max                              | $\left\{ \begin{array}{l} (0.12 \ k \ (80 \ \rho_1 \ f_{ck})^{0.33} + 0.15 \ \sigma_{cp}) \ bw \ d \\ (v_{min} + 0.15 \ \sigma_{cp}) \ bw \ d \end{array} \right.$ |
| <b>Max Shear Capacity</b>                                   |   |                                  |  |
| $v$   | = | $0.6 * (1 - f_{ck} / 310)$       | */ fck in Mpa  |
|   | = | 0.53226                          |  |
| $V_{RDC, \ max}$  | = | $0.5 \ bw \ d \ v \ f_{cd}$      |  |
|   | = | 4992.58                          | Tonne  |



**CHECK FOR ABUTMENT SHAFT SLENDERNESS RATIO:**

(IRC 112 / clause 8.3.2 (3))



$$\begin{aligned} A_c &= 12000000 \text{ mm}^2 \\ A_s &= 25334 \text{ mm}^2 \\ f_{cd} &= 15.6 \text{ Mpa} \\ f_{yd} &= 435 \text{ Mpa} \end{aligned}$$

**Slenderness criteria**

$$\begin{aligned} \text{Moment of Inertia about TT axis } I_{TT} &= 1\text{E}+12 \text{ mm}^4 \\ \text{Moment of Inertia about LL axis } I_{LL} &= 1.44\text{E}+14 \text{ mm}^4 \\ \text{Radius of gyration along LL axis } i_L &= \sqrt{I_{TT} / A} \\ &= 288.7 \text{ mm} \\ \text{Radius of gyration along TT axis } i_T &= \sqrt{I_{LL} / A} \\ &= 3464.1 \text{ mm} \end{aligned}$$

$$\begin{aligned} \text{Clear Height of compression member } l_o &= 3.68 \text{ m} \\ \text{Effective Length of column along LL -axis } l_{eL} &= 1.4 * l_o \\ &= 5.16 \text{ m} \end{aligned}$$

$$\begin{aligned} \text{Slenderness ratio along L-L axis } \lambda_L &= l_{eL} / i_L \\ &= 17.8689 \end{aligned}$$

$$\begin{aligned} \text{Effective Length of column along TT -axis } l_{eT} &= 2.3 * l_o \\ &= 8.47 \text{ m} \end{aligned}$$

$$\begin{aligned} \text{Slenderness ratio along TT' axis } \lambda_T &= l_{eT} / i_T \\ &= 2.45 \end{aligned}$$

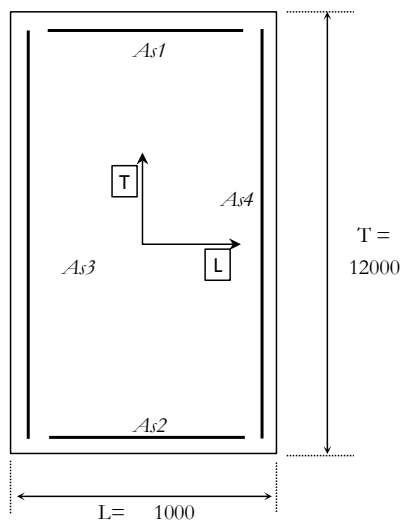
$$\begin{aligned} \text{Check } \lambda_L / \lambda_T &= 7.30 > 2 && \text{Check for limiting slenderness ratio} \\ \text{And } \lambda_T / \lambda_L &= 0.14 < 2 && \text{Ignore second order effect} \end{aligned}$$

| SUMMERY OF FORCES AT BOTTOM OF SHAFT: |                            |                                    |                |                |                  |                  |  | CHECK FOR SLENDERNESS RATIO   |                               |           |           |                     |                     |                                      |
|---------------------------------------|----------------------------|------------------------------------|----------------|----------------|------------------|------------------|--|-------------------------------|-------------------------------|-----------|-----------|---------------------|---------------------|--------------------------------------|
| S.N.                                  | Description                | Forces at bottom of abutment shaft |                |                |                  |                  |  | $e_L = \frac{M_{TT}}{N_{ED}}$ | $e_T = \frac{M_{LL}}{N_{ED}}$ | $e_L / L$ | $e_T / T$ | $(e_L/L) / (e_T/T)$ | $(e_T/T) / (e_L/L)$ | CHECK                                |
|                                       |                            | N <sub>ED</sub>                    | H <sub>L</sub> | H <sub>T</sub> | M <sub>ETT</sub> | M <sub>ELL</sub> |  |                               |                               |           |           |                     |                     |                                      |
|                                       |                            | Tonne                              | Tonne          | Tonne          | Tm               | Tm               |  |                               |                               |           |           |                     |                     |                                      |
| LC-1                                  | NS, LWL, Span dislodge, FP | 195.7                              | 51.2           | 0.0            | 126.6            | 0.0              |  | 0.6                           | 0.0                           | 0.6       | 0.000     | 100.0               | 0.000               | Check for limiting slenderness ratio |
| LC-2                                  | NS, LWL, Span dislodge, EP | 195.7                              | 168.8          | 0.0            | 374.1            | 0.0              |  | 1.9                           | 0.0                           | 1.9       | 0.000     | 100.0               | 0.000               | Check for limiting slenderness ratio |
| LC-3                                  | NS, LWL, Min LL Lead, FP   | 542.4                              | 81.8           | 0.0            | 356.6            | 145.9            |  | 0.7                           | 0.3                           | 0.7       | 0.022     | 29.3                | 0.034               | Check for limiting slenderness ratio |
| LC-4                                  | NS, LWL, Min LL Lead, EP   | 542.4                              | 199.4          | 0.0            | 604.0            | 145.9            |  | 1.1                           | 0.3                           | 1.1       | 0.022     | 49.7                | 0.020               | Check for limiting slenderness ratio |
| LC-5                                  | NS, LWL, Max LL, FP        | 625.0                              | 90.7           | 0.0            | 419.2            | 386.4            |  | 0.7                           | 0.6                           | 0.7       | 0.052     | 13.0                | 0.077               | Check for limiting slenderness ratio |

|       |  |       |       |      |       |       |  |     |     |     |       |      |       |                                      |
|-------|--|-------|-------|------|-------|-------|--|-----|-----|-----|-------|------|-------|--------------------------------------|
| LC-6  | NS, LWL, Max LL, EP                    | 625.0 | 169.2 | 0.0  | 584.2 | 386.4 |  | 0.9 | 0.6 | 0.9 | 0.052 | 18.1 | 0.055 | Check for limiting slenderness ratio |
| 0.0   | 0.0                                    |       |       |      |       |       |  |     |     |     |       |      |       |                                      |
| LC-7  | SIS,LWL, Span dislodge ,Seismic Sx=1,S | 199.3 | 125.0 | 16.4 | 318.0 | 63.4  |  | 1.6 | 0.3 | 1.6 | 0.026 | 60.2 | 0.017 | Check for limiting slenderness ratio |
| LC-8  | SIS, LWL,Span dislodge ,Seismic Sx=1,S | 192.0 | 125.0 | 16.4 | 316.5 | 63.4  |  | 1.6 | 0.3 | 1.6 | 0.027 | 60.0 | 0.017 | Check for limiting slenderness ratio |
| LC-9  | SIS,LWL,Min LL Acc,Seismic Sx=1,Sz=    | 501.5 | 167.9 | 33.7 | 564.5 | 153.7 |  | 1.1 | 0.3 | 1.1 | 0.026 | 44.1 | 0.023 | Check for limiting slenderness ratio |
| LC-10 | SIS, LWL,Min LL Acc,Seismic Sx=1,Sz=   | 486.5 | 167.9 | 33.7 | 561.5 | 153.7 |  | 1.2 | 0.3 | 1.2 | 0.026 | 43.9 | 0.023 | Check for limiting slenderness ratio |
| LC-11 | SIS,LWL,Max LL,Seismic Sx=1,Sz=0.3,S   | 510.6 | 167.9 | 34.5 | 567.5 | 184.5 |  | 1.1 | 0.4 | 1.1 | 0.030 | 36.9 | 0.027 | Check for limiting slenderness ratio |
| LC-12 | SIS, LWL,Max LL,Seismic Sx=1,Sz=0.3,S  | 495.2 | 167.9 | 34.5 | 564.3 | 184.5 |  | 1.1 | 0.4 | 1.1 | 0.031 | 36.7 | 0.027 | Check for limiting slenderness ratio |

**CHECK FOR ABUTMENT SHAFT SECOND ORDER FORCES:**

( IRC 112 / clause 11.2.1)



$$\begin{aligned} A_c &= 12000000 \text{ mm}^2 \\ A_s &= 25333.8 \text{ mm}^2 \\ f_{cd} &= 15.6 \text{ Mpa} \\ f_{yd} &= 434.8 \text{ Mpa} \end{aligned}$$

*Slenderness criteria*

$$\begin{aligned} \text{Moment of Inertia about TT axis } I_{TT} &= 1\text{E}+12 \text{ mm}^4 \\ \text{Moment of Inertia about LL axis } I_{LL} &= 1.44\text{E}+14 \text{ mm}^4 \\ \text{Radius of gyration along LL axis } i_L &= \sqrt{I_{TT} / A} \\ &= 289 \text{ mm} \\ \text{Radius of gyration along TT axis } i_T &= \sqrt{I_{LL} / A} \\ &= 3464 \text{ mm} \end{aligned}$$

$$\begin{aligned} \text{Clear Height of compression member } l_o &= 3.68 \text{ m} \\ \text{Effective length of column along L-L } l_{eL} &= 1.4 * l_o \\ &= 5.16 \text{ m} \\ \text{Slenderness ratio along L-L axis } \lambda_L &= l_{eL} / i_L \\ &= 17.87 \\ \text{Effective Length of column along TT -axis } l_{eT} &= 2.3 * l_o \\ &= 8.47 \text{ m} \\ \text{Slenderness ratio along TT axis } \lambda_T &= l_{eT} / i_T \\ &= 2.45 \end{aligned}$$

Finding Limiting Value of Slenderness Ratio.

$$\lambda_{lim} = 20 A B C / \sqrt{n}$$

$$\phi(\infty, t_0) = 1.47 \text{ Creep for abutment shaft}$$

$$M_{OEqp}/M_{OEd} = \text{Ratio of BM in Quasi Permanent LC of SLS to BM in Design LC of ULS}$$

$$\phi_{ef} = \phi(\infty, t_0) * M_{OEqp}/M_{OEd}$$

$$A = 1 / (1 + 0.2 \phi_{ef})$$

$$\omega = A_s f_{yd} / (A_c f_{cd})$$

$$= 0.059$$

$$B = \sqrt{(1 + 2\omega)}$$

$$= 1.057$$

$$r_m = M_{o1} / M_{o2} \quad (\text{Ratio of First order moments at two ends of members})$$

$$= 0$$

$$C = 1.7 - r_m$$

$$= 1.7$$

$$n = N_{ED} / (A_c f_{cd})$$

$$= N_{ED} / 18760 \quad */ (N_{ED} \text{ in Tonne})$$

| SUMMARY OF FORCES AT BOTTOM OF SHAFT: |                 |                  |                  |                  |                  |
|---------------------------------------|-----------------|------------------|------------------|------------------|------------------|
| S.N.                                  | ULS FORCES      |                  |                  | SLS (QP LC)      |                  |
|                                       | N <sub>ED</sub> | M <sub>ETT</sub> | M <sub>ELL</sub> | M <sub>ETT</sub> | M <sub>ELL</sub> |
|                                       | Tonne           | Tm               | Tm               | Tm               | Tm               |
| LC-2                                  | 195.7           | 374.1            | 0.0              | 221.0            | -3.3             |
| LC-4                                  | 542.4           | 604.0            | 145.9            | 221.0            | -3.3             |
| LC-6                                  | 625.0           | 584.2            | 386.4            | 221.0            | -3.3             |
|                                       |                 |                  |                  |                  |                  |

| CHECK FOR SECOND ORDER EFFECT ( along LL Axis) |                 |      |      |                  |  |
|--|-----------------|------|------|------------------|--|
| M <sub>OEqp</sub> / M <sub>OEd</sub>           | φ <sub>ef</sub> | A    | n    | λ <sub>lim</sub> | Second Order Effect  |
|  |                 |      |      |                  | (λ < λ <sub>lim</sub> ) : Ignore<br>(λ > λ <sub>lim</sub> ) : Consider |
| 0.59   | 0.87            | 0.85 | 0.01 | 299.80           | Ignore second order effect   |
| 0.37   | 0.54            | 0.90 | 0.03 | 190.82           | Ignore second order effect   |
| 0.38   | 0.56            | 0.90 | 0.03 | 177.17           | Ignore second order effect   |
|  |                 |      |      |                  |  |

| Load Case | CHECK FOR SECOND ORDER EFFECT ( along TT Axis) |                 |      |      |                  |  |
|-----------|--|-----------------|------|------|------------------|--|
|           | Mo <sub>Exp</sub> / Mo <sub>Ed</sub>           | ϕ <sub>ef</sub> | A    | n    | λ <sub>lim</sub> | Second Order Effect  |
|           |  |                 |      |      |                  | (λ < λ <sub>lim</sub> ) : Ignore<br>(λ > λ <sub>lim</sub> ) : Consider |
| LC-2      | 0.00   | 0.00            | 1.00 | 0.01 | 351.93           | Ignore second order effect   |
| LC-4      | 0.00   | 0.00            | 1.00 | 0.03 | 211.37           | Ignore second order effect   |
| LC-6      | 0.00   | 0.00            | 1.00 | 0.03 | 196.90           | Ignore second order effect   |





