ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT ADDENDUM REPORT

FOR PROPOSED

NEAMATI MODULAR FERRY TERMINAL PROJECT JORHAT, ASSAM

Report No. AIWTDS/2025/07/03-V3

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Abbreviations

AIWCL	Assam Inland Waterways Corporation Limited
AIWTDS	Assam Inland Water Transport Development Society
AIWTP	Assam Inland Water Transport Project
AoI	Area of Influence
CPCB	Central Pollution Control Board
DIWTA	Directorate of Inland Water Transport, Assam
EC	Environmental Clearance
EHS	Environment, Health, and Safety
ESIA	Environmental and Social Impact Assessment
EMF	Environmental Management Framework
EMP	Environmental Management Plan
ESMP	Environmental and Social Management Plan
FGL	Finished Ground Level
GoA	Government of Assam
PwD	Persons with Disabilities
PCBA	Pollution Control Board of Assam
TSSC	Technical Services & Supervision Consultant

1 INTRODUCTION

The Transport Department of Government of Assam (GoA) is implementing "Assam Inland Water Transport Project (AIWTP)" with funding assistance from the World Bank. The aim of the AIWTP is to improve the quality of inland water transport services and incorporate high quality passenger and ferry services into Assam's larger transportation network. As a part of the wider inland water transport infrastructure development plan, Assam Inland Water Transport Development Society (AIWTDS) is developing a new ferry terminal at Neamati Ghat. Neamati ghat is the most significant location for facilitating regional connectivity between Jorhat and Majuli. The Neamati terminal serves as the primary gateway to Majuli - the world's largest river island. Located approximately 17 kilometers from the Jorhat city center, Neamati Ghat facilitates the daily movement of passengers, goods, and services, underscoring its strategic and socio-economic importance. The project once completed will be handed over to Assam Inland Waterways Corporation Limited (AIWCL) for operations.

The proposed Neamati Passenger Ferry Terminal, located at the strategically important Neamati Ghat in Kumargaon, Hezari Mouza, Jorhat district, is a vital component of the broader initiative to modernize the passenger ferry infrastructure between Jorhat and Majuli on river Brahmaputra (National Waterway-2) in Assam. The proposed terminal will be a modular facility designed to enhance service quality through the provision of dual approach ramps, each connected to individual vessel berthing pontoons. Additionally, a G+1 terminal building is planned to accommodate essential passenger amenities, along with a designated vehicle parking area.

The Environmental and Social Impact Assessment (ESIA) study of the proposed ferry terminal was carried out by WAPCOS Limited during March 2022 to June 2023 (Report No. IN-IWT-242294-CS-QCBS, October 2023) and was disclosed in AIWTDS website[1]. Subsequently, Cumulative Impact Assessment (CIA) study was carried out for the whole project for the ferry terminals being constructed in the river Brahmaputra as part of the Assam Inland Water Transport Project (AIWTP) by Sustainability Intelligence India LLP which was disclosed in AIWTDS website[2]. The disclosed CIA report version number is 06 dated 24th May 2024.

However, AIWTDS has proposed design modification of the terminal due to the underestimation of quantities of boulders coupled with stability concerns related to the core-filled approach ramp of the proposed terminal. To address these issues, the AIWTD Society has engaged the Indian Institute of Technology (IIT) Guwahati to undertake a design modification study aimed at identifying appropriate and sustainable engineering alternatives. Accordingly, design modification of the ferry terminal has been carried out that include hybrid approach ramp, retaining wall, winch system and erosion mitigation. Based on the design modification of the terminal, the World Bank, advised the preparation of an Addendum to the ESIA report.

This Addendum ESIA report assesses the potential environmental and social impacts arising from the revised design. It includes a detailed evaluation of the impacts on the project site

[1] ESIA report for the Neamati ferry terminal (October 2023) (https://aiwtdsociety.assam.gov.in/sites/default/files/public_utility/ESIA_EMP-Neamati.pdf)

[2] CIA report for the AIWTP project (version 06 dated 24th May 2024) (https://aiwtdsociety.assam.gov.in/sites/default/files/public_utility/CIA%20Report.pdf)

and its surrounding areas, along with recommended mitigation measures to avoid, minimize, or offset adverse effects.

This Addendum Report should be read in conjunction with the Environmental and Social Impact Assessment (ESIA) prepared by WAPCOS Limited for the proposed Neamati Passenger Ferry Terminal project.

2 PROJECT DESCRIPTION

The Neamati terminal has been designed to enhance ferry infrastructure and improve connectivity along National Waterway-2 (NW-2) between Jorhat and Majuli district of Assam. The project encompasses a comprehensive range of facilities intended to improve passenger services, streamline vehicle access, and increase overall operational efficiency. The proposed infrastructure at the Neamati terminal can be broadly categorized into landside features and riverine features.

2.1 PROJECT LOCATION

The proposed Neamati ferry terminal will be located near the existing Neamati Ghat on the bank of Brahmaputra river at village Kumargaon, Mouza Hezari, District Jorhat, Assam. The plot area of the proposed project site for the terminal building is 3687 sq.m. The project site has a gently sloping terrain that descends toward the riverbank, facilitating natural drainage. The coordinates of the terminal site are 26°51'28.27"N and 94°15'0.84"E. The ghat lies in a flood-prone zone, resulting in periodic fluctuation in river water level. The surrounding area includes low lying agricultural land and ferry-related infrastructure on the river bank. The project location is shown in Figure 2.1 site vicinity in Figure 2.2.

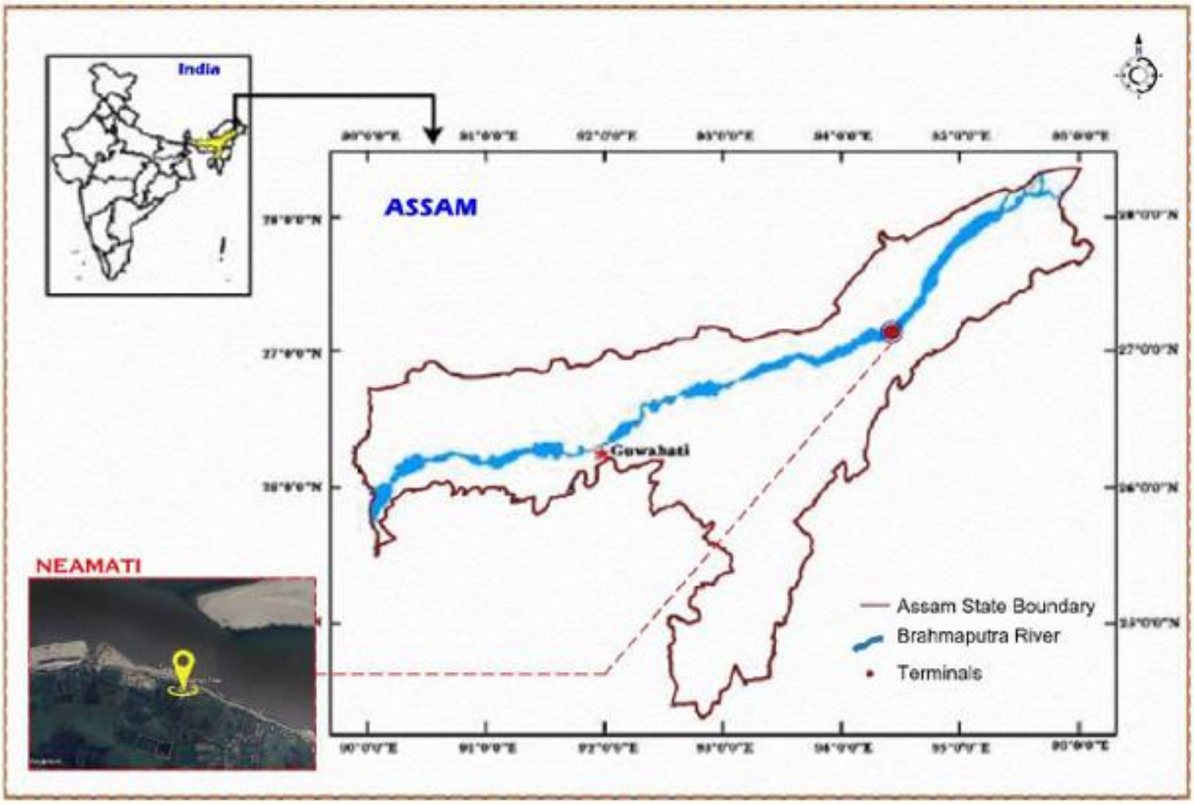


Figure 2.1: Location Map of the Neamati Ferry Terminal

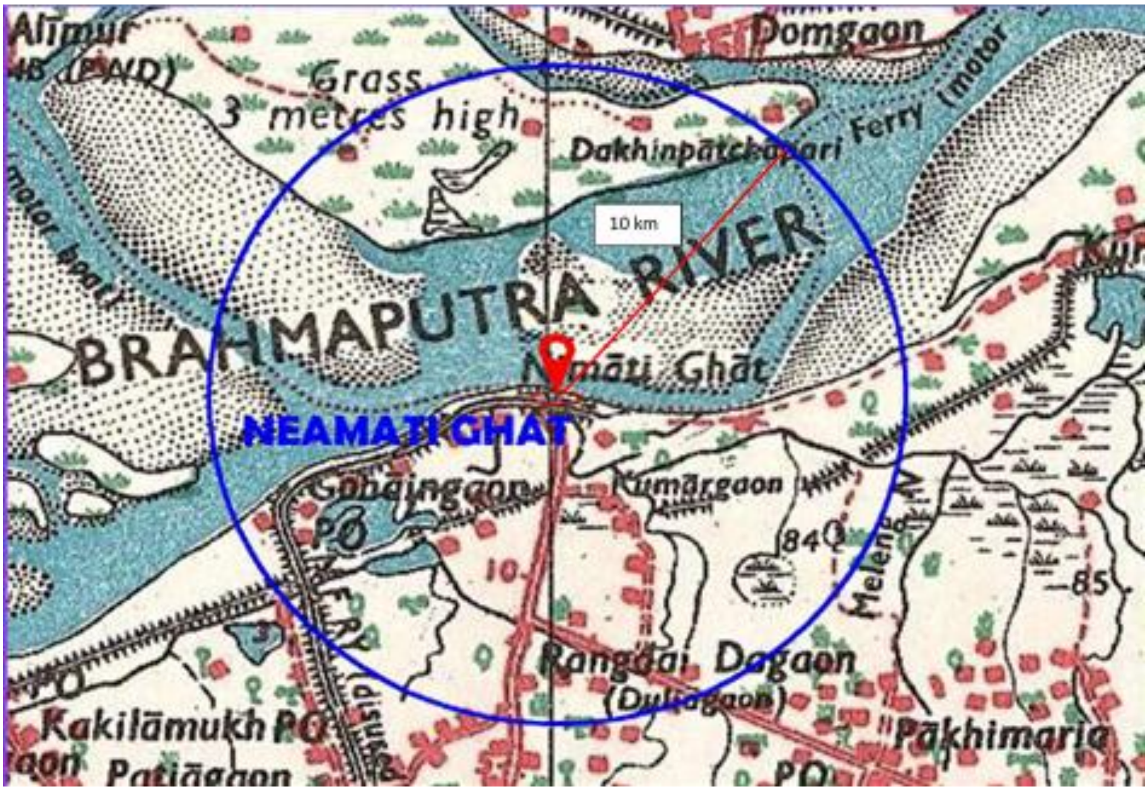
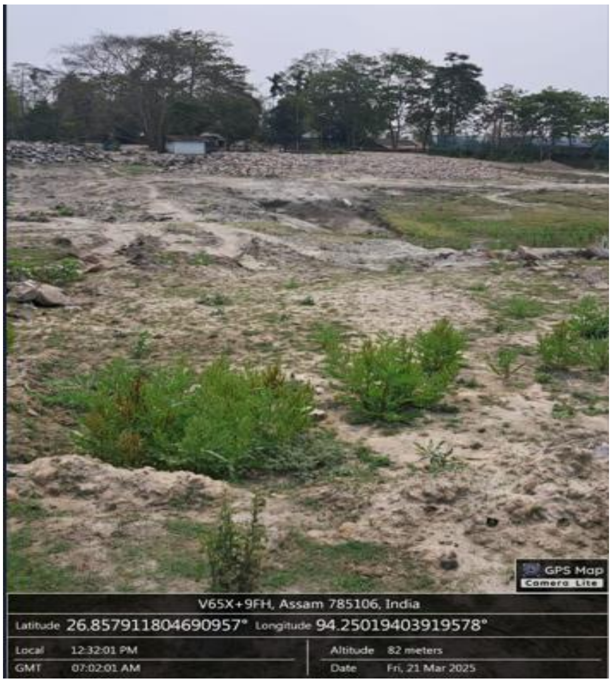


Figure 2.2: Neamati Terminal Site

A land acquisition estimate for 28 Bigha- 4 Kotha-16 Lesha (28B-4K-16L) was submitted for approval towards District Commissioner, Jorhat which has been approved. About 26505 sq. m of land will be required for the proposed terminal construction. The satellite imagery of the project site is shown in Figure 2.3.

Figure 2.3: Satellite Imagery of the project site

The site photographs showing the site as on March 2025 is presented in below Figure 2.4 below.

<table>
<tr>
<td>
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<tr>
<td>Photo 1: Project Site filled with boulders</td>
<td>Photo 2: Project Site filled with boulders</td>
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</table>

Photo 3: Project Site

Photo 4: River Brahmaputra on the frontage of Project Site

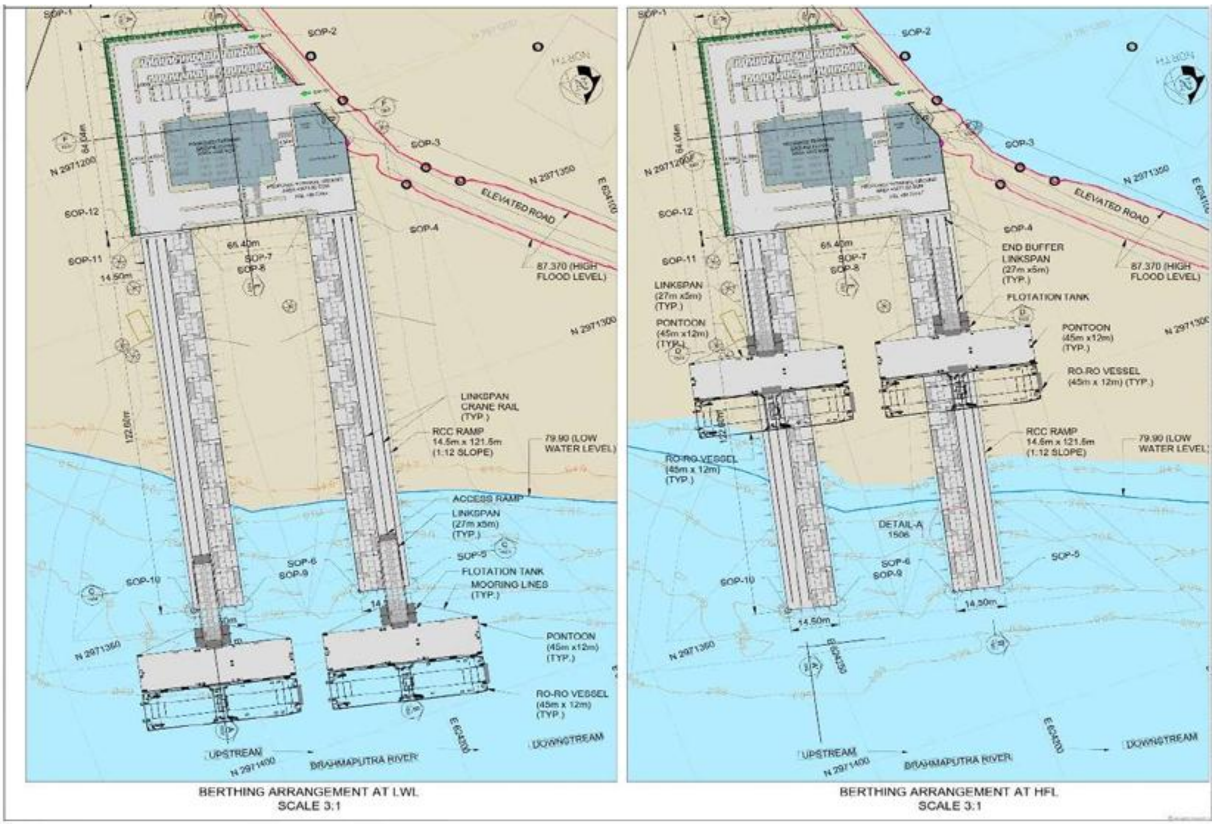
Photo 5: Site offices near project location

Photo 6: Site offices near project location

Figure 2.4: Project Site and Site Offices

2.2 PROJECT ACTIVITIES

The project comprised of a terminal building with rest rooms, ticketing facility, parking spaces, bio-digester tank, approach ramp, floating pontoons and link span. The layout of the facility is shown in below Figure 2.5. The figure below shows berthing arrangement during Lowest Water Level (LWL) which is dry period and Highest Flood Level (HFL) during rainy period. The terminal layout remains unchanged, except that a portion of the ramp with core filling has been replaced by a pile foundation in the revised design. The details of this design modification are elaborated in Section 2.3 of this report.



Layout 1: Berthing Arrangement at LWL	Layout 2: Berthing Arrangement at HFL

Figure 2.5: Layout showing the Neamati Terminal Facility

2.2.1 LAND SIDE FACILITIES

Terminal Building

The proposed terminal building is a G+1 structure, comprising a ground floor area of 625 sq.m and a first floor area of 635 sq.m. It is designed to accommodate both administrative operations and passenger-related services. Key features of the terminal building include:

- Parking spaces for two-wheelers
- Parking space for four-wheelers
- EV charging
- Underground bio-digester tanks, oil/grease water separators, boundary walls, footpaths, and landscaped parking zones.

There is no change in the project footprint in the revised design. Hence, no additional land acquisition is required for the project.

2.2.2 RIVERSIDE FACILITIES

The riverine facilities comprised of two key components - Floating Pontoon with Linkspan, and slope protection.

Approach Ramp

- Approach ramp of length 122.6 m with a width of 14.5 m.
- The 92 m of the ramp positioned on the riverbank, with the remaining 30 m extending into the river during lean season conditions.
- The structure to be constructed using quarry-run boulders and stabilized with non-woven geotextile and gabion mattresses to enhance durability and structural integrity.

Floating Pontoon and Linkspan

The facility provides a movable floating pontoon integrated with a linkspan, which ensures safe and efficient access to vessels during varying river water levels. The linkspan is designed to function in alignment with a sloping access bund, allowing it to effectively accommodate seasonal fluctuations in water level while maintaining continuous connectivity.

Slope Protection:

The foundation and slope protection system was planned for increasing stability and erosion resistance:

- The base to consist of core filling with quarry-run boulders, ranging in weight from 0.10 kg to 500 kg, forming a stable foundation for the riverine infrastructure.
- A layer of non-woven geotextile is placed over the core fill to enhance filtration and separation.
- Over this, a 0.5-meter-thick gabion mattress was planned installed to provide robust slope protection and prevent erosion.

2.3 DESIGN MODIFICATION

2.3.1 DESIGN MODIFICATION OF THE TERMINAL

The underestimation of the Bill of Quantities and stability concerns related to the core filling of the approach ramp of the proposed terminal have necessitated the exploration of alternative design solutions. To address these issues, the AIWTD Society has engaged IIT Guwahati to undertake a design modification study aimed at identifying suitable and sustainable engineering solutions. Accordingly, a technical committee from IIT Guwahati conducted a site visit on 29th September 2024. Based on the site visit, the technical committee recommends the following changes in the original design of the project:

- Hybrid Approach Ramp: Construct the ramp with 65.00 m of core filling and 31.20 m of pile foundation.
- Retaining Wall: Implement fiber-reinforced soil wall technology for the terminal building foundation to enhance stability and reduce settlement risks.
- Winch System: Adopt a winch system to ensure efficient and safe handling of the link span during water level changes.
- Erosion Mitigation: Focus on erosion control measures, including optimized material usage and slope protection, to prevent disruptions to the riverine ecosystem and ensure project longevity.

Following the recommendations provided by IIT Guwahati, the AIWTD Society requested a revision of the approach ramp design to optimize material use and reduce the quantity of boulders in the core filling. Accordingly, IIT Guwahati proposed the following modifications to the design of the approach ramp and terminal building:

Approach Ramp: An approach ramp to be constructed using an alternate design involving a pile foundation, replacing the original core filling with boulders. The length of the approach ramp superstructure supported on piles should extend at least up to the Low Water Level (LWL) and must not be reduced, ensuring structural integrity and navigational functionality. The ramp will be constructed with 65.00 m of core filling and 31.20 m of pile foundation.

Terminal Building: The original design involving core filling with slope around the terminal building is to be replaced with a retaining structure, consisting of a reinforced soil wall and a retaining wall, extending from the PCC (Plain Cement Concrete) bottom level up to the Finished Ground Level (FGL), which is 2.10 meters. The surrounding area may be filled using available river sand, thereby optimizing material usage.

These modifications aim to enhance structural stability, minimize erosion risk and reduce material quantities, helping to keep project costs within the tendered limits. The layout of the facility is shown in Figure 2.6. The detail design of the ferry terminal is enclosed in Annexure-1.

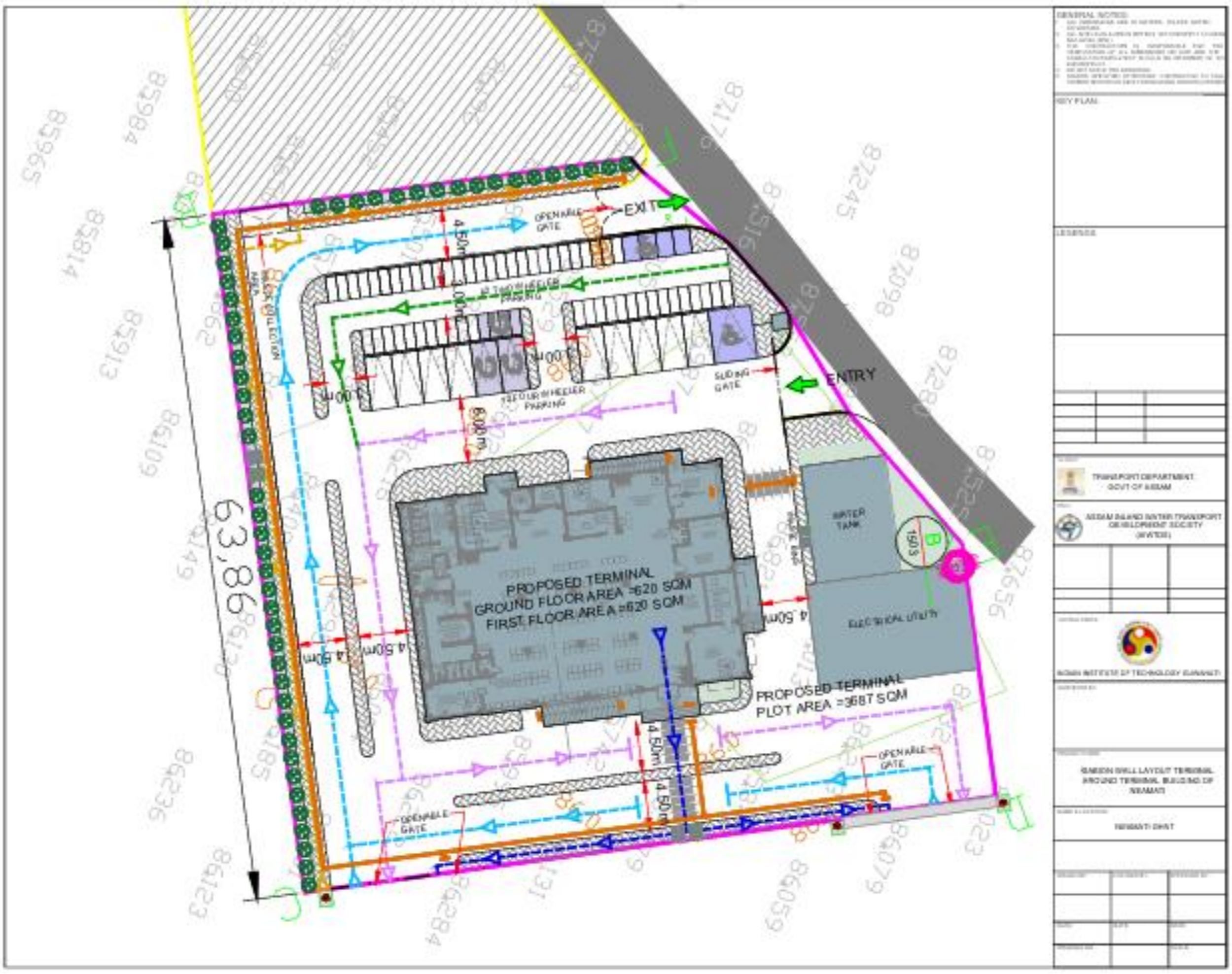


Figure 2.6: Layout of the Terminal after design modification

The design modification report is attached in Annex-1.

2.3.2 Gabion Wall

The design of the gabion retaining wall for the terminal will be based on well-established engineering principles and standards to ensure structural integrity and long-term performance. The design approach includes detailed methodology, analytical calculations, and stability assessments in accordance with both the Bureau of Indian Standards (IS 6403:1981) and the American Association of State Highway and Transportation Officials (AASHTO) guidelines. The installation and material specifications follow the guidelines outlined in IRC SP 116-2018, ensuring high quality construction practices. The overall structural safety assessment aligns with IRC 006:2014. The gabion wall design follows a gravity-based approach, where the stability of the structure is derived from its self-weight and the interlocking of individual gabion units. Gabion retaining walls have been chosen for their effectiveness in retaining soil, controlling erosion, and allowing natural drainage, making it a practical and sustainable solution for the site. The height of the Gabion wall will be 3 m, width at base would be 3.5 m and top width would be 1 m. The gabion wall structure will be composed of gabion rock, double twisted hexagonal mesh with wire thickness of 2.7mm. The use of these durable and corrosion-resistant materials ensures longevity, making the wall a sustainable and cost-effective solution for riverbank protection. The design also considers environmental factors, ensuring that the structure blends with the surrounding landscape while providing necessary structural support. The gabion wall layout plan is shown in Figure 2.7.

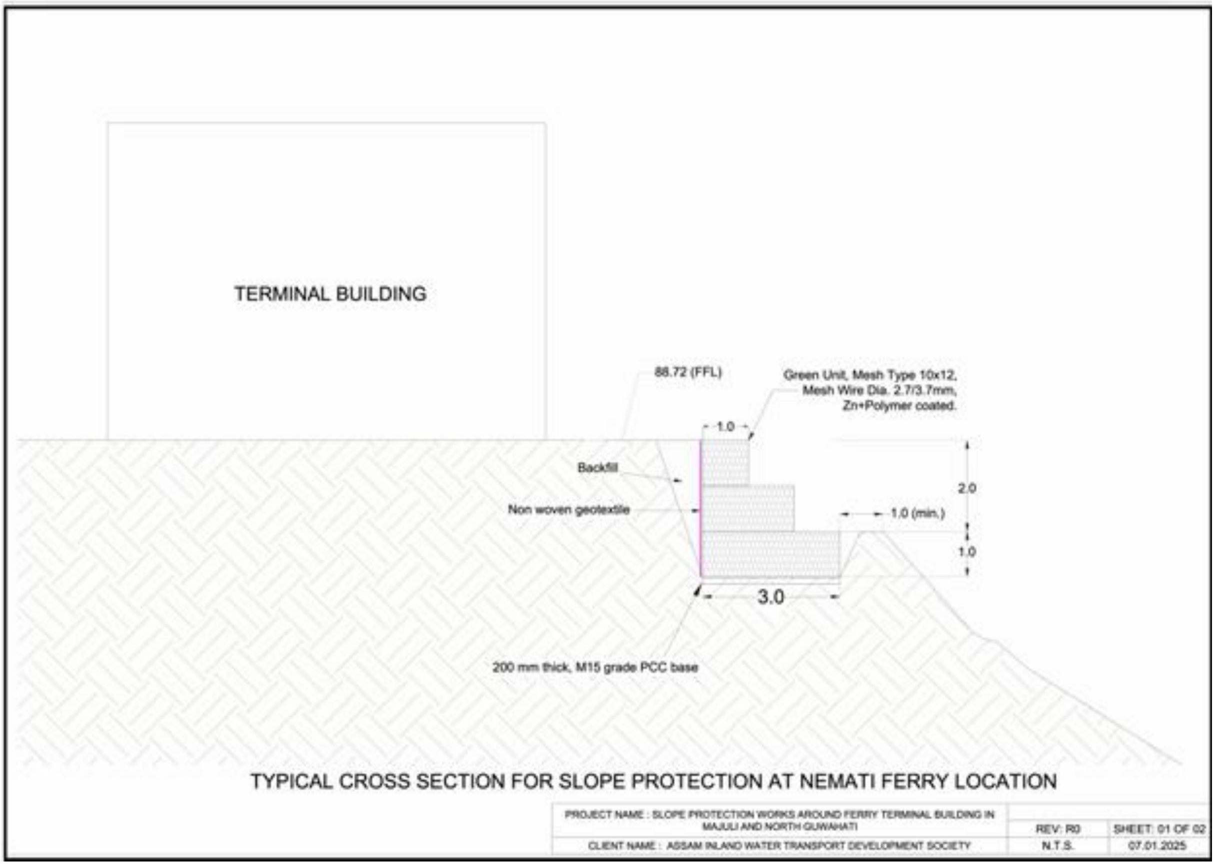


Figure 2.7: Layout of Gabion Wall

2.3.3 BOULDER REMOVAL

As per the previous work plan, around 28000cu.m of boulders were placed in the riverbed for core filling. As per the modified design, it is proposed to Construct the ramp with 65.00 m of core filling and 31.20 m of pile foundation. Hence, boulder at the pile foundation area will be removed using chisel, excavator bucket. The extracted boulder quantity is estimated to be approximately 300 cu.m. The extracted boulders will be reused in the terminal construction.

2.3.4 SAND EXTRACTION FROM THE PILE LINER

Pile driving will be undertaken using a hydraulic impact hammer, reaching a depth of 35 meters from the High Flood Level (HFL). Sediment accumulated within the pile liner will be removed using an airlift pump system or another suitable technique. It is estimated that approximately 35 m³ of sediment will be removed per pile, amounting to a total of 900 m³ for 36 piles.

The water and sediment mixture will be pumped from the liner to the landside area, where water will be separated from the sediment by natural gravity. The dewatered material (dry sand) will be reused for filling and levelling works at the terminal building site.

2.3.5 PILE FOUNDATION

Based on the revised design, a total of 36 piles are required, each with a diameter of 1000 mm and a length of 35 meters measured from the existing ground level (HFL). The pile foundation will require the following materials:

- Cement: PSC conforming to IS: 455-2015
- High Yield Strength corrosion resistant deformed bars of grade Fe 500 D conforming to IS: 1786
- Once the pile cavity has been bored, reinforcing steel cages will be lowered into the pile cavity. The steel cages provide essential tensile strength, enhancing the pile's load-bearing capacity and resistance to lateral forces. Then the hole is filled with concrete directly at the construction site.

The pile section and pile layout with reinforcement details is shown in Figure 2.8 and Figure 2.9 respectively.

