



हुगली कोचीन शिपयार्ड लिमिटेड
(भारत सरकार का उद्यम)
HOOGHLY COCHIN SHIPYARD LIMITED
(A Govt. of India Enterprise)



वैश्वेव कुटुम्बकम्
ONE EARTH • ONE FAMILY • ONE FUTURE

Date: 03.10.2025

CORRIGENDUM-3

Ref. HCSL/PUR/TEN/2025/071 dt 12.08.2025

Sub: Corrigendum for Publishing Reply for Pre-Bid Queries.

TENDER FOR “Turn Key- Engineering, Supply, Installation, and commissioning of one number Boat Hoist/ Lift of 800T capacity for the Ship Repair Facility at Pandu, Guwahati, Assam, India”.

The Pre-Bid Meeting for Tender for “Turn Key- Engineering, Supply, Installation, and commissioning of one number Boat Hoist/ Lift of 800T capacity for the Ship Repair Facility at Pandu, Guwahati, Assam, India” was conducted online on 10th September 2025.

Further to the Pre bid meeting, reply for the pre-bid queries are herewith attached as Enclosure -I.

Design Project Report is also attached herewith as Enclosure-II.

All other terms & conditions shall remain unaltered.



For Hooghly Cochin Shipyard Limited



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P.O. Danesh Shaikh Lane, Nazirgunge, Howrah, West Bengal - 711 109.
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CIN : U35900WB2017G01223197, GSTIN : 19AAECH3640L1ZD

NAME OF THE WORK: Turn Key - Engineering, Supply, Installation, and Commissioning of one number Boat Hoist/ Lift of 800T capacity for the Ship Repair Facility at Pandu, Guwahati, Assam.

TENDER NO: HCSL/PUR/TEN/2025/071 dated 12.08.2025

REPLY TO BIDDERS QUERIE'S

SL.No	Query Reference	Reference Clause	Page No	Description	Bidder's Query	HCSL Reply
1	Financial Part (Vol IV) Payment Schedule	8	09 of 16	Stage 1- On issuance of the purchase order for the material supply. 10 % of the supply order value excluding taxes and duties against submission of equivalent bank guarantee, as per HCSL format, valid till completion of material supply and submission of bank guarantee for 10% of the Contract Price towards performance of the contract in accordance with the "Conditions of Contract" 4.2 and the "Appendix to Tender" (see Volume II).	20% advance against submission of ABG. - 80% against irrevocable Letter of Credit with following milestones.	Tender condition shall prevail.
				Stage 2- Delivery of boat lift materials/ items at Pandu site after certification by third party Classification society. (Prior to dispatch for items). 60% of the supply order value including all taxes and duties	60% of the supply order value including all taxes and duties after the certification of Third Party Inspection. (Prior to despatch)	
				Stage 3- Positioning of Boat lift erection equipment at the site. 10% of the supply order value including all taxes and duties and 10% of installation and commissioning value including all taxes and duties	10% of the supply order value including all taxes and duties after Completion of assembly , erection of structural frame work ,transversal beam and wheelgroups and certification by thirdparty Classification society	
				Stage 4 - Completion of assembly , erection of structural frame work , transversal beam and wheel groups and certification by third party Classification society. 10% of the supply order value including all taxes and duties and 30% of installation and commissioning value including all taxes and duties	10%. Completion of assembly, erection of all machineries, electrical and control system components and certification by third party Classification society	
				Stage 5 - Completion of assembly, erection of all machineries, electrical and control system components and certification by third party Classification society. 10% of the supply order value including all taxes and duties and 30% of installation and commissioning value including all taxes and duties	Erection & Commissioning 1)30% - mobilization of advance before commencement of Erection & assembly of the Boat Lift parts. 2) 40% Completion of assembly, erection of all machineries, electrical and control system components and certification by third party Classification society	
				Stage 6 Completion of installation and completion of functional and operational test and certification by third party Classification society. 20% of installation and commissioning value including all taxes and duties	3) 20% Completion of installation and completion of functional and operational test and certification by third party Classification society. 4) 10% Successful commission of the boat lift, and certification by third party Classification society, providing operational training and maintenance training and receipt of BG towards performance and guarantee of the equipment	
				Stage 7 Successfull commissioning of the boat lift, and certification by third party Classification society, providing operational training and maintenance training and receipt of BG towards performance and gurantee of the equipment. 10% of installation and commissioning value including all taxes and duties		