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# DESIGN OF SHAFT

## SLS LOAD COMBINATION

| LC-1 | QP, LWL, FP                | Forces about toe |                |                |                 |                 |  | LC-1 |
|------|----------------------------|------------------|----------------|----------------|-----------------|-----------------|--|------|
| S.N. | Description                | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |  |      |
|      |                            | Tonne            | Tonne          | Tonne          | Tm              | Tm              |  |      |
| 1)   | Sub-structure & Foundation | 144.93           |                |                | 2.596           | 0               |  | 1    |
| 3)   | Super-structure DL         | 155.13           |                |                | 50.416          | 0               |  | 1    |
| 4)   | SIDL (excluding surfacing) | 45.817           |                |                | 14.891          | 0               |  | 1    |
| 5)   | Surfacing                  | 13.326           |                |                | 4.3309          | -3.331          |  | 1    |
| 9)   | Fluid Pressure             |                  | 16.589         |                | 13.271          |                 |  | 1    |

| S.N. | Description | Forces at bottom of abutment shaft |                |                |                 |                 |  |
|------|-------------|------------------------------------|----------------|----------------|-----------------|-----------------|--|
|      |             | V                                  | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |  |
|      |             | Tonne                              | Tonne          | Tonne          | Tm              | Tm              |  |
| LC-1 | QP, LWL, FP | 359.2                              | 16.589         | 0              | 85.504          | -3.331          |  |

| LC-2 | QP, LWL, EP                | Forces about toe |                |                |                 |                 |  | LC-2 |
|------|----------------------------|------------------|----------------|----------------|-----------------|-----------------|--|------|
| S.N. | Description                | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |  |      |
|      |                            | Tonne            | Tonne          | Tonne          | Tm              | Tm              |  |      |
| 1)   | Sub-structure & Foundation | 144.93           |                |                | 2.596           | 0               |  | 1    |
| 3)   | Super-structure DL         | 155.13           |                |                | 50.416          | 0               |  | 1    |
| 4)   | SIDL (excluding surfacing) | 45.817           |                |                | 14.891          | 0               |  | 1    |
| 5)   | Surfacing                  | 13.326           |                |                | 4.3309          | -3.331          |  | 1    |
| 9.1) | Earth Pressure LWL         |                  |                |                |                 |                 |  | 1    |
|      | Horizontal Component       |                  | 79.16          |                | 164.86          |                 |  | 1    |
|      | Vertical Component         | 32.283           |                |                | -16.14          |                 |  | 1    |

| S.N. | Description | Forces at bottom of abutment shaft |                |                |                 |                 |  |
|------|-------------|------------------------------------|----------------|----------------|-----------------|-----------------|--|
|      |             | V                                  | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |  |
|      |             | Tonne                              | Tonne          | Tonne          | Tm              | Tm              |  |
| LC-2 | QP, LWL, EP | 391.48                             | 79.16          | 0              | 220.96          | -3.331          |  |

| LC-3 | RARE, LWL, Span dislodge FP | Forces about toe |                |                |                 |                 |  | LC-3 |
|------|-----------------------------|------------------|----------------|----------------|-----------------|-----------------|--|------|
| S.N. | Description                 | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |  |      |
|      |                             | Tonne            | Tonne          | Tonne          | Tm              | Tm              |  |      |
| 1)   | Sub-structure & Foundation  | 144.93           |                |                | 2.596           | 0               |  | 1    |

|       |                        |  |        |  |        |  |  |     |
|-------|------------------------|--|--------|--|--------|--|--|-----|
| 9)    | Fluid Pressure         |  | 16.589 |  | 13.271 |  |  | 1   |
| 10.1) | Surcharge Pressure LWL |  | 41.754 |  | 102.73 |  |  | 0.8 |

| S.N. | Description                 | Forces at bottom of abutment shaft |                |                |                 |                 |
|------|-----------------------------|------------------------------------|----------------|----------------|-----------------|-----------------|
|      |                             | V                                  | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|      |                             | Tonne                              | Tonne          | Tonne          | Tm              | Tm              |
| LC-3 | RARE, LWL, Span dislodge FP | 144.93                             | 49.992         | 0              | 98.048          | 0               |

| LC-4  | RARE, LWL, Span dislodge EP | Forces about toe |                |                |                 |                 |  | LC-4 |
|-------|-----------------------------|------------------|----------------|----------------|-----------------|-----------------|--|------|
| S.N.  | Description                 | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |  |      |
|       |                             | Tonne            | Tonne          | Tonne          | Tm              | Tm              |  |      |
| 1)    | Sub-structure & Foundation  | 144.93           |                |                | 2.596           | 0               |  | 1    |
| 9.1)  | Earth Pressure LWL          |                  |                |                |                 |                 |  | 1    |
|       | Horizontal Component        |                  | 79.16          |                | 164.86          |                 |  | 1    |
|       | Vertical Component          | 32.283           |                |                | -16.14          |                 |  | 1    |
| 10.1) | Surcharge Pressure LWL      |                  | 41.754         |                | 102.73          |                 |  | 0.8  |

| S.N. | Description                 | Forces at bottom of abutment shaft |                |                |                 |                 |
|------|-----------------------------|------------------------------------|----------------|----------------|-----------------|-----------------|
|      |                             | V                                  | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|      |                             | Tonne                              | Tonne          | Tonne          | Tm              | Tm              |
| LC-4 | RARE, LWL, Span dislodge EP | 177.21                             | 112.56         | 0              | 233.5           | 0               |

| LC-6        | RARE, LWL, Min LL acomp, EP          | Forces about toe |                |                |                 |                 |  | LC-6 |
|-------------|--------------------------------------|------------------|----------------|----------------|-----------------|-----------------|--|------|
| S.N.        | Description                          | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |  |      |
|             |                                      | Tonne            | Tonne          | Tonne          | Tm              | Tm              |  |      |
| 1)          | Sub-structure & Foundation           | 144.93           |                |                | 2.596           | 0               |  | 1    |
| 3)          | Super-structure DL                   | 155.13           |                |                | 50.416          | 0               |  | 1    |
| 4)          | SIDL (excluding surfacing)           | 45.817           |                |                | 14.891          | 0               |  | 1    |
| 5)          | Surfacing                            | 13.326           |                |                | 4.3309          | -3.331          |  | 1    |
| 6.2)        | Live Load Vertical Load Min Reaction | 45.333           |                |                | 14.733          | 131.92          |  | 0.75 |
| 7)          | Live Load Horizontal Forces          |                  | 26.592         |                | 101.98          |                 |  | 0.75 |
| <b>9.1)</b> | Earth Pressure LWL                   |                  |                |                |                 |                 |  | 1    |
|             | Horizontal Component                 |                  | 79.16          |                | 164.86          |                 |  | 1    |
|             | Vertical Component                   | 32.283           |                |                | -16.14          |                 |  | 1    |
| 10.1)       | Surcharge Pressure LWL               |                  | 41.754         |                | 102.73          |                 |  | 0.8  |

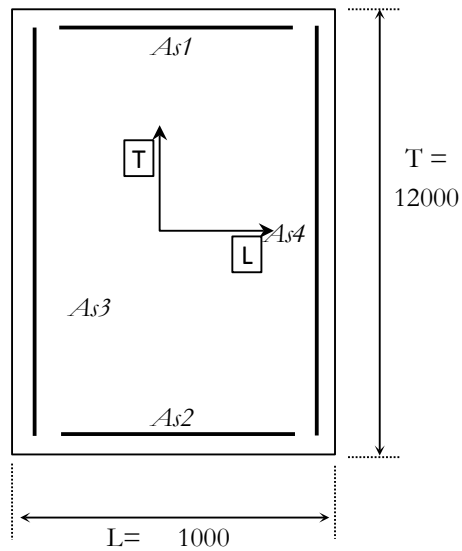
| S.N. | Description                 | Forces at bottom of abutment shaft |                |                |                 |                 |
|------|-----------------------------|------------------------------------|----------------|----------------|-----------------|-----------------|
|      |                             | V                                  | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|      |                             | Tonne                              | Tonne          | Tonne          | Tm              | Tm              |
| LC-6 | RARE, LWL, Min LL acomp, EP | 425.48                             | 132.51         | 0              | 390.67          | 95.609          |

| LC-8        | RARE, LWL, Max LL lead, EP           | Forces about toe |                |                |                 |                 |  | LC-8 |
|-------------|--------------------------------------|------------------|----------------|----------------|-----------------|-----------------|--|------|
| S.N.        | Description                          | V                | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |  |      |
|             |                                      | Tonne            | Tonne          | Tonne          | Tm              | Tm              |  |      |
| 1)          | Sub-structure & Foundation           | 144.93           |                |                | 2.596           | 0               |  | 1    |
| 3)          | Super-structure DL                   | 155.13           |                |                | 50.416          | 0               |  | 1    |
| 4)          | SIDL (excluding surfacing)           | 45.817           |                |                | 14.891          | 0               |  | 1    |
| 5)          | Surfacing                            | 13.326           |                |                | 4.3309          | -3.331          |  | 1    |
| 6.1)        | Live Load Vertical Load Max Reaction | 89.867           |                |                | 29.207          | 261.51          |  | 1    |
| 7)          | Live Load Horizontal Forces          |                  | 26.592         |                | 101.98          |                 |  | 1    |
| <b>9.1)</b> | Earth Pressure LWL                   |                  |                |                |                 |                 |  | 1    |
|             | Horizontal Component                 |                  | 79.16          |                | 164.86          |                 |  | 1    |
|             | Vertical Component                   | 32.283           |                |                | -16.14          |                 |  | 1    |
| 10.1)       | Surcharge Pressure LWL               |                  | 41.754         |                | 102.73          |                 |  | 0.8  |

| S.N. | Description                | Forces at bottom of abutment shaft |                |                |                 |                 |
|------|----------------------------|------------------------------------|----------------|----------------|-----------------|-----------------|
|      |                            | V                                  | H <sub>L</sub> | H <sub>T</sub> | M <sub>TT</sub> | M <sub>LL</sub> |
|      |                            | Tonne                              | Tonne          | Tonne          | Tm              | Tm              |
| LC-8 | RARE, LWL, Max LL lead, EP | 481.35                             | 139.16         | 0              | 434.32          | 258.18          |

# **FORCES AT SHAFT BOTTOM:**

## **SLS LOAD COMBINATION :**

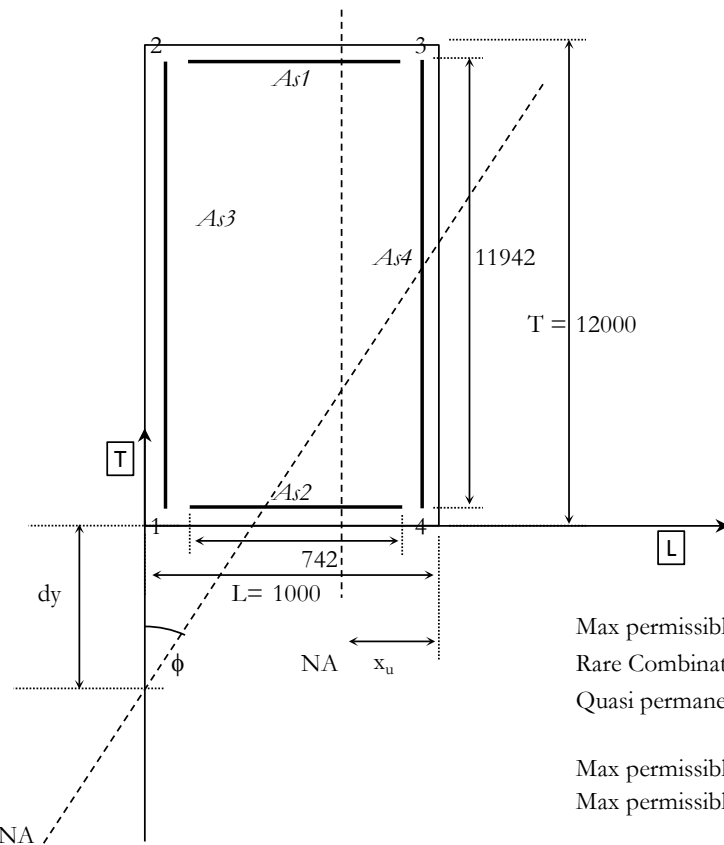


## **SLS CHECK FOR ABUTMENT SHAFT :**

| S.N. | Description                 | Forces at bottom of abutment shaft |         |       |           |             |
|------|-----------------------------|------------------------------------|---------|-------|-----------|-------------|
|      |                             | $N_{ED}$                           | $H_L$   | $H_T$ | $M_{ETT}$ | $M_{ELL}$   |
|      |                             | Tonne                              | Tonne   | Tonne | Tm        | Tm          |
| LC-3 | RARE, LWL, Span dislodge FP | 144.93                             | 49.9922 | 0     | 98.0475   | 0           |
| LC-4 | RARE, LWL, Span dislodge EP | 177.213                            | 112.564 | 0     | 233.499   | 0           |
| LC-5 | RARE, LWL, Min LL acomp, FP | 393.198                            | 69.936  | 0     | 255.219   | 95.60854688 |
| LC-6 | RARE, LWL, Min LL acomp, EP | 425.481                            | 132.508 | 0     | 390.671   | 95.60854688 |
| LC-7 | RARE, LWL, Max LL lead, FP  | 449.065                            | 76.5839 | 0     | 298.871   | 258.1805469 |
| LC-8 | RARE, LWL, Max LL lead, EP  | 481.348                            | 139.156 | 0     | 434.322   | 258.1805469 |

## STRESS CHECK

## SECTION AT SHAFT BOTTOM



### Section Dimensions:

|   |   |       |    |
|---|---|-------|----|
| D | = | 1000  | mm |
| B | = | 12000 | mm |

### Material Properties:

|     |   |        |                   |
|-----|---|--------|-------------------|
| fck | = | 35     | N/mm <sup>2</sup> |
| fyk | = | 500    | N/mm <sup>2</sup> |
| Es  | = | 200000 | N/mm <sup>2</sup> |