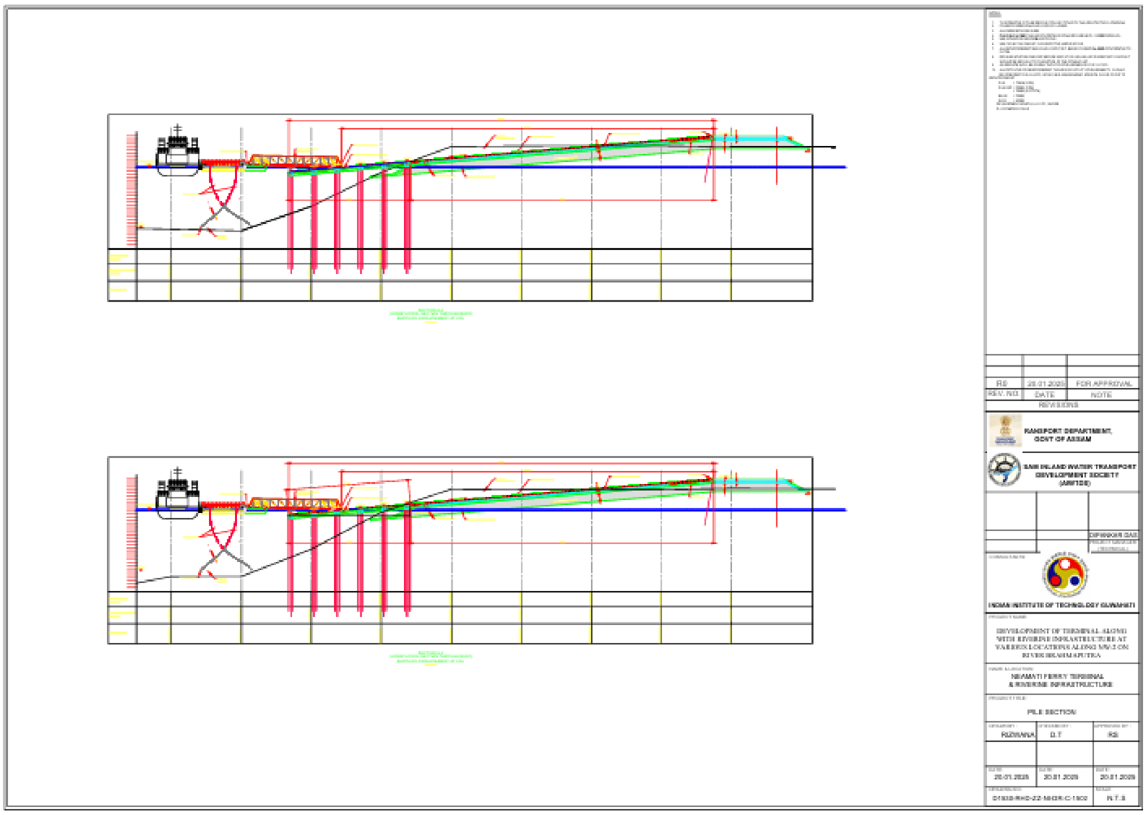


Figure 2.8: Pile Section

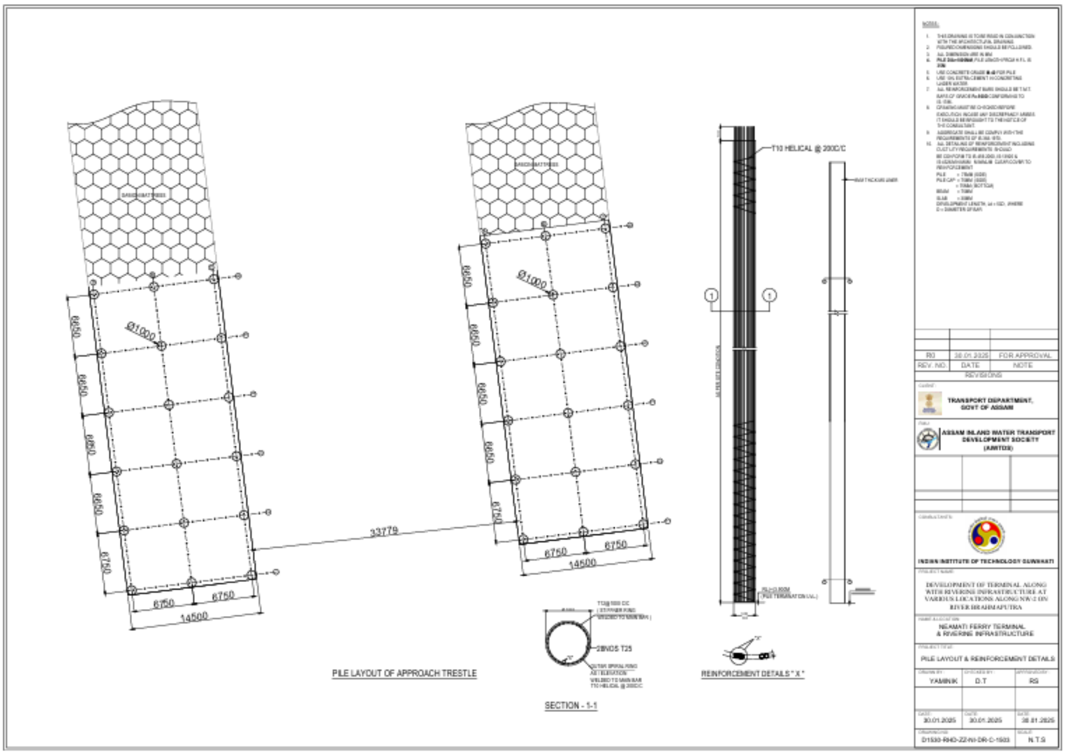


Figure 2.9: Pile Layout & Reinforcement Details

2.3.6 PILE CHIPPING

The terminal construction will involve pile and beam framed structure to form a stable grid. Hence there is no provision of pile cap and major chipping of the pile is not required. However, minor chipping of the pile may be required which will be carried out using manual or hydraulic chipping hammers. The waste generation is concrete and slurry removed from the top of piles which will be used in site levelling.

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3 BASELINE CONDITION

The environmental baseline study for the project was carried out during the detailed ESIA study in 2022. Most of the environmental monitoring was carried out during summer season (March to May 2022, aquatic ecology was carried out in November 2022. The socioeconomic aspects were studied during May 2022 to June 2023.

1	**Physico-Chemical**	**Dates**
	Soil quality	30th March 2022
	Water quality	30th March 2022
	Air quality	4th August to 29th August 2022
	Noise level	31st August 2022
2	**Ecological Aspects**	
	Terrestrial Ecology	10th March 2025
	Aquatic Ecology	27th August 2022
3	**Socio-economic aspects**	
	Social Screening and FGD	15th – 22nd May 2022
	Stakeholder Consultaiton	8th February 2023
	Census and Joint Survey	9th June 2023

Meteorology: The baseline of ESIA report indicates that the project area is located within sub-tropical humid climatic zone characterized by hot and wet summer and dry and cool winter. The annual rainfall in the region is 2609 mm whereas the mean monthly temperature ranged from 18.8°C to 28.1°C, and the relative humidity is generally high throughout the year.

Geology: The geology of the region is flood plain of river Brahmaputra and the site falls into north cluster as per geological location. Geomorphologically, the site is located in an earthquake prone zone (zone V) as per Seismic Zoning Map of the country given in IS 1983 (part I): 2002. The soil type of the area is sandy loam with a pH in the range of 7.41 to 7.89 (neutral range having slight alkalinity) and the EC values range between 492 to 512 μS/cm.

Land Use: The land use pattern of the study was studied through digital satellite imagery data which were categorized into Flooded Vegetation**,** Open Land, Built Area, Crop area and water bodies. The flooded vegetation is highest (56.98%) and open land 3.38%. The land use map is shown in Figure 3.1.

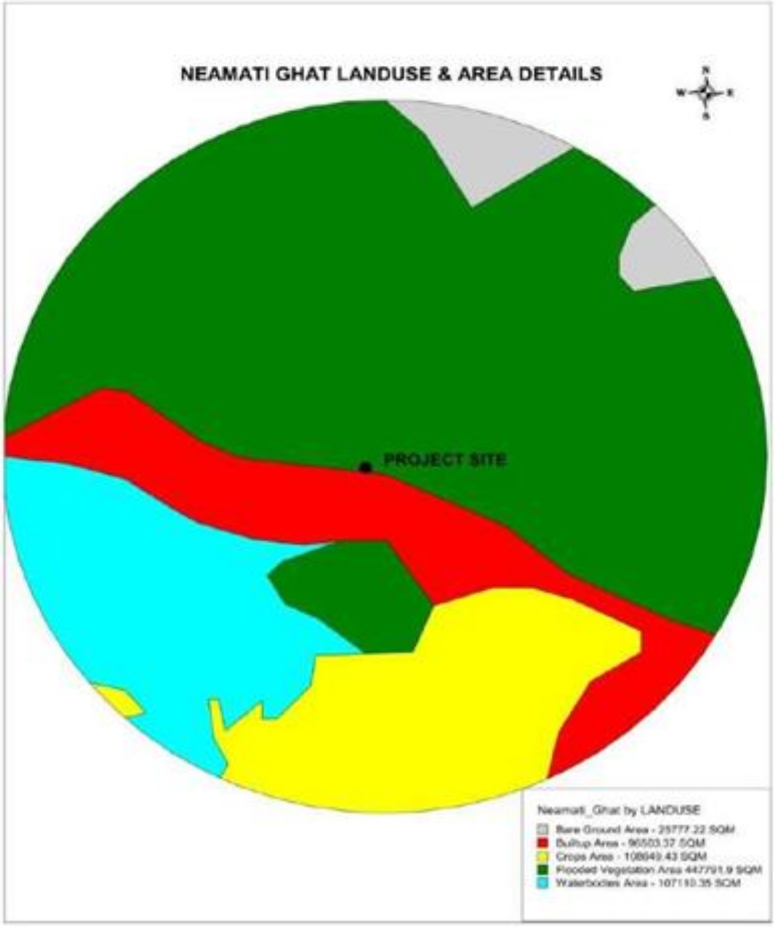

Figure 3.1: Land Use Map

Water Quality: The analysis of river water samples indicates that Electrical Conductivity (EC) in water samples ranged from 216 to 292 μS/cm and total hardness ranged from 62.0 to 76.0 mg/l. Dissolved oxygen values ranges from 6.3 to 6.5 mg/l. The BOD and COD values were quite low and DO levels were good, which indicates the absence of organic pollution loading. The heavy metal concentration was below the permissible limit. It can be concluded that water quality was quite good, as parameters were well below the permissible limits specified for meeting drinking requirements after conventional treatment.

Air Quality: Ambient air quality at site was found to be within the permissible standards for the polluntants such as PM10, PM2.5, SO2, NOx, CO, O3, NH3, VOC and heavy metals.

Noise Level: Noise levels were observed to be well within permissible limit (55 dB(A)) specified for residential area and (65 dB(A)) specified for commercial area.

Terrestrial Ecology: The surrounding area of the project site consists of trees, shrubs, herbs, grasses and climbers. The most dominant families recorded in the Neamati site were-Poaceae, followed by Asteraceae & Fabaceae, Myrtaceae, Amaranthaceae, Apocynaceae, Euphorbiaceae, Lamiaceae, Malvacea and Verbenaceae.

Faunal Diversity in and around Neamati site is represented by mammals, birds, reptiles, butterflies and amphibians.

Aquatic Ecology: Further, aquatic ecology study was carried out through survey of the river stretches of 1 km of both sides around the project locations from river bank. The study found various species of fishes, herpetofauna, birds, and mammals in and around the vicinity of proposed project locations. There was frequent sighting of Dolphins near the Ghat and estimated a good population of Gangetic Dolphins at Neamati Ghat during the survey. More Dolphins were sighted in the deeper part of the river as per the survey conducted by ZSI. The study also includes assessment of phytoplankton population that comprised of representative elements from three groups namely- Bacillariophyceae, Chlorophyceae and Cyanophyceae. Zooplankton community comprised of Cladocera, Copepoda, Euglenophyceae, Protozoa and Rotifera. The benthos of River Brahmaputra comprised mainly of Gastropods, Bivalves, Oligochaets, Chironomids and aquatic insects.

The baseline condition of the project can be referred from ESIA report for Neamati terminal (Refer report no. IN-IWT-242294-CS-QCBS, October 2023).

4 ENVIRONMENTAL IMPACTS OF DESIGN MODIFICATION

Based on the project details and the baseline environmental status, potential impacts that are expected to accrue as a result of the proposed project activities are discussed in this section. The impacts during construction phase is likely to be on water quality, air quality, aquatic ecology, soil and groundwater quality and socio-economy. The impacts will be will be localized and short-term and primarily related to civil works, piling work and erection of equipment. The duration of impact will be limited to the construction phase only which is assumed to be only 6 months. The area of influence is likely to be 500 meter from the project boundary.

4.1 Aspects and Impacts

The following activities may cause environmental, health and safety impacts during construction of the proposed project based on design modification:

- Boulder removal from pile foundation area of the river bed
- Piling liner driving work
- Sediment removal from the pile liner
- Concreting of the pile
- Chipping of the pile
- Levelling and backfilling
- Erection of concrete and steel structures
- Operation of the machinery and equipment
- Use of hazardous materials (fuel, oil etc.) for machinery

The above mentioned activities will require qualified and experienced Engineers, supervisors, skill and unskilled workers. The total number of workers needed for the project is estimated to be around 40 to 45 per day (average) during the construction period. The contractor may engage local as well as interstate (migrant) workers from other states of India depending on the construction requirement. In case of engaging migrant workers, contractor shall obtain Migrant Workers License Under Inter State Migrant Workmen (Re & Cs) Act,1979.

Potential risks and impacts pertaining to labour management, including labour influx, Sexual Exploitation and Abuse/Sexual Harassment (SEA/SH), and child labour, have been considered under the social safeguard framework for the AIWT project (Social Management Framework[3] (SMF), RPF, IPDF & Gender Development Framework, Volume I, March 2019.

The project is likely to cause temporary adverse social impacts due to labour influx that may increase anti-social activity, spreading of viral / communicable diseases including STDs/AIDS, child labour engagement, gender based violence and harassments (SEA/SH), eve teasing. As per the baseline survey conducted by AIWTDS in April 2023, nineteen (19) numbers of eve teasing was reported in the project area. An assessment of the risks and impacts related to labour issues, such as labour influx, SEA/SH, and child labour has been carried out and mitigation measures are provided in the ESIA report[4] prepared by WAPCOS in October 2023 for the project.

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[3] https://aiwtdsociety.assam.gov.in/sites/default/files/public_utility/smf_english_0.pdf

[4] https://aiwtdsociety.assam.gov.in/sites/default/files/public_utility/ESIA_EMP-Neamati.pdf

The anticipated environmental, health, safety & social aspects and impacts of the project design modification for the proposed ferry terminal for construction phase are presented in Table 4.1.

Table 4.1: EHS Aspects and Impacts for Construction Phase

Sl. No.	Activities	Aspects	Impacts	Nature of Impacts
A	**Environment Aspects and Impacts**			
1	Removal of boulders from pile foundation area	Fine sediment generation	River water pollution Disturbance to aquatic species/ habitat	Short term, Reversible, Localized, Low
		Noise generation	Disturbance to aquatic species	Short term, Reversible, Localized, Low
2	Transportation of steel pile sheets	Air emissions from material transporting vehicles	Air pollution	Short term, Reversible, Localized, Low
		Noise generation from vehicles	Nuisance	Short term, Reversible, Localized, Low
3	Cutting of steel plates for liner pile	Noise generation	Noise pollution	Short term, Reversible, Localized, Low
4	Fabrication of steel plates for pile liner works	Welding waste generation including scrap metal, used electrodes, grinding dust, and slag.	Soil pollution	Short term, Reversible, Localized, Low
5	Mobilization of heavy equipment for piling work	Accidental spillage of oil and fuel	Water pollution	Short term, Reversible, Localized, Low
		Noise emission	Disturbance to aquatic species	Short term, Reversible, Localized, Low
6	Pile liner driving work on the river bed	Generation of water turbidity / fine silts from piling	Water pollution	Short term, Reversible, Localized, Low

Sl. No.	Activities	Aspects	Impacts	Nature of Impacts
		Underwater vibration and noise	Aquatic habitat disturbance / damage to benthic species	Short term, Reversible, Localized, Medium
		Ambient noise generation	Disturbance to workers and nearby community	Short term, Reversible, Localized, Low
		Generation of mud/sediments	Water pollution	Short term, Reversible, Localized, Low
7	Sand extraction from pile liner	Generation of mixture of sediment and water (slurry)	Water pollution	Short term, Reversible, Localized, Low
		Generation of dust from dry sediment stockpile	Air pollution	Short term, Reversible, Localized, Low
8	Concreting of piles	Spills of concrete mix from RMC transit mixture	River water contamination	Short term, Reversible, Localized, Low
9	Pile chipping	Concrete debris (waste) generation	Water pollution in case of spillage in river body	Short term, Reversible, Localized, Low
10	Construction of retaining wall and gabion wall	Material sourcing (quarry stones, wire mesh)	Depletion of natural resources	Short term, Reversible, Localized, Low
		Dust emission soil filling, site levelling, filling work	Air pollution	Short term, Reversible, Localized, Low
11	Use of machinery and equipment	Gaseous emissions from machinery and equipment	Air pollution	Short term, Reversible, Localized, Low
		Fugitive dust emission from movement of vehicles and machinery	Air pollution	Short term, Reversible, Localized, Low
12	Use of hazardous materials (fuel in vehicles/machinery)	Accidental spillage of fuel	Land and water contamination	Short term, Reversible, Localized, Low
13	Workers at site,	Generation of solid	Land and water	Short term,

Sl. No.	Activities	Aspects	Impacts	Nature of Impacts
	and machinery maintenance	and liquid and hazardous waste	contamination	Reversible, Localized, Low
B	**Health and Safety Aspects and Impacts**			
1	Earth work & excavations for gabion wall	Open trenches, unstable ground	Falls, injury due to falling	Medium
2	Work at height	Crane bucket, link span	Falls from height, falling tools or materials, injury or fatality	Medium
3	Material Handling	Manual lifting of materials	Musculoskeletal injuries, slips/ trips/falls, crush injuries	Medium
4	Use of Heavy Machinery	Cranes, excavators, barge	Collision, entrapment, noise-induced hearing loss, operator injury	Low
5	Welding and Cutting Operations	Use of oxy-acetylene, electric arc welding	Burns, eye damage (UV exposure), fire risk, inhalation of fumes	Medium
6	Dust and Airborne Particulates from stock pile	Fine dust, cutting debris	Respiratory illnesses eye irritation, reduced air quality	Low
7	Noise Exposure	cutting & grinding tools, heavy machinery, pile chipping	Hearing loss, stress, communication issues	Low
8	Fire and Explosion Risks	Flammable materials, welding sparks	Burns, loss of property, severe injuries	Low
9	Inadequate Personal Protective Equipment (PPE)	Not using helmets, gloves, safety boots, etc.	Head injuries, exposure to hazards	Low
10	Exposure to extreme weather Conditions	Heat, cold, rain, storm	Heat stroke, hypothermia, slipping hazards	Low

Sl. No.	Activities	Aspects	Impacts	Nature of Impacts
11	Lack of Training or Supervision	Inexperienced workers, unsupervised tasks	Accidents due to unsafe practices or misunderstanding of procedures	Low
12	Labour for piling work and gabion wall	Irregular wages and working hours of labours	Financial insecurity, difficulty in managing expenses,	Low
C	**Social Aspects**			
1	Engagement of workers/ labours for Construction work of the terminal	Labour Influx	Pressure on local resources, increased risk of conflicts with local communities, and rise in anti-social activities	Short term, Localized, Reversible, Medium
2		Public Health and Safety	Increased risk of spreading communicable and vector-borne diseases, including STDs/ HIV/ AIDS, due to interaction between workers and local population	Short term, Localized, Reversible, Low
3		Child Labour	Risk of engagement of child labour in construction activities.	Short term, Localized, Reversible, Low
4		Gender-Based Violence (GBV) and Sexual Exploitation and Abuse/Sexual Harassment (SEA/SH)	Risk of gender-based violence, harassment, and exploitation of women workers or community members	Short term, Localized, Reversible, Medium
5		Social Cohesion and Community Relations	Possible friction between workers and local residents due to cultural differences or	Short term, Localized, Reversible, Low

Sl. No.	Activities	Aspects	Impacts	Nature of Impacts
			inappropriate behaviour	
6	Riverine works (boulder removal, piling, barge movement)	Temporary restriction of access to fishing areas, making the site less accessible for local fisherfolk	Livelihood / Income generation	Insignificant

4.2 Description of the Key Impacts of Design Modification

As per the original design, core filling with quarry-run boulders was undertaken as part of the foundation works for the riverine structures. In the revised design of the ferry terminal, a hybrid approach has been adopted for the ramp construction, consisting of 32 meters of core filling and 40 meters supported by pile foundations. Consequently, approximately 2,000 m^3 of previously filled boulders are proposed to be removed. This design modification is likely to have the following key environmental impacts:

1. Impacts on Aquatic Habitat

The removal of boulders from the pile foundation area is expected to result in increased turbidity, along with localized noise, vibration, and suspension of sediments. These disturbances may cause temporary impacts on aquatic fauna, including river dolphins, which are sensitive to changes in water quality and underwater acoustic conditions.

In addition, the pile driving activities associated with the revised ramp design are likely to generate underwater noise and vibration, as well as fine sediment suspension, potentially disturbing aquatic habitats in the immediate vicinity.

However, the boulder removal activities are planned during the lean season, when floodwaters will recede, which will help minimize hydrodynamic disturbances and sediment transport. Moreover, each pile is expected to be driven in approximately three to four hours, and operations will be conducted primarily during daylight hours, further reducing the potential for significant ecological disturbance. Importantly, the project site is located adjacent to an existing ghat, an area already subjected to regular anthropogenic activity. This proximity is expected to further mitigate the significance of impacts related to both boulder removal and pile driving.

2. Impact on River Water Quality

The removal of boulders from the riverbed is anticipated to lead to a temporary increase in turbidity, resulting from the resuspension of sediments, which may negatively affect river water quality. Similarly, pile driving in the riverbed could lead to short-term suspension of fine sediments, with localized impacts on water clarity and quality.

Further sediment slurry removal from the pile liner will stockpile on the land side for discharge of water. The discharge of fine sand with water into the water body will contaminate river water by increasing suspended solids.

The planned scheduling of boulder removal activities during the lean season is expected to limit sediment transport, as the lower flow conditions reduce the likelihood of widespread dispersion. Further, piling activity will be carried out as per the SOP. Additionally, given the site's proximity to an existing ghat, the anticipated impacts on river water quality are expected to be minimal.

3. Impact on Fisherfolk

The baseline data presented in the ESIA report (October 2023) specifies that there are no significant fishing zones at or near the project site. The Brahmaputra river stretch, including the downstream area, records a low fish catch and a limited community dependence on fishing activities. Consequently, fishing activity in the vicinity of the terminal site is minimal.

Hence, no significant adverse impacts on fisherfolk are anticipated from the proposed project. The potential impacts on fish species and associated livelihoods are expected to be low. However, appropriate mitigation measures have been recommended to minimize any potential impacts on aquatic life in the ESIA report.

4.3 Aspects and Impacts for Operation Phase

The operation of the ferry terminal is not likely to have any significant adverse impact on the environment, health, safety and social aspects except generation of general waste (daily), waste accumulation in pontoon particularly during flooding season. Waste will be collected in the specified waste bins and disposed daily through approved waste transporters. Any accumulation of waste in pontoons during flooding period will be cleaned by the operation team.

Further, the site has a low catch and limited or no community dependence on fishing activities, the project is not likely have any significant impact on the livelihood of fisherfolk during operation phase. The key aspects and impacts for operation phase of the project are as provided in Table 4.2.

Table 4.2: EHS Aspects and Impacts for Operation Phase

Sl. No.	Activities	Aspects	Impacts	Nature of Impacts
A	**Environment Aspects and Impacts**			
1	Use of terminals by Passengers	Waste generation	Aquatic habitat disturbance	Long term, Localized, Low
2	Accumulation of waste in the pontoons	Accumulation of waste in the pontoons	Odour, affect water quality	Short term, Localized, Low

Sl. No.	Activities	Aspects	Impacts	Nature of Impacts
3	Emergency Situation during terminal operation	Fire outbreak, Accident /injuries, natural disaster (flooding, earthquake), Boat/ barge accident, Explosion, Traffic accident	Injury or loss of life, property damage, interruption of work activities, Soil and water contamination, harm to aquatic life.	Short term, High, Localized

5 ENVIRONMENTAL MANAGEMENT PLAN

The Environment Management Plan (EMP) is required to ensure sustainable development of the proposed terminal on river Brahmaputra both during the construction as well as operational phases. The Environmental Management Plan (EMP) outlines how project will minimize and manage its environmental impacts during construction and operation phase. It is prepared considering the legal and regulatory framework to minimize the environmental impacts. Environmental management Plan will be implemented by the contractor and subcontractors during the construction phase. While during operation phase, the EMP will be implemented by the Assam Inland Waterways Company Limited.

A detailed environmental management plan to be followed during the construction and operation phase is presented in Table 5.1 and 5.2. respectively.

Table 5.1: Environment, Health & Safety Management Plan as per Modified Design - Construction Phase

Sl. No.	EHS Aspects	EHS Impacts	Mitigation Measures	Responsibility
A	**Environment**			
1	Fine sediment generation from boulder removal	River Water Pollution	a) Prepare boulder removal plan and methodology from the river bed. b) Boulder removal to be carried out outside fish breeding/spawning seasons. c) Remove the boulder from the reverbed during lean season wherever possible. d) Avoid removal during monsoon or high-flow seasons. e) Segmented removal of boulders to minimize sediment release. f) Use silt curtains to control sediment dispersion during the boulder removal.	Contractor to implement the mitigation measures, and supervision by TSSC/AIWTDS
2	Noise and vibration from boulder removal from riverbed	Disturbance to aquatic species	a) Use low-impact mechanical methods to avoid excessive noise disturbance. b) Use machinery with low noise and ensure use of properly maintained machinery. c) Remove boulders during the day light hours. d) Store the boulders in a safe location prior reuse. e) Provide earplugs to the workers.	Contractor to implement the mitigation measures, and supervision by TSSC/AIWTDS
3	Noise and vibration from pile driving activity in river bed	Disturbance to river dolphins and other aquatic species	a) Piling activities will be conducted in accordance with the approved Ganges River Dolphin Safety Management Plan to ensure that dolphins and other aquatic species are not harmed b) Anchors will be carefully placed only after confirming that dolphin and fish species are not present in the immediate area. c) Deployment of dolphin observers during the riverine construction work. d) Deployment of hydrophones for dolphin monitoring if night time	Contractor to implement the mitigation measures, and supervision by TSSC/AIWTDS

Sl. No.	EHS Aspects	EHS Impacts	Mitigation Measures	Responsibility
			construction work is carried out[5]. e) Use of bubble curtains to limit the noise and vibration emanation out the piling area. f) Signage on dolphin protection shall be displayed to generate awareness among workers. g) Recording dolphin sighting on daily basis using online software (kobo app) and on the register. h) Escalation matrix of the dolphin safety management plan shall be implemented in case of emergency. i) Use of pingers to deter dolphins from the construction area. j) Pile driving to be carried out during non-breeding seasons	
		Noise disturbance to local community	a) Install hammer cushions between the hammer and pile to absorb impact and reduce noise generation. b) Use noise acoustic enclosures on pile-driving equipment to minimize sound propagation. c) Erect temporary noise barriers (e.g., soundproof fencing) around the construction site to block airborne noise from reaching nearby sensitive receptors. d) Use well maintained machinery for the piling work. e) Provide advance notice to nearby communities about pile driving schedules. f) Provide ear plugs to the workers.	

[5] Night time construction activities will generally be avoided. In instances where night works, particularly piling, become necessary, acoustic monitoring through hydrophones will be undertaken to detect and record dolphin presence near the work zone, enabling immediate mitigation actions to minimize disturbance to aquatic fauna.

Sl. No.	EHS Aspects	EHS Impacts	Mitigation Measures	Responsibility
4	Fine sediment generation from piling work	River water pollution, Disturbance to aquatic habitat	a) Include silt curtains to control sediment dispersion during piling work. b) Use of bubble curtains in the piling area to reduce sediment dispersal immediately adjacent to the bubble curtain. c) Carry out piling work as per the approved methodology/SOP. d) Piling activities shall be carried out using polymer-based mud as the drilling fluid. The polymer shall be stored in designated storage areas with appropriate containment measures to ensure there is no spillage into water bodies, soil, or sediment. e) It will be ensured that spent drilling mud are not disposed of in the river.	Contractor to implement the mitigation measures, and supervision by TSSC/AIWTDS
5	Discharge of fine silts with water from sediment stockpile removed extracted from the pile liner	Increase suspended solid in river water River water contamination	a) Provide silt curtain at the sediment stock pile to prevent discharge of silt into the waterbody. b) The sediment slurry shall be stored at safe distance from the river edge to prevent runoff or accidental discharge in the river[6].	Contractor to implement the mitigation measures, and supervision by TSSC/AIWTDS
6	Noise from the operation of airlift pump for removal of sediment from pile liner	Noise generation	a) Use low-noise pumps with acoustic dampening features. b) Install sound barriers/enclosures around pumps placed onshore. c) Position pumps away from sensitive receptors d) Use well maintained pump. e) Provide ear protection (earplugs/earmuffs) to all operators and workers stationed near the pump.	Contractor to implement the mitigation measures, and supervision by TSSC/AIWTDS
7	Accidental spillage of concrete mixture into	River water contamination	a) Implement construction methodology and SOPs for riverine activities.	Contractor to implement the

[6] The sediment slurry shall be stored at a safe distance from the river edge to facilitate controlled dewatering and to minimize the risk of runoff or accidental discharge into the river. The dewatered material (dry sand) will be reused for plinth levelling of the terminal building and for grading and leveling across the entire project footprint thereby promoting material reuse and minimizing waste generation.