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2	COC (Vol II) Delay damages	Sub Clause 8.7	14 of 26	In Sub-Clause 8.7, the sum referred to in the second sentence shall be 0.05% of the Contract Price as delay damages in respect of the Works, payable (per day) in the proportions of currencies in which the Contract Price is payable. The maximum amount of delay damages shall be ten percent (10%) of the Contract Price stated in the Contract Agreement.	Bidder request to accept the following terms In case of delay in supply and installation of complete system, liquidated damages (LD) may be levied at the rate of 1/2.% (half percent) per week or part of the week of the total basic price of undelivered portion of Equipment, subject to a maximum of 5% of the total basic price of undelivered material	Tender condition shall prevail.
3	COC (Vol II) Time for Completion	Sub Clause 8.2	13 of 26	Time for Completion for Sections according Sub-Clause 1.1.5.6 are: <u>Phase 1</u> Preliminary Design 15 days Detailed Design 15 days Review period by the Employer 15 days Final Detailed Design 15 days Certification (design appraisal) by Third party certification agency like Lloyds Register, DNV, BV, IRS, TUV etc 15 days <u>Phase 2</u> Manufacturing Phase 4 months or 120 days Delivery, Installation & Commission of Boat Lift 3 months or 90 days	We request you to accept 14 months from the date of receipt of the techno-commercially clear PO and advance payment/ Letter of Credit intimation. Ex-works delivery: 10-11 months + 1,5 months delivery + 1,5 months for installation, commissioning, and training.	Tender condition shall prevail. Time is the essence of the contract.
4	ITT (Vol I) General	1.5.1 (a)	09 & 14 of 51	The Tenderers shall be a single firm. No JV or Consortium is allowed. The bidder/firm shall submit a Notary vetted Certificate of Incorporation of the company.	Please confirm whether the foreign OEM can bid directly as the prime bidder and engage a single Indian subcontractor to provide installation, commissioning support, after-sales/service, spare parts supply, and repair and maintenance works in India. Please confirm that engaging such an Indian subcontractor will not be treated as a JV/consortium.	Refer the Tender Conditions & Defentions.
5	ITT (Vol I) General	2.6 & 4.2	17 & 22 of 51	Tenderers shall deposit an amount of Rs 36 Lakhs (for Indian firms) / USD 41 Thousand/ EUR 35.30 Thousand only. (In case of foreign suppliers) in any hard and free convertible currency as Earnest Money Deposit (EMD) along with the tender.	Please specify the EMD amount, mode of submission, and applicability for foreign OEM bidders. Please confirm the acceptable currency for EMD (e.g., EUR) and whether a SWIFT guarantee from an Italian bank is acceptable.	HCSL already issued response under Corrigendum-I dated 22/08/2025. Please Refer Tender Clause 2.6 for EMD.



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6	Financial Part (Vol IV) Payment Schedule		11 & 12 of 16		Please specify tax duties and withholding requirements applicable to foreign OEM, including: (i) GST on goods; (ii) GST on services (reverse charge); (iii) Customs duty on imported goods; (iv) TDS on payments.	The bidders shall ascertain the prevailing duties and taxes on their own and submit the bid accordingly.



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7	ITT (Vol I) General	1.5.2 (a)	09 & 10 of 51	The Tenderer shall have over the past Ten (10) years experiences as original equipment manufacturer and supplier of a minimum of two (02) similar maritime Boat lift system, which have been in operation satisfactorily for at least one (01) year. The two Boat lifts systems may be part of different projects. Similar capacity shall mean Boat lift system between 400 Ton to 800 Ton with self-driven wheels and power unit. The projects shall include successful Design, Fabrication, Installation and Commissioning. Employer's certificates, third party Test Certificate and copy of the Contract comprising the maximum lifting capacity of the system have to be submitted in the Tender. If documents not mentioning the Employers or the tenderers company name additionally a clarification letter is required. The reference projects have to be filled in the form according Annex 5 and information related to present projects according Annex 6. In case the work experience is for the work executed outside India, the bidders have to submit the completion/experience certificate issued by the owner duly signed & stamped, and affidavit to the correctness of the completion/experience certificates. The Contractor shall also get the completion/experience certificates attested by the Indian Embassy/Consulate/High Commission in the respective country. In the event of submission of completion/experience certificate by the Bidder in a language other than English, the English translation of the same shall be duly authenticated by Chamber of Commerce of the respective country and attested by the Indian Embassy/consulate/High Commission in the respective country. For the purpose of evaluation of Bidders, the conversion rate of such a currency into INR shall be the daily representative exchange rate published by the SBI TT selling rate as on the Date of completion of work. HCSL reserves the right to obtain clarifications or confirmations from the clients listed by the Tenderer in their previous experience record. HCSL reserves the right to visit the boat lift installations done by the Tenderer in order to have firsthand information regarding the performance of the boat lift/hoist and after sales support provided by the supplier. The Tenderer shall co-ordinate for obtaining approval/ consent for the above-mentioned visit whereas travelling and all other expenses for the same shall be borne by HCSL. Final acceptance of the offer is subject to the receipt of satisfactory feedback from the Clients as mentioned above.	Please clarify documentation requirements for foreign OEM credentials. Please confirm whether authentication by Indian Embassy is required for technical experience and completion certificates and specify the process. Please confirm whether apostille under the Hague Convention is an acceptable alternative if embassy authentication is not possible.	Tender condition shall prevail.