Max permissible Stress in Concrete

Rare Combination = 16.8 Mpa

Quasi permanent Combination = 12.6 Mpa

Max permissible Stress in Steel (QLS) = 400 Mpa

Max permissible Stress in Steel (Rare) = 300 Mpa

### Reinforcement Details :

| Reinf. | Dia | Spacing | Cover | Eff. cover | Nos. | Spacing | Total As | From |       | To  |       | As per unit |
|--------|-----|---------|-------|------------|------|---------|----------|------|-------|-----|-------|-------------|
|        |     |         |       |            |      |         |          | L    | T     | L   | T     |             |
| As1    | 16  | 200     | 50    | 58         | 3    | 209.5   | 603.2    | 323  | 11942 | 742 | 11942 | 1.4         |
| As2    | 16  | 200     | 50    | 58         | 3    | 209.5   | 603.2    | 323  | 58    | 742 | 58    | 1.4         |
| As3    | 16  | 200     | 75    | 83         | 60   | 201.4   | 12064    | 83   | 58    | 83  | 11942 | 1.0         |
|        | 0   | 200     | 123   | 123        | 60   | 201.4   | 0.0      | 123  | 58    | 123 | 11942 | 0.0         |
| As4    | 16  | 200     | 50    | 58         | 60   | 201.4   | 12064    | 942  | 58    | 942 | 11942 | 1.0         |
| Closed |     |         |       |            |      |         |          |      |       |     |       |             |

### SECTION COORDINATE

| S.N    | x    | y     |
|--------|------|-------|
| 1      | 0    | 0     |
| 2      | 0    | 12000 |
| 3      | 1000 | 12000 |
| 4      | 1000 | 0     |
| 5      | 0    | 0     |
| Closed |      |       |

### Properties of Gross Cross-section

| Properties      | @ XY axis                | @ centroidal axis      |
|-----------------|--------------------------|------------------------|
| A               | = 1E+07 mm <sup>2</sup>  | 1E+07 mm <sup>2</sup>  |
| cgL             | = 500 mm                 | 500 mm                 |
| cgT             | = 6000 mm                | 6000 mm                |
| I <sub>LL</sub> | = 6E+14 mm <sup>4</sup>  | 1E+14 mm <sup>4</sup>  |
| I <sub>TT</sub> | = 4.E+12 mm <sup>4</sup> | 1.E+12 mm <sup>4</sup> |
| I <sub>LT</sub> | = 4.E+13 mm <sup>4</sup> | 0.E+00 mm <sup>4</sup> |

### Modulus of Elasticity for Concrete

|                       |            |   |                     |  |
|-----------------------|------------|---|---------------------|--|
| Design Bending Moment | $M_{RARE}$ | = | 434.32              | Tm   |
|                       | $M_{QP}$   | = | 220.96              | Tm   |
|                       | $M_{ST}$   | = | $M_{RARE} - M_{QP}$ | (Bending Moment due to short term loading) |
|                       |            | = | 213.37              | Tm   |

Modulus of Elasticity for Concrete

For short term loading  $E_{cm}$  = 32308.2 Mpa

Creep coefficient  $\phi$  = 1

For long term loading  $E_{cm}'$  = 16154.1 Mpa

Reinf. modulus of elasticity  $E_s$  = 200000 N/mm<sup>2</sup>

Modular ratio for QP Combination =  $E_s / E_{cm}'$  = 12.38

Equivalent Modulus of Elasticity for Rare Combination :

$$E_{c,eq} = \frac{E_{cm} * (M_{QP} + M_{ST})}{M_{ST} + (1 + \phi) * M_{QP}} = 21414.1 \text{ MPa}$$

Modular ratio for Rare Combination =  $E_s / E_{c,eq}$  = 9.34

| LC   | Forces |          |          | Modular ratio | Finding Position of Neutral Axis |        |                |        |                            |        |           |
|------|--------|----------|----------|---------------|----------------------------------|--------|----------------|--------|----------------------------|--------|-----------|
|      | P      | $M_{TT}$ | $M_{LL}$ |               | First Trail                      |        | Valuse Adopted |        | Value suggested by program |        |           |
|      | T      | Tm       | Tm       |               | $\phi$                           | dy     | $\phi$         | dy     | $\phi$                     | dy     | NA_stress |
|      |        |          |          |               | radian                           | mm     | radian         | mm     | radian                     | mm     | Mpa       |
| LC-1 | 359.20 | 85.50    | -3.23    | 12.38         | 4.7                              | 2E+06  | 4.7            | 7E+06  | 1.6                        | 5E+05  | 1.51      |
| LC-2 | 391.48 | 220.96   | -3.23    | 12.38         | 4.7                              | 5E+06  | 4.7            | -7E+07 | 1.6                        | 1E+07  | -37.04    |
| LC-3 | 144.93 | 98.05    | 0.10     | 9.34          | 4.7                              | -7E+07 | 4.7            | -5E+06 | 4.7                        | -3E+07 | -0.41     |
| LC-4 | 177.21 | 233.50   | 0.10     | 9.34          | 4.7                              | -2E+08 | 4.7            | -1E+08 | 4.7                        | -6E+07 | 24.98     |
| LC-5 | 393.20 | 255.22   | 95.71    | 9.34          | 4.7                              | -2E+05 | 4.7            | -2E+06 | 4.7                        | -5E+05 | 20.39     |
| LC-6 | 425.48 | 390.67   | 95.71    | 9.34          | 4.7                              | -3E+05 | 4.7            | -4E+06 | 4.7                        | -8E+05 | 84.67     |
| LC-7 | 449.06 | 298.87   | 258.28   | 9.34          | 4.7                              | -8E+04 | 4.7            | -2E+05 | 4.7                        | -2E+05 | 1.93      |
| LC-8 | 481.35 | 434.32   | 258.28   | 9.34          | 4.7                              | -1E+05 | 4.7            | -5E+05 | 4.7                        | -3E+05 | 18.21     |

| LOAD COMBIANTIONS |                          | x                             | y |      |        | x                                  | y     |      |    | Dist.<br>from<br>N.A<br>(mm) (4) |
|-------------------|--------------------------|-------------------------------|---|------|--------|------------------------------------|-------|------|----|----------------------------------|
|                   |                          | 1000                          | 0 |      |        | 0                                  | 12000 |      |    |                                  |
|                   |                          | Max. Concrete<br>Stress (Mpa) |   |      |        | Permissible conc.<br>stresses(Mpa) |       |      |    |                                  |
| LC-1              | QP, LWL, FP              | 0.7                           |   | 12.6 | OK     | -1.3                               |       | -400 | OK | 862.7                            |
| LC-2              | QP, LWL, EP              | 2.4                           |   | 12.6 | OK     | -60.3                              |       | -400 | OK | 326.0                            |
| LC-3              | RARE, LWL, Span dislodge | 0.6                           |   | 16.8 | OK     | -4.5                               |       | -400 | OK | -570.3                           |
| LC-4              | RARE, LWL, Span dislodge | 34.4                          |   | 16.8 | REVISE | -195.6                             |       | -400 | OK | -621.8                           |
| LC-5              | RARE, LWL, Min LL        | 3.3                           |   | 16.8 | OK     | -82.1                              |       | -400 | OK | -279.4                           |
| LC-6              | RARE, LWL, Min LL        | 5.6                           |   | 16.8 | OK     | -216.6                             |       | -400 | OK | -196.6                           |
| LC-7              | RARE, LWL, Max LL lead,  | 4.2                           |   | 16.8 | OK     | -104.5                             |       | -400 | OK | -284.4                           |
| LC-8              | RARE, LWL, Max LL lead,  | 6.8                           |   | 16.8 | OK     | -237.0                             |       | -400 | OK | -219.5                           |

First Trail NA

$$\tan(\phi) = \frac{M_{LL} * I_{TT} / M_{TT} / I_{LL}}{I_{LL}}$$

$$\tan(\phi) = \frac{(e_L - e_L') * I_{LL} - (e_T - e_T') * I_{LT}}{(e_T - e_T') * I_{TT} - (e_L - e_L') * I_{LT}}$$

$$\sigma_{(L1, T1)} = \frac{P}{A_{eff}} + \frac{P * (e_L - e_L') - P * (e_T - e_T') * (I_{LTeff} / I_{Leff})}{I_{Teff} - (I_{LTeff}^2 / I_{Leff})} (L1 - Cg_{Leff}) + \frac{P * (e_T - e_T') - P * (e_L - e_L') * (I_{LTeff} / I_{Teff})}{I_{Leff} - (I_{LTeff}^2 / I_{Teff})} (T1 - Cg_{Teff})$$



**(SLS) CHECK FOR CRACK WIDTH (QUASI PERMANENT LOAD COMBINATIONS)**

Minimum Reinforcement for crack control :

$$A_{s,min} = k_c k_{ct,eff} A_{ct} / \sigma_s \quad (IRC 112 / clause 12.3.3 (2))$$

For Web

$$k_c = 0.4 \text{ For Bending member}$$

$$h = 1 \text{ m}, \quad b = 1 \text{ m}$$

$$k = 0.65$$

$$f_{ct,eff} = \text{Max} (f_{ctm}, 2.9)$$

$$= 2.90 \text{ Mpa}$$

$A_{ct}$  = Area of concrete within tensile zone just before the first crack form, section behaves elastically until the tensile fiber stress reaches  $f_{ctm}$ . hence Neutral axis depth will be considered for gross section

$$A_{ct} = b * h / 2$$

$$= 0.5 \text{ m}^2$$

$\sigma_s$  = Maximum stress permitted in reinf. Immediately after formation of crack

$$= f_{yk}$$

$$= 500 \text{ Mpa}$$

$$A_{s,min} = 754 \text{ mm}^2/\text{m} < 1005 \text{ mm}^2/\text{m} \text{ on tension face} \quad \text{OK}$$

$$< 1005 \text{ mm}^2/\text{m} \text{ on compression face} \quad \text{OK}$$

**Calculation of crack width :** (IRC 112 / clause 12.3.4)

$$w_{k,max} = 0.3 \text{ mm}$$

$$\text{Clear cover } c = 75 \text{ mm}$$

$$\text{Bar dia } \phi_{eq} = 16.00 \text{ mm}$$

$$5 (c + \phi_{eq} / 2) = 415 \text{ mm}$$

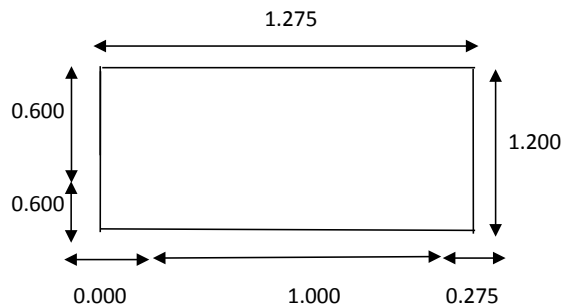
$$\text{Spacing b/w bars} = 200 \text{ mm} < 415 \text{ mm}$$

$$s_{rmax} = \text{Maximum crack spacing}$$

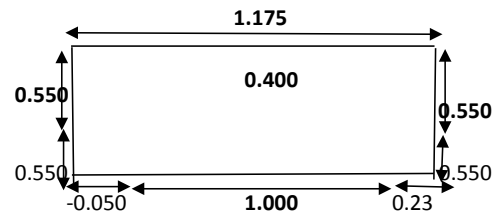
The Following formula can be used for calculation of maximum crack spacing.

$$\begin{aligned}
&= 3.4c + 0.17 \phi / \rho_{P,eff} \\
&= 958.931 \text{ mm} \\
h_{c,eff} &= \text{Min} \begin{cases} 2.5 (h - d) \\ (h - x)/3 \\ h/2 \end{cases} \\
&= 0.26017 \text{ m} \\
\begin{array}{lcl} h & = & 1 \text{ m} \\ d & = & 0.803 \text{ m} \\ x & = & 0.22 \text{ m} \end{array} \quad \begin{array}{l} \\ \\ \text{*/ (for Quasi Permanent Load} \\ \text{combination)} \end{array} \\
\text{width } b &= 1 \text{ m} \\
A_{c,eff} &= h_{c,eff} * b = 0.26017 \text{ m}^2 \\
\rho_{P,eff} &= A_s / A_{c,eff} \\
&= 1005.3 / 260172 \\
&= 0.00386 \\
\sigma_{sc} &= \text{Stress in tension Reinforcement assuming cracked section} \\
&= 60.31 \text{ Mpa} \quad \text{*/ (for Quasi Permanent Load combination)} \\
E_s &= 200000 \text{ Mpa} \\
E_{cm}' &= 16154 \text{ Mpa} \quad \text{*/ (for Long term loading)} \\
\alpha_e &= E_s / E_{cm} \\
\alpha_e &= 12.381 \\
k_t &= 0.5 \quad \text{(factor dependent on duration of load)} \\
\varepsilon_{sm} - \varepsilon_{cm} &= \text{Max} \begin{cases} \frac{\sigma_{sc} - k_t f_{ct,eff} (1 + \alpha_e \rho_{P,eff}) / \rho_{P,eff}}{E_s} \\ 0.6 \sigma_{sc} / E_s \end{cases} \\
&= 0.00018 \\
w_k &= s_{rmax} (\varepsilon_{sm} - \varepsilon_{cm}) \\
&= 0.174 \text{ mm} < 0.300 \text{ mm} \quad \text{OK}
\end{aligned}$$

## DESIGN OF ABUTMENT CAP



**Abutment Cap Concrete Dimension**



**Transverse Reinforcement in Cap**

The Abutment Cap is designed as per Cl. 710.8.7 of IRC:78-2014

|   |   |                   |   |               |
|---|---|-------------------|---|---------------|
| Concrete Vol. per m width of cap                | = | 1.275 x 0.225     | = | 0.287 Cum/M   |
| Vol. of steel to be provided = 1% of cap volume | = |                   | = | 0.00287 Cum/M |
| Wt. of Steel required                           | = | 0.00286875 x 7850 | = | 23.00 Kg/M    |
| Longitudinal steel required                     | = | 0.5 x 23          | = | 11.50 Kg/M    |
| Transverse steel required                       | = | 0.5 x 23          | = | 11.50 Kg/M    |
| Length of outer stirrup                         | = |                   | = | 4.550 m       |
| Providing 12 mm dia bar Wt. of each stirrup     | = | 4.55 x 0.889      | = | 4.045 Kg      |
| No. of stirrup required per m width of cap      | = |                   | = | 3.0           |
| Required spacing of stirrup                     | = | 1000/3            | = | 333 mm C/C    |

**Provide 12 mm dia 2 Legged Stirrups @ 150 mm C/C = 26.97 Kg/M OK**

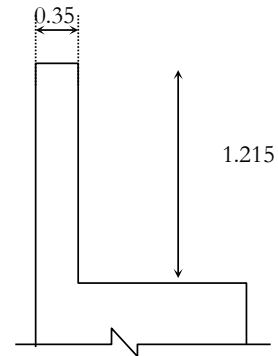
Providing 12 mm bars in longitudinal direction, wt of each bar 0.889 Kg/M

No. of Longitudinal bars required = 11.5/0.889 = 13 Nos.