Sl. No.	EHS Aspects	EHS Impacts	Mitigation Measures	Responsibility
	riverbed from construction work		b) Make provision of spillage collection to prevent falling of concrete mixture into the river bed.	mitigation measures, and supervision by TSSC/AIWTDS
8	Accidental spillage of concrete mixture from pile chipping	River water contamination	a) Make provision for collection of concrete debris to prevent falling into the river bed. b) Reuse the debris in site grading and levelling.	Contractor to implement the mitigation measures, and supervision by TSSC/AIWTDS
9	Accidental spillage of fuel and oil from the machinery (barge, crane)	River water contamination	c) Use well maintained machinery and equipment for construction work. d) Inspection of barge, cranes and other equipment for riverine construction work shall be checked/inspected on daily basis prior start of work. e) Any leakage of oil/fuel shall be immediately rectified. f) Spill containment kit shall be used in the barge. g) Use oil containment booms in case of accidental spillage of fuel/oil. h) Implement spill management plan in case of spillage fuel / oil.	Contractor to implement the mitigation measures, and supervision by TSSC/AIWTDS
10	Gaseous emissions from construction machinery Crane, Excavator, and construction vehicles	Air pollution	a) Use of well-maintained/serviced construction machinery at the site. b) Servicing of the machinery shall be carried out as per manufacturers specifications at the workshops. c) The Concrete mixer machine shall conform with the Ministry of Road Transport and Highway (MoRTH) emission standards for construction machinery. d) All construction vehicles should comply with air emission	Contractor to implement the mitigation measures and supervision by TSSC/AIWTDS

Sl. No.	EHS Aspects	EHS Impacts	Mitigation Measures	Responsibility
			standards and be maintained properly. e) Use of low Sulphur diesel in the construction machinery and vehicles. f) Ensure that all vehicles used at the site are Pollution Under Control (PUC) certified. g) There shall be no idling of construction vehicles and machinery.	
11	Dust emissions from movement of vehicles, machinery soil filling activity, transportation of materials	Air pollution	a) Water sprinkling will be carried out on loose soil in the project site and approach road adjacent to the site. b) Stock piles will be covered with tarpaulin to prevent dust emissions. c) Trucks carrying sand/earth materials will be provided with tarpaulin sheets to cover the bed and sides of the trucks. d) Boundary fence will be provided in the project site to limit the dust emission in the neighbouring area. e) Construction vehicles and machinery speed will be limited to reduce dust emission.	Contractor to implement the mitigation measures and supervision by TSSC/AIWTDS
12	Fumes from hazardous material storage (Fuel, paints)	Air pollution	a) Hazardous materials (eg. Fuel, oil, paints etc.) will be stored in designated shade area to reduce VOC emissions. b) Any accidental spillage of hazardous materials will be cleaned immediately by trained personnel. c) Hazardous materials handling shall be carried out trained/experienced personnel. d) Low VOC paints will be used.	Contractor to implement the mitigation measures and supervision by TSSC/AIWTDS
13	Noise from construction machinery and vehicles	Noise Pollution	a) Use of well-maintained machinery and vehicles for the construction work b) Noise generating activities such as piling work will be carried out in the day time wherever possible. c) Limit idling of machinery and vehicles.	Contractor to implement the mitigation measures and supervision by

Sl. No.	EHS Aspects	EHS Impacts	Mitigation Measures	Responsibility
			d) Generator set and compressor units wherever used will be provided with e) Limit vehicular speed to reduce noise emission. f) Workers working near noisy area will be provided with ear plugs.	TSSC/AIWTDS
14	Hazardous materials handling (Spillage of hazardous materials)	Soil contamination, groundwater contamination, river water contamination	a) Minimal storage of Hazardous materials (fuel, oil) in a designated area away from the river bed in impermeable surface with proper labelling and ventilation. b) Check machinery and equipment for any leakage/spillage of fuel. c) Material safety data sheet will be provided for all hazardous materials d) Spill kits will be provided in the in the hazardous materials storage area. e) Hazardous materials handling shall be carried out by trained personnel. f) Fuel drums shall be kept in spill containment tray g) Accidental spillage of hazardous materials shall be contained using spill kits by trained personnel. h) SOP for hazardous material handling and implemented.	Contractor to implement the mitigation measures and supervision by TSSC/AIWTDS
15	Solid waste generation	Soil contamination, Odour	a) Implement waste management plan at the site. b) The contractor shall comply with Municipal Solid Waste (Management and Handling Rules, 2000) for handling and disposal. c) Separate colour coded waste bins shall be provided in the site for collection of wet waste and dry waste. d) Reduce, Reuse of resources wherever possible to reduce waste generation. e) Waste bins shall have cover and kept tidy all the times. f) Solid waste disposal should be through approved waste contractor.	Contractor to implement the mitigation measures and supervision by TSSC/AIWTDS

Sl. No.	EHS Aspects	EHS Impacts	Mitigation Measures	Responsibility
			g) Waste bins shall be properly labelled for the type of waste. h) The recyclable waste should be sent to r recycling facility. i) Training and awareness of waste management to workers. j) There shall be no burning/disposal of wastes in open area. k) Solid waste disposal log shall be maintained.	
16	Liquid waste generation	Soil, Groundwater and Surface water contamination,	a) Wastewater generation from the sanitary facility of site accommodation and construction site will be collected in a septic tank with soak pit. b) Carry out daily inspection of the septic tank and soak pit for any overflow of waste water. c) Inspection shall be carried out for any leakage of wastewater on weekly basis. d) No wastewater discharge in open area. e) Waste water disposal records shall be maintained.	Contractor to implement the mitigation measures and supervision by TSSC/AIWTDS
17	Hazardous Waste generation	Soil, Groundwater and Surface water contamination,	a) All hazardous waste will be separated from other non-hazardous wastes. b) All hazardous waste container will be appropriate labelled. c) Hazardous waste to be handled as per Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2016 d) Waste management plan will be developed for handling and disposal hazardous waste. e) Awareness training will be provided to personnel for identification, segregation, and management of waste. f) In case of soil contamination due to spillage of hazardous materials, contaminated soil will be collected as hazardous waste. g) Hazardous waste shall be transported and disposed PCBA approved hazardous waste management company. h) Waste disposal records shall be maintained.	Contractor to implement the mitigation measures and supervision by TSSC/AIWTDS

Sl. No.	EHS Aspects	EHS Impacts	Mitigation Measures	Responsibility
B	**Health and Safety**			
1	Sanitation and Health	Health care of workers	a) Lavatories shall be cleaned on daily basis. b) Health check-ups of construction workers shall be carried out. c) Prevent vector borne disease by eliminating mosquito breeding sites, practicing good hygiene. d) Ensure the draining of stagnant water, covering water storage containers and regular cleaning and maintenance at the site.	Contractor to implement the mitigation measures and supervision by TSSC/AIWTDS
2	Construction work (civil work, lifting objects, falling objects, pile work)	Environment, Health and safety of workers	a) Construction activities shall be carried out as per the work methodology and Standard Operating Procedure. b) Work permits shall be ensured for high risk works. c) Hazard Identification and Risk Assessment (HIRA) shall be shall be carried out. d) Health and Safety induction shall be provided to all the new workers/staff and periodic training to on EHS. e) Tool Box Talk meeting shall be conducted on daily basis prior to the start of daily work. f) Workers shall be provided with required Personal Protective Equipment (PPE). g) Limit manual handling up to max 30 kg h) Use hand gloves during material handling i) Use trolley for material shifting j) Check the physical fitness of the personnel for material handling	Contractor to implement the mitigation measures and supervision by TSSC/AIWTDS
3	Use of vehicles and machinery for construction work	Injury to workers Traffic congestion	a) Drivers shall Strictly Adhere to Traffic Rules b) Vehicle Speed will be reduced at the construction site c) Generate traffic Awareness Campaigns for Drivers d) On-Site Security Supervision e) Collision prevention by signage, signals, safe routes f) Machine guarding to prevent entrapment	Contractor to implement the mitigation measures and supervision by TSSC/AIWTDS

Sl. No.	EHS Aspects	EHS Impacts	Mitigation Measures	Responsibility
			g) Provide safety training to machine/equipment operators h) Provide safety gears as required based on the nature of work.	
4	Use of hand tools / power tools	Injury to workers	a) Provide welding goggles to welder's for eye protection b) Ensure proper ventilation of the area c) Area shall be cleared of Flammables and combustibles before commencing welding d) Cylinders should keep at upright direction only. e) Provide Flash back arrestor each side of gas cutting f) Damaged electrical cable to be replaced immediate, if any.	Contractor to implement the mitigation measures and supervision by TSSC/AIWTDS
5	Painting and blasting activity	Respiratory illness to workers	a) Ensure good ventilation b) Wear required PPE for handling of hazardous materials/ painting work. c) Use low VOC paints d) Train staff on hazardous materials handling e) Provide PPEs such as gloves, goggles, f) Provide spill containment such as spill kit	Contractor to implement the mitigation measures and supervision by TSSC/AIWTDS
6	Handling of Flammable materials (Paints, oils)	Burns, loss of property, severe injuries	a) Handle hazardous materials as per SOP b) Handling of hazardous materials shall be carried out by trained personnel. c) Use of proper PPEs during construction work. d) Ensure proper ventilation of the area e) Ensure there is no naked flame/ spark generating equipment f) No smoking signage in the area g) Keep the suitable fire extinguisher in ready condition	Contractor to implement the mitigation measures and supervision by TSSC/AIWTDS

Sl. No.	EHS Aspects	EHS Impacts	Mitigation Measures	Responsibility
7	Exposure to Weather Conditions Heat, cold, rain, wind	Heat stroke, hypothermia,	a) Implement safe work system. b) Plan activities considering the weather conditions. c) Check weather forecast daily d) Use proper clothing and safety gear (jacket, boot, gloves etc.) e) Drink plenty of water to prevent heat stroke f) Work rotation and monitoring shall be carried out to limit heat exposure. g) Provide training and awareness of the workers	Contractor to implement the mitigation measures and supervision by TSSC/AIWTDS
8	Fumes from welding, gas cutting of metals	Air pollution	a) Installation of fume extractor at the source of emission to capture and filter fumes wherever possible. b) Ensure adequate airflow in welding areas, especially in enclosed spaces. c) Carry out welding/cutting in well-ventilated areas. d) Use low-fume generating materials or welding techniques. e) Enforce safety PTW systems for hot work operations	Contractor to implement the mitigation measures and supervision by TSSC/AIWTDS
9	Emergency situation (Fire outbreak, oil/fuel spillage, Accident/injuries, natural disaster (flooding, earthquake), Boat/ barge accident, Explosion, Traffic accident	Injury or loss of life, property damage, interruption of work activities, Soil and water contamination, harm to aquatic life, health hazards.	a) Develop and implement a site-specific Emergency Response Plan (ERP) b) Provide fire extinguishers, sand buckets, and hydrants at critical locations. c) Conduct fire safety training and mock drills periodically. d) Maintain safe storage and handling of fuel and flammable materials. e) Maintain spill containment kits and absorbent materials. f) Ensure first-aid facilities and trained personnel are available on-site. g) Provide adequate PPE and enforce its use. h) Identify flood-prone areas and prepare site evacuation routes.	Contractor to implement the mitigation measures and supervision by TSSC/AIWTDS

Sl. No.	EHS Aspects	EHS Impacts	Mitigation Measures	Responsibility
			i) Equip all vessels with life jackets, fire extinguishers, and emergency kits j) Conduct regular safety briefings for boat operators. k) Implement immediate response protocols for rescue and containment.	
C	**Social**			
1	Labour Influx	Pressure on local resources, increased risk of conflicts with local communities, and rise in anti-social activities	a) Prepare and implement a Labour Influx Management Plan. b) Encourage hiring of local workforce to the extent possible. c) Conduct induction and periodic awareness programs on community behaviour, local customs, and code of conduct. d) Ensure adequate labour camp facilities and supervision to avoid community interference.	Contractor to implement the mitigation measures and supervision by TSSC/AIWTDS
2	Public Health and Safety	Increased risk of spreading communicable and vector-borne diseases, including STDs/ HIV/ AIDS, due to interaction between workers and local population	a) Conduct regular health check-ups and awareness programs for workers. b) Provide adequate sanitation, waste disposal, and drinking water facilities at labour camps and construction site. c) Tie up with registered hospital for periodic medical screening of workers. d) Implement health awareness programs in collaboration with health agencies.	Contractor to implement the mitigation measures and supervision by TSSC/AIWTDS

Sl. No.	EHS Aspects	EHS Impacts	Mitigation Measures	Responsibility
3	Child Labour	Risk of engagement of child labour in construction activities.	a) Strictly prohibit employment of children below 18 years of age. b) Verify age and identity proof of all workers before engagement. c) Conduct periodic inspections of the project site.	Contractor to implement the mitigation measures and supervision by TSSC/AIWTDS
4	Gender-Based Violence (GBV) and Sexual Exploitation and Abuse/Sexual Harassment (SEA/SH)	Risk of gender-based violence, harassment, and exploitation of women workers or community members	a) Adopt and enforce a zero-tolerance policy on SEA/SH. b) Conduct mandatory gender-sensitization and behaviour training for all workers. c) Establish a grievance redressal mechanism with referral pathways. d) Display information on GBV/SEA/SH prevention and reporting at site and camps.	Contractor to implement the mitigation measures and supervision by TSSC/AIWTDS
5	Social Cohesion and Community Relations	Possible friction between workers and local residents due to cultural differences or inappropriate behaviour	a) Enforce a strict code of conduct for all workers. b) Maintain regular communication with community representatives and stakeholders. c) Address grievances promptly through community liaison officer.	Contractor to implement the mitigation measures and supervision by TSSC/AIWTDS

Table 5.2: Environmental Management Plan - Operation Phase

Sl. No.	Environmental Aspects	Environmental Impacts	Mitigation Measures	Responsibility
1	Waste generation from the passengers	Water contamination	a) Provide waste bins in the ferry terminal. b) Provide instruction and displays for waste management.	Operation and maintenance team of AIWCL
2	Accumulation of wastes in the pontoons	Odour generation, affect water quality	a) Removal / cleaning of the accumulated waste if any at the base of the pontoons. b) Ensure no waste is disposed on the river. c) Provide signage's on river safety and protection of ecology. d) Provide signage's for no feeding to aquatic animals.	Operation and maintenance team of AIWCL
3	Emergency situation Fire outbreak, Accident/injuries, natural disaster (flooding, earthquake), Boat/ barge accident, Explosion, Traffic accident	Injury or loss of life, property damage, interruption of work activities, Soil and water contamination, harm to aquatic life.	a) Develop and implement a site-specific Emergency Response Plan (ERP) b) Provide fire extinguishers, sand buckets, and hydrants at critical locations. c) Conduct fire safety training and mock drills periodically. d) Maintain spill containment kits and absorbent materials. e) Ensure first-aid facilities and certified first aiders are available) f) Identify flood-prone areas and prepare site evacuation routes. g) Equip all vessels with life jackets, fire extinguishers, and emergency kits h) Conduct regular safety briefings for boat operators. e) Implement immediate response protocols for rescue and containment.	Operation and maintenance team of AIWCL

5.1 ENVIRONMENT MONITORING PLAN

Environmental Monitoring Programme has been developed to ensure that the intended environmental mitigation measures are achieved and monitor the efficiency of EMP. The monitoring program ensures compliance with environmental standards and minimizing adverse environmental impacts. The environmental monitoring program provided in Table 5.3 shall be implemented in alignment with the approved Environmental and Social Management Plan (ESMP) for the entire project.

Table 5.3: Environmental Monitoring Schedule – Construction Phase

Sl. No.	Monitoring Parameter	Activity	Locations	Monitoring Frequency	Mode of Monitoring
1	River Dolphin	Boulder removal	Up to 500 m upstream and downstream of river	Continuous	Visual Inspection
		Piling work	Up to 500 m upstream and downstream of river	Continuous	Visual Inspection during the day time
		Extraction of sediment from the pile liner	Piling site	Continuous	Visual Inspection
		Pontoon installation	Up to 300 m upstream and downstream of river	Continuous	Hydrophone during night time
		Other riverine construction work	Up to 500 m upstream and downstream of river	Continuous	Visual Inspection
2	Other aquatic species	Piling, pontoon installation and boulder removal	Up to 500 m upstream and downstream of river	Continuous	Visual Inspection
3	Noise level	Piling work	Project boundary and nearest sensitive receptor	Hourly basis during peak construction/ piling work	Noise meter
4	Turbidity	Piling and Boulder removal	Up to 300 m downstream of river	During piling and boulder removal	Turbidity meter

Note: The Contractor is required to update and submit a site-specific Construction Environmental and Social Management Plan (C-ESMP) in accordance with the Environmental and Social Impact Assessment (ESIA) Report prepared by WAPCOS in 2023, and duly incorporating the mitigation measures and recommendations provided in the current ESIA Addendum Report for the proposed ferry terminal.

The contractor shall also implement Dolphin Management Protocol “Ganges River Dolphin Safety Management Plan” developed for the project.

6 ANNEXURE

Annexure 1:

Design Modification Report of Neamati Ferry Terminal

Proposed Design Change for Ferry Terminal at Neamati

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Department of Civil Engineering
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CONFIDENTIALITY

During and after the tenure of the Project, both the parties undertake to maintain strict confidentiality and refrain from disclosure thereof, of all or any part of the information and data exchanged/generated from the Project for any purpose other than in accordance with this certificate. It shall be the responsibility of all the parties to ensure maintenance of such confidentially in respect of their behalf and on behalf of their employees, representatives and associates involved in the Project. Any and all information document received by either party from the other upon request shall be promptly returned, however, the parties involved in the Project may retain one copy of such information in their confidential files, solely for record purposes.

1 Neamati Terminal Project

The Neamati Terminal is an integral component of the Assam Inland Water Transport Project (AIWTP), jointly funded by the World Bank (80%) and the Government of Assam (20%). This terminal has been designed to enhance ferry infrastructure and connectivity along National Waterway-2 (NW-2). The project includes a range of facilities aimed at improving passenger services, vehicle access, and overall operational efficiency. The facilities being proposed at Neamati terminal could be broadly categorised into landside features and riverine features.

1.1 Landside Facilities

Terminal Building: The terminal building is a G+1 structure with a ground floor area of 625 sq.m and a first floor of 635 sq.m. The structure is designed to accommodate administrative and passenger-related functions. Key features include:

- Dedicated parking spaces
    - Two-wheelers: 62 slots, with 4 reserved for persons with disabilities (PwD).
    - Four-wheelers: 12 slots, with 1 reserved for PwD.
- EV charging: 6 slots.

Site Development: Essential site development works include core filling, underground biodigester tanks, oil/grease water separators, boundary walls, footpaths, and landscaped parking zones. These elements contribute to efficient site usage and environmental compliance.

Approach Ramp: The length of ramp is 122.600 m with a width of 14.500 m. A slope of 1:12 is being provided to ensure year-round accessibility for pedestrians and vehicles, particularly during seasonal water level fluctuations. The design specifics of the approach ramp are as follows:

- 92 m of the ramp is positioned on the riverbank, with the remaining 30 m extending into the river during lean season conditions.
- Constructed with quarry-run boulders and stabilized with non-woven geotextile and gabion mattresses for enhanced durability.

1.2 Riverine Features

The riverine facilities consist of floating pontoon and linkspan, and foundation and slope protection.

Floating Pontoon and Linkspan: A movable floating pontoon is integrated with a linkspan that provides access to vessels during varying water levels. The linkspan is designed to operate parallel to a sloping access bund, accommodating seasonal water level changes efficiently.

Foundation and Slope Protection: The protection works comprises core filling with quarry-run boulders, ranging from 0.10 kg to 500 kg, forms the foundation for riverine structures. A non-woven geotextile layer is placed over the core filling, followed by a 0.5-meter-thick gabion mattress to provide slope protection and prevent erosion. These measures ensure structural stability, especially in regions prone to moderate erosion and seasonal flooding.

2 Design Changes of Neamati Terminal

The issues of underestimating the Bill of Quantities and stability concerns about the core filling of the approach ramp has initiated the need to explore alternative design solutions to address them. With the objective to address these issues, a technical committee visited the site on September 29, 2024 and observed the following aspects:

- The site comprises dense silty sand and is moderately prone to erosion.
- Seasonal water fluctuations necessitate flexible infrastructure, particularly for the floating pontoon and linkspan.
- The slope of the boulder-filled approach ramp was confirmed to be 1:2, as recommended by the design vetted by IIT-Guwahati.
- Boulder filling is planned to reach the highest flood level (HFL) of +87.220 m, with gabion mattresses providing additional stability.

Based on the identified issues and proposed changes, the Technical Committee recommends the following changes in the original design of the project:

- **Hybrid Approach Ramp**: Construct the ramp with 65.00 m of core filling and 31.20 m of pile foundation to balance cost, stability, and environmental considerations.
- **Retaining Wall**: Implement fiber-reinforced soil wall technology for the terminal building foundation to enhance stability and reduce settlement risks.
- **Winch System**: Adopt a winch system to ensure efficient and safe handling of the linkspan during water level changes.
- **Erosion Mitigation**: Focus on erosion control measures, including optimized material usage and slope protection, to prevent disruptions to the riverine ecosystem and ensure project longevity.

AIWTDS approached IIT Guwahati vide their letter with reference no .526122/215, dated November 22, 2024, to revise the design in terms of minimizing the boulder quantity in approach ramp core filling, which can able to restrict the project cost within the tender value. Pursuant to this, the following two design solutions have been provided with the mandate to provide the detailed design and BoQ of the revised design:

Design Solution 1: Approach ramp Project may proceed with the alternate design as suggested in the approach bund such as by putting of pile foundation instead of core filling through bolders. The length of approach ramp (superstructure) above pile foundation should not be reduced from the Low water level.

Design Solution 2: The core filling in the terminal building with slope can be replaced by It is opined for constructing a retaining wall with a reinforced soil wall around the terminal building, extending from the PCC bottom level to the FGL (2.10 m). The surrounding area may be filled with available river sand.

The scope of the consultancy assignment awarded to IITG relating to this project, Neamati Terminal, is relating to the design of pile foundation to replace the boulder pitching of the approach ramp core filling and gabion wall around the terminal building. The design and analysis of river bank protection works is not within the scope of the work assigned to IITG.

3 Gabion Wall Design

The design of a gabion retaining wall for the Nemati Ferry Terminal incorporates established engineering principles and standards to ensure a robust and reliable structure. The design delves into the methodology, calculations, and analysis underpinning the design, ensuring compliance with both the Bureau of Indian Standards (BIS) and AASHTO (American Association of State Highway and Transportation Officials) guidelines.

Gabion walls offer a practical solution for retaining soil and mitigating erosion while integrating well into the natural environment. For this project, the design philosophy being adopted for the study aims to carry out design analysis with the objective to withstand static and dynamic loads, particularly in a seismically active region.

3.1 Input Data

The design calculations are based on the following input parameters:

- **Wall Geometry**
  - Height (“h”): 3.0 m
  - Base Width (“B”): 3.5 m
  - Top Width (“a”): 1.0 m
  - Batter Angle (“β”): 0°
  - Backfill Inclination (“i”): 0°
  - Foundation Depth: 1.0 m
- **Material Properties**
  - Unit Weight of Gabion Rock (“γ”): 26.0 kN/m³
  - Porosity (“n”): 35%
  - Mesh Type: Double-twisted hexagonal mesh (10×12)
  - Mesh Weight: 8.5 kg/m³
  - Wire Thickness: 2.7 mm, PVC or Zn-Al coated
  - Unit Weight of Foundation Soil (“γ”): 17.5 kN/m³
  - Angle of Friction (“φ”): 27°
  - Cohesion (“c”): 0.0 kN/m²
  - Unit Weight of Backfill Soil (“γ”): 18.0 kN/m³
  - Angle of Friction (“φ”): 28°
- **Loading Conditions**
  - Uniformly Distributed Load (UDL): 10.0 kN/m² (DL + LL)
  - Earthquake Zone Factor (“Z”): 0.36
  - Horizontal Seismic Coefficient (“ah”): 0.18
  - Vertical Seismic Coefficient (“av”): 0.12
  - Coefficient of Active Earth Pressure (“Ka”): 0.319

3.2 Output Data

The following results were obtained from the design analysis:

Sliding Stability

- Resisting Force (“R”): 62.07 kN/m

- Driving Force (“Pd”): 54.97 kN/m
- Factor of Safety (“FOS”): 1.13 > 1.125 (safe)

Overturning Stability

- Resisting Moment (“Mr”): 320.05 kN-m/m
- Overturning Moment (“Md”): 81.94 kN-m/m
- Factor of Safety (“FOS”): 3.91 (safe)

Bearing Stability

- Maximum Stress (“qmax”): 47.01 kN/m²
- Minimum Stress (“qmin”): 22.60 kN/m²
- Allowable Stress (“qall”): 115.04 kN/m² (safe)

3.3 Design Philosophy

The gabion wall design follows a gravity-based approach, where the stability of the structure is derived from its self-weight and the interlocking of individual gabion units. This principle ensures that the wall can effectively resist lateral earth pressures, seismic forces, and surcharge loads while maintaining flexibility and drainage efficiency. The modular nature of gabions allows for adaptability to site conditions, reducing the need for extensive foundation work. The porosity of the gabion structure prevents hydrostatic pressure buildup, enhancing long-term performance. Additionally, the use of durable and corrosion-resistant materials ensures longevity, making the wall a sustainable and cost-effective solution for riverbank protection. The design also considers environmental factors, ensuring that the structure blends with the surrounding landscape while providing necessary structural support.

3.4 Structural Geometry and Loading Conditions

The gabion wall follows a modular structure with individual layers of 1.0 meter height. The overall stability of the wall is achieved by ensuring an appropriate base width, which allows the self-weight of the structure to counteract lateral earth pressures effectively. The unit weight of gabions, accounting for porosity, is considered as 16.9 kN/m³.

The wall is subjected to various external forces, including lateral earth pressure, surcharge loading, and seismic forces. The coefficient of active earth pressure is determined to be 0.319, ensuring accurate computation of the lateral thrust exerted by the backfill. Seismic coefficients are considered based on Zone V parameters, with a horizontal seismic coefficient of 0.18 and a vertical coefficient of 0.12.

3.5 Stability Analysis

The stability of the gabion wall is assessed based on three primary failure modes: sliding, overturning, and bearing capacity failure. The factor of safety against sliding is calculated as 1.13, which marginally exceeds the minimum required value of 1.125. Although this meets the standard safety criteria, additional measures such as increasing the base width or incorporating a shear key could further enhance stability.

The factor of safety against overturning is found to be 3.91, significantly higher than the minimum requirement of 1.5, indicating a strong resistance against toppling forces. The bearing stress at the foundation level is well within the permissible limits, with a maximum stress of 47.01 kN/m² against an allowable stress of 115.04 kN/m². This ensures that the foundation soil will not experience excessive settlement or shear failure.

3.6 Seismic Design Considerations

As the site falls under Seismic Zone V, earthquake forces play a critical role in the design. Seismic loads are incorporated into the active earth pressure calculations, increasing the lateral thrust exerted on the wall. The earthquake-induced inertial forces are also considered in the stability analysis. The application of seismic coefficients as per IS 1893:2016 ensures that the structure is designed to withstand significant ground motions without structural failure.

To enhance seismic resistance, it is recommended to use geosynthetic reinforcement or anchorages that can dissipate seismic energy and improve overall structural integrity. Additionally, ensuring proper drainage behind the wall will prevent hydrostatic pressure buildup, which could exacerbate seismic instability.

3.6.1 Internal Stability and Layer Analysis

The gabion wall consists of multiple layers, each contributing to overall structural stability. The mesh used for gabions is 10×12 with a 2.7 mm wire, protected with PVC or Zn-Al coating to prevent corrosion and enhance durability in the riverine environment. Each layer is carefully analyzed for internal shear stress to ensure that individual segments remain stable under loading conditions.

One of the primary advantages of gabion structures is their porosity, which allows water to drain through and reduces hydrostatic pressure behind the wall. However, additional drainage provisions, such as weep holes or perforated pipes, are recommended to further improve long-term performance. The inclusion of a graded filter layer behind the wall will prevent soil migration and maintain structural stability over time.

3.7 Compliance with Standards

The gabion wall design adheres to multiple national and international standards to ensure safety and performance. Compliance with IS 1893:2016 guarantees appropriate seismic considerations, while IS 6403:1981 governs the bearing capacity calculations. Installation and material specifications follow the guidelines outlined in IRC SP 116-2018, ensuring high-quality construction practices. The overall structural safety assessment aligns with IRC 006:2014, validating the design for long-term stability.

3.8 Design Drawings, Specifications and Layout

The design calculation of the gabion wall is given in Annexure 1. While, the typical cross-section of the gabion wall is shown in Annexure 2. The technical specifications of the gabion is highlighted in Annexure 3. Annexure 4 shows the layout plan of the gabion wall around the terminal building. Finally, the BoQ for the gabion wall is shown in Annexure 5.

3.9 References

1. IS 6403:1997 – Code of Practice for Determination of Bearing Capacity.
2. IS 1893:2016 – Criteria for Earthquake Resistant Design of Structures.
3. IRC:SP:116-2018 – Guidelines for Design and Installation of Gabion Structures
4. AASHTO LRFD Bridge Design Specifications.

4 Pile Foundation

4.1 Materials and Cover

4.1.1 Cement

For all structural elements, PSC conforming to IS: 455-2015 shall be used.

4.1.2 Reinforcement

High Yield Strength corrosion resistant deformed bars of grade Fe 500 D conforming to IS: 1786 shall be used.

Table 4.1 Grade of Concrete and Steel

Structure	Materials	
	Concrete	Steel
Piles	M40	Fe 500D
Pile Muffs	M40	Fe 500D
Beams	M40	Fe 500D
Deck Slab	M35	Fe 500D

4.1.3 Clear Cover to be Provided

Following clear cover to outer most reinforcement to be provided for various structural members.

Piles	:	75 mm
Pile muff	:	75mm
Beams	:	50 mm
Deck Slab	:	40mm

4.2 Design Life

The design life of the facility is 50 Years. This maintenance system of the structure is as follows:

Item	Life
Frequency of inspection & Repairs of work	5 years
The design life of the fender	10 years
The design life of the Bollards	10 years
The design life of the Ladders	5 years

4.3 Design Loads

4.3.1 Dead Load

Self–weight of the structural member is taken as the dead load. Density of Concrete is assumed as 25kN/m^3.

4.3.2 Live Load

Live load - 50kN/m^2

4.3.3 Crane Load:

The Crane load considered for the covered shed is 5T (50kN) and the utility building is 2T (as required by the client).

4.3.4 Seismic Force

Seismic force is calculated according to IS 1893 (Part 1) 2016 (Reaffirmed 2021), considering 100% dead load+ 50% live load as acting on the structure. As per IS code, Jorhat (Neamati) is under (Zone V) and the basic horizontal seismic coefficient is calculated accordingly.

Horizontal seismic Coefficient $A_h = \dfrac{ZISa}{2Rg}$

Where,

Z	=	Zone factor (0.36), Table 3
I	=	Importance factor (1.5), Table 8
R	=	Response reduction factor (3), Table 9
$\frac{Sa}{g}$	=	Average Response acceleration coefficient

(Depends on natural time period of the structure)

4.4 Indian Standard Codes Referred

The following Indian Standard Codes are used for the design of the structure.

IS 4651(Part 4) 2014 Code of Practice for Planning and Design of Ports and Harbours

IS 456-2000 Design of Plain and reinforced Concrete

IS 2911-2010 Codes of practice for Design and (Part 1/Sec 2) Construction of pile foundation.

IS 2911-2010 Codes of practice for Design and (Part 4) Construction of pile foundation.

IS 1893-2002 Criteria for Earthquake Resistant Design of structures.

IRC: 78-2000 Standard specifications and code of practice for road bridges

SP-16 Design Aids for Reinforced Concrete to IS 456-1978

4.5 Analysis Methodology

The structure is a piled structure with covered sheds. The loads shall be applied as per the guidelines of IS codes. The critical load case will be considered for the design. The P-δ analysis shall be carried out. The analysis is shown in Annexure 8.

4.6 Design Methodology

The various components of the structure shall be designed according to various standards listed in the above section. All the elements will be designed as per Limit state of collapse and checked for Limit state of serviceability.

4.6.1 Deflection

Deflection due to all loads including creep and shrinkage should not exceed = span / 200 as allowable Deflection in lateral direction (steel table IS 800-2007, table 6) and also as per crane vendor requirements.

4.6.2 Crack Width

Crack width is to be checked in accordance with IS 4651-2014 & IS 456 Clause 35.3.2.

4.7 Pile Foundation

Design shall be carried out considering soil parameter at structure location. The static capacity of the pile shall be derived based on IS 2911 part 1/sec-2:2010.

Following points shall be taken in to consideration when designing the piles:

- Pile geotechnical capacity calculations shall be calculated as per IS 2911 guidelines for bored cast-in-situ RC piles.
- A minimum spacing of 3 times the diameter of pile is to be maintained between piles to avoid pile group effect. If it is not possible, the piles are to be checked for group effect and reduce the allowable capacity accordingly.
- The main pile should have liner up to top of weathered rock.
- Reinforcement detailing shall be as per IS 2911 guidelines.
- The allowable load Q_{ap} on the pile is given by the equation

4.7.1 For Granular soils

$$Q_u = A_p \left(1/2\, D_\gamma N_r + P_d N_q\right) + \sum_i^n KPDi \tan \delta\, Asi$$

Where

Ap	=	Cross section area of pile toe in cm^2
D	=	Stem diameter in m
Pd	=	Effective over burden pressure at pile in kg/cm^2
Nγ ,Nq	=	Bearing capacity factors depending upon the angle of internal friction Ø
$\sum_i^n = 1$	=	summation for *n* layers in which pile is installed
K	=	Co efficient of earth pressure
PDi	=	Effective overburden pressure in kg/cm^2 for i^{th} layer where i varies from 1 to n
δ	=	Angle of wall friction between pile and soil in degrees (May be taken equal to Ø)
Asi	=	Surface area of pile shaft in cm^2

4.7.2 For Cohesive Soils

$Q_u = A_p N_c C_p + \alpha C A_s$

Where,

Ap	=	Cross section area of pile toe in m^2
Nc	=	Bearing Capacity factor usually taken as 9
Cp	=	Average Cohesion at pile tip kg/cm^2
α	=	Reduction factor (Refer IS: 2911)
C	=	Average cohesion throughout the length of pile in kg/cm^2
As	=	Surface area of pile shaft in cm^2

4.7.3 For Rock

$Q_u = c_{u1} N_c (\pi B^2/4Fs) + \alpha c_{u2} (\pi BL/Fs)$

Where,

cu1	=	Shear strength of rock below base of the pile, in kN/m^2 (ref. fig.3 in IS 2911 (part 1/sec 2) - 2010)
Nc	=	Bearing Capacity factor usually taken as 9
Fs	=	Factor of safety usually taken as 3
α	=	0.9 (recommended value)
cu2	=	Average shear strength of the rock in the socketed length of the pile, in kN/m^2 (ref. fig.3 in IS 2911 (part 1/sec 2) - 2010)
B	=	Min. width of pile shaft (diameter in case of circular piles), in m
L	=	Socket length of pile

NOTE: For **N ≥ 60**, the stratum is to be treated as weathered rock rather than soil.

As per IS 2911 (part 4 - 2010), initial pile load test to be carried out in addition to the high strain energy test on the working pile.

4.8 Covered Shed Details

4.8.1 Geometry

The length of the shed	=	24.7 m
The breadth of the shed	=	42.0 m

4.8.2 Material

Grade of Structural Steel	=	Fy-250 (Hot Rolled Sections)
Rebar	=	Fe-500 D CRS bars
Roofing & Cladding	=	0.6mm Galvalume sheet.

4.9 Loadings

4.9.1 Dead Load

Dead loads are taken into account as per IS: 875 part I

Unit weight of steel	=	78.5 kN/m^3
Unit weight of roofing	=	0.05 kN/m^2
Unit weight of concrete	=	25 kN/m^3
Bird mesh	=	0.05kN/m^2

Dead load calculation

Self weight of sheeting	=	0.05 kN/m^2
Overlaps and fixtures	=	0.05kN/m^2
Assume for electrical fittings	=	0.10kN/m^2
Weight of Bird mesh	=	0.05kN/m^2
Total dead loads	=	0.25 kN/m^2
Self weight of purlin	=	0.19 kN/m
Column spacing	=	18.00 m
Spacing of purlin	=	1.50 m
Total dead load on roof	=	0.25x5.7+(0.190x5.7x1.2/1.5)
	=	2.35 kN/m.

Weight of cladding transferred to the main column

Self weight of sheeting	=	0.05 kN/m^2
Self weight of purlin	=	0.19 kN/m
Column spacing	=	18.00 m
Spacing of purlin	=	1.50 m

4.9.2 Live Load

Live loads are taken into account as per IS: 875 part II.

Live load on roofing = 0.55 KN/m2 (For roof slope of 20°)

Sloping roof with slope greater than 10°, Reduce 0.02 KN/m2 for every degree increase in slope over 10° (IS 875 (Part 2)-1987 Table-2, Page-14).

4.9.3 Wind Load

Wind load corresponding to 1.3 times of basic wind speed of 50.0 m/s is considered as per IS: 875 (Part 3)-1987, Appendix, Clause 5.2 and Page-53 (in Jorhat and Guwahati), Crane operation condition wind load corresponding to 0.7 times of basic wind speed of 50.0 m/s. the survival wind speed 35m/s.