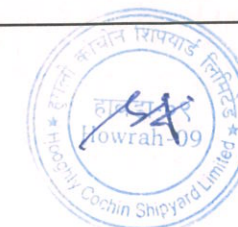


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8	Employers requirement (Vol III)	3	03 of 61	Main Utilities Supply Sources The Contractor has to make himself acquainted with the site conditions and the availability of supply sources. Electricity and fresh water and any other services may be required shall remain in the responsibility of the Contractor.	Please confirm on-site utilities support. Please clarify responsibility for utilities supply (electricity, water) during installation and commissioning, including any support provided by Employer. Please specify required utility capacity (e.g., kVA for power; m³/h for water).	Tender condition shall prevail. The employer, if requested by the successful bidders, shall provide the recommendatory assistance, to enable them to approach the local authorities to avail the required utility services. However the responsibility for arranging the utility services shall always rest with the successful bidders.
9	ITT (Vol I) General	1.14	14 of 51	For the following specialized works, the Employer permits specialized Subcontractors, if required by the main contractor: i. design and manufacturing of Boat lift control system ii. fabrication of the boat lift structure (only steel works) Tenderers planning to subcontract specialized works shall specify, in the Tender submission form, the activity(ies) or parts of the works to be subcontracted along with complete details of the Subcontractors and their qualification and experience. The Subcontractors proposed shall be fully qualified for their work proposed, and meet the specified criteria in Clause 1.5.1 b) - e) & g) and Clause 1.5.2 a) for his proposed works, failing which such Subcontractors will not be permitted to participate. The qualification and experience of Subcontractors proposed by the Tenderer will not be considered for evaluation of the Tenderer. The Tenderers on its own (without taking into account the qualification and experience of the Subcontractor) have to meet the post-qualification criteria. Each Subcontractor has to be listed in the form of Annex 8.	Please clarify: (a) whether subcontracting is strictly limited to these two activities or if additional specialized works could be proposed and approved; (b) the exact format and level of detail required in Annex 8 for listing subcontractors, including any supporting documentation for their qualifications and experience (draft Annex 8 sheets for prospective subcontractors are attached for comment on format); (c) how the specified criteria (e.g., technical and financial thresholds) will be applied and verified for subcontractors, and whether partial compliance or equivalents from international standards (e.g., EU certifications) would be acceptable; (d) if multiple subcontractors can be proposed for a single activity, and the process for selecting or approving them; (e) the implications if a proposed subcontractor is rejected (e.g., whether it disqualifies the entire bid or allows substitution); (f) confirmation that the tenderer's post-qualification evaluation relies solely on its own merits, without any aggregation of subcontractor experience or resources; (g) confirmation that any substitute subcontractor can be proposed within seven days of HCSL rejection.	(a) As contemplated, the sub contracting shall be limited only to those specialized activities. (b) The bidders are expected to follow the format as provided in Annexure-8 with required supporting documents, as deemed appropriate. (c) Tender condition alone shall prevail. The successful bidders are expected to follow the tender stipulations while nominating the sub contractors. (d) It is the responsibility of the successful bidders to select the suitable sub contractors who has sufficient previous experience and expertise. (e),(f)&(g) Tender condition shall Prevail.