**Provide 12 mm dia 20 Nos. Long. bar distributed at top and bottom = 17.78 Kg/M OK**

### DESIGN OF DIRT WALL :

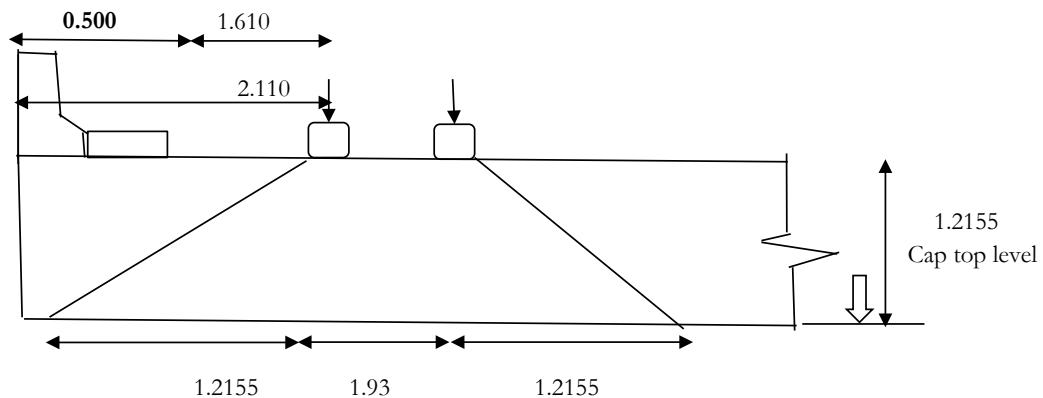
|                                  |   |                      |
|----------------------------------|---|----------------------|
| Density of Earth                 | = | 2.0 T/m <sup>3</sup> |
| Earth Pressure coefficient Ka    | = | 0.297                |
| Earth Pressure                   | = | $1/2 K_a \gamma h^2$ |
|                                  | = | 0.439 T/m            |
| Lever arm                        | = | 0.42 *h              |
|                                  | = | 0.511 m              |
| Moment at bottom M <sub>EP</sub> | = | 0.224 Tm/m           |
| Live Load surcharge intensity q  | = | 2.4 t/m <sup>2</sup> |
| Live load surcharge Pressure     | = | K <sub>a</sub> *q*h  |
|                                  | = | 0.866 T/m            |
| Lever arm                        | = | 0.5 *h               |
|                                  | = | 0.608 m              |
| Moment at bottom M <sub>SP</sub> | = | 0.527 Tm/m           |



### Braking force on dirt wall

20T 70R Axle load is considered over dirt wall

|               |   |       |
|---------------|---|-------|
| Braking force | = | 4.0 T |
|---------------|---|-------|



|  |   |                 |   |           |
|--|---|-----------------|---|-----------|
| Effective width of Dispersion          | = | 1.22+1.93+1.22  | = | 4.36      |
| Braking Force per m width of Dirt wall | = | 4/4.36          | = | 0.92 T/m  |
| Moment due to Braking Force            | = | 0.92*(1.22+1.2) | = | 2.22 Tm/m |

### ULS DESIGN FORCES:

| LOADS              |   | Unfactored |      | Load Factor | Factored Forces |             |
|--------------------|---|------------|------|-------------|-----------------|-------------|
|                    |   | Force      | BM   |             | Force           | BM          |
|                    |   | T          | Tm   |             | T               | Tm          |
| Earth Pressure     | = | 0.44       | 0.22 | 1.5         | 0.66            | 0.34        |
| Surcharge Pressure | = | 0.87       | 0.53 | 1.2         | 1.04            | 0.63        |
| Braking force      | = | 0.92       | 2.22 | 1.5         | 1.38            | 3.32        |
| <b>Total</b>       |   |            |      |             | <b>3.07</b>     | <b>4.29</b> |

***SLS DESIGN FORCES:***

| LOADS              |   | Unfactored |                | SLS RARE COMB. |             |                | SLS QUASI PER. COMB. |             |                |
|--------------------|---|------------|----------------|----------------|-------------|----------------|----------------------|-------------|----------------|
|                    |   | Force      | BM             | Load Factor    | Force       | BM             | Load Factor          | Force       | BM             |
|                    |   | T          | T <sub>m</sub> |                | T           | T <sub>m</sub> |                      | T           | T <sub>m</sub> |
| Earth Pressure     | = | 0.439      | 0.224          | 1              | 0.44        | 0.22           | 1                    | 0.44        | 0.22           |
| Surcharge Pressure | = | 0.866      | 0.527          | 0.8            | 0.69        | 0.42           | 0                    | 0           | 0              |
| Braking force      | = | 0.92       | 2.22           | 1              | 0.92        | 2.22           | 0                    | 0           | 0              |
| <b>Total</b>       |   |            |                |                | <b>2.05</b> | <b>2.86</b>    |                      | <b>0.44</b> | <b>0.22</b>    |

***ULS DESIGN FORCES:***

| LOADS                 |   | Unfactored |       | Load Factor | Factored Forces |      |
|-----------------------|---|------------|-------|-------------|-----------------|------|
|                       |   | Force      | BM    |             | Force           | BM   |
|                       |   | T          | Tm    |             | T               | Tm   |
| NON-SEISMIC COMPONENT |   |            |       |             |                 |      |
| Earth Pressure        | = | 0.439      | 0.224 | 1.0         | 0.439           | 0.22 |
| Surcharge Pressure    | = | 0.866      | 0.527 | 0.2         | 0.173           | 0.11 |
| Braking force         | = | 0.183      | 0.443 | 0.2         | 0.037           | 0.09 |
| SEISMIC COMPONENT     |   |            |       |             |                 |      |
| Earth Pressure        | = | 0.000      | 0.000 | 1.5         | 0.000           | 0.00 |
| Surcharge Pressure    | = | 0.000      | 0.000 | 0.3         | 0.000           | 0.00 |
| Total                 |   |            |       |             | 0.65            | 0.42 |

**ULS DESIGN :**

Design Bending Moment  $M_{ED}$  = 4.29 Tm

D = 0.35 m \*/ overall depth at d from face of support

d = 0.308 m \*/ deff at d from face of support

Clear Cover = 50 mm

Ast Provided = 16  $\phi$  @ 150 c/c  
= 1340 mm<sup>2</sup>/m

Grade of Concrete fck = 35 Mpa

Grade of steel fyk = 500 Mpa

xu = 0.87 fyk Ast / 0.362 fck b  
= 46 mm

x<sub>u</sub>max = 0.609 d'  
= 187 mm

UNDER REINFORCED

|                      |   |         |
|----------------------|---|---------|
| fyk                  | = | 500 Mpa |
| ε <sub>uk</sub>      | = | 0.0025  |
| ε <sub>ud</sub>      | = | 0.00225 |
| fck                  | = | 35 Mpa  |
| ε <sub>cu2</sub>     | = | 0.0035  |
| xu <sub>max</sub> /d | = | 0.6087  |

$$\begin{aligned}
 A_{st} \text{ calculated} &= M / 0.87 f_{yk} (d' - 0.416 x_u) \\
 &= 342 \text{ mm}^2/\text{m} \\
 A_{st} \text{ minimum} &= 0.15\% * b * d \\
 &= 525 \text{ mm}^2/\text{m} \\
 A_{st} \text{ required} &= \text{Max}(342, 525) \\
 &= 525 \text{ mm}^2/\text{m} \\
 \text{Increase required reinforcement by 50\%} &= 788 \text{ mm}^2/\text{m} < 1340 \text{ mm}^2/\text{m} \quad \text{OK} \\
 \text{Provide } 16 \text{ mm dia bars @ } 150 \text{ mm C/C vertical bars on both faces}
 \end{aligned}$$

### Horizontal Reinforcement

$$\begin{aligned}
 \text{Total horiz steel required} &= 25\% \text{ of vertical bars or } 0.001 A_c \text{ whichever is more on each face} \\
 &= 350 \text{ mm}^2 \\
 \text{Provide } 10 \text{ mm dia @ } 150 \text{ C/C horz bars on each face} &= 523 \text{ mm}^2 \quad \text{OK}
 \end{aligned}$$

### (ULS) CHECK FOR SHEAR FORCE

$$\text{Factored Shear Force } V_{ED} = 3.07 \text{ Tonne}$$

$$\begin{aligned}
 D &= 0.350 \text{ m} \quad */ \text{ overall depth at face of support} \\
 d &= 0.308 \text{ m} \quad */ \text{ deff at face of support}
 \end{aligned}$$

Design Shear Resitance

$$\begin{aligned}
 k &= \text{Min} \left\{ \begin{array}{l} 1 + \sqrt{200/d} \\ 2 \end{array} \right. \quad d \text{ is depth in mm} \\
 &= 1.806
 \end{aligned}$$

$$\begin{aligned}
 \rho_1 &= \text{Min} \left\{ \begin{array}{l} A_{sl} / b_w d \\ 0.02 \end{array} \right. \\
 &= 0.0044
 \end{aligned}$$

$$\sigma_{cp} = 0 \text{ Mpa}$$

$$\begin{aligned}
 v_{\min} &= 0.031 k^{3/2} f_{ck}^{1/2} \\
 &= 0.445
 \end{aligned}$$

$$\begin{aligned}
 V_{Rdc} &= \text{Max} \left\{ \begin{array}{l} (0.12 k (80 \rho_1 f_{ck})^{0.33} + 0.15 \sigma_{cp}) b_w d \\ (v_{\min} + 0.15 \sigma_{cp}) b_w d \end{array} \right. \quad (\text{IRC 112 / clause 10.3.2 (2)}) \\
 &= 15.23 \text{ Tonne} > 3.07 \text{ Tonne} \quad \text{OK}
 \end{aligned}$$

### Max Shear Capacity of section

$$\begin{aligned}
 v &= 0.6 * (1 - f_{ck} / 310) \quad */ \text{ fck in Mpa} \\
 &= 0.532
 \end{aligned}$$

$$\begin{aligned}
 f_{cd} &= 0.4467 * f_{ck} \\
 &= 15.63 \text{ Mpa}
 \end{aligned}$$

$$V_{RDC, \max} = 0.5 b w d v_{fd} = 128 \text{ Tonne} > 3.1 \text{ Tonne OK}$$

### (SLS) CHECK FOR STRESSES (RARE & QUASI PERMANENT LOAD COMBINATIONS)

$$\begin{aligned} \text{Design Bending Moment } M_{RARE} &= 2.86 \text{ Tm} \\ M_{QP} &= 0.22 \text{ Tm} \\ M_{ST} &= M_{RARE} - M_{QP} \quad (\text{Bending Moment due to short term loading}) \\ &= 2.64 \text{ Tm} \end{aligned}$$

$$\begin{aligned} \text{Modulus of Elasticity for Concrete} \\ \text{For short term loading } E_{cm} &= 32308 \text{ Mpa} \\ \text{Creep coefficient } \phi &= 1.47 \\ \text{For long term loading } E_{cm}' &= 13070 \text{ Mpa} \end{aligned}$$

$$\text{Reinf. modulus of elasticity } E_s = 200000 \text{ N/mm}^2$$

$$\text{Modular ratio for QP Combination} = E_s / E_{cm}' = 15.30$$

Equavalent Modulus of Elasticity for Rare Combination :

$$E_{c,eq} = \frac{E_{cm} * (M_{QP} + M_{ST})}{M_{ST} + (1 + \phi) * M_{QP}} = 28969 \text{ MPa}$$

$$\text{Modular ratio for Rare Combination} = E_s / E_{c,eq} = 6.90$$

| Formula used for calculation of stress    |   |
|---|---|
| dc (depth of neutral axis)                | $= \frac{-m * A_s + \sqrt{(m^2 * A_s^2 + 2 * m * A_s * b * d)}}{b}$ |
| $I_{NA}$ (Transformed)                    | $= b * dc^3 / 3 + m * A_s * (d - dc)^2$                             |
| Compressive stress in concrete $\sigma_c$ | $= M_{RARE} * dc / I_{NA}$  |
| Tensile stress in steel $\sigma_s$        | $= m * M_{RARE} * (d - dc) / I_{NA}$                                |

| <i>Description</i>                        | <i>Stress Check For Rare Combination</i> | <i>Stress Check For QP Combination</i> |
|---|--|--|
| Design Moment                             | = 2.86 Tm                                | = 0.22 Tm                              |
| Total Depth at section                    | = 0.35 m                                 | = 0.35 m                               |
| deff                                      | = 0.308 m                                | = 0.308 m                              |
| width b                                   | = 1 m                                    | = 1 m                                  |
| $A_{st, provided}$                        | = 1340.413 mm <sup>2</sup> /m            | = 1340.41 mm <sup>2</sup> /m           |
| Modular ratio                             | = 6.90                                   | = 15.30                                |
| dc (depth of neutral axis)                | = 66.81 mm                               | = 93.75 mm                             |
| $I_{NA}$ (Transformed)                    | = 6.38E+08 mm <sup>4</sup>               | = 1.22E+09 mm <sup>4</sup>             |
| Compressive stress in concrete $\sigma_c$ | = 3.00 N/mm <sup>2</sup>                 | = 0.17 N/mm <sup>2</sup>               |
| Permissible Compressive stress            | = 16.8 N/mm <sup>2</sup> OK              | = 12.6 N/mm <sup>2</sup> OK            |
| Tensile stress in steel $\sigma_s$        | = 75 N/mm <sup>2</sup>                   | = 6 N/mm <sup>2</sup>                  |

|                            |   |                          |   |                          |
|----------------------------|---|--------------------------|---|--------------------------|
| Permissible tensile stress | = | 300 N/mm <sup>2</sup> OK | = | 400 N/mm <sup>2</sup> OK |
|----------------------------|---|--------------------------|---|--------------------------|