Risk coefficient (k1) = 1.07

Topography factor (k3) = 1.00

Terrain height and structure size factor (K2) (Category 1, class C)

Design wind speed (Vz) = 1.3 x V_b x k1 x k2 x k3.

Design wind pressure (Pz) = 0.6 x Vz^2.

Wind pressure coefficients corresponding to a roof slope of 20° is considered.

4.9.4 Seismic Load

Seismic loads corresponding to zone V with importance factor 1.5 and with soil category 2 is considered as per IS: 1893- 2002.

4.10 Load Case and Wind Load Coefficient

Dead (DL)	-	Self weight of the structure.
Super dead (SD)	-	Other dead loads.
Live (LL)	-	Live loads
Wind (WL0°& WL90°)	-	Wind load on X & Y directions.

4.11 Load Combinations

4.11.1 General Load Combinations

Limit state of Strength.(IS: 800-2007, Table-4 and Page-29)

1. 1.5 Dead load + 1.5Live load
2. 1.2 Dead load + 1.2Live load+0.6 (Seismic load/wind load)
3. 1.2Dead load + 1.2Live load+1.2 (Seismic load/wind load)
4. 1.5Dead load + 1.5(Seismic load/wind load)
5. 0.9Dead load +1.5(Seismic load/wind load)

Limit state of Serviceability. (IS: 800-2007, Table-4 and Page-29)

1. 1.0Dead load + 1.0Live load
2. 1.0Dead load +0.8Live load+0.8 (Seismic load/wind load)
3. 1.0Dead load + 1.0(Seismic load/wind load)

4.11.2 Analysis Load Combinations

Limit state of Strength

1. 1.5DL+ 1.5LL
2. 0.9DL+1.5WL0°
3. 0.9DL+1.5WL0 °
4. 0.9DL+1.5WL90 °
5. 0.9DL+1.5WL90 °
6. 0.9DL+1.5 EQ -X
7. 0.9DL+1.5 EQ -Z

8. 0.9DL+1.5EQ0 - (–X)
9. 0.9DL+1.5EQ90- (-Z)
10. 1.5DL+1.5WL0^{o}
11. 1.5DL+1.5WL90^{o}
12. 1.5DL+1.5WL0^{o}
13. 1.5DL+1.5WL90^{o}
14. 1.5DL+1.5EQ-X
15. 1.5DL+1.5EQ-Z
16. 1.5DL+1.5EQ- (–X)
17. 1.5DL+1.5WL- (-Z)
18. 1.2DL+1.2LL+0.6WL0^{o}
19. 1.2DL+1.2LL+0.6WL90^{o}
20. 1.2DL+1.2LL+0.6WL0^{o}
21. 1.2DL+1.2LL+0.6WL90^{o}
22. 1.2DL+1.2LL+0.6EQ-X
23. 1.2DL+1.2LL+0.6EQ-Z
24. 1.2DL+1.2LL+0.6EQ- (–X)
25. 1.2DL+1.2LL+0.6EQ-(-Z)
26. 1.2DL+1.2LL+1.2WL0^{o}
27. 1.2DL+1.2LL+1.2WL90^{o}
28. 1.2DL+1.2LL+1.2WL0^{o}
29. 1.2DL+1.2LL+1.2WL90^{o}
30. 1.2DL+1.2LL+1.2EQ -X
31. 1.2DL+1.2LL+1.2EQ-Z
32. 1.2DL+1.2LL+1.2EQ -(–X)
33. 1.2DL+1.2LL+1.2EQ-(–Z)

Limit state of Serviceability.

1. 1.0DL+ 1.0LL
2. 1.0DL+1.0WL0^{o}
3. 1.0DL+1.0WL90^{o}
4. 1.0DL+1.0WL0^{o}
5. 1.0DL+1.0WL90^{o}
6. 1.0DL+1.0EQ-X
7. 1.0DL+1.0EQ-Z

8. 1.0DL+1.0EQ-(–X)
9. 1.0DL+1.0EQ-(–Z)
10. 1.0DL+0.8LL+0.8WL0º
11. 1.0DL+0.8LL+0.8WL90º
12. 1.0DL+0.8LL+0.8WL0º
13. 1.0DL+0.8LL+0.8WL90º
14. 1.0DL+0.8LL+0.8EQ-X
15. 1.0DL+0.8LL+0.8EQ-Z
16. 1.0DL+0.8LL+0.8EQ-(–X)
17. 1.0DL+0.8LL+0.8EQ-(–Z)

4.12 Deflection Limits

As per IS 800-2007 Table – 6 Deflection limits, deflection under serviceability loads of an industrial building.

Lateral

Maximum Deflection = H/200.

Vertical

Maximum Deflection = L/240.

4.13 Meteorology Data

4.13.1 Wind Data

The annual wind pattern for Neamati follows the following cycle:

- North East Monsoon (End November to End February): During this period, Jorhat experiences predominantly north-easterly winds. This is the winter season, characterized by cooler temperatures and generally dry conditions.
- Pre-Monsoon (March to May): This transitional period sees a shift in wind direction. The winds gradually change from north-easterly to south-westerly. This phase often brings increasing temperatures and occasional pre-monsoon showers.
- Pre-Monsoon (March to May): This transitional period sees a shift in wind direction. The winds gradually change from north-easterly to south-westerly. This phase often brings increasing temperatures and occasional pre-monsoon showers.
- South-West Monsoon (Middle of May to Middle of October): The south-west monsoon dominates this period, bringing predominantly south-westerly winds. This is the primary rainy season for Jorhat, characterized by cloudy weather and frequent rainfall. The region experiences high humidity and moderate temperatures during this time.
- Post-Monsoon (Middle of October to End November): This short transitional period is marked by variable weather conditions. The winds begin to shift back towards the north-easterly direction, preparing for the winter monsoon. This phase often sees a gradual decrease in rainfall and humidity. This cyclical pattern of wind directions and

associated weather conditions plays a crucial role in Jorhat's climate, agriculture, and daily life throughout the year.

4.13.2 Temperature

The mean monthly temperature range for the Neamati region is reported to be between 18.8°C and 28.1°C1. This range likely represents the average of daily minimum and maximum temperatures over the course of a year.

For the broader Brahmaputra basin, which includes Neamati, the minimum and maximum temperatures are reported as 16.16°C and 38.79°C, respectively. However, these figures likely represent extreme values rather than daily averages.

4.13.3 Humidity

Based on the available data, we can provide information on

The average annual relative humidity for Jorhat, which is close to Neamati, is 75.15%. For Jorhat, the relative humidity varies throughout the year:

- The highest humidity is typically in July, with an average of 87.72%.
- The lowest humidity is usually in March, with an average of 57.7%.

It's worth noting that humidity levels can fluctuate significantly between seasons, with the monsoon period generally having higher humidity compared to the drier winter months.

4.13.4 Rainfall

Jorhat, which is close to Neamati, receives approximately 2699 mm of precipitation annually. The daily cumulative rainfall for Jorhat averages 130.800 mm, based on data from June 2018 to February 2025. Jorhat typically has about 66.44 rainy days per year, which accounts for 18.2% of the time.

4.13.5 Water Level Data

The key water level measurements for the Brahmaputra River at various locations:

Highest Flood Levels (HFL)

Neamatighat (Jorhat): 87.37 m (July 11, 1991)

Danger Levels

Neamatighat (Jorhat): 85.04 m

Historical Discharge Data

Average discharge: ~22,000 m^3/s (780,000 cu ft/s)

Flood discharge: Up to 103,000 m^3/s (3,600,000 cu ft/s)

Highest reconstructed discharge (1998): 60,312 m^3/s

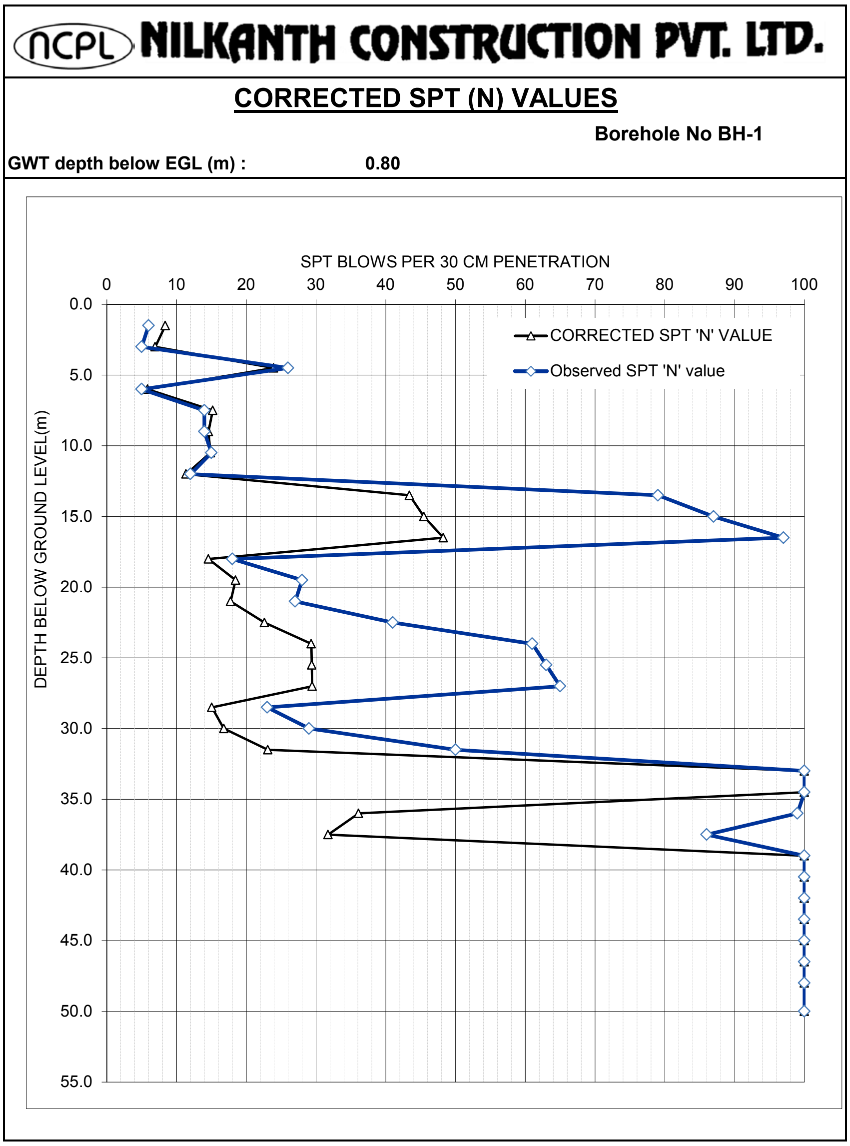
4.14 Soil Data

Soil investigation was carried out previously for construction of jetty at Neamati by M/s Nilkanth Construction Pvt. Ltd. The firm had conducted land boreholes at two locations. The soil data are furnished below.

The borehole profile indicates a stratified subsurface composition with varying densities and soil types, as per IS: 1498 classification.

From 0 m to approximately 12 m, the soil comprises brownish-grey silty sand (SM) with nominal clay, transitioning from loose to medium density. SPT values range from 3 to 14, indicating a relatively soft stratum. Between 12 m and 20 m, the profile shows medium to very dense silty sand with traces of gravel (SM). SPT values increase significantly, reaching up to 48, suggesting increased soil compactness. From 20 m to 30 m, the soil is brownish-grey, very dense, silty sand with gravels (SP-SM), with SPT values ranging from 18 to 63, indicating a very compact layer. Below 30 m, extending up to 50 m, the composition transitions to brownish-grey or dark-grey very dense silty fine to medium sand with gravels (SP-SM). SPT values exceed 50, often reaching refusal (>100 blows), confirming a hard and compact stratum.

The data reveals progressively denser and more granular soil layers with depth, suitable for supporting heavy structures, particularly beyond 20 m, where gravelly and compact formations dominate.



SPT Values for Borehole 1

5 Project Cost

The proposal being envisaged for the Nemati Ferry Terminal include provision of a gabion wall and pile foundation to replace the gabion mattress that had been proposed earlier. The cost of the proposed design of gabion wall around the terminal and pile foundation to replace the bounder pitching to support the approach ramp is shown below:

Sl. No.	Item	Amount (INR)
1	Gabion Wall Around the Terminal Building	1,10,44,999.99
2	Pile Foundation to support the two Approach Ramps	9,86,36,718.59
	Total Amount	**10,96,81,718.58**

The BoQ for Gabion Wall is presented in Annexure 5 and Pile Foundation to support the two approach ramps in Annexure 7.

Annexure 1 – Gabion Wall Design Calculation

TYPICAL HAND CALCULATION FOR GABION WALL

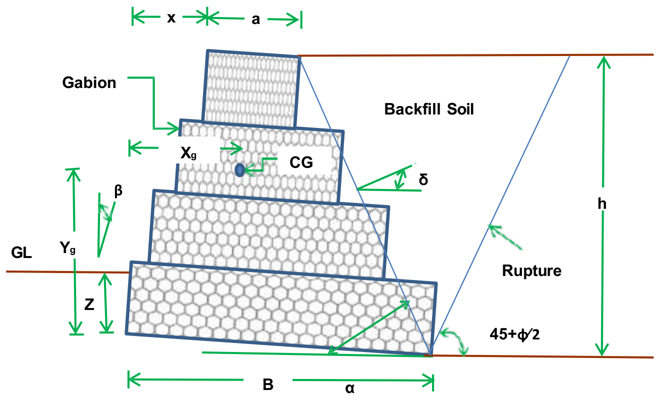
Date: **18.01.2025**

Project: **Design of Gabion Retaining Wall (3 m high)**
Location: **Nemati Ferry Terminal**
Section: **3.0 m AGL**

INPUT DATA:

General

1	Height ofwall (**h**)	=	3.0 m
2	Batter Angle (β)	=	0.0 deg
3	Uniformly distributed load **(q)** =DL+LL	=	10.0 kN/Sq.m
4	Base width of wall **(B)**	=	3.5 m
5	Top width of wall **(a)**	=	1.0 m
6	Inclination of Backfill with Horizontal (i)	=	0.0 deg



Schematic Diagram

Gabions

1	Unit wt.of rock (γ_p)	=	26.00 kN/Cu.m
2	Porosity **(n)**	=	35.00%
3	Mesh Size	=	10*12 - 2.7mm
4	Mesh Weight (Pu) in kg/Cu.m	=	8.5
5	Size of Each Layers		

Nos.	Length in m	Width in m	Height in m	Offest in m	Area in Sq.m	Total Height @ the base of each layer in m	Volume in Cu.m	Cum. Volume @ the base in m
1	3.5	1	1	0	3.5	3.0	3.5	6.5
2	2	1	1	1.5	2	2.0	2	3
3	1	1	1	1	1	1.0	1	1

Project:	**Design of Gabion Retaining Wall (3 m high)**	
Location:	**Nemati Ferry Terminal**	

6	Cross Section Area of Gabion **(A)**	=	6.50 Sq.m
7	External offest b/w toe and wall top **(x)**	=	2.5 m

Seismic Coefficients

1	Earthquake zone	=	5

Existing Backfill

1	Unit wt. of soil **(γ)**	=	18.00 kN/Cu.m
2	Angle of friction **(ϕ)**	=	28.0 deg
3	Cohesion **(C)**	=	0.00 kN/Sq.m

Existing Foundation

1	Unit wt. of soil **(γ)**	=	17.50 kN/Cu.m
2	Angle of friction **(ϕ)**	=	27.0 deg
3	Cohesion **(C)**	=	0.00 kN/Sq.m
4	Depth of foundation **(z)**	=	0.5 m

Project:	**Design of Gabion Retaining Wall (3 m high)**
Location:	**Nemati Ferry Terminal**

OUTPUT:

1	Factor of Safety against Sliding	=	**1.13**	**>1.125 safe**
2	Factor of Safety against Overturning	=	**3.91**	**>1.5 safe**
3	Eccentricity	e=	**-0.20 m**	
4	Maximum Allowable stress on foundation	=	**115.04 kN/Sq.m**	
5	Stresses on foundation	qmax=	**47.01 kN/Sq.m**	**<qall safe**
		qmin =	**22.60 kN/Sq.m**	**<qall safe**

(Refer AASHTO Clause no .5.5.5)

Design Parameters:

1	Angle included between line of action of earth thrust & perpendicular to the Plane on which pressure acts **(** δ **)** =(15% Friction reduction due to geotextile in Backfill)	=	23.80 deg
2	Angle between horizontal & plane on which pressure acts **(** α **)**	=	90.00 deg
3	Unit wt.of Gabions **(** γ_g **)** = γ_p * (1-n)	=	16.90 kN/Cu.m
4	Total wt. of Gabions **(W)**	=	109.85 kN/m
5	Total height of wall with batter H = h sin α / sin(α-β)	=	3.00 m
6	Earthquake Zone factor Z	=	0.36
7	Horizontal Coefficient(α_h)= [(Z/2)*(Sa/G)] / [R/ I]	=	0.18
8	Vertical Coefficient(α_v)	=	0.12
9	Area of failure wedge(Assuming failure wedge passing-tan(45+ϕ/2),A_w	=	2.70 Sq.m
10	Weight of the failure wedge, W_w	=	48.67 Sq.m

Refer page 14 of IS 1893 - Part 1 :2002 /Clause No 222 of IRC:6 2000

Design Calculations

Active thrust

Coeff. Of active pressure, = 0.319

Ka = (sin2(α+ϕ)) / (sin2α * sin(α-δ)*[1+ √((sin(ϕ+δ)*sin(ϕ-i)) / (sin(α-δ)*sin(i+α)))]2)

Active Earth Pressures= Effect due to Earth Pressures+Surcharge+Effect due to Seismic

$P_a = 0.5*\Upsilon*H^2*Ka+q*H*Ka+(\alpha_h*W_w) - 2*c*\sqrt{Ka}$ = 44.14 kN/Sq.m

CG of Failure Wedge

$X_w = 1/6A[\Sigma_{i=0}^{N-1} [(X_i+X_{i+1})(X_i*Y_{i+1} - X_{i+1}*Y_i)]]$ = 4.101

$Y_w = 1/6A[\Sigma_{i=0}^{N-1} [(Y_i+Y_{i+1})(X_i*Y_{i+1} - X_{i+1}*Y_i)]]$ = 2.000

Where X_i, X_{i+1}, X_{i+2}..... - are the X axis coordinate of the Gabion structure.

Yi, Y_{i+1}, Y_{i+2}..... - are the Y axis coordinate of the Gabion structure.

Assuming the structure is placed @ 0,0 (ie X_i=0, Y_i=0)

CG of Gabions

The centroid of the Gabion structure is

$Y_g = 1/6A[\Sigma_{i=0}^{N-1} [(Y_i+Y_{i+1})(X_i*Y_{i+1} - X_{i+1}*Y_i)]]$ = 1.27 m

$X_g = 1/6A[\Sigma_{i=0}^{N-1} [(X_i+X_{i+1})(X_i*Y_{i+1} - X_{i+1}*Y_i)]]$ = 2.35 m

Point of application of action H_{pa}, = 1.307 m

Direction of the Active earth Pressure, θ_{pa} = 23.80 deg

Check for Sliding

Normal Force at base,

$N=W*\cos\beta+P_a*\cos(\alpha-\delta-\beta)-\alpha_v*W_w$ = 121.82 kN/m

Resistance Force at base, $R = N*\tan(\phi)+c*B$ = 62.07 kN/m

Horizontal Inertia force,P_{IR} = (0.5*Υ_b*H*H)*α_h = 14.58 kN/m

Driving Force at base,$P_a*\sin(\alpha-\delta-\beta)$ = 54.97 kN/m

Factor of Safety = Resistance force /Driving Force = **1.13**

>1.125 safe

(Refer AASHTO Clause no .5.5.5)

Project: **Design of Gabion Retaining Wall (3 m high)**

Location: **Nemati Ferry Terminal**

Check for Overturning

Coordinates of application of active pressure, P_a

$Xp_a = B*\cos\beta + Hp_a*\tan(90+\alpha)$	= 3.500 m
$Yp_a = Hp_a - B*\sin\beta$	= 1.307 m
Moment due to horizontal component of active pressure, M_{eh}	
$M_{eh} = P_a*\sin(\alpha-\delta)*Yp_a + P_{IR}*Y_w$	= 81.94 kN.m/m
Moment due to self weight, $Mw = W*X_g$	= 257.73 kN.m/m
Moment due to vertical component of active pressure, M_{ev}	
$M_{ev} = P_a*\cos(\alpha-\delta-\beta)*Xp_a$	62.32 kN.m/m
Moment of resistance, $M_r = M_w + M_{ev}$	= 320.05 kN.m/m
Factor of safety = Mr / Meh	= **3.91**
	>1.5 safe
	(Refer AASHTO Clause no .5.5.5)
Distance of reaction from heel of wall	
d =(Mr-Meh)/N	= 1.95 m
Eccentricity from centre of base, e = B/2 - d	= **-0.20 m**

Check for Stresses on foundation

Calculation of Bearing Capacity:

(Refer IS 6403 : 1997)

h=	Height of the wall	= 3.0 m	
β =	Batter Angle	= 0.00 deg	
B =	Base Width	= 3.5 m	Note:
B_F=	Effcetive Base width of the foundation, B_F=B-2e	= 3.500 m	If e>0, BF=B-2e
L =	Length of the foundation	= -	If e<0, BF=B
c =	Cohesion	= 0.00 kN/Sq.m	
ϕ =	Angle of Internal Friction	= 27.0 deg	
D_f =	Depth of the Foundation	= 0.5 m	
γ =	Unit weight of the Soil	= 17.50 kN/Cu.m	
W' =	water table correction factor	= 0.5	
q =	Overburden pressure = $\gamma * D_f$	= 8.75 kN/Sq.m	
N_c =	Bearing capacity factor due to cohesion	= 24.01	
N_q =	Bearing capacity factor due to surcharge	= 13.23	
N_γ =	Bearing capacity factor due to weight of subsoil =	= 11.22	
S_c =	Shape factor correction due to cohesion	= 1	
S_q =	Shape factor correction due to surcharge	= 1	
S_γ =	Shape factor correction due to suboil weight	= 1	
FS=	Factor of safety	= 2.5	

Stresses on foundation

q_{ult} =	**Ultimate Bearing Capacity**	
=	$c\,N_c\,s_c + q\,N_q s_q + 0.5\,\gamma\,B_F\,N_\gamma\,s_\gamma\,W'$	= **287.59 kN/Sq.m**
q_{all} =	**Maximum Allowable stress**	= **115.04 kN/Sq.m**
	$q_{max} = N/B * (1 + 6 * e/B)$ =	= **47.01 kN/Sq.m**
		<qall safe
	$q_{min} = N/B * (1 - 6 * e/B)$ =	= **22.60 kN/Sq.m**
		<qall safe

Check for Internal stability

For i^{th} Layer

Bottom Width of i^{th} Layer= B_i

Coefficient of active thrust - Ka

Active Force for the i^{th} Layer $P_{ai} = 1/2 * \gamma * H_i^2 * Ka - 2C(Ka)^{1/2} + K_a * q * H_i + (\alpha h$ *(wt.of failure wedge @ i^{th} Layer))

Vertical Component of active force, = $P_{ai} \sin(\theta_{pa})$

Horizontal Component of active force,=$P_{ai} \cos(\theta_{pa})$

Normal Force at the base of the ith layer, $N_i = ((W_{g1}*H_1+W_{g2}*H_2+......+W_{gi}*H_i)/\cos(\beta))+(P_{ai}*\sin(\theta_{pa}))/\cos(\beta)$

Tangential Force at the base of the ith layer, $T_i = (P_{ai}*\cos(\delta)) - ((W_{g1}*H_1+W_{g2}*H_2+......+W_{gi}*H_i)*\sin(\beta))$

Shear stress at the bottom of i^{th} layer, $\tau_{max}=T_i/B_i$

Allowable shear force at the base of ith layer,$\tau_{all} = N_i*\tan(\phi^*)/B_i+C_g$

$Cg=0.3P_u-0.5$

$\phi^*=2.5\gamma_g - 10^o$

Where, γ_g is the unit weight of gabions.

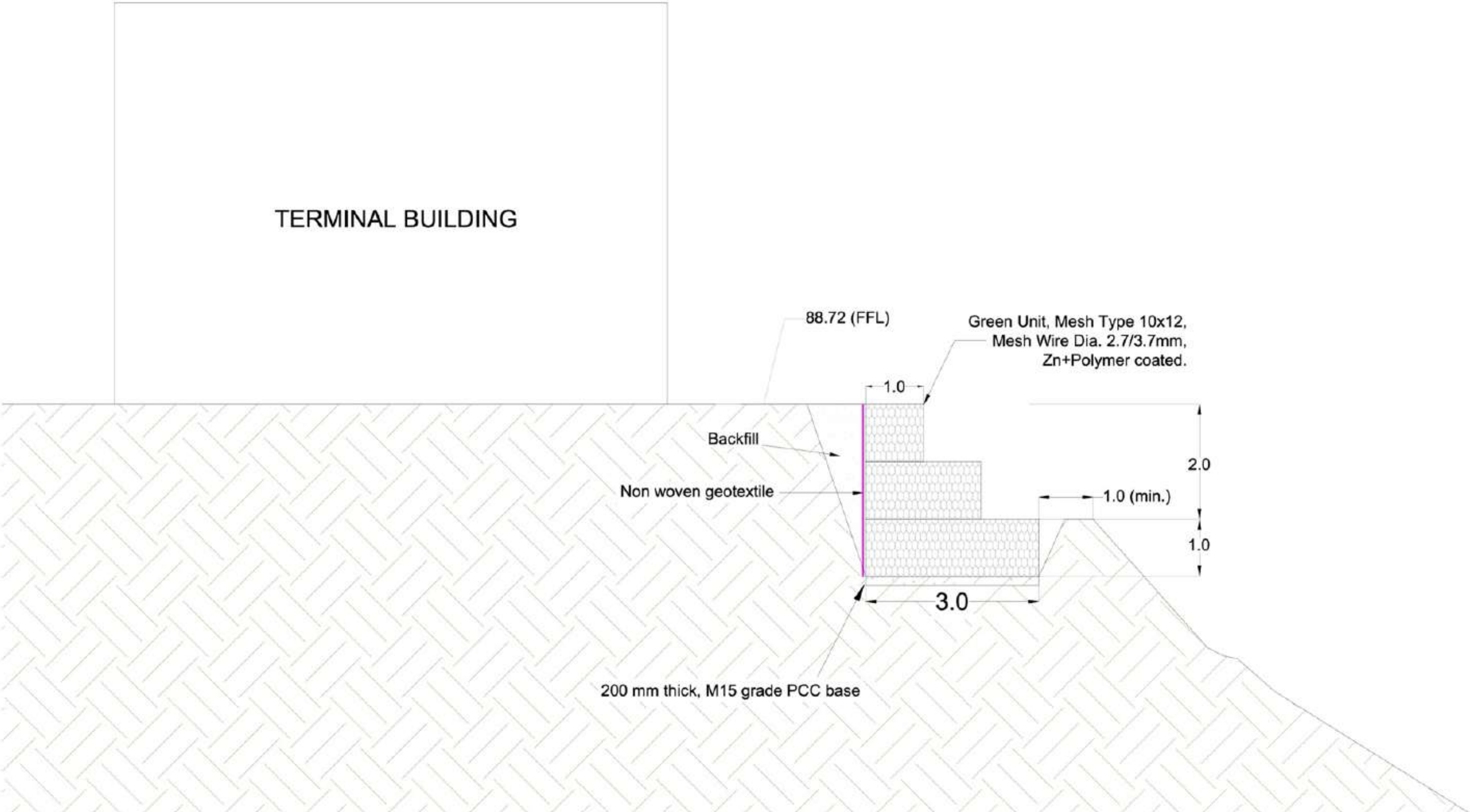
P_u is the meshweight expressed in kg/m^3.

C_g - Cohesive effect of the wire mesh on the Gabion structure expressed in t/m^2

Layer	Height in m	Active Force Pa in kN/m	Normal force @ the base kN/m	Tangential force @ the base kN/m	Shear stress @ the base in kN/Sq.m	Allow. Shear stress @ the base in kN/Sq.m	Remark
1	2.00	23.91	60.35	21.87	10.94	39.54	√
2	1.00	7.57	19.95	6.93	6.93	33.09	√
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							

(Refer AASHTO Clause no .5.5.5)

Annexure 2 – Typical Cross Section of Gabion Wall



TYPICAL CROSS SECTION FOR SLOPE PROTECTION AT NEMATI FERRY LOCATION

PROJECT NAME : SLOPE PROTECTION WORKS AROUND FERRY TERMINAL BUILDING IN MAJULI AND NORTH GUWAHATI	REV: R0	SHEET: 01 OF 02
CLIENT NAME : ASSAM INLAND WATER TRANSPORT DEVELOPMENT SOCIETY	N.T.S.	07.01.2025

Annexure 3 – Technical Specifications of Gabion

TECHNICAL SPECIFICATIONS OF GABION

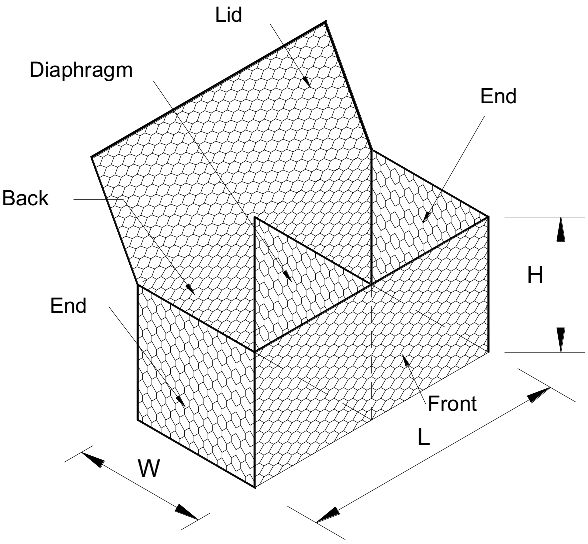
Providing & making Gabion structure with Mechanically Woven Double Twisted Hexagonal Shaped Wire mesh Gabion Boxes as per IS 16014:2012,MORTH Clause 2500, of required size, Mesh Type 10x12 (D=100 mm with tolerance of ±2%), Zinic+10% Al alloy+PVC coated, Mesh wire diameter 2.7/3.7 mm (ID/OD), mechanically edged/selvedged with partitions at every 1m interval and shall have minimum 10 numbers of openings per meter of mesh perpendicular to twist, tying with lacing wire of diameter 2.2/3.2 mm(ID/OD), supplied @3% by weight of Gabion boxes, filled with laterite boulders with least dimension of 200 mm, as per drawing, all complete as per directions of Engineer-in-charge.

Description

This work shall consist of furnishing, assembling, and filling mechanically woven double twist hexagonal wire mesh gabions with rock as specified in the contract to the dimensions, lines and grades shown on the plans, or as determined by the engineer. These specifications are mainly in accordance with Indian Standards IS 16014, IRC SP 116 and MoRTH (Fifth Revision) 2013, Clause 2500 and specifications mentioned in this section.

Material- Gabions

Wire



All tests on the mesh, lacing wire and selvedge wire must be performed prior to manufacturing the mesh.

Tensile strength: The wire used for the manufacture of Mesh shall have a tensile strength minimum 420 N/mm^2 in accordance with IS 280. Wire tolerances (Table 1) shall be in accordance with IS 16014:2012 (Class T1).

Elongation: Elongation shall not be less than 10%, in accordance with IS 16014:2012 and MoRTH(Fifth Revision) Clause 3100. Test must be carried out on a sample at least 20 cm long.

Internal Connecting Wires:

Cross Ties/ stiffener wire: Diameter 2.2 mm, Zinc coated wire with Polymer coating, 3.2mm when measured with Polymer coating.

Metalic Coating (Zn-Al Alloy)

The specifications of metallic coating are as follows:

- Metalic coating: The wire shall have minimum quantities of Zn90%-Al10% alloy shown at Table 1 in accordance with IS 4826:1979
- Adhesion of metalic coating: The adhesion of the metalic coating to the wire shall be such that, when the wire is wrapped ten turns around a mandrel having four times the diameter of the wire, it does not flake or crack when rubbing it with the bare fingers in accordance with IS 4826:1979.
- Outwearing accelerated aging test: when subjected to test in sulphur dioxide environment (EN ISO 6988) after 28 cycles of discontinuous test the mesh shall not show more than 5% of DBR (Dark Brown Rust).

Polymer Coating

The specifications of the polymer coating are as follows:

- Polymer coating thickness: Nominal – 0.5 mm, Minimum – 0.4 mm;
- Colour: grey RAL 7037
- Resistance to UV radiation: the tensile strength and elongation at break of the base compound after a UV-rays exposition of 4000 hours to Xenon Arc (ISO 4892-2) or 2500 hours QUV-A (ISO 4892-3, exposure mode 1) cannot change more than 25% from the initial test results.
- Chemical resistance: the polymer shall resist to the chemical agents in concentrations that are representative of soil and water normally found in civil works.
- Outwearing accelerated aging test: when subjected to the neutral salt spray tests (ISO 9227) after 6000 hours of exposure the mesh shall not show more than 5% of DBR (Dark Brown Rust).