### **(SLS) CHECK FOR CRACK WIDTH (QUASI PERMANENT LOAD COMBINATIONS)**

#### **Minimum Reinforcement for crack control :**

|              |   |   |                                |
|--------------|---|---|--------------------------------|
| $A_{s,min}$  | = | $k_c k_{ct,eff} A_{ct} / \sigma_s$  | (IRC 112 / clause 12.3.3 (2) ) |
| For Web      |   |   |                                |
| $k_c$        | = | 0.4 For Bending member  |                                |
| $h$          | = | 0.35 m  | , $b = 1$ m                    |
| $k$          | = | 1   |                                |
| $f_{ct,eff}$ | = | $f_{ctm}$   |                                |
|              | = | 2.77 Mpa  |                                |
| $A_{ct}$     | = | Area of concrete within tensile zone just before the first crack form, section behaves elastically until the tensile fiber stress reaches $f_{ctm}$ . hence Neutral axis depth will be considered for gross section |                                |
| $A_{ct}$     | = | $b * h/2$   |                                |
|              | = | 0.175 m <sup>2</sup>  |                                |
| $\sigma_s$   | = | Maximum stress permitted in reinf. Immediately after formation of crack   |                                |
|              | = | $f_{yk}$  |                                |
|              | = | 500 Mpa   |                                |
| $A_{smin}$   | = | 388 mm <sup>2</sup> /m  | < 1340 mm <sup>2</sup> /m OK   |

#### **Calculation of Crack Width :** (IRC 112 / clause 12.3.4)

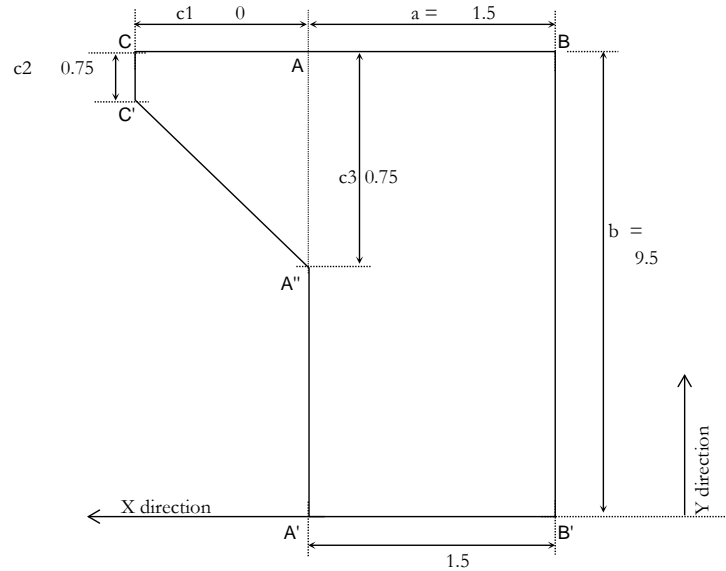
|                       |   |   |                         |
|-----------------------|---|---|-------------------------|
| $w_{k,max}$           | = | 0.3 mm  |                         |
| Clear cover $c$       | = | 50 mm   |                         |
| Bar dia $\phi_{eq}$   | = | 16 mm   |                         |
| $5 (c + \phi_{eq}/2)$ | = | 290 mm  |                         |
| Spacing b/w bars      | = | 150 mm  | < 290 mm                |
| $s_{rmax}$            | = | Maximum crack spacing   |                         |
|                       | = | The Following formula can be used for calculation of maximum crack spacing. |                         |
|                       | = | $3.4c + 0.17 \phi / \rho_{Peff}$  |                         |
|                       | = | 343 mm  |                         |
| $h_{c,eff}$           | = | Min $\begin{cases} 2.5 (h - d) \\ (h - x)/3 \\ h/2 \end{cases}$             |                         |
|                       | = | 0.0854 m  |                         |
| width $b$             | = | 1 m   |                         |
| $A_{c,eff}$           | = | $h_{c,eff} * b$   | = 0.0854 m <sup>2</sup> |

|     |   |           |                             |
|-----|---|-----------|-----------------------------|
| $h$ | = | 0.35 m    |                             |
| $d$ | = | 0.308 m   | */ (for Quasi               |
| $x$ | = | 0.09375 m | Permanent Load combination) |



|                                 |   |   |   |
|---------------------------------|---|---|---|
| $\rho_{P,eff}$                  | = | $A_s / A_{c,eff}$   |   |
|                                 | = | 1340 /  | 85417                                     |
|                                 | = | 0.015693  |   |
| $\sigma_{sc}$                   | = | Stress in tension Reinforcement assuming cracked section  |   |
|                                 | = | 6 Mpa   | */ (for Quasi Permanent Load combination) |
| $E_s$                           | = | 200000 Mpa  |   |
| $E_{cm}'$                       | = | 13070 Mpa   | */ (for Long term loading)                |
| $\alpha_e$                      | = | $E_s / E_{cm}$  |   |
| $\alpha_e$                      | = | 15.30   |   |
| $k_t$                           | = | 0.5   | (factor dependent on duration of load)    |
| $\epsilon_{sm} - \epsilon_{cm}$ | = | $\text{Max} \left\{ \frac{\sigma_{sc} - k_t f_{ct,eff} (1 + \alpha_e \rho_{P,eff}) / \rho_{P,eff}}{E_s} \right.$ $\left. 0.6 \sigma_{sc} / E_s \right.$ |   |
|                                 | = | 1.81E-05  |   |
| $w_k$                           | = | $s_{rmax} (\epsilon_{sm} - \epsilon_{cm})$  |   |
|                                 | = | 0.006 mm  | < 0.300 mm OK                             |

## DESIGN OF RETURN WALL



Width of Solid return wall (a) = 1.5 m  
Height of Solid return wall (b) = 9.5 m

Width of Cantilever return wall c1 = 0 m  
Height of Cantilever return at Tip c2 = 0.75 m  
Height of Cantilever return taper c3-c2 = 0.00 m  
Height of Cantilever return at Root c3 = 0.75 m

Thickness of Solid Return at farther end t1 = 0.5 m  
Thickness of Solid Return at top t2 = 0.5 m  
Thickness of Solid Return at bottom t3 = 0.5 m  
Thickness of Cantilever return = 0.5 m  
Unit wt of Soil = 2.0 t/m<sup>3</sup>

a/b = 0.158

### Case (1) For Uniformly Distributed Load Over Entire Plate

|            |   |       |            |   |       |            |   |       |
|------------|---|-------|------------|---|-------|------------|---|-------|
| For a/b    | = | 0.125 | For a/b    | = | 0.250 | For a/b    | = | 0.158 |
| $\beta_1$  | = | 0.05  | $\beta_1$  | = | 0.182 | $\beta_1$  | = | 0.085 |
| $\beta_2$  | = | 0.047 | $\beta_2$  | = | 0.188 | $\beta_2$  | = | 0.084 |
| $\gamma_1$ | = | 0.312 | $\gamma_1$ | = | 0.572 | $\gamma_1$ | = | 0.380 |
| $\gamma_2$ | = | 0.127 | $\gamma_2$ | = | 0.264 | $\gamma_2$ | = | 0.163 |

Live Load Surcharge:

$$q = 0.297 \times 2 \times 1.2 = 0.713 \text{ t/m}^2$$

$$\sigma_{bmax} = \frac{\beta_1 \times q \times b^2}{t^2} = \frac{0.085 \times 0.713 \times 90.250}{0.25} = 21.80 \text{ t/m}^2$$

For 1000 mm of width

$$Z = \frac{1000 \times 250000}{6} = 4.17E+07 \text{ mm}^3 = 0.04167 \text{ m}^3$$

Hence Moment /m width along Y direction

$$M_Y / \text{m width} = 21.805 \times 0.042 = 0.909 \text{ t-m/m}$$

$$\sigma_{\text{amax}} = \frac{\beta_2 \times q \times b^2}{t^2} = \frac{0.084 \times 0.713 \times 90.250}{0.25} = 21.64 \text{ t/m}^2$$

For 1000 mm of width

$$Z = \frac{1000 \times 250000}{6} = 41666667 \text{ mm}^3 = 0.042 \text{ m}^3$$

Hence Moment /m width along X direction

$$M_X / \text{m width} = 21.642 \times 0.042 = 0.902 \text{ t-m/m}$$

#### Case (2) For Triangular Loading Due to Earth Pressure

|            |   |       |            |   |       |            |   |       |
|------------|---|-------|------------|---|-------|------------|---|-------|
| For a/b    | = | 0.125 | For a/b    | = | 0.25  | For a/b    | = | 0.158 |
| $\beta_1$  | = | 0.043 | $\beta_1$  | = | 0.133 | $\beta_1$  | = | 0.067 |
| $\beta_2$  | = | 0.028 | $\beta_2$  | = | 0.09  | $\beta_2$  | = | 0.044 |
| $\gamma_1$ | = | 0.271 | $\gamma_1$ | = | 0.423 | $\gamma_1$ | = | 0.311 |
| $\gamma_2$ | = | 0.076 | $\gamma_2$ | = | 0.151 | $\gamma_2$ | = | 0.096 |

Earth pressure:

$$q = 0.297 \times 2 \times 9.5 = 5.643 \text{ t/m}^2$$

$$\sigma_{\text{bmax}} = \frac{\beta_1 \times q \times b^2}{t^2} = \frac{0.067 \times 5.643 \times 90.250}{0.25} = 136 \text{ t/m}^2$$

For 1000 mm of width

$$Z = \frac{1000 \times 250000}{6} = 4.167E+07 \text{ mm}^3 = 0.042 \text{ m}^3$$

Hence Moment /m width along Y direction

$$M_Y / \text{m width} = 136 \times 0.042 = 5.660 \text{ t-m/m}$$

$$\sigma_{\text{amax}} = \frac{\beta_2 \times q \times b^2}{t^2} = \frac{0.044 \times 5.64 \times 90.25}{0.25} = 90.28 \text{ t/m}^2$$

For 1000 mm of width

$$Z = \frac{1000 \times 250000}{6} = 4.167 \text{E}+07 \text{ mm}^3$$

$$= 0.042 \text{ m}^3$$

Hence Moment /m width along X direction

$$M_X / \text{m width} = 90.2767 \times 0.0417 = 3.762 \text{ t-m/m}$$

Total Moment in Solid Return /m height = 4.66 t-m/m Along X-direction

Total Moment in Solid Return /m width = 6.57 t-m/m Along Y-direction

**Forces at the cantilever return wall (AA') :**

| Forces at                   | Due to Earth Pressure  | Due to Surcharge Pressure                                   |
|-----------------------------|--|---|
| Force at CC'                | $1/2 \times 0.297 \times 2 \times 0.75^2$<br>= 0.167 t/m       | $0.297 \times 1.2 \times 2 \times 0.75$<br>= 0.535 t/m      |
| Force at AA''               | $1/2 \times 0.297 \times 2 \times 0.75^2$<br>= 0.167 t/m       | $0.297 \times 1.2 \times 2 \times 0.75$<br>= 0.535 t/m      |
| Total Force                 | $(0.167+0.167)/2 \times 0$<br>= 0.000 T                        | $(0.535+0.535)/2 \times 0$<br>= 0.000 T                     |
| Lever arm from AA''         | $(2 \times 0.1670625 + 0) / ( + 0)$<br>$\times 0 / 3$<br>= 0 m | $(2 \times 0.5346 + 0) / ( + 0) \times 0$<br>$/ 3$<br>= 0 m |
| Moment at Face AA''         | 0*0<br>0.000 Tm  | 0*0<br>0.000 Tm   |
| Moment at AA' per m /height | 0/0.75<br>= 0.000 tm/m   | 0/0.75<br>= 0.000 tm/m                                      |
|                             |  |   |

|   |                                  |                               |
|---|----------------------------------|-------------------------------|
| Lever arm from BB'  | 1.5 + 0<br>= 1.5 m               | 1.5 + 0<br>= 1.5 m            |
| Moment at Face BB'  | 0*1.5<br>= 0.000 Tm              | 0*1.5<br>= 0.000 Tm           |
| Moment at BB' per m /height<br>*/ Assumed 50% height is effective | 0/4.75<br>= 0.00 tm/m            | 0/4.75<br>= 0.00 tm/m         |
|   |                                  |                               |
| Lever arm from A'B'   | 9.5-(0.75+0.75)*2/3<br>= 8.500 m | 9.5-(0.75+0.75)/2<br>= 8.75 m |
| Moment at Face BB'  | 0*8.5<br>= 0.000 Tm              | 0*8.75<br>= 0.000 Tm          |
| Moment at AB' per m /width<br>*/ Assumed 50% width is effective   | 0/0.75<br>= 0.00 tm/m            | 0/0.75<br>= 0.00 tm/m         |

**Design Bending Moment at Face of Cantilever Return Wall (Horizontal Reinforcement):**

| Force due to                   | Unfactored<br>Bending Moment<br>at Face AA" | Load Factor |      |    |
|--------------------------------|---|-------------|------|----|
|                                |   | ULS         | SLS  |    |
|                                |   |             | Rare | QP |
| Earth Pressure                 | 0.00 tm/m                                   | 1.5         | 1    | 1  |
| Surcharge Pressure             | 0.00 tm/m                                   | 1.2         | 0.8  | 0  |
|                                |   |             |      |    |
| ULS Design Bending moment      | =   | 0.00 Tm/m   |      |    |
| SLS Rare Design Bending moment | =   | 0.00 Tm/m   |      |    |
| SLS QP Design Bending moment   | =   | 0.00 Tm/m   |      |    |