Abrasion test, in accordance with the procedure described in par. 4.1.2.1 of EN 60229:2008, with a vertical force of the steel angle of 20N: after 100,000 cycles the polymer coating shall not expose the metal wire.

When the mesh is tested at 50 % of the nominal tensile strength in accordance to EN 10223-3:2013 / IRC SP 116 / IS 16014, the wires will not show cracks in the organic coating within the double twist region

Wire mesh (10x12 mesh type):

Mesh type	"D"(mm)	Metalic +Polymer coated		
		Diameter of wire (Inner/Outer wire)		
		Mesh wire(mm)	Selvedge wire (mm)	Lacing wire(mm)
10X12	100mm	2.7/3.7	3.4/4.4	2.2/3.2

Mesh opening: Nominal Dimension D = 100, as per Fig. 2 Tolerances in Mesh Opening size: -4% to +4%

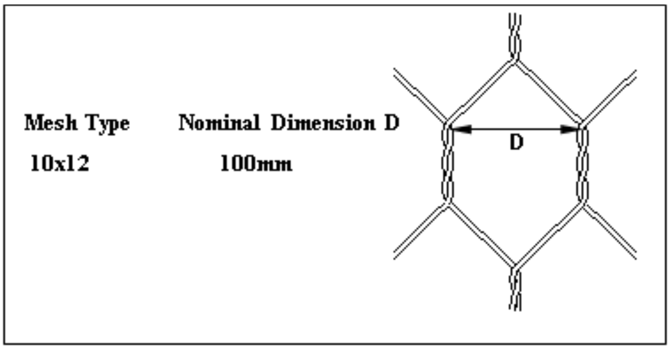


Figure (2)

Tolerances

Wire: wire diameter tolerance and minimum metallic coating requirement shall be as per following table

Table (1)

Wire Diameter mm	2.2 mm	2.7 mm	3.4 mm
Wire Tolerance(+)mm	0.06	0.07	0.09
Minimum Qty of Metalic coating (gm per sqm)	240	260	270

Standard Sizes

Standard sizes (Length x Breadth x Height) of gabions are 4m x 1m x 1m, 3m x 1m x 1m, 2m x 1m x 1m, 1.5m x 1m x 1m, 4m x 1m x 0.5m, 3m x 1m x 0.5m and 2m x 1m x 0.5m as showin in table of standard sizesTolerance in gabion dimensions of ± 5% in all dimensions (length, breadth and height) shall be allowed as tolerance for Gabion units.

Fabrication

Gabions shall be manufactured with all components mechanically connected at the production facility. The front, base, back and lid of the gabions shall be woven into a single unit. The ends and diaphragm(s) shall be factory connected to the base. The lid may be a separate piece made of the same type mesh as the basket. All perimeter edges of the mesh forming the basket and top, or lid, shall be selvedge with wire having a larger diameter.

Gabion is divided into cells by means of diaphragms positioned at approximately 1m centres. The diaphragms shall be secured in position to the base so that no additional lacing is necessary at the jobsite.

Table (2) Standard Sizes of Gabion

Length, m	Width, m	Height, m	Number of Diaphragms
4.0	1.0	1.0	3
3.0	1.0	1.0	2
2.0	1.0	1.0	1
1.5	1.0	1.0	0
4.0	1.0	0.5	3
3.0	1.0	0.5	2
2.0	1.0	0.5	1

Construction Requirements

Gabion filling and lacing and erection at site should be strictly as per the instruction of approved (by engineer) manufacturer's instructions as per the site specific requirements.

Assembly

Gabions are supplied folded flat and packed in bundles. Larger units may be supplied in rolls. The units are assembled individually by erecting the sides, ends, and diaphragms, ensuring that all panels are in the correct position, and the tops of all sides are satisfactorily aligned. The four corners shall be connected first, followed by the internal diaphragms to the outside walls.

The procedure for using lacing wire consists of cutting a sufficient length of wire, and first looping and/or twisting the lacing wire to the wire mesh. Proceed to lace with alternating double and single loops through every mesh opening, pulling each loop tight and finally securing the end of the lacing wire to the wire mesh by looping and/or twisting. Refer figure 3.

Lacing wire

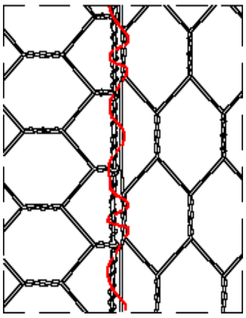


Figure (3)

Installation

After initial assembly, the gabions are carried to their final position and are securely joined together along the vertical and top edges of their contact surfaces using the same connecting procedure(s) described earlier. Whenever a structure requires more than one layer, the upper empty baskets shall also be connected to the top of the lower layer along the front and back edges of the contact surface using the same connecting procedure(s) described in Section 1.3.1.

Filling

Laterite Stone boulder/rock for the Gabion facia shall be hard, durable and of such quality that they shall not disintegrate on exposure to water or weathering during the life of the structure. The rocks shall range between 150 mm to 250 mm for 10x12 type mesh. Each range of sizes may allow for a variation of 5% oversize rock by number of particles, or 5% undersize rock by number of particles, or both. The size of any oversize rock shall allow for the placement of minimum of three layers of rock must be achieved when filling the 1 m high units and a minimum of two layers for the 0.50 m high units. The rock used for filling the gabion facia shall have a minimum density of $24kN/m^3$ and Los Angeles abrasion value not more than 45.

The facing section shall be filled with rock in a careful way to get good horizontal and vertical alignment. During the filling operation skilled manual stone placement is required to minimize voids. The maximum permitted porosity of stone filling shall be 40%. For vertical or near vertical structures the exterior of the basket may be carefully hand placed to give a neat, flat, and compact appearance. Care shall be taken when placing fill material to ensure that the sheathing on the Polymer coated baskets is not damaged. The facing stones should orient in such a way to get their flat surfaces facing to the front.

The cells shall be filled in stages so that local deformation may be avoided. At no time shall any cell be filled to a depth exceeding 0.30 m higher than the adjoining cell. It is also recommended to slightly overfill the baskets by 25mm to 50 mm to allow for settlement of the rock.

Internal Connecting Wires Installation

Internal Connecting Wires shall connect the exposed face of a cell to the opposite side of the cell. An exposed face is any side of a gabion cell that will remain exposed or unsupported after the structure is completed. Lacing wire or prefabricated internal connecting wires shall be used as internal connecting wires.

1 meter High Gabions

1meter high gabions shall be filled in three layers, 300 mm at a time. Connecting wires shall be installed after the placement of each layer, that is, at 300 mm high.

0.5 meter High Gabions

0.5 meter high gabions do not require connecting wires unless the baskets are used to build vertical structures. These units shall be filled in two layers 250mm at a time. Connecting wires shall be installed after the placement of the first layer, which is at 250mm high.

Lid Closing

Once the gabion baskets are completely full, the lids will be pulled tight until the lid meets the perimeter edges of the basket. The lid must then be tightly laced and/or fastened along all edges, ends and tops of diaphragm(s) in the same manner as described in earlier sections.

Mesh Cutting and Folding

Where shown on the drawings or otherwise directed by the engineer, the gabions shall be cut, folded and fastened together to suit existing site conditions. The mesh must be cleanly cut and surplus mesh either folded back or overlapped so that it can be securely fastened together with lacing wire or fasteners in the manner described in earlier Section. Any reshaped gabions shall be assembled, installed, filled and closed as specified in the previous sections.

Method of Measurement

The payment quantities for excavation shall be determined by the outside limits of the gabion structure. Quantities will be determined from cross sections and the linear distance, and paid for under the appropriate bid items.

The quantity to be paid for “In place gabions” shall be the number of cubic meters of gabions. Project conditions and material availability will determine the actual size of gabions to be used.

Excavated material beyond the limits of the gabions shall be backfilled with gravel, crushed rock or other material approved by the engineer.

Basis of Payment

Accepted gabions will be paid for at the unit price for each pay item included in the contract.

Testing and Acceptance Criteria

Testing shall be carried out as per plan indicated in Table 3. The material should get approval from the client before the actual supply start. The manufacturer of the Gabion facing unit should provide "Manufacturers Test Certificate' for the material with every lot/shipment.

Tensile strength test and zinc coating test on basic wire shall be done on one sample per every 10,000 numbers of units supplied.

Polymer Coating Thickness*:* The thickness of the Polymer coating shall be determined on a randomly chosen individual piece of wire removed from the coil at 3 places 1 metre apart.

Measure with a micrometer the diameter of the galvanized steel wire with Polymer coating. Determine the thickness of the Polymer coating by stripping the Polymer coating from the wire and measure the reduced diameter with a micrometer. The thickness of the coating is the difference between the diameter of the galvanized steel wire with Polymer coating and the measured diameter of the galvanized steel wire divided by two. The thickness values should be as per clause 1.2.4. While removing the Polymer coating by stripping, take care not to remove any of the metallic surfaces.

The punch strength test results shall be 22 kN in accordance with MoRTH section 2500 and test specified therein.

Selvedge Strength Test

A tensile test on mesh sample shall be carried out in order to estimate selvedge strength test. The test shall be carried out as per procedure outlined below. The selvedge strength shall be minimum 25 kN/m.

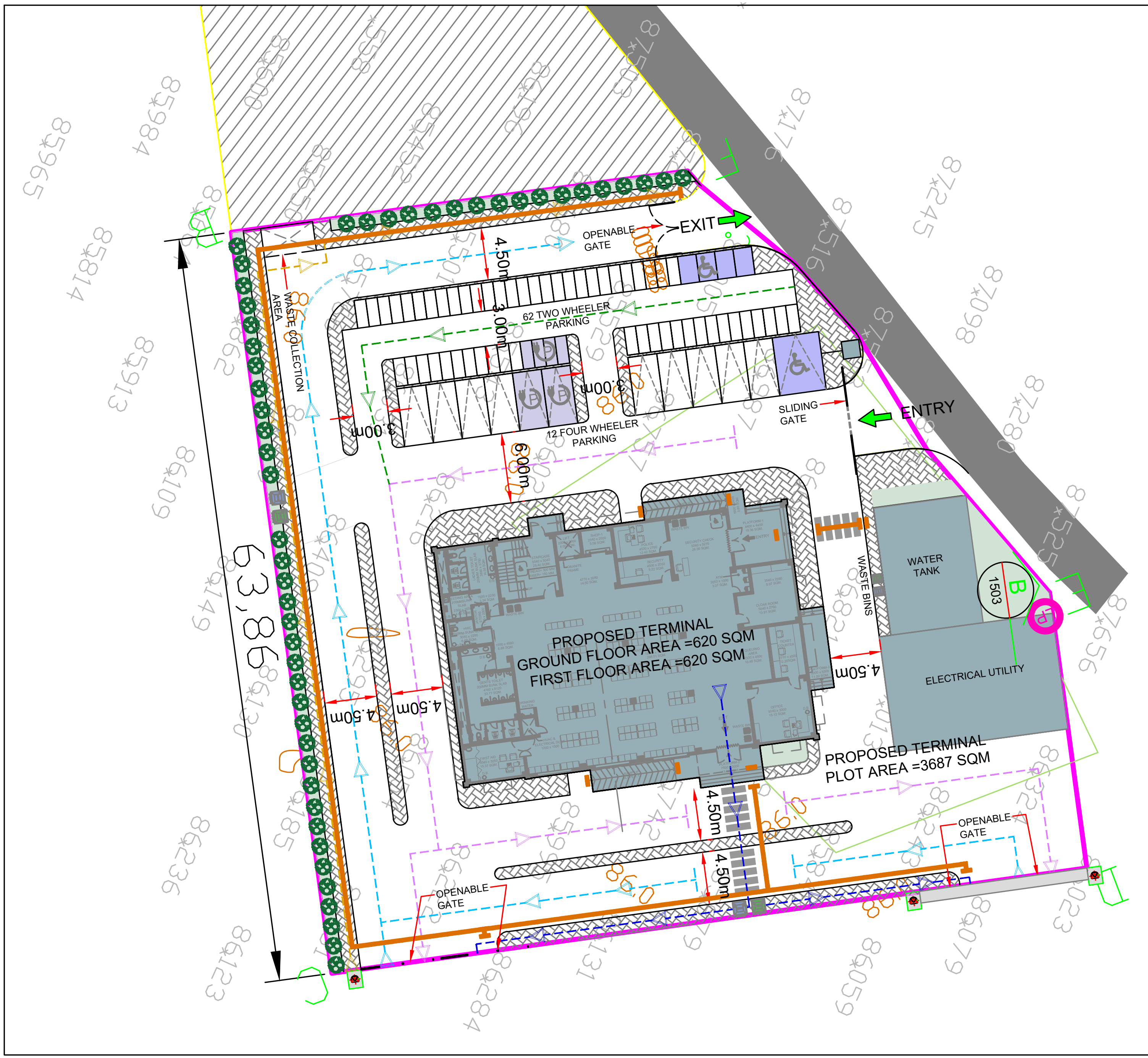
a. Take a DT mesh of approximately 1.0 m width.
b. The height of the sample shall be such that after selvedging on both the sides (1m), there shall be at least two mesh repetitions between the two selvedged wires, so that effective height of the sample shall be more than 300 mm.
c. Sample shall be loaded on the UTM in a direction parallel to twist, with the samples being gripped at the two selvedged wires & not mesh twist.
d. The distance between the two selvedge wires shall be recorded as Initial gauge length.
e. Distance between the two end gripping points (pins) along the width of the sample shall be recorded as the unit width under test. The width shall be at least 700 mm.
f. The load shall be applied gradually to the sample and the test be continued till the break point.
g. The peak load and the % elongation shall be recorded.
h. The strength of the selvedge connection shall be (peak load/unit width under test) expressed in kN/m.

Note. If the sample slips at any of the gripping point during the test, such a test shall be discarded, and a new sample shall be taken.

Table 3 Testing Plan

Sr No	Test	Reference	Frequency of Testing	Sample size	Remarks
	Mesh Wire				
1	Tensile strength & Elongation%	IS 16014 / EN 10223	Once	Three	At DT wire mesh gabion manufacturer's lab
2	Mass of metalic coating & adhesion	IS 4826	Once	Three	At DT wire mesh gabion manufacturer's lab
	DT Mesh and Gabion				
3	DT wire mesh panel strength	IS 16014 / EN 10223	Once	Three	At DT wire mesh gabion manufacturer's lab
4	Physical dimension of Wire mesh gabion	TDS, Visual checking			At DT wire mesh gabion manufacturer's lab
	Polymer Coating				
5	Polymeric coating cracking at 50% tensile strength	IS 16014 / EN 10223	Once	Three	At DT wire mesh gabion manufacturer's lab
6	Polymeric coating thickness	Clause 1.6	Once	Three	At DT wire mesh gabion manufacturer's lab
7	Abrasion of polymeric coating	EN 60229:2008	Once	DOP	At DT wire mesh gabion manufacturer's lab
Note:	Testing of wire shall be done on samples from raw material DOP – Declaration of performance based on facility available at manufacturer laboratory and one third party test report.				

Annexure 4 – Gabion Wall Layout Plan



GENERAL NOTES:

1. ALL DIMENSIONS ARE IN METERS, UNLESS NOTED OTHERWISE.
2. ALL SITE LEVELS ARE IN METERS, WITH RESPECT TO MEAN SEA LEVEL (MSL).
3. THE CONTRACTORS IS RESPONSIBLE FOR THE VERIFICATION OF ALL DIMENSIONS ON SITE AND THE CONSULTANT/ARCHITECT SHOULD BE INFORMED OF ANY DISCREPANCY.
4. DO NOT SCALE THE DRAWINGS.
5. UNLESS SPECIFIED OTHERWISE, CONTRACTOR TO FOLL TENDER SPECIFICATIONS FOR BUILDING FINISHING WORKS.

KEY PLAN:

LEGENDS:

CLIENT:
TRANSPORT DEPARTMENT, GOVT OF ASSAM

PMU:
ASSAM INLAND WATER TRANSPORT DEVELOPMENT SOCIETY (AIWTDS)

CONSULTANTS:
INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI

SURVEYED BY:

PROJECT NAME:
GABION WALL LAYOUT TERMINAL AROUND TERMINAL BUILDING OF NEAMATI

NAME & LOCATION:
NEAMATI GHAT

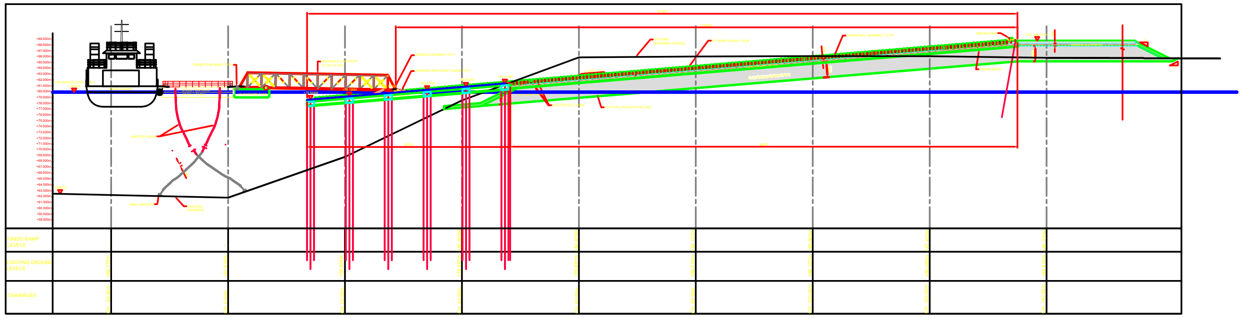
DRAWN BY :	CHECKED BY :	APPROVED BY :
DATE:	DATE:	DATE:
DRAWING NO:		SCALE:

Annexure 5 – Bill of Quantities for Gabion Wall for Neamati Site

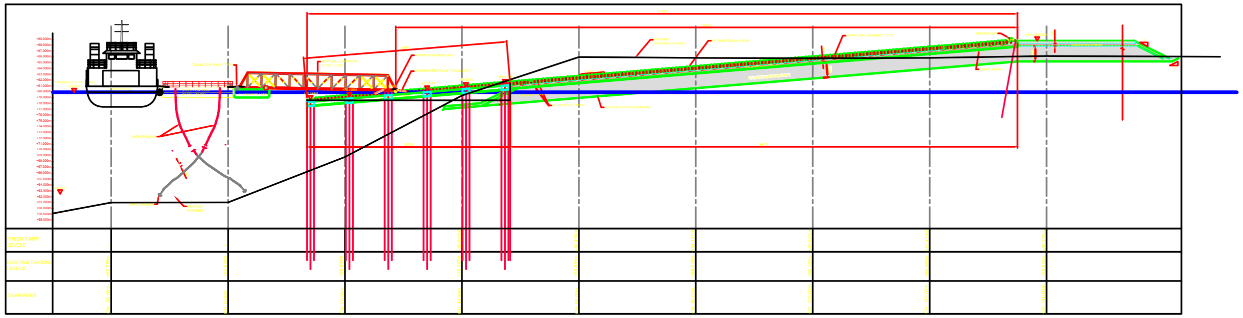
Bill of Quantities for the Gabion Wall for Neamati Site

Code	Description of Items	Unit	Quantity	Rate/ Unit (Rs.)	Amount (Rs.)
DSR 2023 Vol II 16.96	Providing & making Gabion structure with Mechanically Woven Double Twisted Hexagonal Shaped Wire mesh Gabion Boxes as per IS 16014:2018, MORTH Clause 2500, of required size, Mesh Type 10x12 (D=100 mm with tolerance of ±2%), Zinc+10% Al alloy+PVC coated, Mesh wire diameter 2.7/3.7mm (ID/OD), mechanically edged/ selvedged with partitions at every 1m interval and shall have minimum 16 numbers of openings per meter of mesh perpendicular to twist, tying with lacing wire of diameter 2.2/3.2mm (ID/OD), supplied @3% by weight of Gabion boxes, as per drawing, all complete as per directions of Engineer-in-Charge.	cum	1625	5703.50	92,68,195.09
MoRTH 700 & 2504 Sr No 15.6	Laying of a geotextile filter between pitching and embankment slopes on which pitching is laid to prevent escape of the embankment material through the voids of the stone pitching/cement concrete blocks as well as to allow free movement of water without creating any uplift head on the pitching.	sqm	825	201.37	1,66,130.25
DSR 2023 Vol I 4.1.3	Providing and laying in position cement concrete of specified grade excluding the cost of cantering and shuttering for 1:2:4 (1 cement : 2 coarse sand (zone-III) derived from natural sources : 4 graded stone aggregate 20 mm nominal size derived from natural sources)	cum	175	9203.86	16,10,674.65
TOTAL AMOUNT IN INR					**1,10,44,999.99**

Annexure 6 - Piles for Approach Ramp – Drawings and Layout



SECTION A-A
(LONGITUDINAL SECTION THROUGH BUND)
BERTHING ARRANGEMENT AT LWL



SECTION A-A
(LONGITUDINAL SECTION THROUGH BUND)
BERTHING ARRANGEMENT AT LWL

NOTES :

1. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH THE ARCHITECTURAL DRAWING.
2. FIGURED DIMENSIONS SHOULD BE FOLLOWED.
3. ALL DIMENSION ARE IN MM.
4. **PILE DIA=1200MM**, PILE LENGTH FROM EXISTING GROUND LEVEL IS **35M** FROM H.F.L
5. USE CONCRETE GRADE **M-40** FOR PILE
6. USE 10% EXTRA CEMENT IN CONCRETING UNDER WATER.
7. ALL REINFORCEMENT BARS SHOULD BE T.M.T. BARS OF GRADE **Fe-500D** CONFORMING TO IS-1786.
8. DRAWING MUST BE CHECKED BEFORE EXECUTION. INCASE ANY DISCREPANCY ARISES IT SHOULD BE BROUGHT TO THE NOTICE OF THE CONSULTANT.
9. AGGREGATE SHALL BE COMPLY WITH THE REQUIREMENTS OF IS:383-1970.
10. ALL DETAILING OF REINFORCEMENT INCLUDING DUCTILITY REQUIREMENTS SHOULD BE CONFORM TO IS:456-2000, IS:13920 & IS:4326.MINIMUM MINIMUM CLEAR COVER TO REINFORCEMENT

PILE = 75MM (SIDE)
PILE CAP = 75MM (SIDE)
= 75MM (BOTTOM)
BEAM = 75MM
SLAB = 30MM
DEVELOPMENT LENGTH, Ld = 50D , WHERE
D = DIAMETER OF BAR

REV. NO.	DATE	NOTE
R0	20.01.2025	FOR APPROVAL

REVISIONS

TRANSPORT DEPARTMENT,
GOVT OF ASSAM

ASSAM INLAND WATER TRANSPORT DEVELOPMENT SOCIETY (AIWTDS)

DIPANKAR DAS
PROJECT MANAGER (TECHNICAL)

CONSULTANTS:

INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI

PROJECT NAME:

DEVELOPMENT OF TERMINAL ALONG WITH RIVERINE INFRASTRUCTURE AT VARIOUS LOCATIONS ALONG NW-2 ON RIVER BRAHMAPUTRA

NAME & LOCATION:

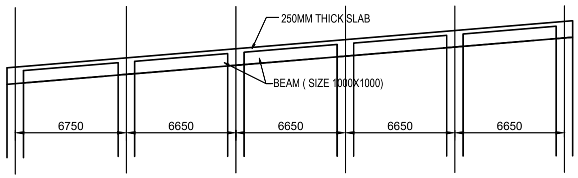
NEAMATI FERRY TERMINAL & RIVERINE INFRASTRUCTURE

PROJECT TITLE:

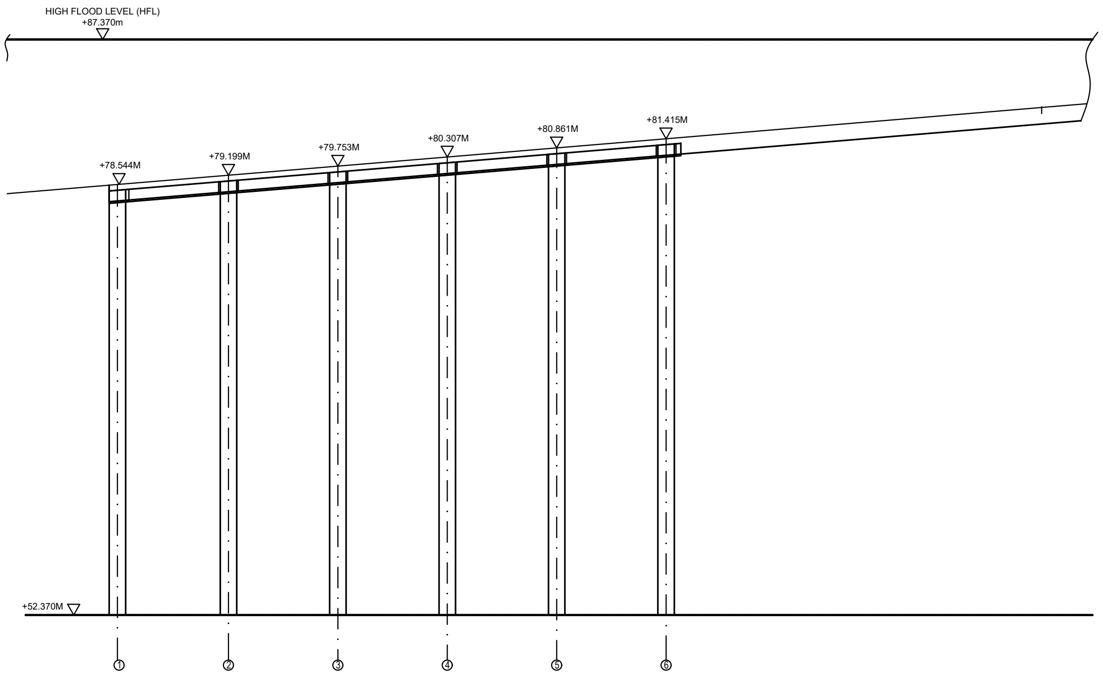
PILE SECTION

DRAWN BY :	CHECKED BY :	APPROVED BY :
RIZWANA	D.T	RS
DATE: 20.01.2025	DATE: 20.01.2025	DATE: 20.01.2025

DRAWING NO:	SCALE:
D1530-RHD-ZZ-NI-DR-C-1502	N.T.S

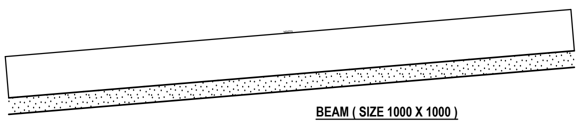


LONG SECTION OF BEAM AND SLAB



LONGITUDINAL PILE SECTION

SL.NO	GRID NO.	PILE CUT-OFF LEVEL
1	1	+78.544M
2	2	+79.199M
3	3	+79.753M
4	4	+80.370M
5	5	+80.861M
6	6	+81.415M



BEAM (SIZE 1000 X 1000)

NOTES :

1. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH THE ARCHITECTURAL DRAWING.
2. FIGURED DIMENSIONS SHOULD BE FOLLOWED.
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6. USE 10% EXTRA CEMENT IN CONCRETING UNDER WATER.
7. ALL REINFORCEMENT BARS SHOULD BE T.M.T. BARS OF GRADE **Fe-500D** CONFORMING TO IS-1786.
8. DRAWING MUST BE CHECKED BEFORE EXECUTION. INCASE ANY DISCREPANCY ARISES IT SHOULD BE BROUGHT TO THE NOTICE OF THE CONSULTANT.
9. AGGREGATE SHALL BE COMPLY WITH THE REQUIREMENTS OF IS:383-1970.
10. ALL DETAILING OF REINFORCEMENT INCLUDING DUCTILITY REQUIREMENTS SHOULD BE CONFORM TO IS:456-2000, IS:13920 & IS:4326.MINIMUM MINIMUM CLEAR COVER TO REINFORCEMENT
    PILE = 75MM (SIDE)
    PILE CAP = 75MM (SIDE)
    = 75MM (BOTTOM)
    BEAM = 75MM
    SLAB = 30MM
    DEVELOPMENT LENGTH, Ld = 50D , WHERE D = DIAMETER OF BAR

R0	20-01-2025	FOR APPROVAL
REV. NO.	DATE	NOTE

REVISIONS

CLIENT:

TRANSPORT DEPARTMENT, GOVT OF ASSAM

PMU:

ASSAM INLAND WATER TRANSPORT DEVELOPMENT SOCIETY (AIWTDS)

CONSULTANTS:

INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI

PROJECT NAME:

DEVELOPMENT OF TERMINAL ALONG WITH RIVERINE INFRASTRUCTURE AT VARIOUS LOCATIONS ALONG NW-2 ON RIVER BRAHMAPUTRA

NAME & LOCATION:

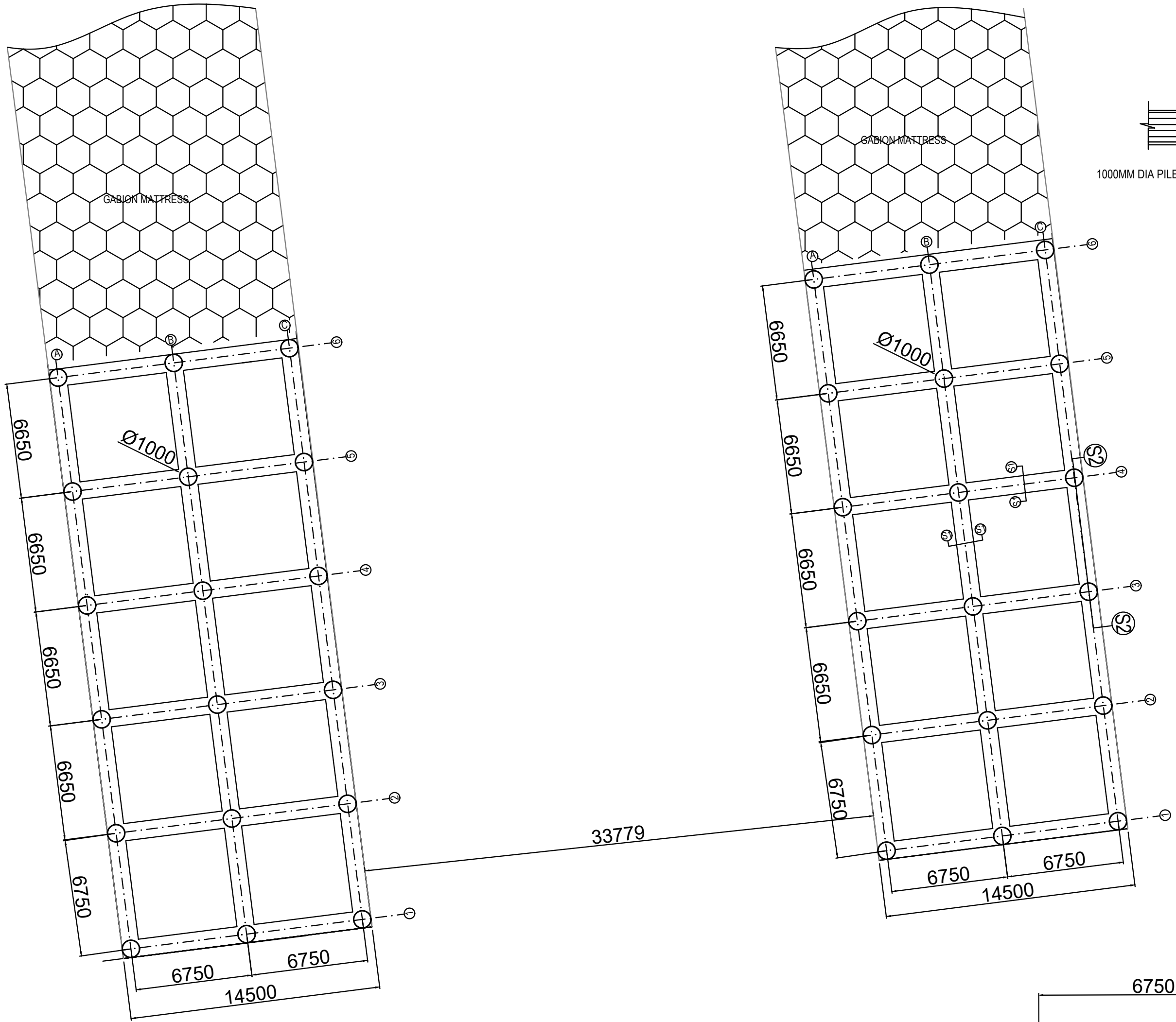
APHALAMUKH FERRY TERMINAL & RIVERINE INFRASTRUCTURE

PROJECT TITLE:

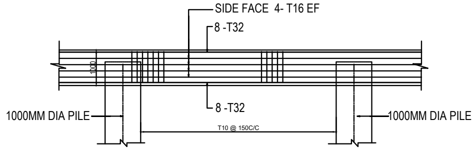
PILE , BEAM AND SLAB SECTION

DRAWN BY :	CHECKED BY :	APPROVED BY :
YAMINIK	D.T	RS
DATE: 20-01-2025	DATE: 20-01-2025	DATE: 20-01-2025

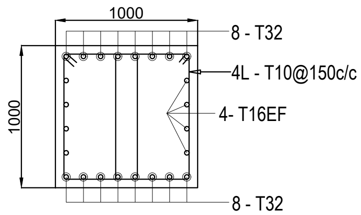
DRAWING NO:	SCALE:
DI1530-RHD-ZZ-AH-DR-C-1003	N.T.S



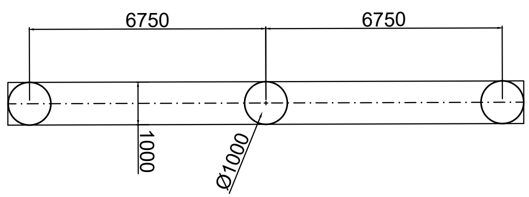
APPROACH CROSS BEAM LAYOUT



SECTION - S2 S2



TYPICAL BEAM DETAILS
OF APPROACH TRESTLE
SECTION - S1 S1



PLAN OF CROSS BEAM

NOTES :

1. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH THE ARCHITECTURAL DRAWING.
2. FIGURED DIMENSIONS SHOULD BE FOLLOWED.
3. ALL DIMENSION ARE IN MM.
4. **PILE DIA=1000MM**, PILE LENGTH FROM H.F.L IS **35M.**
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8. DRAWING MUST BE CHECKED BEFORE EXECUTION. INCASE ANY DISCREPANCY ARISES IT SHOULD BE BROUGHT TO THE NOTICE OF THE CONSULTANT.
9. AGGREGATE SHALL BE COMPLY WITH THE REQUIREMENTS OF IS:383-1970.
10. ALL DETAILING OF REINFORCEMENT INCLUDING DUCTILITY REQUIREMENTS SHOULD BE CONFORM TO IS:456-2000, IS:13920 & IS:4326.MINIMUM MINIMUM CLEAR COVER TO REINFORCEMENT
    PILE = 75MM (SIDE)
    PILE CAP = 75MM (SIDE)
    = 75MM (BOTTOM)
    BEAM = 75MM
    SLAB = 30MM
    DEVELOPMENT LENGTH, Ld = 50D , WHERE
    D = DIAMETER OF BAR

REV. NO.	DATE	NOTE
R0	31.01.2025	FOR APPROVAL

REVISIONS

CLIENT:
TRANSPORT DEPARTMENT, GOVT OF ASSAM

PMU:
ASSAM INLAND WATER TRANSPORT DEVELOPMENT SOCIETY (AIWTDS)

CONSULTANTS:
INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI

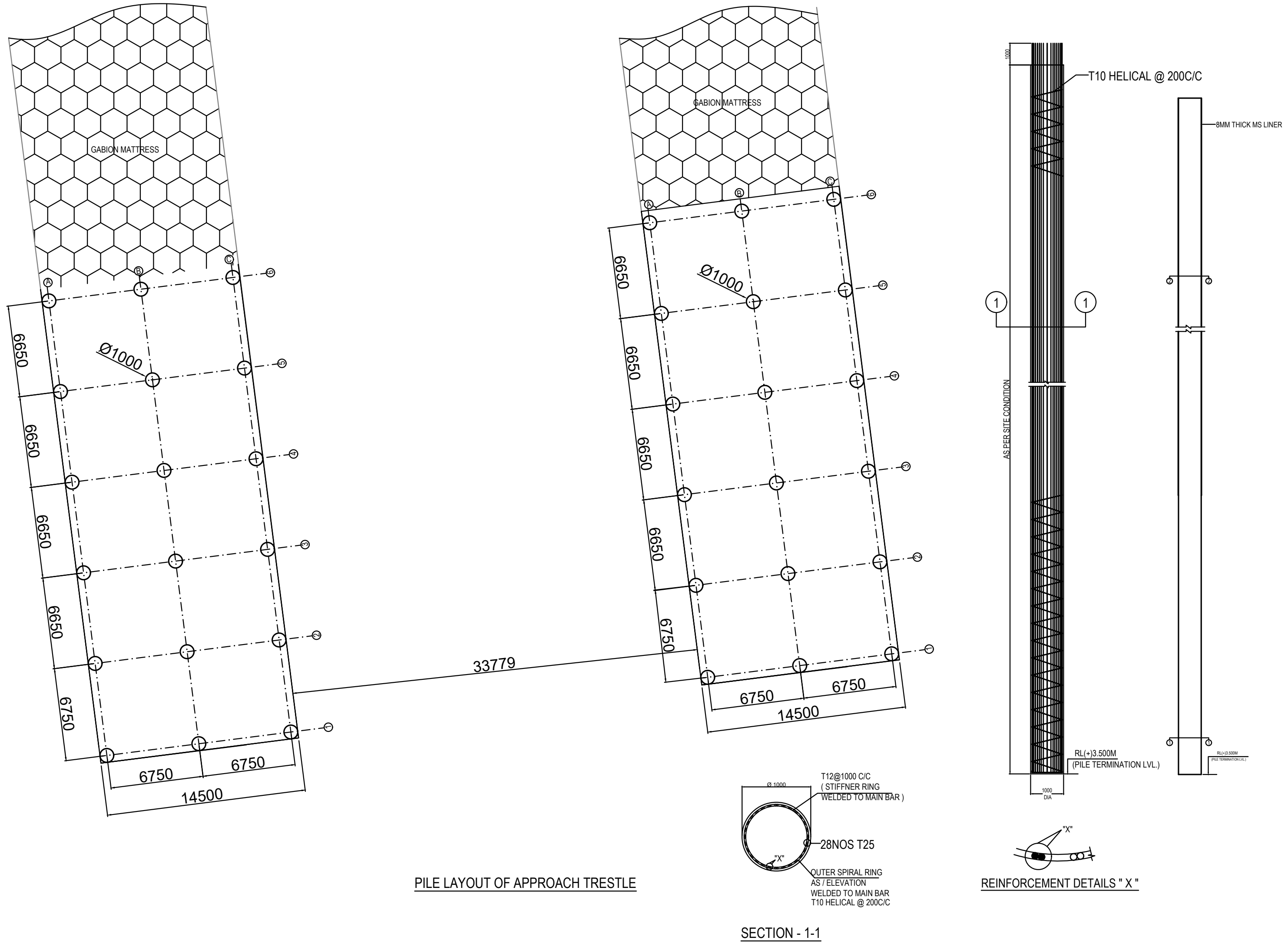
PROJECT NAME:
DEVELOPMENT OF TERMINAL ALONG WITH RIVERINE INFRASTRUCTURE AT VARIOUS LOCATIONS ALONG NW-2 ON RIVER BRAHMAPUTRA

NAME & LOCATION:
NEAMATI FERRY TERMINAL & RIVERINE INFRASTRUCTURE

PROJECT TITLE:
APPROACH TRESTILE LAYOUT AND REINFORCEMENT DETAILS OF CROSS BEAM

DRAWN BY :	CHECKED BY :	APPROVED BY :
YAMINIK	D.T	RS
DATE: 31.01.2025	DATE: 31.01.2025	DATE: 31.01.2025

DRAWING NO:	SCALE:
D1530-RHD-ZZ-NI-DR-C-1503	N.T.S



PILE LAYOUT OF APPROACH TRESTLE

SECTION - 1-1

REINFORCEMENT DETAILS " X "

NOTES :

1. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH THE ARCHITECTURAL DRAWING.
2. FIGURED DIMENSIONS SHOULD BE FOLLOWED.
3. ALL DIMENSION ARE IN MM.
4. **PILE DIA=1000MM**, PILE LENGTH FROM H.F.L IS **35M.**
5. USE CONCRETE GRADE **M-40** FOR PILE
6. USE 10% EXTRA CEMENT IN CONCRETING UNDER WATER.
7. ALL REINFORCEMENT BARS SHOULD BE T.M.T. BARS OF GRADE **Fe-500D** CONFORMING TO IS-1786.
8. DRAWING MUST BE CHECKED BEFORE EXECUTION. INCASE ANY DISCREPANCY ARISES IT SHOULD BE BROUGHT TO THE NOTICE OF THE CONSULTANT.
9. AGGREGATE SHALL BE COMPLY WITH THE REQUIREMENTS OF IS:383-1970.
10. ALL DETAILING OF REINFORCEMENT INCLUDING DUCTILITY REQUIREMENTS SHOULD BE CONFORM TO IS:456-2000, IS:13920 & IS:4326.MINIMUM MINIMUM CLEAR COVER TO REINFORCEMENT
    PILE = 75MM (SIDE)
    PILE CAP = 75MM (SIDE)
    = 75MM (BOTTOM)
    BEAM = 75MM
    SLAB = 30MM
    DEVELOPMENT LENGTH, Ld = 50D , WHERE
    D = DIAMETER OF BAR

REV. NO.	DATE	NOTE
R0	30.01.2025	FOR APPROVAL

REVISIONS

CLIENT:
TRANSPORT DEPARTMENT, GOVT OF ASSAM

PMU:
ASSAM INLAND WATER TRANSPORT DEVELOPMENT SOCIETY (AIWTDS)

CONSULTANTS:
INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI

PROJECT NAME:
DEVELOPMENT OF TERMINAL ALONG WITH RIVERINE INFRASTRUCTURE AT VARIOUS LOCATIONS ALONG NW-2 ON RIVER BRAHMAPUTRA

NAME & LOCATION:
NEAMATI FERRY TERMINAL & RIVERINE INFRASTRUCTURE

PROJECT TITLE:
PILE LAYOUT & REINFORCEMENT DETAILS

DRAWN BY :	CHECKED BY :	APPROVED BY :
YAMINIK	D.T	RS
DATE: 30.01.2025	DATE: 30.01.2025	DATE: 30.01.2025

DRAWING NO: D1530-RHD-ZZ-NI-DR-C-1503

SCALE: N.T.S

Annexure 7 – Bill of Quantities for Piling Works

Bill of Quantities of Pile Foundation for the Two Approach Ramps of Neamati Ferry Terminal

Sl. No	Item	Unit	Rate	Quantity	Amount (Rs)
1	Fabricating and supplying Mild Steel (MS) Liners at a suitable fabrication yard for bored cast-in-situ piles of 1,000 mm dia. piles in backwater to the required length using 8 mm thick plate, including cost of all materials, labour, cutting, rolling, welding etc. complete as per drawings, detailed specifications and directions of the Engineer-in-charge.	tonne	1,23,390.00	225.476	2,78,21,433.35
2	Transporting the fabricated MS liners fabricated as per item No.1 above from the fabrication yard to pile location, handling, pitching and driving the MS liners to required level and verticality including setting piling rigs/ gantry in position, temporary works for driving piles etc. complete all as per drawings, detailed specifications and directions of Engineer-in-charge.	nos.	31,740.00	36	11,42,640.00
3	Boring through all types of soils, viz gravel, clay, stiff clay, cemented clay, sand, weathered soft rock, lean mix concrete and boulders / rubble layer etc. (except soft and hard rock) for 1,000 mm dia. vertical piles upto (-) 60m depth including mobilisation/demobilisation of all plants and equipment, retaining of sides with bentonite slurry or polymer solutions and cleaning the bore holes, cost of all materials, labour, plants, equipment etc., including disposing of bored muck at a suitable dumping area, taking SPT values at founding level etc. complete as per drawings, detailed specifications and directions of Engineer-in-charge. (only length below existing bed level will be measured and paid for.)	m	20,130.00	920.007	1,85,19,740.91
4	Providing and laying Reinforced cement concrete of M40 grade in-situ by standard method of placing by tremie pipe inside the Pile bore including cost of all materials, labour, all sampling and testing/ recording, mixing with Bipolar concrete penetrating corrosion inhibiting admixtures, etc. complete but excluding reinforcement work as per drawings, detailed specifications and directions of Engineer-in-charge. [Only concrete quantity between founding level and 90cm above specified Pile cut off level will be measured & paid for].	cum	15,000.00	929.067	1,39,36,010.79
5	Providing and placing in position reinforcement in cages inside the pile bore using TMT/CRS/ HYSD bars of Fe550/Fe500 /Fe415 grade including cost of all materials, labour, transporting to site, cutting, bending, welding, lapping, tying, binding, fabricating into cages, installing in position, providing cover blocks, hire charges of all equipment, machinery etc. complete as per drawings, detailed specifications and directions of Engineer-in-charge. (The reinforcement bars, authorised laps, lifting hooks, development lengths, dowels for superstructure etc. as per approved bar bending schedule, will be measured & paid for)	tonne	1,40,000.00	135.799	1,90,11,865.69

Sl. No	Item	Unit	Rate	Quantity	Amount (Rs)
6	Chipping the concrete from the top of marine piles of 1,000 mm dia. up to cutoff level, exposing the reinforcement, dressing pile head and disposing off the dismantled materials at suitable locations as per the directions of the Engineer-in-charge and levelling including hire charges of all equipment, machinery, labour, consumables etc. complete.	cum	9,740.00	28.286	2,75,502.86
7	Mobilizing, arranging and carrying out low strain pile integrity test for 1,000 mm dia bored cast in situ pile in accordance with IS:14893 and ASTM D5882, surface impact method or by suitable method as approved by Engineer-in-charge and providing interpretation report from cut off level to founding level as per detailed specifications and directions of Engineer-in-charge.	per test	4,000.00	4	16,000.00
8	Providing and laying in-situ reinforced cement concrete of M40 grade for various components such as Pile caps, Pile Muff, Beams, Slabs etc. using graded course & fine aggregates excluding reinforcement work but including cost of materials, labour, shuttering, levelling, compacting, curing, mixing with Bipolar concrete penetrating corrosion inhibiting admixtures, providing necessary arrangements on slab and beam for fixing bollards, fenders, brackets, installing all pipe support and mechanical/ electrical fittings, fixtures, steel work with necessary welding to reinforcement, anchoring into concrete, pipes for electrical cables etc. complete as per drawings, detailed specifications and directions of Engineer-in-charge.	cum	21,670.00	421.443	91,32,669.81
9	Providing and fixing reinforcement using TMT/CRS/ HYSD bars of Fe 550/ Fe 500/ Fe 415 grade for the RCC works under item 8 above, including conveying, straightening, cutting, bending, welding, lapping and tying in position, fabrication and fixing dowels, shear ties and placing with adequate lapping lengths etc. complete as per drawings, detailed specifications and directions of the Engineer-in-charge.	tonne	1,41,670.00	61.981	87,80,855.18
					9,86,36,718.59

Annexure 8 –Pile Foundation Design Report

LOAD COMBINATION

FOR MAXIMUM PILE CAPACITY

LC-1	NS LWL Span dislodge case	FORCES @ PILE CAP BOTTOM						LC-1
S.N.	Description	V	H_L	H_T	M_{TT}	M_{LL}		
		Tonne	Tonne	Tonne	Tm	Tm		
1)	Sub-structure & Foundation	346.7			0.0	0.0		1
2)	Earth fill	60.9			0.0	0.0		1
3)	Super-structure DL right span	272.4			204.3	0.0		1
4)	SIDL (excluding surfacing) right span	25.5			19.1	0.0		1
5)	Surfacing right span	24.2			18.2	0.0		1
7.4)	Left span dislodge condition		3.5		41.6			1

S.N.	Description	Forces about toe				
		V	H_L	H_T	M_{TT}	M_{LL}
		Tonne	Tonne	Tonne	Tm	Tm
LC-1	NS LWL Span dislodge case	729.70	3.47	0	283.191	0

LC-2	NS LWL No Live load	FORCES @ PILE CAP BOTTOM						LC-2
S.N.	Description	V	H_L	H_T	M_{TT}	M_{LL}		
		Tonne	Tonne	Tonne	Tm	Tm		
1)	Sub-structure & Foundation	346.7			0.0	0.0		
2)	Earth fill	60.9			0.0	0.0		
3)	Super-structure DL Left span	272.4			-204.3	0.0		
4)	SIDL (excluding surfacing) Left span	25.5			-19.1	0.0		
5)	Surfacing Left span	24.2			-18.2	0.0		
3)	Super-structure DL right span	272.4			204.3	0.0		
4)	SIDL (excluding surfacing) right span	25.5			19.1	0.0		
5)	Surfacing right span	24.2			18.2	0.0		
7.3)	No Live load condition		3.5		41.6			

S.N.	Description	Forces about toe				
		V	H_L	H_T	M_{TT}	M_{LL}
		Tonne	Tonne	Tonne	Tm	Tm
LC-2	NS LWL No Live load	1051.79	3.47	0	41.6238	0

LC-3	NS LWL With LL max reaction case	FORCES @ PILE CAP BOTTOM						LC-3
S.N.	Description	V	H_L	H_T	M_{TT}	M_{LL}		
		Tonne	Tonne	Tonne	Tm	Tm		
1)	Sub-structure & Foundation	346.7			0.0	0.0		
2)	Earth fill	60.9			0.0	0.0		
3)	Super-structure DL Left span	272.4			-204.3	0.0		
4)	SIDL (excluding surfacing) Left span	25.5			-19.1	0.0		
5)	Surfacing Left span	24.2			-18.2	0.0		
3)	Super-structure DL right span	272.4			204.3	0.0		
4)	SIDL (excluding surfacing) right span	25.5			19.1	0.0		
5)	Surfacing right span	24.2			18.2	0.0		
6.1)	Max React. LL left span	52.7			-39.6	224.3		
6.2)	Max Reaction LL right span	74.3			55.7	272.9		
7.1)	Maximum Reaction case		16.2		194.3			

S.N.	Description	Forces about toe				
		V	H_L	H_T	M_{TT}	M_{LL}
		Tonne	Tonne	Tonne	Tm	Tm
LC-3	NS LWL With LL max reaction case	1178.8	16.19	0	210.459	497.204

LC-4	NS LWL With LL max moment case	FORCES @ PILE CAP BOTTOM						LC-4
S.N.	Description	V	H_L	H_T	M_{TT}	M_{LL}		
		Tonne	Tonne	Tonne	Tm	Tm		
1)	Sub-structure & Foundation	346.7			0.0	0.0		1
2)	Earth fill	60.9			0.0	0.0		1
3)	Super-structure DL Left span	272.4			-204.3	0.0		1
4)	SIDL (excluding surfacing) Left span	25.5			-19.1	0.0		1
5)	Surfacing Left span	24.2			-18.2	0.0		1
3)	Super-structure DL right span	272.4			204.3	0.0		1
4)	SIDL (excluding surfacing) right span	25.5			19.1	0.0		1
5)	Surfacing right span	24.2			18.2	0.0		1
6.1)	Max long moment LL left span	0.0			0.0	0.0		1
6.2)	Max long. Moment LL right span	149.4		23.5	112.1	798.1		1
7.2)	Maximum moment case		16.2		194.3			1

S.N.	Description	Forces about toe				
		V	H_L	H_T	M_{TT}	M_{LL}
		Tonne	Tonne	Tonne	Tm	Tm
LC-4	NS LWL With LL max moment case	1201.24	16.19	23.54	306.4 1	798.08

LC-5	LC-1 + Seismic Sx=1,Sz=0.3,Sy=-0.3 (	FORCES @ PILE CAP BOTTOM						LC-5
S.N.	Description	V	H_L	H_T	M_{TT}	M_{LL}		
		Tonne	Tonne	Tonne	Tm	Tm		
1)	Sub-structure & Foundation	346.7			0.0	0.0		1
2)	Earth fill	60.9			0.0	0.0		1
3)	Super-structure DL right span	272.4			204.3	0.0		1
4)	SIDL (excluding surfacing) right span	25.5			19.1	0.0		1
5)	Surfacing right span	24.2			18.2	0.0		1
7.4)	Left span dislodge condition		3.5		41.6			1
Seismic Longitudinal LWL								0.5
8.2)	Permanent Loads Right span		38.7		463.8			0.5
11)	Sub-structure Component		9.1		79.4			0.5
Seismic Transveres LWL								0.15
12.2)	Permanent Loads Right span			19.3		261.0		0.15
14)	Sub-structure Component			9.1		79.4		0.15
Seismic Vertical Downward LWL								0.15
15.2)	Permanent Loads Right span	12.9			9.7	0.0		-0.15
17)	Sub-structure Component	6.0			0.0	0.0		-0.15

S.N.	Description	Forces about toe				
		V	H_L	H_T	M_{TT}	M_{LL}
		Tonne	Tonne	Tonne	Tm	Tm
LC-5	LC-1 + Seismic Sx=1,Sz=0.3,Sy=-0.3 (	726.86	27.33	4.26	553.3 3	51.06

LC-6	LC-1 + Seismic Sx=0.3,Sz=1,Sy=-0.3 (	FORCES @ PILE CAP BOTTOM						LC-6
S.N.	Description	V	H_L	H_T	M_{TT}	M_{LL}		
		Tonne	Tonne	Tonne	Tm	Tm		
1)	Sub-structure & Foundation	346.7			0.0	0.0		1
2)	Earth fill	60.9			0.0	0.0		1
3)	Super-structure DL right span	272.4			204.3	0.0		1
4)	SIDL (excluding surfacing) right span	25.5			19.1	0.0		1
5)	Surfacing right span	24.2			18.2	0.0		1
7.4)	Left span dislodge condition		3.5		41.6			1
Seismic Longitudinal LWL								0.15
8.2)	Permanent Loads Right span		38.7		463.8			0.15
11)	Sub-structure Component		9.1		79.4			0.15
Seismic Transveres LWL								0.5
12.2)	Permanent Loads Right span			19.3		261.0		0.5
14)	Sub-structure Component			9.1		79.4		0.5
Seismic Vertical Downward LWL								0.15
15.2)	Permanent Loads Right span	12.9			9.7	0.0		-0.15
17)	Sub-structure Component	6.0			0.0	0.0		-0.15

S.N.	Description	Forces about toe				
		V	H_L	H_T	M_{TT}	M_{LL}
		Tonne	Tonne	Tonne	Tm	Tm
LC-6	LC-1 + Seismic Sx=0.3,Sz=1,Sy=-0.3 (	726.864	10.627	14.1986	363.21 9	170.21 1

LC-7	LC-1 + Seismic Sx=1,Sz=0.3,Sy=0.3 (5	FORCES @ PILE CAP BOTTOM						LC-7
S.N.	Description	V	H_L	H_T	M_{TT}	M_{LL}		
		Tonne	Tonne	Tonne	Tm	Tm		
1)	Sub-structure & Foundation	346.7			0.0	0.0		1
2)	Earth fill	60.9			0.0	0.0		1
3)	Super-structure DL right span	272.4			204.3	0.0		1
4)	SIDL (excluding surfacing) right span	25.5			19.1	0.0		1
5)	Surfacing right span	24.2			18.2	0.0		1
7.4)	Left span dislodge condition		3.5		41.6			1
Seismic Longitudinal LWL								0.5
8.2)	Permanent Loads Right span		38.7		463.8			0.5
11)	Sub-structure Component		9.1		79.4			0.5
Seismic Transveres LWL								0.15
12.2)	Permanent Loads Right span			19.3		261.0		0.15
14)	Sub-structure Component			9.1		79.4		0.15
Seismic Vertical Downward LWL								0.15
15.2)	Permanent Loads Right span	12.9			9.7	0.0		0.15
17)	Sub-structure Component	6.0			0.0	0.0		0.15

S.N.	Description	Forces about toe				
		V	H_L	H_T	M_{TT}	M_{LL}
		Tonne	Tonne	Tonne	Tm	Tm
LC-7	LC-1 + Seismic Sx=1,Sz=0.3,Sy=0.3 (5	732.54	27.33	4.26	556.2 3	51.06

LC-8	LC-1 + Seismic Sx=0.3,Sz=1,Sy=0.3 (5	FORCES @ PILE CAP BOTTOM						LC-8
S.N.	Description	V	H_L	H_T	M_{TT}	M_{LL}		
		Tonne	Tonne	Tonne	Tm	Tm		
1)	Sub-structure & Foundation	346.7			0.0	0.0		1
2)	Earth fill	60.9			0.0	0.0		1
3)	Super-structure DL right span	272.4			204.3	0.0		1
4)	SIDL (excluding surfacing) right span	25.5			19.1	0.0		1
5)	Surfacing right span	24.2			18.2	0.0		1
7.4)	Left span dislodge condition		3.5		41.6			1
Seismic Longitudinal LWL								0.15
8.2)	Permanent Loads Right span		38.7		463.8			0.15
11)	Sub-structure Component		9.1		79.4			0.15
Seismic Transveres LWL								0.5
12.2)	Permanent Loads Right span			19.3		261.0		0.5
14)	Sub-structure Component			9.1		79.4		0.5
Seismic Vertical Downward LWL								0.15
15.2)	Permanent Loads Right span	12.9			9.7	0.0		0.15
17)	Sub-structure Component	6.0			0.0	0.0		0.15

S.N.	Description	Forces about toe				
		V	H_L	H_T	M_{TT}	M_{LL}
		Tonne	Tonne	Tonne	Tm	Tm
LC-8	LC-1 + Seismic Sx=0.3,Sz=1,Sy=0.3 (5	732.543	10.627	14.1986	366.11 8	170.21 1

LC-9	LC-2 + Seismic Sx=1,Sz=0.3,Sy=-0.3	FORCES @ PILE CAP BOTTOM						LC-9
S.N.	Description	V	H_L	H_T	M_{TT}	M_{LL}		
		Tonne	Tonne	Tonne	Tm	Tm		
1)	Sub-structure & Foundation	346.7			0.0	0.0		1
2)	Earth fill	60.9			0.0	0.0		1
3)	Super-structure DL Left span	272.4			-204.3	0.0		1
4)	SIDL (excluding surfacing) Left span	25.5			-19.1	0.0		1
5)	Surfacing Left span	24.2			-18.2	0.0		1
3)	Super-structure DL right span	272.4			204.3	0.0		1
4)	SIDL (excluding surfacing) right span	25.5			19.1	0.0		1
5)	Surfacing right span	24.2			18.2	0.0		1
7.3)	No Live load condition		3.5		41.6			1
Seismic Longitudinal LWL								1
8.2)	Permanent Loads Right span		38.7		463.8			1
11)	Sub-structure Component		9.1		79.4			1
Seismic Transveres LWL								0.3
12.1)	Permanent Loads Left span			19.3		261.0		0.3
12.2)	Permanent Loads Right span			19.3		261.0		0.3
14)	Sub-structure Component			9.1		79.4		0.3
Seismic Vertical Downward LWL								0.3
15.1)	Permanent Loads Left span	12.9			-9.7	0.0		-0.3
15.2)	Permanent Loads Right span	12.9			9.7	0.0		-0.3
17)	Sub-structure Component	6.0			0.0	0.0		-0.3

S.N.	Description	Forces about toe				
		V	H_L	H_T	M_{TT}	M_{LL}
		Tonne	Tonne	Tonne	Tm	Tm
LC-9	LC-2 + Seismic Sx=1,Sz=0.3,Sy=-0.3	1042.25	51.191 2	14.3168	584.80 8	180.44 1

LC-10	LC-2 + Seismic Sx=0.3,Sz=1,Sy=-0.3	FORCES @ PILE CAP BOTTOM						LC-10
S.N.	Description	V	H_L	H_T	M_{TT}	M_{LL}		
		Tonne	Tonne	Tonne	Tm	Tm		
1)	Sub-structure & Foundation	346.7			0.0	0.0		1
2)	Earth fill	60.9			0.0	0.0		1
3)	Super-structure DL Left span	272.4			-204.3	0.0		1
4)	SIDL (excluding surfacing) Left span	25.5			-19.1	0.0		1
5)	Surfacing Left span	24.2			-18.2	0.0		1
3)	Super-structure DL right span	272.4			204.3	0.0		1
4)	SIDL (excluding surfacing) right span	25.5			19.1	0.0		1
5)	Surfacing right span	24.2			18.2	0.0		1
7.3)	No Live load condition		3.5		41.6			1
Seismic Longitudinal LWL								0.3
8.2)	Permanent Loads Right span		38.7		463.8			0.3
11)	Sub-structure Component		9.1		79.4			0.3
Seismic Transveres LWL								1
12.1)	Permanent Loads Left span			19.3		261.0		1
12.2)	Permanent Loads Right span			19.3		261.0		1
14)	Sub-structure Component			9.1		79.4		1
Seismic Vertical Downward LWL								0.3
15.1)	Permanent Loads Left span	12.9			-9.7	0.0		-0.3
15.2)	Permanent Loads Right span	12.9			9.7	0.0		-0.3
17)	Sub-structure Component	6.0			0.0	0.0		-0.3

S.N.	Description	Forces about toe				
		V	H_L	H_T	M_{TT}	M_{LL}
		Tonne	Tonne	Tonne	Tm	Tm
LC-10	LC-2 + Seismic Sx=0.3,Sz=1,Sy=-0.3	1042.25	17.7854	47.7225	204.579	601.469

LC-11	LC-2 + Seismic Sx=1,Sz=0.3,Sy=0.3	FORCES @ PILE CAP BOTTOM						LC-11
S.N.	Description	V	H_L	H_T	M_{TT}	M_{LL}		
		Tonne	Tonne	Tonne	Tm	Tm		
1)	Sub-structure & Foundation	346.7			0.0	0.0		1
2)	Earth fill	60.9			0.0	0.0		1
3)	Super-structure DL Left span	272.4			-204.3	0.0		1
4)	SIDL (excluding surfacing) Left span	25.5			-19.1	0.0		1
5)	Surfacing Left span	24.2			-18.2	0.0		1
3)	Super-structure DL right span	272.4			204.3	0.0		1
4)	SIDL (excluding surfacing) right span	25.5			19.1	0.0		1
5)	Surfacing right span	24.2			18.2	0.0		1
7.3)	No Live load condition		3.5		41.6			1
Seismic Longitudinal LWL								1
8.2)	Permanent Loads Right span		38.7		463.8			1
11)	Sub-structure Component		9.1		79.4			1
Seismic Transveres LWL								0.3
12.1)	Permanent Loads Left span			19.3		261.0		0.3
12.2)	Permanent Loads Right span			19.3		261.0		0.3
14)	Sub-structure Component			9.1		79.4		0.3
Seismic Vertical Downward LWL								0.3
15.1)	Permanent Loads Left span	12.9			-9.7	0.0		0.3
15.2)	Permanent Loads Right span	12.9			9.7	0.0		0.3
17)	Sub-structure Component	6.0			0.0	0.0		0.3

S.N.	Description	Forces about toe				
		V	H_L	H_T	M_{TT}	M_{LL}
		Tonne	Tonne	Tonne	Tm	Tm
LC-11	LC-2 + Seismic Sx=1,Sz=0.3,Sy=0.3	1061.34	51.1912	14.3168	584.808	180.441

LC-12	LC-2 + Seismic Sx=0.3,Sz=1,Sy=0.3	FORCES @ PILE CAP BOTTOM						LC-12
S.N.	Description	V	H_L	H_T	M_{TT}	M_{LL}		
		Tonne	Tonne	Tonne	Tm	Tm		
1)	Sub-structure & Foundation	346.7			0.0	0.0		1
2)	Earth fill	60.9			0.0	0.0		1
3)	Super-structure DL Left span	272.4			-204.3	0.0		1
4)	SIDL (excluding surfacing) Left span	25.5			-19.1	0.0		1
5)	Surfacing Left span	24.2			-18.2	0.0		1
3)	Super-structure DL right span	272.4			204.3	0.0		1
4)	SIDL (excluding surfacing) right span	25.5			19.1	0.0		1
5)	Surfacing right span	24.2			18.2	0.0		1
7.3)	No Live load condition		3.5		41.6			1
Seismic Longitudinal LWL								0.3
8.2)	Permanent Loads Right span		38.7		463.8			0.3
11)	Sub-structure Component		9.1		79.4			0.3
Seismic Transveres LWL								1
12.1)	Permanent Loads Left span			19.3		261.0		1
12.2)	Permanent Loads Right span			19.3		261.0		1
14)	Sub-structure Component			9.1		79.4		1
Seismic Vertical Downward LWL								0.3
15.1)	Permanent Loads Left span	12.9			-9.7	0.0		0.3
15.2)	Permanent Loads Right span	12.9			9.7	0.0		0.3
17)	Sub-structure Component	6.0			0.0	0.0		0.3

S.N.	Description	Forces about toe				
		V	H_L	H_T	M_{TT}	M_{LL}
		Tonne	Tonne	Tonne	Tm	Tm
LC-12	LC-2 + Seismic Sx=0.3,Sz=1,Sy=0.3	1061.34	17.7854	47.7225	204.579	601.469

LC-13	LC-3 + Seismic Sx=1,Sz=0.3,Sy=-0.3	FORCES @ PILE CAP BOTTOM						LC-13
S.N.	Description	V	H_L	H_T	M_{TT}	M_{LL}		
		Tonne	Tonne	Tonne	Tm	Tm		
1)	Sub-structure & Foundation	346.7			0.0	0.0		
2)	Earth fill	60.9			0.0	0.0		
3)	Super-structure DL Left span	272.4			-204.3	0.0		
4)	SIDL (excluding surfacing) Left span	25.5			-19.1	0.0		
5)	Surfacing Left span	24.2			-18.2	0.0		
3)	Super-structure DL right span	272.4			204.3	0.0		
4)	SIDL (excluding surfacing) right span	25.5			19.1	0.0		
5)	Surfacing right span	24.2			18.2	0.0		
6.1)	Max React. LL left span	52.7			-39.6	224.3		0.2
6.2)	Max Reaction LL right span	74.3			55.7	272.9		0.2
Seismic Longitudinal LWL								
8.2)	Permanent Loads Right span		38.7		463.8			
9.2)	Live Load Longitudinal Right span		4.0		48.0			
11)	Sub-structure Component		9.1		79.4			
Seismic Transveres LWL								0.3
12.1)	Permanent Loads Left span			19.3		261.0		0.3
12.2)	Permanent Loads Right span			19.3		261.0		0.3
13.1)	Live Load comp. Left span			3.2		48.4		0.06
13.2)	Live Load comp. Right span			4.5		68.1		0.06
14)	Sub-structure Component			9.1		79.4		0.3
Seismic Vertical Downward LWL								0.3
15.1)	Permanent Loads Left span	12.9			-9.7	0.0		-0.3
15.2)	Permanent Loads Right span	12.9			9.7	0.0		-0.3
16.1)	Live Load comp. Left span	2.1			-1.6	9.0		-0.06
16.2)	Live Load comp. Right span	3.0			2.2	10.9		-0.06
17)	Sub-structure Component	6.0			0.0	0.0		-0.3

S.N.	Description	Forces about toe				
		V	H_L	H_T	M_{TT}	M_{LL}
		Tonne	Tonne	Tonne	Tm	Tm
LC-13	LC-3 + Seismic Sx=1,Sz=0.3,Sy=-0.3	1067.35	51.7225	14.774	594.373	285.679

LC-14	LC-3 + Seismic Sx=0.3,Sz=1,Sy=-0.3	FORCES @ PILE CAP BOTTOM						LC-14
S.N.	Description	V	H_L	H_T	M_{TT}	M_{LL}		
		Tonne	Tonne	Tonne	Tm	Tm		
1)	Sub-structure & Foundation	346.7			0.0	0.0		
2)	Earth fill	60.9			0.0	0.0		
3)	Super-structure DL Left span	272.4			-204.3	0.0		
4)	SIDL (excluding surfacing) Left span	25.5			-19.1	0.0		
5)	Surfacing Left span	24.2			-18.2	0.0		
3)	Super-structure DL right span	272.4			204.3	0.0		
4)	SIDL (excluding surfacing) right span	25.5			19.1	0.0		
5)	Surfacing right span	24.2			18.2	0.0		
6.1)	Max React. LL left span	52.7			-39.6	224.3		0.2
6.2)	Max Reaction LL right span	74.3			55.7	272.9		0.2
Seismic Longitudinal LWL								
8.2)	Permanent Loads Right span		38.7		463.8			0.3
9.2)	Live Load Longitudinal Right span		4.0		48.0			
11)	Sub-structure Component		9.1		79.4			0.3
Seismic Transveres LWL								
12.1)	Permanent Loads Left span			19.3		261.0		
12.2)	Permanent Loads Right span			19.3		261.0		
13.1)	Live Load comp. Left span			3.2		48.4		0.2
13.2)	Live Load comp. Right span			4.5		68.1		0.2
14)	Sub-structure Component			9.1		79.4		
Seismic Vertical Downward LWL								0.3
15.1)	Permanent Loads Left span	12.9			-9.7	0.0		-0.3
15.2)	Permanent Loads Right span	12.9			9.7	0.0		-0.3
16.1)	Live Load comp. Left span	2.1			-1.6	9.0		-0.06
16.2)	Live Load comp. Right span	3.0			2.2	10.9		-0.06
17)	Sub-structure Component	6.0			0.0	0.0		-0.3

S.N.	Description	Forces about toe				
		V	H_L	H_T	M_{TT}	M_{LL}
		Tonne	Tonne	Tonne	Tm	Tm
LC-14	LC-3 + Seismic Sx=0.3,Sz=1,Sy=-0.3	1067.35	18.3168	49.2467	214.144	723.02

LC-15	LC-3 + Seismic Sx=1,Sz=0.3,Sy=0.3	FORCES @ PILE CAP BOTTOM						LC-15
S.N.	Description	V	H_L	H_T	M_{TT}	M_{LL}		
		Tonne	Tonne	Tonne	Tm	Tm		
1)	Sub-structure & Foundation	346.7			0.0	0.0		
2)	Earth fill	60.9			0.0	0.0		
3)	Super-structure DL Left span	272.4			-204.3	0.0		
4)	SIDL (excluding surfacing) Left span	25.5			-19.1	0.0		
5)	Surfacing Left span	24.2			-18.2	0.0		
3)	Super-structure DL right span	272.4			204.3	0.0		
4)	SIDL (excluding surfacing) right span	25.5			19.1	0.0		
5)	Surfacing right span	24.2			18.2	0.0		
6.1)	Max React. LL left span	52.7			-39.6	224.3		0.2
6.2)	Max Reaction LL right span	74.3			55.7	272.9		0.2
Seismic Longitudinal LWL								
8.2)	Permanent Loads Right span		38.7		463.8			
9.2)	Live Load Longitudinal Right span		4.0		48.0			
11)	Sub-structure Component		9.1		79.4			
Seismic Transveres LWL								0.3
12.1)	Permanent Loads Left span			19.3		261.0		0.3
12.2)	Permanent Loads Right span			19.3		261.0		0.3
13.1)	Live Load comp. Left span			3.2		48.4		0.06
13.2)	Live Load comp. Right span			4.5		68.1		0.06
14)	Sub-structure Component			9.1		79.4		0.3
Seismic Vertical Downward LWL								0.3
15.1)	Permanent Loads Left span	12.9			-9.7	0.0		0.3
15.2)	Permanent Loads Right span	12.9			9.7	0.0		0.3
16.1)	Live Load comp. Left span	2.1			-1.6	9.0		0.06
16.2)	Live Load comp. Right span	3.0			2.2	10.9		0.06
17)	Sub-structure Component	6.0			0.0	0.0		0.3

S.N.	Description	Forces about toe				
		V	H_L	H_T	M_{TT}	M_{LL}
		Tonne	Tonne	Tonne	Tm	Tm
LC-15	LC-3 + Seismic Sx=1,Sz=0.3,Sy=0.3	1087.04	51.7225	14.774	594.45	288.066

LC-16	LC-3 + Seismic Sx=0.3,Sz=1,Sy=0.3	FORCES @ PILE CAP BOTTOM						LC-16
S.N.	Description	V	H_L	H_T	M_{TT}	M_{LL}		
		Tonne	Tonne	Tonne	Tm	Tm		
1)	Sub-structure & Foundation	346.7			0.0	0.0		1
2)	Earth fill	60.9			0.0	0.0		1
3)	Super-structure DL Left span	272.4			-204.3	0.0		1
4)	SIDL (excluding surfacing) Left span	25.5			-19.1	0.0		1
5)	Surfacing Left span	24.2			-18.2	0.0		1
3)	Super-structure DL right span	272.4			204.3	0.0		1
4)	SIDL (excluding surfacing) right span	25.5			19.1	0.0		1
5)	Surfacing right span	24.2			18.2	0.0		1
6.1)	Max React. LL left span	52.7			-39.6	224.3		0.2
6.2)	Max Reaction LL right span	74.3			55.7	272.9		0.2
Seismic	**Longitudinal LWL**							1
8.2)	Permanent Loads Right span		38.7		463.8			0.3
9.2)	Live Load Longitudinal Right span		4.0		48.0			1
11)	Sub-structure Component		9.1		79.4			0.3
Seismic	**Transveres LWL**							1
12.1)	Permanent Loads Left span			19.3		261.0		1
12.2)	Permanent Loads Right span			19.3		261.0		1
13.1)	Live Load comp. Left span			3.2		48.4		0.2
13.2)	Live Load comp. Right span			4.5		68.1		0.2
14)	Sub-structure Component			9.1		79.4		1
Seismic	**Vertical Downward LWL**							0.3
15.1)	Permanent Loads Left span	12.9			-9.7	0.0		0.3
15.2)	Permanent Loads Right span	12.9			9.7	0.0		0.3
16.1)	Live Load comp. Left span	2.1			-1.6	9.0		0.06
16.2)	Live Load comp. Right span	3.0			2.2	10.9		0.06
17)	Sub-structure Component	6.0			0.0	0.0		0.3

S.N.	Description	Forces about toe				
		V	H_L	H_T	M_{TT}	M_{LL}
		Tonne	Tonne	Tonne	Tm	Tm
LC-16	LC-3 + Seismic Sx=0.3,Sz=1,Sy=0.3	1087.04	18.3168	49.2467	214.221	725.407

LC-17	LC-4 + Seismic Sx=1,Sz=0.3,Sy=-0.3	FORCES @ PILE CAP BOTTOM						LC-17
S.N.	Description	V	H_L	H_T	M_{TT}	M_{LL}		
		Tonne	Tonne	Tonne	Tm	Tm		
1)	Sub-structure & Foundation	346.7			0.0	0.0		1
2)	Earth fill	60.9			0.0	0.0		1
3)	Super-structure DL Left span	272.4			-204.3	0.0		1
4)	SIDL (excluding surfacing) Left span	25.5			-19.1	0.0		1
5)	Surfacing Left span	24.2			-18.2	0.0		1
3)	Super-structure DL right span	272.4			204.3	0.0		1
4)	SIDL (excluding surfacing) right span	25.5			19.1	0.0		1
5)	Surfacing right span	24.2			18.2	0.0		1
6.1)	Max long moment LL left span	0.0			0.0	0.0		0.2
6.2)	Max long. Moment LL right span	149.4			112.1	798.1		0.2
Seismic	**Longitudinal LWL**							1
8.2)	Permanent Loads Right span		38.7		463.8			1
9.2)	Live Load Longitudinal Right span		4.0		48.0			1
11)	Sub-structure Component		9.1		79.4			1
Seismic	**Transveres LWL**							0.3
12.1)	Permanent Loads Left span			19.3		261.0		0.3
12.2)	Permanent Loads Right span			19.3		261.0		0.3
13.1)	Live Load comp. Left span			0.0		0.0		0.06
13.2)	Live Load comp. Right span			9.0		137.1		0.06
14)	Sub-structure Component			9.1		79.4		0.3
Seismic	**Vertical Downward LWL**							0.3
15.1)	Permanent Loads Left span	12.9			-9.7	0.0		-0.3
15.2)	Permanent Loads Right span	12.9			9.7	0.0		-0.3
16.1)	Live Load comp. Left span	0.0			0.0	0.0		-0.06
16.2)	Live Load comp. Right span	6.0			4.5	17.5		-0.06
17)	Sub-structure Component	6.0			0.0	0.0		-0.3

S.N.	Description	Forces about toe				
		V	H_L	H_T	M_{TT}	M_{LL}
		Tonne	Tonne	Tonne	Tm	Tm
LC-17	LC-4 + Seismic Sx=1,Sz=0.3,Sy=-0.3	1071.78	51.7225	14.8548	613.333	347.232

LC-18	LC-4 + Seismic Sx=0.3,Sz=1,Sy=-0.3	FORCES @ PILE CAP BOTTOM						LC-18
S.N.	Description	V	H_L	H_T	M_{TT}	M_{LL}		
		Tonne	Tonne	Tonne	Tm	Tm		
1)	Sub-structure & Foundation	346.7			0.0	0.0		1
2)	Earth fill	60.9			0.0	0.0		1
3)	Super-structure DL Left span	272.4			-204.3	0.0		1
4)	SIDL (excluding surfacing) Left span	25.5			-19.1	0.0		1
5)	Surfacing Left span	24.2			-18.2	0.0		1
3)	Super-structure DL right span	272.4			204.3	0.0		1
4)	SIDL (excluding surfacing) right span	25.5			19.1	0.0		1
5)	Surfacing right span	24.2			18.2	0.0		1
6.1)	Max long moment LL left span	0.0			0.0	0.0		0.2
6.2)	Max long. Moment LL right span	149.4			112.1	798.1		0.2
Seismic	**Longitudinal LWL**							1
8.2)	Permanent Loads Right span		38.7		463.8			0.3
9.2)	Live Load Longitudinal Right span		4.0		48.0			1
11)	Sub-structure Component		9.1		79.4			0.3
Seismic	**Transveres LWL**							1
12.1)	Permanent Loads Left span			19.3		261.0		1
12.2)	Permanent Loads Right span			19.3		261.0		1
13.1)	Live Load comp. Left span			0.0		0.0		0.2
13.2)	Live Load comp. Right span			9.0		137.1		0.2
14)	Sub-structure Component			9.1		79.4		1
Seismic	**Vertical Downward LWL**							0.3
15.1)	Permanent Loads Left span	12.9			-9.7	0.0		-0.3
15.2)	Permanent Loads Right span	12.9			9.7	0.0		-0.3
16.1)	Live Load comp. Left span	0.0			0.0	0.0		-0.06
16.2)	Live Load comp. Right span	6.0			4.5	17.5		-0.06
17)	Sub-structure Component	6.0			0.0	0.0		-0.3

S.N.	Description	Forces about toe				
		V	H_L	H_T	M_{TT}	M_{LL}
		Tonne	Tonne	Tonne	Tm	Tm
LC-18	LC-4 + Seismic Sx=0.3,Sz=1,Sy=-0.3	1071.78	18.3168	49.5159	233.104	787.455

LC-19	LC-4 + Seismic Sx=1,Sz=0.3,Sy=0.3	FORCES @ PILE CAP BOTTOM						LC-19
S.N.	Description	V	H_L	H_T	M_{TT}	M_{LL}		
		Tonne	Tonne	Tonne	Tm	Tm		
1)	Sub-structure & Foundation	346.7			0.0	0.0		1
2)	Earth fill	60.9			0.0	0.0		1
3)	Super-structure DL Left span	272.4			-204.3	0.0		1
4)	SIDL (excluding surfacing) Left span	25.5			-19.1	0.0		1

5)	Surfacing Left span	24.2			-18.2	0.0		1
3)	Super-structure DL right span	272.4			204.3	0.0		1
4)	SIDL (excluding surfacing) right span	25.5			19.1	0.0		1
5)	Surfacing right span	24.2			18.2	0.0		1
6.1)	Max long moment LL left span	0.0			0.0	0.0		0.2
6.2)	Max long. Moment LL right span	149.4			112.1	798.1		0.2
Seismic Longitudinal LWL								1
8.2)	Permanent Loads Right span		38.7		463.8			1
9.2)	Live Load Longitudinal Right span		4.0		48.0			1
11)	Sub-structure Component		9.1		79.4			1
Seismic Transveres LWL								0.3
12.1)	Permanent Loads Left span			19.3		261.0		0.3
12.2)	Permanent Loads Right span			19.3		261.0		0.3
13.1)	Live Load comp. Left span			0.0		0.0		0.06
13.2)	Live Load comp. Right span			9.0		137.1		0.06
14)	Sub-structure Component			9.1		79.4		0.3
Seismic Vertical Downward LWL								0.3
15.1)	Permanent Loads Left span	12.9			-9.7	0.0		0.3
15.2)	Permanent Loads Right span	12.9			9.7	0.0		0.3
16.1)	Live Load comp. Left span	0.0			0.0	0.0		0.06
16.2)	Live Load comp. Right span	6.0			4.5	17.5		0.06
17)	Sub-structure Component	6.0			0.0	0.0		0.3

S.N.	Description	Forces about toe				
		V	H_L	H_T	M_{TT}	M_{LL}
		Tonne	Tonne	Tonne	Tm	Tm
LC-19	LC-4 + Seismic Sx=1,Sz=0.3,Sy=0.3	1091.59	51.722 5	14.8548	613.87 1	349.33 6

LC-20	LC-4 + Seismic Sx=0.3,Sz=1,Sy=0.3	FORCES @ PILE CAP BOTTOM						LC-20
S.N.	Description	V	H_L	H_T	M_{TT}	M_{LL}		
		Tonne	Tonne	Tonne	Tm	Tm		
1)	Sub-structure & Foundation	346.7			0.0	0.0		1
2)	Earth fill	60.9			0.0	0.0		1
3)	Super-structure DL Left span	272.4			-204.3	0.0		1
4)	SIDL (excluding surfacing) Left span	25.5			-19.1	0.0		1
5)	Surfacing Left span	24.2			-18.2	0.0		1
3)	Super-structure DL right span	272.4			204.3	0.0		1
4)	SIDL (excluding surfacing) right span	25.5			19.1	0.0		1
5)	Surfacing right span	24.2			18.2	0.0		1
6.1)	Max long moment LL left span	0.0			0.0	0.0		0.2
6.2)	Max long. Moment LL right span	149.4			112.1	798.1		0.2
Seismic Longitudinal LWL								1
8.2)	Permanent Loads Right span		38.7		463.8			0.3
9.2)	Live Load Longitudinal Right span		4.0		48.0			1
11)	Sub-structure Component		9.1		79.4			0.3
Seismic Transveres LWL								1
12.1)	Permanent Loads Left span			19.3		261.0		1
12.2)	Permanent Loads Right span			19.3		261.0		1
13.1)	Live Load comp. Left span			0.0		0.0		0.2
13.2)	Live Load comp. Right span			9.0		137.1		0.2
14)	Sub-structure Component			9.1		79.4		1
Seismic Vertical Downward LWL								0.3
15.1)	Permanent Loads Left span	12.9			-9.7	0.0		0.3
15.2)	Permanent Loads Right span	12.9			9.7	0.0		0.3
16.1)	Live Load comp. Left span	0.0			0.0	0.0		0.06
16.2)	Live Load comp. Right span	6.0			4.5	17.5		0.06
17)	Sub-structure Component	6.0			0.0	0.0		0.3

S.N.	Description	Forces about toe				
		V	H_L	H_T	M_{TT}	M_{LL}
		Tonne	Tonne	Tonne	Tm	Tm
LC-20	LC-4 + Seismic Sx=0.3,Sz=1,Sy=0.3	1091.59	18.316 8	49.5159	233.64 2	789.55 9

LC-21	NS HFL Span dislodge case	FORCES @ PILE CAP BOTTOM						LC-21
S.N.	Description	V	H_L	H_T	M_{TT}	M_{LL}		
		Tonne	Tonne	Tonne	Tm	Tm		
1)	Sub-structure & Foundation	346.7			0.0	0.0		1
3)	Super-structure DL right span	272.4			204.3	0.0		1
4)	SIDL (excluding surfacing) right span	25.5			19.1	0.0		1
5)	Surfacing right span	24.2			18.2	0.0		1
7.4)	Left span dislodge condition		3.5		41.6			1
8) byouency		-86.4						1
9.2) WC at 20% variation			1.4	3.9	1.9	5.2		1

S.N.	Description	Forces about toe				
		V	H_L	H_T	M_{TT}	M_{LL}
		Tonne	Tonne	Tonne	Tm	Tm
LC-21	NS HFL Span dislodge case	582.389	4.8884 4	3.90083	285.08 1	5.1914

LC-22	NS HFL No Live load	FORCES @ PILE CAP BOTTOM						LC-22
S.N.	Description	V	H_L	H_T	M_{TT}	M_{LL}		
		Tonne	Tonne	Tonne	Tm	Tm		
1)	Sub-structure & Foundation	346.7			0.0	0.0		1
3)	Super-structure DL Left span	272.4			-204.3	0.0		1
4)	SIDL (excluding surfacing) Left span	25.5			-19.1	0.0		1
5)	Surfacing Left span	24.2			-18.2	0.0		1
3)	Super-structure DL right span	272.4			204.3	0.0		1
4)	SIDL (excluding surfacing) right span	25.5			19.1	0.0		1
5)	Surfacing right span	24.2			18.2	0.0		1
7.3)	No Live load condition		3.5		41.6			1
8) byouency		-86.4						1
9.2) WC at 20% variation			1.4	3.9	1.9	5.2		1

S.N.	Description	Forces about toe				
		V	H_L	H_T	M_{TT}	M_{LL}
		Tonne	Tonne	Tonne	Tm	Tm
LC-22	NS HFL No Live load	904.478	4.8884 4	3.90083	43.513 3	5.1914

LC-23	NS HFL With LL max reaction case	FORCES @ PILE CAP BOTTOM						LC-23
S.N.	Description	V	H_L	H_T	M_{TT}	M_{LL}		
		Tonne	Tonne	Tonne	Tm	Tm		
1)	Sub-structure & Foundation	346.7			0.0	0.0		1
3)	Super-structure DL Left span	272.4			-204.3	0.0		1
4)	SIDL (excluding surfacing) Left span	25.5			-19.1	0.0		1
5)	Surfacing Left span	24.2			-18.2	0.0		1
3)	Super-structure DL right span	272.4			204.3	0.0		1
4)	SIDL (excluding surfacing) right span	25.5			19.1	0.0		1
5)	Surfacing right span	24.2			18.2	0.0		1
6.1)	Max React. LL left span	52.7			-39.6	224.3		1
6.2)	Max Reaction LL right span	74.3			55.7	272.9		1
7.1)	Maximum Reaction case		16.2		194.3			1
8) byouency		-86.4						1
9.2) WC at 20% variation			1.4	3.9	1.9	5.2		1

S.N.	Description	Forces about toe				
		V	H_L	H_T	M_{TT}	M_{LL}
		Tonne	Tonne	Tonne	Tm	Tm
LC-23	NS HFL With LL max reaction case	1031.49	17.6134	3.90083	212.349	502.396

LC-24	NS HFL With LL max moment case	FORCES @ PILE CAP BOTTOM						LC-24
S.N.	Description	V	H_L	H_T	M_{TT}	M_{LL}		
		Tonne	Tonne	Tonne	Tm	Tm		
1)	Sub-structure & Foundation	346.7			0.0	0.0		1
3)	Super-structure DL Left span	272.4			-204.3	0.0		1
4)	SIDL (excluding surfacing) Left span	25.5			-19.1	0.0		1
5)	Surfacing Left span	24.2			-18.2	0.0		1
3)	Super-structure DL right span	272.4			204.3	0.0		1
4)	SIDL (excluding surfacing) right span	25.5			19.1	0.0		1
5)	Surfacing right span	24.2			18.2	0.0		1
6.1)	Max long moment LL left span	0.0			0.0	0.0		1
6.2)	Max long. Moment LL right span	149.4			112.1	798.1		1
7.2)	Maximum moment case		16.2		194.3			1
8) byouency		-86.4						1
9.2) WC at 20% variation			1.4	3.9	1.9	5.2		1

S.N.	Description	Forces about toe				
		V	H_L	H_T	M_{TT}	M_{LL}
		Tonne	Tonne	Tonne	Tm	Tm
LC-24	NS HFL With LL max moment case	1053.93	17.6134	3.90083	308.301	803.275

LC-25	LC-21 + Seismic Sx=1,Sz=0.3,Sy=-0.3	FORCES @ PILE CAP BOTTOM						LC-25
S.N.	Description	V	H_L	H_T	M_{TT}	M_{LL}		
		Tonne	Tonne	Tonne	Tm	Tm		
1)	Sub-structure & Foundation	346.7			0.0	0.0		1
2)	Earth fill	60.9			0.0	0.0		1
3)	Super-structure DL right span	272.4			204.3	0.0		1
4)	SIDL (excluding surfacing) right span	25.5			19.1	0.0		1
5)	Surfacing right span	24.2			18.2	0.0		1
7.4)	Left span dislodge condition		3.5		41.6			1
8) byouency		-86.4						1
9.2) WC at 20% variation			1.4	3.9	1.9	5.2		1
Seismic Longitudinal HFL								0.5
8.2)	Permanent Loads Right span		38.7		463.8			0.5
11)	Sub-structure Component		9.1		79.4			0.5
12)	Pile cap		11.7		10.6			0.5
12)	Hydrodynamic Longitudinal		1.6		-8.5			0.5
Seismic Transveres HFL								0.15
12.2)	Permanent Loads Right span			19.3		261.0		0.15
14)	Sub-structure Component			9.1		79.4		0.15
15)	Pile cap			11.7		10.6		0.15
15)	Hydrodynamic Transverse			1.6		-8.5		0.15
Seismic Vertical Downward HFL								0.15
15.2)	Permanent Loads Right span	12.9			9.7	0.0		-0.15
17)	Sub-structure Component	6.0			0.0	0.0		-0.15
18)	Pile cap	7.8			0.0	0.0		-0.15

S.N.	Description	Forces about toe				
		V	H_L	H_T	M_{TT}	M_{LL}
		Tonne	Tonne	Tonne	Tm	Tm
LC-25	LC-21 + Seismic Sx=1,Sz=0.3,Sy=-0.3	639.248	35.431	10.1648	556.263	56.5667

LC-26	LC-21 + Seismic Sx=0.3,Sz=1,Sy=-0.3	FORCES @ PILE CAP BOTTOM						LC-26
S.N.	Description	V	H_L	H_T	M_{TT}	M_{LL}		
		Tonne	Tonne	Tonne	Tm	Tm		
1)	Sub-structure & Foundation	346.7			0.0	0.0		1
2)	Earth fill	60.9			0.0	0.0		1
3)	Super-structure DL right span	272.4			204.3	0.0		1
4)	SIDL (excluding surfacing) right span	25.5			19.1	0.0		1
5)	Surfacing right span	24.2			18.2	0.0		1
7.4)	Left span dislodge condition		3.5		41.6			1
8) byouency		-86.4						1
9.2) WC at 20% variation			1.4	3.9	1.9	5.2		1
Seismic Longitudinal HFL								0.15
8.2)	Permanent Loads Right span		38.7		463.8			0.15
11)	Sub-structure Component		9.1		79.4			0.15
12)	Pile cap		11.7		10.6			0.15
12)	Hydrodynamic Longitudinal		1.6		-8.5			0.15
Seismic Transveres HFL								0.5
12.2)	Permanent Loads Right span			19.3		261.0		0.5
14)	Sub-structure Component			9.1		79.4		0.5
15)	Pile cap			11.7		10.6		0.5
15)	Hydrodynamic Transverse			1.6		-8.5		0.5
Seismic Vertical Downward HFL								0.15
15.2)	Permanent Loads Right span	12.9			9.7	0.0		-0.15
17)	Sub-structure Component	6.0			0.0	0.0		-0.15
18)	Pile cap	7.8			0.0	0.0		-0.15

S.N.	Description	Forces about toe				
		V	H_L	H_T	M_{TT}	M_{LL}
		Tonne	Tonne	Tonne	Tm	Tm

LC-26	LC-21 + Seismic Sx=0.3,Sz=1,Sy=-0.3	639.248	14.0512	24.7808	365.421	176.442

LC-27	LC-21 + Seismic Sx=1,Sz=0.3,Sy=0.3 (	FORCES @ PILE CAP BOTTOM						LC-27
S.N.	Description	V	H_L	H_T	M_{TT}	M_{LL}		
		Tonne	Tonne	Tonne	Tm	Tm		
1)	Sub-structure & Foundation	346.7			0.0	0.0		1
2)	Earth fill	60.9			0.0	0.0		1
3)	Super-structure DL right span	272.4			204.3	0.0		1
4)	SIDL (excluding surfacing) right span	25.5			19.1	0.0		1
5)	Surfacing right span	24.2			18.2	0.0		1
7.4)	Left span dislodge condition		3.5		41.6			1
8) byouency		-86.4						1
9.2) WC at 20% variation			1.4	3.9	1.9	5.2		1
Seismic Longitudinal HFL								0.5
8.2)	Permanent Loads Right span		38.7		463.8			0.5
11)	Sub-structure Component		9.1		79.4			0.5
12)	Pile cap		11.7		10.6			0.5
12)	Hydrodynamic Longitudinal		1.6		-8.5			0.5
Seismic Transveres HFL								0.15
12.2)	Permanent Loads Right span			19.3		261.0		0.15
14)	Sub-structure Component			9.1		79.4		0.15
15)	Pile cap			11.7		10.6		0.15
15)	Hydrodynamic Transverse			1.6		-8.5		0.15
Seismic Vertical Downward HFL								0.15
15.2)	Permanent Loads Right span	12.9			9.7	0.0		0.15
17)	Sub-structure Component	6.0			0.0	0.0		0.15
18)	Pile cap	7.8			0.0	0.0		0.15

S.N.	Description	Forces about toe				
		V	H_L	H_T	M_{TT}	M_{LL}
		Tonne	Tonne	Tonne	Tm	Tm
LC-27	LC-21 + Seismic Sx=1,Sz=0.3,Sy=0.3 (	647.274	35.431	10.1648	559.162	56.5667

LC-28	LC-21 + Seismic Sx=0.3,Sz=1,Sy=0.3 (	FORCES @ PILE CAP BOTTOM						LC-28
S.N.	Description	V	H_L	H_T	M_{TT}	M_{LL}		
		Tonne	Tonne	Tonne	Tm	Tm		
1)	Sub-structure & Foundation	346.7			0.0	0.0		1
2)	Earth fill	60.9			0.0	0.0		1
3)	Super-structure DL right span	272.4			204.3	0.0		1
4)	SIDL (excluding surfacing) right span	25.5			19.1	0.0		1
5)	Surfacing right span	24.2			18.2	0.0		1
7.4)	Left span dislodge condition		3.5		41.6			1
8) byouency		-86.4						1
9.2) WC at 20% variation			1.4	3.9	1.9	5.2		1
Seismic Longitudinal HFL								0.15
8.2)	Permanent Loads Right span		38.7		463.8			0.15
11)	Sub-structure Component		9.1		79.4			0.15
12)	Pile cap		11.7		10.6			0.15
12)	Hydrodynamic Longitudinal		1.6		-8.5			0.15
Seismic Transveres HFL								0.5
12.2)	Permanent Loads Right span			19.3		261.0		0.5
14)	Sub-structure Component			9.1		79.4		0.5
15)	Pile cap			11.7		10.6		0.5
15)	Hydrodynamic Transverse			1.6		-8.5		0.5
Seismic Vertical Downward HFL								0.15
15.2)	Permanent Loads Right span	12.9			9.7	0.0		0.15
17)	Sub-structure Component	6.0			0.0	0.0		0.15
18)	Pile cap	7.8			0.0	0.0		0.15

S.N.	Description	Forces about toe				
		V	H_L	H_T	M_{TT}	M_{LL}
		Tonne	Tonne	Tonne	Tm	Tm
LC-28	LC-21 + Seismic Sx=0.3,Sz=1,Sy=0.3 (	647.274	14.0512	24.7808	368.32	176.442

LC-29	LC-22 + Seismic Sx=1,Sz=0.3,Sy=-0.3	FORCES @ PILE CAP BOTTOM						LC-29
S.N.	Description	V	H_L	H_T	M_{TT}	M_{LL}		
		Tonne	Tonne	Tonne	Tm	Tm		
1)	Sub-structure & Foundation	346.7			0.0	0.0		1
2)	Earth fill	60.9			0.0	0.0		1
3)	Super-structure DL Left span	272.4			-204.3	0.0		1
4)	SIDL (excluding surfacing) Left span	25.5			-19.1	0.0		1
5)	Surfacing Left span	24.2			-18.2	0.0		1
3)	Super-structure DL right span	272.4			204.3	0.0		1
4)	SIDL (excluding surfacing) right span	25.5			19.1	0.0		1
5)	Surfacing right span	24.2			18.2	0.0		1
7.3)	No Live load condition		3.5		41.6			1
8) byouency		-86.4						1
9.2) WC at 20% variation			1.4	3.9	1.9	5.2		1
Seismic Longitudinal HFL								1
8.2)	Permanent Loads Right span		38.7		463.8			1
11)	Sub-structure Component		9.1		79.4			1
12)	Pile cap		11.7		10.6			1
12)	Hydrodynamic Longitudinal		1.6		-8.5			1
Seismic Transveres HFL								0.3
12.1)	Permanent Loads Left span			19.3		261.0		0.3
12.2)	Permanent Loads Right span			19.3		261.0		0.3
14)	Sub-structure Component			9.1		79.4		0.3
15)	Pile cap			11.7		10.6		0.3
15)	Hydrodynamic Transverse			1.6		-8.5		0.3
Seismic Vertical Downward HFL								0.3
15.1)	Permanent Loads Left span	12.9			-9.7	0.0		-0.3
15.2)	Permanent Loads Right span	12.9			9.7	0.0		-0.3
17)	Sub-structure Component	6.0			0.0	0.0		-0.3
18)	Pile cap	7.8			0.0	0.0		-0.3

S.N.	Description	Forces about toe				
		V	H_L	H_T	M_{TT}	M_{LL}
		Tonne	Tonne	Tonne	Tm	Tm
LC-29	LC-22 + Seismic Sx=1,Sz=0.3,Sy=-0.3	953.459	65.9737	22.2264	588.777	186.256