**Design Forces for Solid Return wall:****Bending Moment At Face BB' (Horizontal Reinforcement)**

| Force due to                                   | Unfactored<br>Bending Moment<br>at Face BB' | Load Factor |      |    |
|--|---|-------------|------|----|
|  |   | ULS         | SLS  |    |
|  |   |             | Rare | QP |
| Earth Pressure From cantilever return wall     | 0.00 tm/m                                   | 1.5         | 1    | 1  |
| Earth Pressure over solid return wall          | 3.762 tm/m                                  | 1.5         | 1    | 1  |
| Surcharge Pressure From cantilever return wall | 0.00 tm/m                                   | 1.2         | 0.8  | 0  |
| Surcharge Pressure over solid return wall      | 0.902 tm/m                                  | 1.2         | 0.8  | 0  |
| ULS Design Bending moment = 6.72 Tm            |   |             |      |    |
| SLS Rare Design Bending moment = 4.48 Tm       |   |             |      |    |
| SLS QP Design Bending moment = 3.76 Tm         |   |             |      |    |

**Design Bending Moment At Face A'B' (Vertical Reinforcement)**

| Force due to                                   | Unfactored<br>Bending Moment<br>at Face A'B' | Load Factor |      |    |
|--|--|-------------|------|----|
|  |  | ULS         | SLS  |    |
|  |  |             | Rare | QP |
| Earth Pressure From cantilever return wall     | 0.00 tm/m                                    | 1.5         | 1    | 1  |
| Earth Pressure over solid return wall          | 5.66 tm/m                                    | 1.5         | 1    | 1  |
| Surcharge Pressure From cantilever return wall | 0.00 tm/m                                    | 1.2         | 0.8  | 0  |
| Surcharge Pressure over solid return wall      | 0.91 tm/m                                    | 1.2         | 0.8  | 0  |
| ULS Design Bending moment = 9.58 Tm            |  |             |      |    |
| SLS Rare Design Bending moment = 6.39 Tm       |  |             |      |    |
| SLS QP Design Bending moment = 5.66 Tm         |  |             |      |    |

**SHEAR FORCE CALCULATION FOR RETURN WALL :***Case (1) For uniformly distributed load over entire plate*

$$R1 = \gamma_1 q b = 0.380 \times 0.713 \times 9.5 = 2.58 \text{ t-m/m}^2$$

$$R2 = \gamma_2 q b = 0.163 \times 0.713 \times 9.5 = 1.10 \text{ t-m/m}^2$$

*Case (2) For Triangular loading due to earth pressure*

$$R1 = \gamma_1 q b = 0.311 \times 5.643 \times 9.5 = 16.67 \text{ t-m/m}^2$$

$$R2 = \gamma_2 q b = 0.096 \times 5.643 \times 9.5 = 5.13 \text{ t-m/m}^2$$

*Design Shear Force At Face A'B' (Vertical Reinforcement)*

| Force due to  | Unfactored<br>Bending Moment<br>at Face A'B' | ULS Load Factor |
|---|--|-----------------|
| Earth Pressure over solid return wall               | 16.67 tm/m                                   | 1.50            |
| Surcharge Pressure over solid return wall           | 2.58 tm/m                                    | 1.20            |
| Design Shear Force $V_{ED} = 28.10 \text{ t-m/m}^2$ |  |                 |

*Design Shear Force At Face A'B' (Vertical Reinforcement)*

| Force due to                                       | Unfactored<br>Bending Moment<br>at Face BB' | ULS Load Factor |
|--|---|-----------------|
| Earth Pressure over solid return wall              | 5.13 tm/m                                   | 1.50            |
| Surcharge Pressure over solid return wall          | 1.10 tm/m                                   | 1.20            |
| Design Shear Force $V_{ED} = 9.02 \text{ t-m/m}^2$ |   |                 |

### DESIGN OF RETURN WALL :

#### MATERIAL PROPERTIES :

|   |   |    |            |
|---|---|----|------------|
| Grade of concrete                               | = | M  | 30 MPa     |
| Grade of Reinforcement                          | = | Fe | 500 MPa    |
| fywd = 0.8 fyk                                  | = |    | 400 MPa    |
| Clear cover                                     | = |    | 75 mm      |
| Modulus of Elasticity steel Es                  | = |    | 200000 Mpa |
| For short Term loading Ecm                      | = |    | 32308 Mpa  |
| For long Term loading Ecm'                      | = |    | 16154 Mpa  |
| f <sub>cteff</sub> Mean tensile strength = fctm | = |    | 2.77 Mpa   |
| fed   | = |    | 15.63 Mpa  |
| Creep factor $\phi$                             | = |    | 1.00       |
| $\epsilon_{uk}$                                 | = |    | 0.0025     |
| $\epsilon_{ud}$                                 | = |    | 0.0022     |
| $\epsilon_{cu2}$                                | = |    | 0.0035     |
| $x_{u,max}/d$                                   | = |    | 0.6167     |

#### PERMISSIBLE STRESSES

##### 1) Permissible concrete compressive stresses

| Load Combi | Permissible Stress  |
|------------|---------------------|
| SLS Rare   | 0.48 fck = 14.4 Mpa |
| SLS QP     | 0.36 fck = 10.8 Mpa |

2) Permissible Tensile stress in steel (Rare) = 0.6 fy = 300 Mpa

Permissible Tensile stress in steel (QLS) = 0.8 fy = 400 Mpa

##### 3) Permissible crack width w<sub>k</sub>

SLS QP Load combination = 0.3 mm

#### A) ULS CAPACITY CHECK

| Load comb.                     | M <sub>ED</sub> | b    | Overall<br>depth D | d   | Area of steel provided |         |                               | x <sub>max</sub> | xu = 0.87 fyk<br>Ast / 0.362 fck | b      | Check | Λ <sub>sg,cal</sub> = M / 0.87<br>fyk (d'-0.416<br>xu) | Check   | Λ <sub>sg</sub> <sub>Cal</sub> < Λ <sub>st</sub><br>Provided | Λ <sub>st</sub> min | Check   | ΔF <sub>d</sub> | z = d-<br>0.416 xu | M <sub>ED</sub> /z<br>+ ΔF <sub>D</sub> | M <sub>Rd</sub> = 0.87 fyk<br>Ast (d-0.416<br>xu)            | M <sub>RD</sub> /z | Check  |
|--------------------------------|-----------------|------|--------------------|-----|------------------------|---------|-------------------------------|------------------|----------------------------------|--------|-------|--|---|--|---------------------|---|-----------------|--------------------|---|--|--------------------|--|
|                                |                 |      |                    |     | Dia                    | Spacing | Λ <sub>st</sub> ,<br>Provided |                  |                                  |        |       |  | Λ <sub>sg</sub> <sub>Cal</sub> > Λ <sub>st</sub><br>min |  |                     | Λ <sub>sg</sub> <sub>Cal</sub> > Λ <sub>st</sub><br>min |                 |                    |   |  |                    | M <sub>Rd</sub> /z ><br>M <sub>ED</sub> /z + ΔF <sub>D</sub> |
|                                | Tm              | mm   | mm                 | mm  | mm                     | mm      | mm                            | mm <sup>2</sup>  | mm                               | mm     |       | mm <sup>2</sup>  | mm <sup>2</sup>   | mm <sup>2</sup>  | T                   | m   | T               | Tm                 | Tm/m                                    | M <sub>Rd</sub> /z ><br>M <sub>ED</sub> /z + ΔF <sub>D</sub> |                    |  |
| Face of cantilever wing wall   | 0.00            | 1000 | 500                | 419 | 12                     | 100     | 1131                          | 258              | 45                               | UR, OK | 0     | OK   | 628.5   | OK   | 0.00                | 400   | 0               | 20                 | 49                                      | OK   |                    |  |
| Design of Section At Face BB'' | 6.72            | 1000 | 500                | 415 | 20                     | 100     | 3142                          | 256              | 126                              | UR, OK | 426   | OK   | 623   | OK   | 0.00                | 363   | 19              | 50                 | 137                                     | OK   |                    |  |
| Design of Section At Face AB'' | 9.58            | 1000 | 500                | 413 | 25                     | 100     | 4909                          | 254              | 197                              | UR, OK | 666   | OK   | 619   | OK   | 0.00                | 331   | 29              | 71                 | 214                                     | OK   |                    |  |



## B) SLS STRESS CHECK

Rare Load combination.

$$E_{c,eq} = \frac{E_{cm} * (M_{QP} + M_{ST})}{M_{ST} + (1 + \phi) * M_{QP}}$$

$$M_{ST} = M_{RARE} - M_{QP}$$

$$m = E_s / E_{c,eq}$$

Quasi Permanent Load Combination

$$m = E_s / E_{cm}'$$

| Formula used for calculation of stress    |   |
|---|---|
| dc (depth of neutral axis)                | $= \frac{-m * A_s + \sqrt{(m^2 * A_s^2 + 2 * m * A_s * b * d)}}{b}$ |
| $I_{NA}$ (Transformed)                    | $= b * dc^3 / 3 + m * A_s * (d - dc)^2$                             |
| Compressive stress in concrete $\sigma_c$ | $= M_{RARE} * dc / I_{NA}$  |
| Tensile stress in steel $\sigma_s$        | $= m * M_{RARE} * (d - dc) / I_{NA}$                                |

Stress Check for SLS Load Combinations

| Load comb.                                  | M<br>(tm/m) | b<br>mm | d<br>mm | $A_{st}$<br>Provided<br>mm <sup>2</sup> | modular<br>ratio | N.A.<br>depth<br>(dc)<br>mm | $I_{NA}$<br>mm <sup>4</sup> | Comp<br>stress<br>Mpa | Max C.<br>Stress<br>Mpa | Check | Tensile<br>stress<br>Mpa | Max T<br>Stress<br>Mpa | Check |
|---|-------------|---------|---------|---|------------------|-----------------------------|-----------------------------|-----------------------|-------------------------|-------|--------------------------|------------------------|-------|
| <i>Face of cantilever wing wall</i>         |             |         |         |   |                  |                             |                             |                       |                         |       |                          |                        |       |
| SLS (R Comb.)                               | 0.00        | 1000    | 419     | 1131                                    | 6.19             | 69.91                       | 1E+09                       | 0.00                  | 14.4                    | OK    | 0.00                     | 300                    | OK    |
| SLS (QP Comb.)                              | 0.00        | 1000    | 419     | 1131                                    | 12.38            | 95.22                       | 2E+09                       | 0.00                  | 10.8                    | OK    | 0.00                     | 400                    | OK    |
| <i>Section at deff from face of colonne</i> |             |         |         |   |                  |                             |                             |                       |                         |       |                          |                        |       |
| SLS (R Comb.)                               | 4.48        | 1000    | 415     | 3142                                    | 11.38            | 140.20                      | 4E+09                       | 1.74                  | 14.4                    | OK    | 39                       | 300                    | OK    |
| SLS (QP Comb.)                              | 3.76        | 1000    | 415     | 3142                                    | 12.38            | 144.94                      | 4E+09                       | 1.42                  | 10.8                    | OK    | 33                       | 400                    | OK    |
| <i>Section just below bearing</i>           |             |         |         |   |                  |                             |                             |                       |                         |       |                          |                        |       |
| SLS (R Comb.)                               | 6.39        | 1000    | 413     | 4909                                    | 11.68            | 167.56                      | 5E+09                       | 2.14                  | 14.4                    | OK    | 36                       | 300                    | OK    |
| SLS (QP Comb.)                              | 5.66        | 1000    | 413     | 4909                                    | 12.38            | 171.24                      | 5E+09                       | 1.86                  | 10.8                    | OK    | 32                       | 400                    | OK    |

**C) SLS CRACK WIDTH CHECK (QUASI PERMANENT LOAD COMBINATION)**

**1) CHECK  $A_{st,min}$  for crack control**

| Load comb.                           | b    | h   | d   | Act =bh/2       | σs = fyk | k    | kc  | A <sub>s,min</sub> =k <sub>c</sub> k f <sub>ct,eff</sub> | A <sub>s,provided</sub> | check |
|--------------------------------------|------|-----|-----|-----------------|----------|------|-----|--|-------------------------|-------|
|                                      | mm   | mm  | mm  | mm <sup>2</sup> | Mpa      |      |     | A <sub>ct</sub> / σ <sub>s</sub>                         |                         |       |
|                                      | mm   | mm  | mm  | mm <sup>2</sup> | Mpa      |      |     | mm <sup>2</sup>  | mm <sup>2</sup>         |       |
| Section at face of columne           |      |     |     |                 |          |      |     |  |                         |       |
| SLS QP                               | 1000 | 500 | 349 | 250000          | 500      | 0.86 | 0.4 | 477  | 1131                    | OK    |
| Section at deff from face of columne |      |     |     |                 |          |      |     |  |                         |       |
| SLS QP                               | 1000 | 500 | 345 | 250000          | 500      | 0.86 | 0.4 | 477  | 3142                    | OK    |
| Section just below bearing           |      |     |     |                 |          |      |     |  |                         |       |
| SLS QP                               | 1000 | 500 | 343 | 250000          | 500      | 0.86 | 0.4 | 477  | 4909                    | OK    |

| h   | k    |
|-----|------|
| 0   | 1    |
| 0.3 | 1    |
| 0.8 | 0.65 |
| 3   | 0.65 |
|     |      |

**2) CHECK FOR MAXIMUM SPACING b/w bars.**

| Load comb.                                   | Bar dia     | cover | Spacing b/w bars |            | Check |
|--|-------------|-------|------------------|------------|-------|
|  |             |       | Provided         | Calculated |       |
|  | $\phi_{eq}$ | c     | mm               | mm         |       |
| <i>Section at face of columnne</i>           |             |       |                  |            |       |
| SLS QP                                       | 12          | 75    | 100              | 405        | OK    |
| <i>Section at deff from face of columnne</i> |             |       |                  |            |       |
| SLS QP                                       | 12          | 75    | 100              | 405        | OK    |
| <i>Section just below bearing</i>            |             |       |                  |            |       |
| SLS QP                                       | 12          | 75    | 100              | 405        | OK    |

### 3) CHECK FOR CRACK WIDTH

| Load comb.                                     | $h_{c,eff} = \text{Min} [ 2.5 ( h - d ) , ( h - x/3 ) , h/2 ]$ | $A_{c,eff} = h_{c,eff} * b$ | $A_{s,provided}$ | $\rho_{peff} = A_s / A_{c,eff}$ | $s_{max} = 3.4c + 0.17 \phi / \rho_{peff}$ | $\sigma_{sc}$ | x =neutral axis depth | kt  | $\alpha_e = E_s / E_{cm}$ | $\epsilon_{sm} - \epsilon_{cm} = \text{Max} [ [ \sigma_{sc} - k_t f_{ct,eff} ( 1 + \alpha_e \rho_{peff} ) / \rho_{peff} ] / E_s , 0.6 \sigma_{sc} / E_s ]$ | $w_k$ | check |
|--|--|-----------------------------|------------------|---------------------------------|--|---------------|-----------------------|-----|---------------------------|--|-------|-------|
|  | mm   | mm <sup>2</sup>             | mm <sup>2</sup>  |                                 | mm   | Mpa           | mm                    |     |                           |  |       |       |
| Section at face of columne<br>SLS QP           | 250  | 250000                      | 1130.97          | 0.005                           | 705.939                                    | 0.00          | 95.22                 | 0.5 | 12.38                     | 0  | 0.000 | OK    |
| Section at deff from face of columne<br>SLS QP | 250  | 250000                      | 3142             | 0.013                           | 417.338                                    | 32.65         | 144.94                | 0.5 | 12.38                     | 1E-04  | 0.041 | OK    |
| Section just below bearing<br>SLS QP           | 250  | 250000                      | 4908.74          | 0.020                           | 358.896                                    | 32.44         | 171.24                | 0.5 | 12.38                     | 1E-04  | 0.035 | OK    |

### D) CHECK FOR SHEAR: (IRC 112 / clause 10.3.2 (2) )

Check of Shear Reinforcement Requirement

| Load comb.          | $V_{ED}$ | $\beta$ | $\beta V_{ED}$ | d      | bw   | $k = \text{Min} [ 1 + \sqrt{200/d} , 2 ]$ | $A_{sl}$        | $\rho_1 = \text{Min} [ A_{sl} / bw d , 0.02 ]$ | $v_{min} = 0.031 k^{3/2} / f_{ck}^{1/2}$ | $\sigma_{cp}$ | $V_{kac} = \text{Max} [ ( 0.12 k ( 80 \rho_1 f_{ck} )^{0.33} + 0.15 \sigma_{cp} ) bw d , ( v_{min} + 0.15 \sigma_{cp} ) bw d ]$ | Check                    |
|---------------------|----------|---------|----------------|--------|------|---|-----------------|--|--|---------------|---|--------------------------|
|                     | T        |         | T              | mm     | mm   |   | mm <sup>2</sup> |  |  | Mpa           | Tonne   |                          |
| At face BB'<br>ULS  | 9.02     | 0.25    | 2.26           | 419    | 1000 | 1.69                                      | 1130.97         | 0.0027   | 0.373                                    | 0             | 15.75   | No Shear reinf. Required |
| At face A'B'<br>ULS | 28.10    | 0.25    | 7.02           | 415.00 | 1000 | 1.69                                      | 3141.59         | 0.0076   | 0.374                                    | 0             | 21.97   | No Shear reinf. Required |

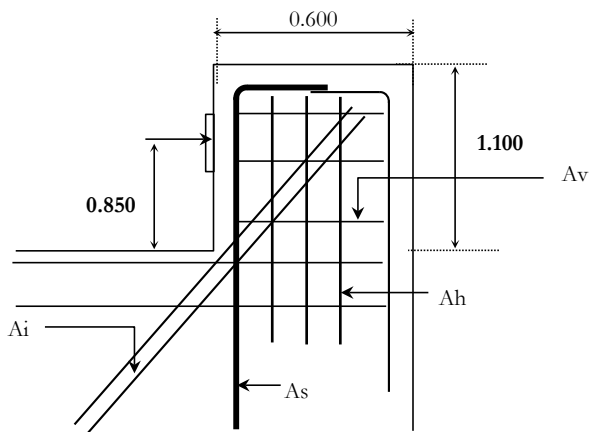
| <b>Check for Maximum Shear Capacity :</b> |          |      |     |            |               |     |   |       | $\theta = 0.5 \sin^{-1} \left[ \frac{2 * V_{NS}}{(\alpha_{cw} * b_w * z * v1 * f_{cd})} \right]$ | $\theta$ adopted | $\Delta F_d = 0.5 V_{ED} \cot \theta$ |
|---|----------|------|-----|------------|---------------|-----|---|-------|--|------------------|---------------------------------------|
| Load comb.                                | $V_{ED}$ | bw   | d   | $z = 0.9d$ | $\alpha_{cw}$ | v1  | $V_{edmax} = \alpha_{cw} * b_w * z * v1 * f_{cd} / 2$ | Check |  |                  |                                       |
|   | T        | mm   | mm  | mm         |               |     | Tonne   |       | deg  | deg              | T                                     |
| At face A'B<br>ULS                        | 9.02     | 1000 | 419 | 377.1      | 1             | 0.6 | 177   | OK    | 1.46   | 45               | 4.51                                  |
| At face BB'<br>ULS                        | 28.10    | 1000 | 415 | 374        | 1             | 0.6 | 175   | OK    | 4.62   | 45               | 14.05                                 |

$\Delta F_d$  = Additional Tensile force, to be accounted in longitudinal reinforcement

## Design of Seismic Stopper in Transverse Direction

### Stopper Details :

|                              |   |           |
|------------------------------|---|-----------|
| Width of stopper             | = | 1020 mm   |
| Overall depth h              | = | 600 mm    |
| Clear cover to Reinforcement | = | 50 mm     |
| Dia of main reinforcement    | = | 32 mm     |
| Effective Depth provided d   | = | 534 mm    |
| Shear span $a_v$             | = | 850 mm    |
| $a_v/d$                      | = | 1.592 > 1 |
| Design as Flexural Member    |   |           |



### Material properties :

|                        |                     |   |          |
|------------------------|---------------------|---|----------|
| Grade of concrete      | $f_{ck}$            | = | 35 Mpa   |
|                        | $f_{cd}$            | = | 15.6 Mpa |
| Grade of reinforcement | $f_y$               | = | 500 Mpa  |
|                        | $f_{yd} = 0.87 f_y$ | = | 435 Mpa  |

### Design Load calculation :

|  |    |   |             |
|--|----|---|-------------|
| Seismic Zone   |    | = | V           |
| Type of soil   |    | = | medium      |
| Zone factor  | Z  | = | 0.36        |
| Importance factor  | I  | = | 1.2         |
| Sa/g -Transverse Seismic Case                                |    | = | 1           |
| Seis. Coeff. -Trans., $A_{hT} = (Z/2)*(I)*(Sa/g)_{(Trans.)}$ |    | = | 0.216       |
| Response Reduction Factor, $R_{trans.}$                      |    | = | 1           |
| Design Seis. Coeff. -Trans. $A_{hT} = A_h'/R_{(Trans.)}$     |    | = | 0.216       |
|  |    |   |             |
| Total weight of super-structure DL+SIDL                      |    | = | 429 Tonne   |
| Seismic Component in Transverse direction                    |    | = | 93 Tonne    |
|  |    |   |             |
| Total Horizontal force                                       |    | = | 93 Tonne    |
|  |    |   |             |
| Nos. of Stopper sharing loads                                |    | = | 2 Nos       |
| Horizontal force over each stopper                           |    | = | 46.28 Tonne |
|  |    |   |             |
| Unfactored Vertical force V                                  |    | = | 46.28 Tonne |
| Unfactored Horizontal Force H                                |    | = | 9.26 Tonne  |
|  |    |   |             |
| Load factor  |    | = | 1.5         |
|  |    |   |             |
| Factored Vertical Load                                       | Vu | = | 69.42 T     |
| Factored Horizontal Force                                    | Nu | = | 13.88 T     |
|  |    |   |             |
| Lever arm  |    | = | 574 0.85 m  |

**Design of Stopper :**

|                       |          |                            |                                     |
|-----------------------|----------|----------------------------|-------------------------------------|
| Design Bending Moment | $M_{ED}$ | =                          | 59.01 Tm                            |
| D                     | =        | 0.6 m                      | */ overall depth at face of support |
| d                     | =        | 0.534 m                    | */ deff at face of support          |
| Clear Cover           | =        | 50 mm                      |                                     |
| Ast Provided          | =        | 32 $\phi$ @ 5 Nos          |                                     |
|                       | =        | 4021 mm <sup>2</sup> /m    |                                     |
|                       | =        | 0.753 %                    |                                     |
| Grade of Concrete fck | =        | 35 Mpa                     |                                     |
| Grade of steel fyk    | =        | 500 Mpa                    |                                     |
| xu                    | =        | 0.87 fyk Ast / 0.362 fck b |                                     |
|                       | =        | 135 mm                     |                                     |
| x <sub>umax</sub>     | =        | 0.609 d'                   |                                     |
|                       | =        | 325 mm                     | UNDER REINFORCED                    |
| Ast calculated        | =        | M/ 0.87 fyk (d'-0.416 xu)  |                                     |
|                       | =        | 2840 mm <sup>2</sup> /m    |                                     |
| Ast minimum           | =        | 0.15% * b*d                |                                     |
|                       | =        | 918 mm <sup>2</sup> /m     |                                     |
| Ast required          | =        | Max( 2840 , 918 )          |                                     |
|                       | =        | 2840 mm <sup>2</sup> /m    | < 4021 mm <sup>2</sup> /m OK        |

**(ULS) CHECK FOR SHEAR FORCE**

$$\text{Factored Shear Force } V_{ED} = 69.4 \text{ T/m}$$

$$\begin{aligned} \text{Reduction factor } \beta_1 &= a_v/2d \\ &= 1 \quad \text{*/ no reduction is applied} \end{aligned}$$

$$\begin{aligned} \text{Design Shear Force } V_{NS}' &= \beta_1 * V_{NS} \\ &= 69.42 \text{ Tonne} \end{aligned}$$

**Max Shear Capacity of section**

$$\begin{aligned} v &= 0.6 * (1 - f_{ck} / 310) \quad \text{*/ } f_{ck} \text{ in mm} \\ &= 0.532 \end{aligned}$$

$$\begin{aligned} f_{cd} &= 15.63 * f_{ck} \\ &= 547 \text{ Mpa} \end{aligned}$$

$$\begin{aligned} V_{RDC, \max} &= 0.5 b_w d v f_{cd} \\ &= 7931 \text{ Tonne} > 69.4 \text{ Tonne} \quad \text{OK} \end{aligned}$$

$$\begin{aligned} D &= 0.6 \text{ m} \quad \text{*/ overall depth at face of support} \\ d &= 0.534 \text{ m} \quad \text{*/ deff at face of support} \end{aligned}$$

**Check for Design Shear Reinforcement :**

$$k = \text{Min} \left\{ \begin{array}{l} 1 + \sqrt{200/d} \\ 2 \end{array} \right. \quad \text{d is depth in mm}$$

$$k = 1.612$$

$$\rho_1 = \text{Min} \left\{ \begin{array}{l} A_{sl} / b_w d \\ 0.02 \end{array} \right.$$

$$\rho_1 = 0.0074$$

$$\sigma_{cp} = 0 \text{ Mpa}$$

$$\begin{aligned} v_{\min} &= 0.031 k^{3/2} f_{ck}^{1/2} \\ &= 0.375 \end{aligned}$$

$$V_{Rdc} = \text{Max} \left\{ \begin{array}{l} (0.12 k (80 \rho_1 f_{ck})^{0.33} + 0.15 \sigma_{cp}) b_w d \\ (v_{\min} + 0.15 \sigma_{cp}) b_w d \end{array} \right. \quad (\text{IRC 112 / clause 10.3.2 (2)})$$

$$= 28.6 \text{ Tonne} < 69.4 \text{ Tonne} \quad \text{PROVIDE DESIGN SHEAR REINF.}$$

***FINDING VALUE OF  $\theta$  AT DESIGN SECTIONS FOR DESIGN SHEAR REINFORCEMENT***

$$\begin{aligned} V_{Rd\max} &= V_{NS} \\ \theta &= 0.5 \sin^{-1} (2 V_{NS} / \alpha_{cw} b_w z v_1 f_{cd}) \\ &= 0.25 \text{ deg} \end{aligned}$$

$$\theta \text{ adopted} = 45 \text{ deg}$$

|               |   |           |
|---------------|---|-----------|
| $\alpha_{cw}$ | = | 1         |
| $v_1$         | = | 0.6       |
| $z$           | = | $0.9 * d$ |
|               | = | 0.481 m   |

***FINDING DESIGN SHEAR REINFORCEMENT REQUIREMENT***

$$V_{NS} = V_{Rds} = (A_{sw}/s) * z * f_{ywd} * \cot \theta \quad (\text{IRC 112 / clause 10.3.3.2 Eq 10.7})$$

$$A_{sw} = V_{NS} * s / z f_{ywd} \cot \theta$$

$$f_{ywd} = 0.8 f_{yk} / \gamma_s$$

$$f_{ywd} = 348 \text{ Mpa}$$

$$A_{sw} = 415 \text{ mm}^2$$

|            |   |      |
|------------|---|------|
| $\gamma_s$ | = | 1.15 |
|------------|---|------|