LC-30

S.N.	LC-22 + Seismic Sx=0.3,Sz=1,Sy=-0.3	FORCES @ PILE CAP BOTTOM						LC-30
	Description	V	H_L	H_T	M_{TT}	M_{LL}		
1)		Tonne	Tonne	Tonne	Tm	Tm		
	Sub-structure & Foundation	346.7			0.0	0.0		1
2)	Earth fill	60.9			0.0	0.0		1
	Super-structure DL Left span	272.4			-204.3	0.0		1
3)	SIDL (excluding surfacing) Left span	25.5			-19.1	0.0		1
	Surfacing Left span	24.2			-18.2	0.0		1
4)	Super-structure DL right span	272.4			204.3	0.0		1
	SIDL (excluding surfacing) right span	25.5			19.1	0.0		1
5)	Surfacing right span	24.2			18.2	0.0		1
	No Live load condition		3.5		41.6			1
3)	cy	-86.4						1
	at 20% variation		1.4	3.9	1.9	5.2		1

Seismic Longitudinal HFL								0.3
8.2)	Permanent Loads Right span		38.7		463.8			0.3
11)	Sub-structure Component		9.1		79.4			0.3
12)	Pile cap		11.7		10.6			0.3
12)	Hydrodynamic Longitudinal		1.6		-8.5			0.3
Seismic Transveres HFL								1
12.1)	Permanent Loads Left span			19.3		261.0		1
12.2)	Permanent Loads Right span			19.3		261.0		1
14)	Sub-structure Component			9.1		79.4		1
15)	Pile cap			11.7		10.6		1
15)	Hydrodynamic Transverse			1.6		-8.5		1
Seismic Vertical Downward HFL								0.3
15.1)	Permanent Loads Left span	12.9			-9.7	0.0		-0.3
15.2)	Permanent Loads Right span	12.9			9.7	0.0		-0.3
17)	Sub-structure Component	6.0			0.0	0.0		-0.3
18)	Pile cap	7.8			0.0	0.0		-0.3

S.N.	Description	Forces about toe				
		V	H_L	H_T	M_{TT}	M_{LL}
		Tonne	Tonne	Tonne	Tm	Tm
LC-30	LC-22 + Seismic Sx=0.3,Sz=1,Sy=-0.3	953.459	23.214	64.9861	207.093	608.74

LC-31	LC-22 + Seismic Sx=1,Sz=0.3,Sy=0.3	FORCES @ PILE CAP BOTTOM						LC-31
S.N.	Description	V	H_L	H_T	M_{TT}	M_{LL}		
		Tonne	Tonne	Tonne	Tm	Tm		
1)	Sub-structure & Foundation	346.7			0.0	0.0		1
2)	Earth fill	60.9			0.0	0.0		1
3)	Super-structure DL Left span	272.4			-204.3	0.0		1
4)	SIDL (excluding surfacing) Left span	25.5			-19.1	0.0		1
5)	Surfacing Left span	24.2			-18.2	0.0		1
3)	Super-structure DL right span	272.4			204.3	0.0		1
4)	SIDL (excluding surfacing) right span	25.5			19.1	0.0		1
5)	Surfacing right span	24.2			18.2	0.0		1
7.3)	No Live load condition		3.5		41.6			1
8) byouency		-86.4						1
9.2) WC at 20% variation			1.4	3.9	1.9	5.2		1
Seismic Longitudinal HFL								1
8.2)	Permanent Loads Right span		38.7		463.8			1
11)	Sub-structure Component		9.1		79.4			1
12)	Pile cap		11.7		10.6			1
12)	Hydrodynamic Longitudinal		1.6		-8.5			1
Seismic Transveres HFL								0.3
12.1)	Permanent Loads Left span			19.3		261.0		0.3
12.2)	Permanent Loads Right span			19.3		261.0		0.3
14)	Sub-structure Component			9.1		79.4		0.3
15)	Pile cap			11.7		10.6		0.3
15)	Hydrodynamic Transverse			1.6		-8.5		0.3
Seismic Vertical Downward HFL								0.3
15.1)	Permanent Loads Left span	12.9			-9.7	0.0		0.3
15.2)	Permanent Loads Right span	12.9			9.7	0.0		0.3
17)	Sub-structure Component	6.0			0.0	0.0		0.3
18)	Pile cap	7.8			0.0	0.0		0.3

S.N.	Description	Forces about toe				
		V	H_L	H_T	M_{TT}	M_{LL}
		Tonne	Tonne	Tonne	Tm	Tm
LC-31	LC-22 + Seismic Sx=1,Sz=0.3,Sy=0.3	977.242	65.9737	22.2264	588.777	186.256

LC-32	LC-22 + Seismic Sx=0.3,Sz=1,Sy=0.3	FORCES @ PILE CAP BOTTOM						LC-32
S.N.	Description	V	H_L	H_T	M_{TT}	M_{LL}		
		Tonne	Tonne	Tonne	Tm	Tm		
1)	Sub-structure & Foundation	346.7			0.0	0.0		1
2)	Earth fill	60.9			0.0	0.0		1
3)	Super-structure DL Left span	272.4			-204.3	0.0		1
4)	SIDL (excluding surfacing) Left span	25.5			-19.1	0.0		1
5)	Surfacing Left span	24.2			-18.2	0.0		1
3)	Super-structure DL right span	272.4			204.3	0.0		1
4)	SIDL (excluding surfacing) right span	25.5			19.1	0.0		1
5)	Surfacing right span	24.2			18.2	0.0		1
7.3)	No Live load condition		3.5		41.6			1
8) byouency		-86.4						1
9.2) WC at 20% variation			1.4	3.9	1.9	5.2		1
Seismic Longitudinal HFL								0.3
8.2)	Permanent Loads Right span		38.7		463.8			0.3
11)	Sub-structure Component		9.1		79.4			0.3
12)	Pile cap		11.7		10.6			0.3
12)	Hydrodynamic Longitudinal		1.6		-8.5			0.3
Seismic Transveres HFL								1
12.1)	Permanent Loads Left span			19.3		261.0		1
12.2)	Permanent Loads Right span			19.3		261.0		1
14)	Sub-structure Component			9.1		79.4		1
15)	Pile cap			11.7		10.6		1
15)	Hydrodynamic Transverse			1.6		-8.5		1
Seismic Vertical Downward HFL								0.3
15.1)	Permanent Loads Left span	12.9			-9.7	0.0		0.3
15.2)	Permanent Loads Right span	12.9			9.7	0.0		0.3
17)	Sub-structure Component	6.0			0.0	0.0		0.3
18)	Pile cap	7.8			0.0	0.0		0.3

S.N.	Description	Forces about toe				
		V	H_L	H_T	M_{TT}	M_{LL}
		Tonne	Tonne	Tonne	Tm	Tm
LC-32	LC-22 + Seismic Sx=0.3,Sz=1,Sy=0.3	977.242	23.214	64.9861	207.093	608.74

LC-33	LC-23 + Seismic Sx=1,Sz=0.3,Sy=-0.3	FORCES @ PILE CAP BOTTOM						LC-33
S.N.	Description	V	H_L	H_T	M_{TT}	M_{LL}		
		Tonne	Tonne	Tonne	Tm	Tm		
1)	Sub-structure & Foundation	346.7			0.0	0.0		1
	Earth fill	60.9			0.0	0.0		1
2)	Super-structure DL Left span	272.4			-204.3	0.0		1
	SIDL (excluding surfacing) Left span	25.5			-19.1	0.0		1
3)	Surfacing Left span	24.2			-18.2	0.0		1
	Super-structure DL right span	272.4			204.3	0.0		1
4)	SIDL (excluding surfacing) right span	25.5			19.1	0.0		1
	Surfacing right span	24.2			18.2	0.0		1
5)	Max React. LL left span	52.7			-39.6	224.3		0.2
	Max Reaction LL right span	74.3			55.7	272.9		0.2
	cy	-86.4						1
3)	at 20% variation		1.4	3.9	1.9	5.2		1
	Longitudinal HFL							1
4)	Permanent Loads Right span		38.7		463.8			1
	Live Load Longitudinal Right span		4.0		48.0			1
	Sub-structure Component		9.1		79.4			1
	Pile cap		11.7		10.6			1

5)

6.1)

6.2)

8) byouen

9.2) WC

Seismic

8.2)

9.2)

11)

12)

12)	Hydrodynamic Longitudinal		1.6		-8.5			
Seismic Transveres HFL								0.3
12.1)	Permanent Loads Left span			19.3		261.0		0.3
12.2)	Permanent Loads Right span			19.3		261.0		0.3
13.1)	Live Load comp. Left span			3.2		48.4		0.06
13.2)	Live Load comp. Right span			4.5		68.1		0.06
14)	Sub-structure Component			9.1		79.4		0.3
15)	Pile cap			11.7		10.6		0.3
15)	Hydrodynamic Transverse			1.6		-8.5		0.3
Seismic Vertical Downward HFL								0.3
15.1)	Permanent Loads Left span	12.9			-9.7	0.0		-0.3
15.2)	Permanent Loads Right span	12.9			9.7	0.0		-0.3
16.1)	Live Load comp. Left span	2.1			-1.6	9.0		-0.06
16.2)	Live Load comp. Right span	3.0			2.2	10.9		-0.06
17)	Sub-structure Component	6.0			0.0	0.0		-0.3
18)	Pile cap	7.8			0.0	0.0		-0.3

S.N.	Description	Forces about toe				
		V	H_L	H_T	M_{TT}	M_{LL}
		Tonne	Tonne	Tonne	Tm	Tm
LC-33	LC-23 + Seismic Sx=1,Sz=0.3,Sy=-0.3	978.557	66.505	22.6836	598.342	291.495

LC-34	LC-23 + Seismic Sx=0.3,Sz=1,Sy=-0.3	FORCES @ PILE CAP BOTTOM						LC-34
S.N.	Description	V	H_L	H_T	M_{TT}	M_{LL}		
		Tonne	Tonne	Tonne	Tm	Tm		
1)	Sub-structure & Foundation	346.7			0.0	0.0		
2)	Earth fill	60.9			0.0	0.0		
3)	Super-structure DL Left span	272.4			-204.3	0.0		
4)	SIDL (excluding surfacing) Left span	25.5			-19.1	0.0		
5)	Surfacing Left span	24.2			-18.2	0.0		
3)	Super-structure DL right span	272.4			204.3	0.0		
4)	SIDL (excluding surfacing) right span	25.5			19.1	0.0		
5)	Surfacing right span	24.2			18.2	0.0		
6.1)	Max React. LL left span	52.7			-39.6	224.3		0.2
6.2)	Max Reaction LL right span	74.3			55.7	272.9		0.2
8) byouency		-86.4						
9.2) WC at 20% variation			1.4	3.9	1.9	5.2		
Seismic Longitudinal HFL								
8.2)	Permanent Loads Right span		38.7		463.8			0.3
9.2)	Live Load Longitudinal Right span		4.0		48.0			
11)	Sub-structure Component		9.1		79.4			0.3
12)	Pile cap		11.7		10.6			0.3
12)	Hydrodynamic Longitudinal		1.6		-8.5			0.3
Seismic Transveres HFL								
12.1)	Permanent Loads Left span			19.3		261.0		
12.2)	Permanent Loads Right span			19.3		261.0		
13.1)	Live Load comp. Left span			3.2		48.4		0.2
13.2)	Live Load comp. Right span			4.5		68.1		0.2
14)	Sub-structure Component			9.1		79.4		
15)	Pile cap			11.7		10.6		
15)	Hydrodynamic Transverse			1.6		-8.5		
Seismic Vertical Downward HFL								0.3
15.1)	Permanent Loads Left span	12.9			-9.7	0.0		-0.3
15.2)	Permanent Loads Right span	12.9			9.7	0.0		-0.3
16.1)	Live Load comp. Left span	2.1			-1.6	9.0		-0.06
16.2)	Live Load comp. Right span	3.0			2.2	10.9		-0.06
17)	Sub-structure Component	6.0			0.0	0.0		-0.3
18)	Pile cap	7.8			0.0	0.0		-0.3

S.N.	Description	Forces about toe				
		V	H_L	H_T	M_{TT}	M_{LL}
		Tonne	Tonne	Tonne	Tm	Tm
LC-34	LC-23 + Seismic Sx=0.3,Sz=1,Sy=-0.3	978.557	23.7454	66.5102	216.657	730.291

LC-35	LC-23 + Seismic Sx=1,Sz=0.3,Sy=0.3	FORCES @ PILE CAP BOTTOM						LC-35
S.N.	Description	V	H_L	H_T	M_{TT}	M_{LL}		
		Tonne	Tonne	Tonne	Tm	Tm		
1)	Sub-structure & Foundation	346.7			0.0	0.0		
2)	Earth fill	60.9			0.0	0.0		
3)	Super-structure DL Left span	272.4			-204.3	0.0		
4)	SIDL (excluding surfacing) Left span	25.5			-19.1	0.0		
5)	Surfacing Left span	24.2			-18.2	0.0		
3)	Super-structure DL right span	272.4			204.3	0.0		
4)	SIDL (excluding surfacing) right span	25.5			19.1	0.0		
5)	Surfacing right span	24.2			18.2	0.0		
6.1)	Max React. LL left span	52.7			-39.6	224.3		0.2
6.2)	Max Reaction LL right span	74.3			55.7	272.9		0.2
8) byouency		-86.4						
9.2) WC at 20% variation			1.4	3.9	1.9	5.2		
Seismic Longitudinal HFL								
8.2)	Permanent Loads Right span		38.7		463.8			
9.2)	Live Load Longitudinal Right span		4.0		48.0			
11)	Sub-structure Component		9.1		79.4			
12)	Pile cap		11.7		10.6			
12)	Hydrodynamic Longitudinal		1.6		-8.5			
Seismic Transveres HFL								0.3
12.1)	Permanent Loads Left span			19.3		261.0		0.3
12.2)	Permanent Loads Right span			19.3		261.0		0.3
13.1)	Live Load comp. Left span			3.2		48.4		0.06
13.2)	Live Load comp. Right span			4.5		68.1		0.06
14)	Sub-structure Component			9.1		79.4		0.3
15)	Pile cap			11.7		10.6		0.3
15)	Hydrodynamic Transverse			1.6		-8.5		0.3
Seismic Vertical Downward HFL								0.3
15.1)	Permanent Loads Left span	12.9			-9.7	0.0		0.3
15.2)	Permanent Loads Right span	12.9			9.7	0.0		0.3
16.1)	Live Load comp. Left span	2.1			-1.6	9.0		0.06
16.2)	Live Load comp. Right span	3.0			2.2	10.9		0.06
17)	Sub-structure Component	6.0			0.0	0.0		0.3
18)	Pile cap	7.8			0.0	0.0		0.3

S.N.	Description	Forces about toe				
		V	H_L	H_T	M_{TT}	M_{LL}
		Tonne	Tonne	Tonne	Tm	Tm
LC-35	LC-23 + Seismic Sx=1,Sz=0.3,Sy=0.3	1002.95	66.505	22.6836	598.419	293.881

LC-36	LC-23 + Seismic Sx=0.3,Sz=1,Sy=0.3	FORCES @ PILE CAP BOTTOM						LC-36
S.N.	Description	V	H_L	H_T	M_{TT}	M_{LL}		
		Tonne	Tonne	Tonne	Tm	Tm		
1)	Sub-structure & Foundation	346.7			0.0	0.0		
2)	Earth fill	60.9			0.0	0.0		
3)	Super-structure DL Left span	272.4			-204.3	0.0		

4)	SIDL (excluding surfacing) Left span	25.5			-19.1	0.0		
5)	Surfacing Left span	24.2			-18.2	0.0		
3)	Super-structure DL right span	272.4			204.3	0.0		
4)	SIDL (excluding surfacing) right span	25.5			19.1	0.0		
5)	Surfacing right span	24.2			18.2	0.0		
6.1)	Max React. LL left span	52.7			-39.6	224.3		0.2
6.2)	Max Reaction LL right span	74.3			55.7	272.9		0.2
8) byouency		-86.4						
9.2) WC at 20% variation			1.4	3.9	1.9	5.2		
Seismic Longitudinal HFL								
8.2)	Permanent Loads Right span		38.7		463.8			0.3
9.2)	Live Load Longitudinal Right span		4.0		48.0			
11)	Sub-structure Component		9.1		79.4			0.3
12)	Pile cap		11.7		10.6			0.3
12)	Hydrodynamic Longitudinal		1.6		-8.5			0.3
Seismic Transveres HFL								
12.1)	Permanent Loads Left span			19.3		261.0		
12.2)	Permanent Loads Right span			19.3		261.0		
13.1)	Live Load comp. Left span			3.2		48.4		0.2
13.2)	Live Load comp. Right span			4.5		68.1		0.2
14)	Sub-structure Component			9.1		79.4		
15)	Pile cap			11.7		10.6		
15)	Hydrodynamic Transverse			1.6		-8.5		
Seismic Vertical Downward HFL								0.3
15.1)	Permanent Loads Left span	12.9			-9.7	0.0		0.3
15.2)	Permanent Loads Right span	12.9			9.7	0.0		0.3
16.1)	Live Load comp. Left span	2.1			-1.6	9.0		0.06
16.2)	Live Load comp. Right span	3.0			2.2	10.9		0.06
17)	Sub-structure Component	6.0			0.0	0.0		0.3
18)	Pile cap	7.8			0.0	0.0		0.3

S.N.	Description	Forces about toe				
		V	H_L	H_T	M_{TT}	M_{LL}
		Tonne	Tonne	Tonne	Tm	Tm
LC-36	LC-23 + Seismic Sx=0.3,Sz=1,Sy=0.3	1002.95	23.745 4	66.5102	216.735	732.67 8

LC-37	LC-24 + Seismic Sx=1,Sz=0.3,Sy=-0.3	FORCES @ PILE CAP BOTTOM						LC-37
S.N.	Description	V	H_L	H_T	M_{TT}	M_{LL}		
		Tonne	Tonne	Tonne	Tm	Tm		
1)	Sub-structure & Foundation	346.7			0.0	0.0		
2)	Earth fill	60.9			0.0	0.0		
3)	Super-structure DL Left span	272.4			-204.3	0.0		
4)	SIDL (excluding surfacing) Left span	25.5			-19.1	0.0		
5)	Surfacing Left span	24.2			-18.2	0.0		
3)	Super-structure DL right span	272.4			204.3	0.0		
4)	SIDL (excluding surfacing) right span	25.5			19.1	0.0		
5)	Surfacing right span	24.2			18.2	0.0		
6.1)	Max long moment LL left span	0.0			0.0	0.0		0.2
6.2)	Max long. Moment LL right span	149.4			112.1	798.1		0.2
8) byouency		-86.4						
9.2) WC at 20% variation			1.4	3.9	1.9	5.2		
Seismic Longitudinal HFL								
8.2)	Permanent Loads Right span		38.7		463.8			
9.2)	Live Load Longitudinal Right span		4.0		48.0			
11)	Sub-structure Component		9.1		79.4			
12)	Pile cap		11.7		10.6			
12)	Hydrodynamic Longitudinal		1.6		-8.5			
Seismic Transveres HFL								0.3
12.1)	Permanent Loads Left span			19.3		261.0		0.3
12.2)	Permanent Loads Right span			19.3		261.0		0.3
13.1)	Live Load comp. Left span			0.0		0.0		0.06
13.2)	Live Load comp. Right span			9.0		137.1		0.06
14)	Sub-structure Component			9.1		79.4		0.3
15)	Pile cap			11.7		10.6		0.3
Seismic Vertical Downward HFL								0.3
15.1)	Permanent Loads Left span	12.9			-9.7	0.0		-0.3
15.2)	Permanent Loads Right span	12.9			9.7	0.0		-0.3
16.1)	Live Load comp. Left span	0.0			0.0	0.0		-0.06
16.2)	Live Load comp. Right span	6.0			4.5	17.5		-0.06
17)	Sub-structure Component	6.0			0.0	0.0		-0.3
18)	Pile cap	7.8			0.0	0.0		-0.3

S.N.	Description	Forces about toe				
		V	H_L	H_T	M_{TT}	M_{LL}
		Tonne	Tonne	Tonne	Tm	Tm
LC-37	LC-24 + Seismic Sx=1,Sz=0.3,Sy=-0.3	982.991	66.505	22.2754	617.302	355.59 1

LC-38	LC-24 + Seismic Sx=0.3,Sz=1,Sy=-0.3	FORCES @ PILE CAP BOTTOM						LC-38
S.N.	Description	V	H_L	H_T	M_{TT}	M_{LL}		
		Tonne	Tonne	Tonne	Tm	Tm		
1)	Sub-structure & Foundation	346.7			0.0	0.0		
2)	Earth fill	60.9			0.0	0.0		
3)	Super-structure DL Left span	272.4			-204.3	0.0		
4)	SIDL (excluding surfacing) Left span	25.5			-19.1	0.0		
5)	Surfacing Left span	24.2			-18.2	0.0		
3)	Super-structure DL right span	272.4			204.3	0.0		
4)	SIDL (excluding surfacing) right span	25.5			19.1	0.0		
5)	Surfacing right span	24.2			18.2	0.0		
6.1)	Max long moment LL left span	0.0			0.0	0.0		0.2
6.2)	Max long. Moment LL right span	149.4			112.1	798.1		0.2
8) byouency		-86.4						
9.2) WC at 20% variation			1.4	3.9	1.9	5.2		
Seismic Longitudinal HFL								
8.2)	Permanent Loads Right span		38.7		463.8			0.3
9.2)	Live Load Longitudinal Right span		4.0		48.0			
11)	Sub-structure Component		9.1		79.4			0.3
12)	Pile cap		11.7		10.6			0.3
12)	Hydrodynamic Longitudinal		1.6		-8.5			0.3
Seismic Transveres HFL								
12.1)	Permanent Loads Left span			19.3		261.0		
12.2)	Permanent Loads Right span			19.3		261.0		
13.1)	Live Load comp. Left span			0.0		0.0		0.2
13.2)	Live Load comp. Right span			9.0		137.1		0.2
14)	Sub-structure Component			9.1		79.4		
15)	Pile cap			11.7		10.6		
Seismic Vertical Downward HFL								0.3
15.1)	Permanent Loads Left span	12.9			-9.7	0.0		-0.3
15.2)	Permanent Loads Right span	12.9			9.7	0.0		-0.3
16.1)	Live Load comp. Left span	0.0			0.0	0.0		-0.06
16.2)	Live Load comp. Right span	6.0			4.5	17.5		-0.06
17)	Sub-structure Component	6.0			0.0	0.0		-0.3
18)	Pile cap	7.8			0.0	0.0		-0.3

S.N.	Description	Forces about toe				
		V	H_L	H_T	M_{TT}	M_{LL}

		Tonne	Tonne	Tonne	Tm	Tm
LC-38	LC-24 + Seismic Sx=0.3,Sz=1,Sy=-0.3	982.991	23.7454	65.1495	235.617	803.206

LC-39	LC-24 + Seismic Sx=1,Sz=0.3,Sy=0.3	FORCES @ PILE CAP BOTTOM						LC-39
S.N.	Description	V	H_L	H_T	M_{TT}	M_{LL}		
		Tonne	Tonne	Tonne	Tm	Tm		
1)	Sub-structure & Foundation	346.7			0.0	0.0		1
2)	Earth fill	60.9			0.0	0.0		1
3)	Super-structure DL Left span	272.4			-204.3	0.0		1
4)	SIDL (excluding surfacing) Left span	25.5			-19.1	0.0		1
5)	Surfacing Left span	24.2			-18.2	0.0		1
3)	Super-structure DL right span	272.4			204.3	0.0		1
4)	SIDL (excluding surfacing) right span	25.5			19.1	0.0		1
5)	Surfacing right span	24.2			18.2	0.0		1
6.1)	Max long moment LL left span	0.0			0.0	0.0		0.2
6.2)	Max long. Moment LL right span	149.4			112.1	798.1		0.2
8) byouency		-86.4						1
9.2) WC at 20% variation			1.4	3.9	1.9	5.2		1
Seismic Longitudinal HFL								1
8.2)	Permanent Loads Right span		38.7		463.8			1
9.2)	Live Load Longitudinal Right span		4.0		48.0			1
11)	Sub-structure Component		9.1		79.4			1
12)	Pile cap		11.7		10.6			1
12)	Hydrodynamic Longitudinal		1.6		-8.5			1
Seismic Transveres HFL								0.3
12.1)	Permanent Loads Left span			19.3		261.0		0.3
12.2)	Permanent Loads Right span			19.3		261.0		0.3
13.1)	Live Load comp. Left span			0.0		0.0		0.06
13.2)	Live Load comp. Right span			9.0		137.1		0.06
14)	Sub-structure Component			9.1		79.4		0.3
15)	Pile cap			11.7		10.6		0.3
Seismic Vertical Downward HFL								0.3
15.1)	Permanent Loads Left span	12.9			-9.7	0.0		0.3
15.2)	Permanent Loads Right span	12.9			9.7	0.0		0.3
16.1)	Live Load comp. Left span	0.0			0.0	0.0		0.06
16.2)	Live Load comp. Right span	6.0			4.5	17.5		0.06
17)	Sub-structure Component	6.0			0.0	0.0		0.3
18)	Pile cap	7.8			0.0	0.0		0.3

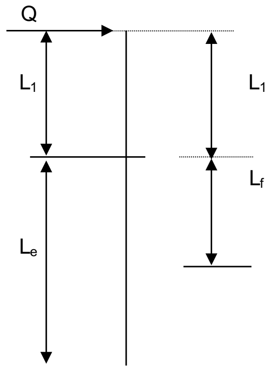
S.N.	Description	Forces about toe				
		V	H_L	H_T	M_{TT}	M_{LL}
		Tonne	Tonne	Tonne	Tm	Tm
LC-39	LC-24 + Seismic Sx=1,Sz=0.3,Sy=0.3	1007.49	66.505	22.2754	617.84	357.695

LC-40	LC-24 + Seismic Sx=0.3,Sz=1,Sy=0.3	FORCES @ PILE CAP BOTTOM						LC-40
S.N.	Description	V	H_L	H_T	M_{TT}	M_{LL}		
		Tonne	Tonne	Tonne	Tm	Tm		
1)	Sub-structure & Foundation	346.7			0.0	0.0		1
2)	Earth fill	60.9			0.0	0.0		1
3)	Super-structure DL Left span	272.4			-204.3	0.0		1
4)	SIDL (excluding surfacing) Left span	25.5			-19.1	0.0		1
5)	Surfacing Left span	24.2			-18.2	0.0		1
3)	Super-structure DL right span	272.4			204.3	0.0		1
4)	SIDL (excluding surfacing) right span	25.5			19.1	0.0		1
5)	Surfacing right span	24.2			18.2	0.0		1
6.1)	Max long moment LL left span	0.0			0.0	0.0		0.2
6.2)	Max long. Moment LL right span	149.4			112.1	798.1		0.2
8) byouency		-86.4						1
9.2) WC at 20% variation			1.4	3.9	1.9	5.2		1
Seismic Longitudinal HFL								1
8.2)	Permanent Loads Right span		38.7		463.8			0.3
9.2)	Live Load Longitudinal Right span		4.0		48.0			1
11)	Sub-structure Component		9.1		79.4			0.3
12)	Pile cap		11.7		10.6			0.3
12)	Hydrodynamic Longitudinal		1.6		-8.5			0.3
Seismic Transveres HFL								1
12.1)	Permanent Loads Left span			19.3		261.0		1
12.2)	Permanent Loads Right span			19.3		261.0		1
13.1)	Live Load comp. Left span			0.0		0.0		0.2
13.2)	Live Load comp. Right span			9.0		137.1		0.2
14)	Sub-structure Component			9.1		79.4		1
15)	Pile cap			11.7		10.6		1
Seismic Vertical Downward HFL								0.3
15.1)	Permanent Loads Left span	12.9			-9.7	0.0		0.3
15.2)	Permanent Loads Right span	12.9			9.7	0.0		0.3
16.1)	Live Load comp. Left span	0.0			0.0	0.0		0.06
16.2)	Live Load comp. Right span	6.0			4.5	17.5		0.06
17)	Sub-structure Component	6.0			0.0	0.0		0.3
18)	Pile cap	7.8			0.0	0.0		0.3

S.N.	Description	Forces about toe				
		V	H_L	H_T	M_{TT}	M_{LL}
		Tonne	Tonne	Tonne	Tm	Tm
LC-40	LC-24 + Seismic Sx=0.3,Sz=1,Sy=0.3	1007.49	23.745 4	65.149 5	236.15 5	805.30 9

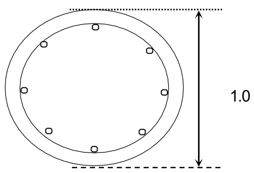
CHECK FOR HORIZONTAL CAPACITY OF PILE

Calculating Depth of Fixity :



E = 32308.25 MN/m^2

I = 0.101788 m^4



Unconfined compressive strength

q_u = 0 KN/m2

**/ As revcomended in geotech report (Average value adopted)*

Modulus of subgarde reaction for cohessive soil

η_h = **7.42** MN/m^3

****/ As per IS2911-2010 Table 3 Annx C***

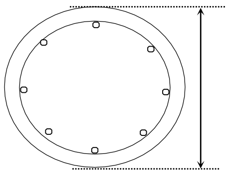
T = (EI/η)^0.2

= 3.383 m

		LWL		Scour/Liqefaction level	
Free Length of Pile , L_1	=	0	m	12.5	m
Total Length of Pile	=	30.5	m	30.5	m
Embedded length of pile , L_e	=	31	m	18	m
L_1/T	=	0.00		3.68	
Corresponding value of L_f/T	=	2.20		1.9	
Moment reduction factor m	=	0.82		0.95	
Depth of fixity, L_f	=	7.44	m	6.38	m
$L_1 + L_f$	**=**	**7.442**	**m**	**18.841**	**m**

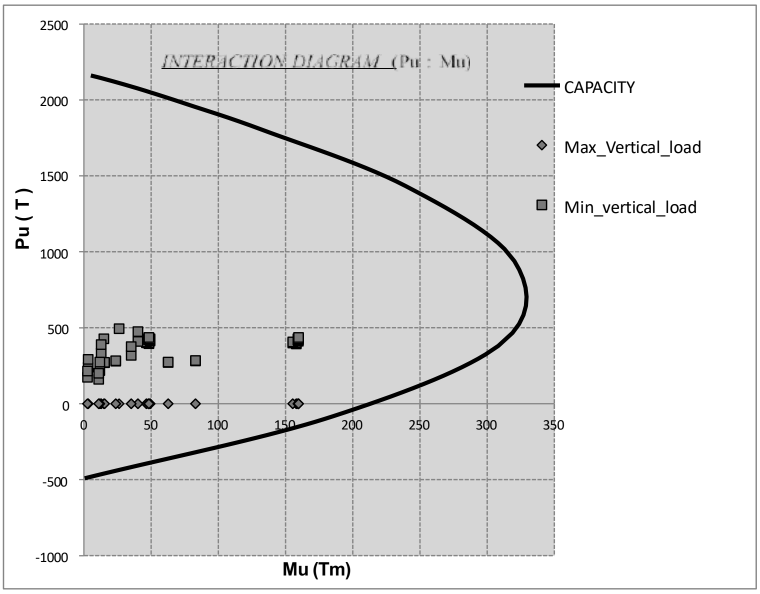
	Non Seismic		Seismic	
<u>Non-seismic case LWL condition</u>:	LWL	HFL	LWL	HFL
Horizontal force acting on each pile Q =	5.7 t	3.6 t	10.76 t	14.12 t
$L_1 + L_f$ =	7.44 m	18.84 m	7.44 m	18.8 m
Pile Head deflection Q *(L1 +Lf)³/ 12 E =	0.60 mm	6.12 mm	1.12 mm	23.94 mm
Permissible pile head deflection =	12 mm	12 mm		
Check	**OK**	**OK**	**Check Not Required**	

ULS, CHECK FOR PILE MOMENT CAPACITY :



$L_1 + L_f$ LWL	=	7.442 m
$L_1 + L_f$ HFL	=	18.841 m
Moment reduction factor m	=	0.82

fck	=	35 Mpa
fcd	=	15.6 Mpa
fyd	=	434.8 Mpa
Ac	=	
Ashear	=	1130973
As (Total Reinf)	=	mm^2



Design Shear *(IRC 112 / clause 10.3.2 (2))*

k = Min $\left\{ 1 + \sqrt{200/d} \right.$ d is depth in mm

k = 1.408

$\rho 1$ = Min $\left\{ Asl / bw\, d \right.$

Asl = 0.02 */

$\rho 1$ = *(40% reinforcement is considered in the tension zone)*

σ_{cp} = Axial stress

v_{min} = $0.031\ k^{3/2}\ fck^{1/2}$

= 0.306

V_{Rdc} = Max $\left\{ (0.12\ k\ (80\ \rho 1\ fck)^{0.33} + 0.15\ \sigma_{cp}) \right.$

Max Shear

ν = 0.6 * (1- fck /310) */ fck in Mpa

=

$V_{RDC,\,max}$ = 0.5 bw d ν fcd

= 315.26