**Minimum shear reinforcement (IRC 112 / clause 10.3.3.5 Eq 10.20)**

$$A_{sw, \min} = \rho_{w, \min} * s * b_w$$

$$\rho_{w, \min} = (0.072 \sqrt{f_{ck}}) / f_{yk}$$

$$= 0.00085$$

$$A_{sw, \min} = 85 \text{ mm}^2$$

$$\text{Provide } 16 \text{ dia } 6 \text{ legged stp. /m @ } 100 \text{ c/c} \quad \frac{576}{c/c}$$

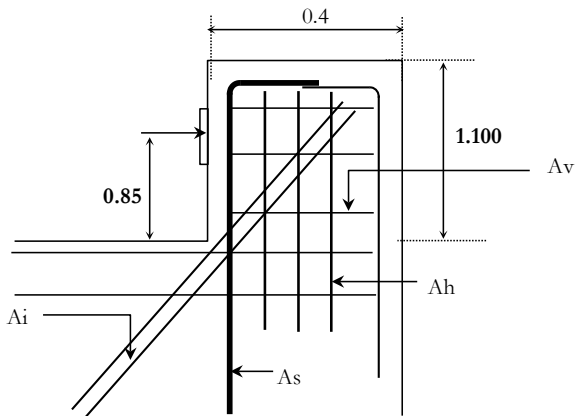
$\Rightarrow$  1206 mm<sup>2</sup> @ 100 mm c/c > 415 mm<sup>2</sup> OK



## Design of Seismic Stopper in Longitudinal direction action in Dirt Wall

### Stopper Details :

|                              |   |           |
|------------------------------|---|-----------|
| Width of stopper             | = | 800 mm    |
| Overall depth h              | = | 400 mm    |
| Clear cover to Reinforcement | = | 50 mm     |
| Dia of main reinforcement    | = | 20 mm     |
| Effective Depth provided d   | = | 340 mm    |
| Shear span $a_v$             | = | 850 mm    |
| $a_v/d$                      | = | 2.500 > 1 |
| Design as Flexural Member    |   |           |



### Material properties :

|                        |                     |   |          |
|------------------------|---------------------|---|----------|
| Grade of concrete      | $f_{ck}$            | = | 35 Mpa   |
|                        | $f_{cd}$            | = | 15.6 Mpa |
| Grade of reinforcement | $f_y$               | = | 500 Mpa  |
|                        | $f_{yd} = 0.87 f_y$ | = | 435 Mpa  |

### Design Load calculation :

|   |   |             |
|---|---|-------------|
| Seismic Zone  | = | V           |
| Type of soil  | = | medium      |
| Zone factor Z   | = | 0.36        |
| Importance factor I   | = | 1.2         |
| Sa/g -Transverse Seismic Case   | = | 1           |
| Seis. Coeff. -Trans., $A_{hT} = (Z/2) \cdot (I) \cdot (S_a/g)_{(Trans.)}$ | = | 0.216       |
| Response Reduction Factor, $R_{trans.}$                                   | = | 1           |
| Design Seis. Coeff. -Trans. $A_{hT} = A_h' / R_{(Trans.)}$                | = | 0.216       |
| Total weight of super-structure DL+SIDL                                   | = | 429 Tonne   |
| Seismic Component in Transverse direction                                 | = | 93 Tonne    |
| Total Horizontal force  | = | 93 Tonne    |
| Nos. of Stopper sharing loads   | = | 4 Nos       |
| Horizontal force over each stopper  | = | 23.14 Tonne |
| Unfactored Vertical force V   | = | 23.14 Tonne |
| Unfactored Horizontal Force H   | = | 4.63 Tonne  |
| Load factor   | = | 1.5         |
| Factored Vertical Load $V_u$  | = | 34.71 T     |
| Factored Horizontal Force $N_u$   | = | 6.94 T      |
| Lever arm   | = | 0.85 m      |
| LL Dispersion in Dirt Wall through Girder                                 | = | 1.4 m       |

**Design of Stopper :**

|                       |          |                            |                                     |
|-----------------------|----------|----------------------------|-------------------------------------|
| Design Bending Moment | $M_{ED}$ | =                          | 21.07 Tm                            |
| D                     | =        | 0.4 m                      | */ overall depth at face of support |
| d                     | =        | 0.340 m                    | */ deff at face of support          |
| Clear Cover           | =        | 50 mm                      |                                     |
| Ast Provided          | =        | 20 $\phi$ @ 5 Nos          |                                     |
|                       | =        | 1571 mm <sup>2</sup> /m    |                                     |
|                       | =        | 0.462 %                    |                                     |
| Grade of Concrete fck | =        | 35 Mpa                     |                                     |
| Grade of steel fyk    | =        | 500 Mpa                    |                                     |
| xu                    | =        | 0.87 fyk Ast / 0.362 fck b |                                     |
|                       | =        | 67 mm                      |                                     |
| x <sub>umax</sub>     | =        | 0.609 d'                   |                                     |
|                       | =        | 207 mm                     | UNDER REINFORCED                    |
| Ast calculated        | =        | M/ 0.87 fyk (d'-0.416 xu)  |                                     |
|                       | =        | 1553 mm <sup>2</sup> /m    |                                     |
| Ast minimum           | =        | 0.15% * b*d                |                                     |
|                       | =        | 480 mm <sup>2</sup> /m     |                                     |
| Ast required          | =        | Max( 1553 , 480 )          |                                     |
|                       | =        | 1553 mm <sup>2</sup> /m    | < 1571 mm <sup>2</sup> /m OK        |

**(ULS) CHECK FOR SHEAR FORCE**

$$\text{Factored Shear Force } V_{ED} = 34.7 \text{ T/m}$$

$$\begin{aligned} \text{Reduction factor } \beta_1 &= \frac{a_v}{2d} \\ &= 1 \quad \text{*/ no reduction is applied} \end{aligned}$$

$$\begin{aligned} \text{Design Shear Force } V_{NS}' &= \beta_1 * V_{NS} \\ &= 34.71 \text{ Tonne} \end{aligned}$$

**Max Shear Capacity of section**

$$\begin{aligned} v &= 0.6 * (1 - f_{ck} / 310) \quad \text{*/ } f_{ck} \text{ in mm} \\ &= 0.532 \end{aligned}$$

$$\begin{aligned} f_{cd} &= 15.63 * f_{ck} \\ &= 547 \text{ Mpa} \end{aligned}$$

$$\begin{aligned} V_{RDC, \max} &= 0.5 b_w d v f_{cd} \\ &= 3961 \text{ Tonne} > 34.7 \text{ Tonne} \quad \text{OK} \end{aligned}$$

$$\begin{aligned} D &= 0.4 \text{ m} \quad \text{*/ overall depth at face of support} \\ d &= 0.34 \text{ m} \quad \text{*/ deff at face of support} \end{aligned}$$

**Check for Design Shear Reinforcement :**

$$\begin{aligned} k &= \text{Min} \left\{ \begin{array}{l} 1 + \sqrt{200/d} \\ 2 \end{array} \right. \quad d \text{ is depth in mm} \\ k &= 1.767 \end{aligned}$$

$$\begin{aligned} \rho_1 &= \text{Min} \left\{ \begin{array}{l} A_{sl} / b_w d \\ 0.02 \end{array} \right. \\ \rho_1 &= 0.0058 \end{aligned}$$

$$\sigma_{cp} = 0 \text{ Mpa}$$

$$\begin{aligned} v_{\min} &= 0.031 k^{3/2} f_{ck}^{1/2} \\ &= 0.431 \end{aligned}$$

$$\begin{aligned} V_{Rdc} &= \text{Max} \left\{ \begin{array}{l} (0.12 k (80 \rho_1 f_{ck})^{0.33} + 0.15 \sigma_{cp}) b_w d \\ (v_{\min} + 0.15 \sigma_{cp}) b_w d \end{array} \right. \quad (\text{IRC 112 / clause 10.3.2 (2)}) \\ &= 14.4 \text{ Tonne} < 34.7 \text{ Tonne} \quad \text{PROVIDE DESIGN SHEAR REINF.} \end{aligned}$$

***FINDING VALUE OF  $\theta$  AT DESIGN SECTIONS FOR DESIGN SHEAR REINFORCEMENT***

$$\begin{aligned} V_{Rd\max} &= V_{NS} \\ \theta &= 0.5 \sin^{-1} (2 V_{NS} / \alpha_{cw} b_w z v_1 f_{cd}) \\ &= 0.20 \text{ deg} \\ \theta \text{ adopted} &= 45 \text{ deg} \end{aligned}$$

|               |   |         |
|---------------|---|---------|
| $\alpha_{cw}$ | = | 1       |
| $v_1$         | = | 0.6     |
| $z$           | = | 0.9*d   |
|               | = | 0.306 m |

***FINDING DESIGN SHEAR REINFORCEMENT REQUIREMENT***

$$\begin{aligned} V_{NS} &= V_{Rds} = (A_{sw}/s) * z * f_{ywd} * \cot \theta \quad (\text{IRC 112 / clause 10.3.3.2 Eq 10.7}) \\ A_{sw} &= V_{NS} * s / z f_{ywd} \cot \theta \\ f_{ywd} &= 0.8 f_{yk} / \gamma_s \\ f_{ywd} &= 348 \text{ Mpa} \\ A_{sw} &= 326 \text{ mm}^2 \end{aligned}$$

|            |   |      |
|------------|---|------|
| $\gamma_s$ | = | 1.15 |
|------------|---|------|

**Minimum shear reinforcement (IRC 112 / clause 10.3.3.5 Eq 10.20)**

$$\begin{aligned} A_{sw, \min} &= \rho_{w, \min} * s * b_w \\ \rho_{w, \min} &= (0.072 \sqrt{f_{ck}}) / f_{yk} \\ &= 0.00085 \\ A_{sw, \min} &= 85.2 \text{ mm}^2 \end{aligned}$$

$$\begin{aligned} \text{Provide } 12 \text{ dia } 4 \text{ legged stp. / m @ } 100 \text{ c/c} &= 580 \\ \Rightarrow 452 \text{ mm}^2 @ 100 \text{ mm c/c} &> 326 \text{ mm}^2 \quad \text{OK} \end{aligned}$$

## HYDRAULIC CALCULATION FOR HIGH LEVEL BRIDGE AT Km 2+590

### Calculation of discharge for high level bridge at Chainage 2+590 Km Yingkiong, Upper Siang, Arunachal Pradesh

#### 1.0 Data

|                              |              |
|------------------------------|--------------|
| Design Chainage              | 2+590 km     |
| HFL                          | 273.5 m      |
| Bed level                    | 272.03 m     |
| Energy slope (Fall of river) | 0.105        |
| Catchment Area               | 14.3 Sq km   |
|                              | 1430 Hectare |

#### 2.0 Discharge estimation by Dickens Formula

$$Q = CM^{3/4}$$

##### Where

|          |   |  |  |
|----------|---|--|--|
| <b>Q</b> | = | The peak run-off in M <sup>3</sup> /s  |  |
| <b>M</b> | = | Catchment area in sq. km   |  |
| <b>C</b> | = | 11-14 Where annual Rainfall is 60-120cm<br>14-19 Where annual Rainfall is more than 120cm<br>22 in Western Ghats |  |
| <b>M</b> | = | 14 Sq km   |  |
| <b>C</b> | = | 19 Considered  |  |
| <b>Q</b> | = | 140 m <sup>3</sup> /sec  |  |

#### 3.0 Discharge estimation by Ryves Formula

$$Q = CM^{2/3}$$

##### Where

|          |   |   |  |
|----------|---|---|--|
| <b>Q</b> | = | The peak run-off in M <sup>3</sup> /s   |  |
| <b>M</b> | = | Catchment area in sq. km  |  |
| <b>C</b> | = | 6.8 for areas within 25 km of the coast<br>8.5 for areas between 25 km and 160 km of the coast<br>10 for limited areas near the hills |  |
| <b>M</b> | = | 14.3 Sq km  |  |
| <b>C</b> | = | 10 Considered   |  |
| <b>Q</b> | = | 59 m <sup>3</sup> /sec  |  |

#### 4.0 Discharge estimation by Area velocity Method (Manning's Formula)

$$V = \frac{1}{n} \times R^{2/3} \times S^{1/2}$$

$V$  = Velocity of stream  
 $n$  = Rugosity Coefficient = 0.055  
 $S$  = Slope = 0.10455  
 $P$  = Wetted Perimeter = 20.03 m  
 $A$  = Flow Area = 18.25 m<sup>2</sup>  
 $R$  =  $A/P$  (Hydraulic Radius) = 0.911  
 $V$  =  $\frac{1}{n} R^{2/3} S^{1/2}$  = 5.53 m/sec  
 Discharge  $Q$  =  $V \times A$  = 101 m<sup>3</sup>/sec

#### 5.0 Fixing Design Discharge

Summary of Discharge from different methods

| S.No. | Method of calculation            | Discharge in cumecs |
|-------|----------------------------------|---------------------|
| 1     | Dickens Formula                  | 140                 |
| 2     | Ryves Formula                    | 59                  |
| 3     | Area Velocity Method (Manning's) | 101                 |

First Highest discharge of above = 140 m<sup>3</sup>/sec  
 Second Highest discharge of above = 101 m<sup>3</sup>/sec  
 1.5 times of second highest discharge = 151 m<sup>3</sup>/sec

As per clause 6.2.1 of IRC:SP:13-2004

If 1.5\*2nd highest < 1st Highest than adopt 1.5\*2nd highest

If 1.5\*2nd highest > 1st Highest than adopt 1st highest

**Adopted design discharge** 140 m<sup>3</sup>/sec

#### 6.0 Scour Depth

Maximum scour depth is calculated for the foundations in flowing channel. In case of pier it is 2\*dsm and in case of abutments it is 1.27\*dsm which varies in the combination of seismic forces. Since there is no pier and abutment in the flowing channel restricting the flow of the channel, calculation of scour depth is not required.