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Sl.No	Query Reference	Reference Clause	Page No	Description	Bidder's Query	HCSL Reply
10	ITT (Vol I) General	2.8.2.5	18 of 51	All single rates proposed by the Tenderer should be inclusive of all applicable taxes, customs duty, fees, royalties, etc.	We refer to the tender documents regarding the consignee and export procedures for the Original Equipment Manufacturer (OEM), particularly in the context of customs duties under Indian Customs Law (Chapter 89) for ship repair facilities. Please clarify: (a) whether the consignee is Inland Waterways or HCSL; (b) if Inland Waterways is designated as the consignee (as the actual user) and their PANDU facility is registered as a Ship Repair Facility (SRF) under the Directorate General of Shipping, whether the OEM's export can be made directly in the name of Inland Waterways instead of HCSL; (c) confirmation that, if export is allowed to Inland Waterways as the actual-user consignee, the OEM would be eligible to waive customs duty calculations under Chapter 89 of the Indian Customs Tariff Act, including any specific conditions or documentation required for such exemption; (d) the consignee's GSTIN / IEC that must appear on shipping documents.	Tender condition shall prevail. The bidders shall ascertain the applicable duties and taxes, customs duties, fees, royalties, etc., and submit a single rate proposal as specified in the bid document.
11	ITT (Vol I) General	2.8.2.6	18 & 19 of 51	For Overseas firms-. Applicable taxes in India (Income tax and GST extra as applicable) shall be borne by the Supplier (As per Income tax act, 1961 for Indian suppliers and Income Tax Act, 1961 and DTAA agreements in the case of foreign vendors). Income tax liability of non-resident service engineer based on his period of stay in India will not be borne by HCSL. In all cases, the non-resident vendor/service provider shall provide such documents that are necessitated by the Indian income tax laws so as to enable HCSL to comply with the provisions of Indian statute and for payments of income tax in India. Following documents shall be sought by HCSL in this regard (i) Certificate under 10 (F) (ii) Tax residency certificate (iii) The certification regarding the existence/non-existence of business connection or permanent establishment in India (The above is only an indicative list) Note - Filing of Form 10F is to be done on line which is mandatorily required to be complied with for availing DTAA benefit If overseas bidder is not agreeing for above clause, loading factor will be considered during price comparison for arriving L1. For Indian firms- Income tax will be deducted from payments. GST shall be paid extra as applicable.	Please clarify: (a) specific Income Tax and GST rates applicable to our supplies (goods, services, or installation) under the Income Tax Act, 1961, and the India-Italy DTAA, including withholding tax (TDS) rates and processes for availing DTAA benefits (e.g., reduced rates for business profits, royalties, or technical services, with required documentation like Tax Residency Certificate or Form 10F); (b) criteria for determining "income accruing or arising in India," including Permanent Establishment (PE) thresholds (e.g., based on transaction value, user interactions, or physical presence) and its impact on taxation; (c) whether HCSL will withhold taxes at source and the mechanism for claiming relief; (d) GST handling for imports, including applicability of reverse charge, registration requirements for foreign suppliers without physical presence in India, and tax rates (e.g., 18% for services or varying for goods); (e) income tax triggers for non-resident service engineers based on stay duration, along with any DTAA exemptions or reliefs; (f) whether HCSL will issue the statutory TDS certificates (Form 16A / 27Q).	The bidders shall ascertain the prevailing duties, taxes etc., on their own and submit the bid accordingly. Refer tender Condition; VOLUME IV Financial Part, Clause 8. Payment Schedule.



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12	ITT (Vol I) General	1.14	37 of 51		We intend to subcontract to an Indian company all the works and activities to be performed on site (i.e. site preparation, erection, commissioning, load test).	Tender condition shall prevail.
13	Financial Part (Vol IV) Payment Schedule	Para 8	9 of 16		We kindly ask to accept the following payment conditions: FOR SUPPLY (included taxes and duties) Stage 1 Advance Payment - On issuance of the purchase order for the Boat Lift: 20 % of the contract order FOR THE SUPPLY against submission of equivalent bank guarantee, valid for 10% at FAT certificate and 10% till the commissioning date. Stage 2 - 80% by means of an irrevocable and confirmable L/C to be issued via a first-rate international bank not later than one month from the execution of this contract agreement and payable as follows: •30% of the contract value FOR THE SUPPLY after the FAT test at Seller's premises duly signed from a third-party inspection •30% of the contract value FOR THE SUPPLY against shipping documents . •10% of the contract value FOR THE SUPPLY upon arrival on site in Pandu. •10% of the contract value FOR THE SUPPLY after assembly, erection and commissioning in Pandu. FOR ERECTION AND COMMISSIONING (included taxes and duties) 1.30% - mobilization of advance before commencement of Erection & assembly of the Boat Lift parts.	



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					2.40% Completion of assembly, erection of all machineries, electrical and control system components and certification by third party Classification society 3.20% Completion of Installation and completion of functional and operational test and certification by third party Classification society. 4.10% Successful commission of the boat lift, and certification by third party Classification society, providing operational training and maintenance training and receipt of BG towards performance and guarantee of the equipment	
14	Financial Part (Vol IV) Payment Schedule	Para 9	10 of 16		Please clarify the following sentence: Towards stage 1 payment, a Bank Guarantee In HCSL format equivalent to the stage 7 payment, to cover the period till entire completion of material supplies is to be furnished. On receipt of bank guarantee and receipt of performance security in accordance with the "Conditions of Contract" 4.2 and the "Appendix to Tender" (see Volume II), stage I payment shall be released.	



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15	COC (Vol II) Time for Completion	Sub Clause 8.2	13 of 26		OEM estimates the following time of completion: Preliminary Design: 15 days Detailed Design: 30 days Review period by the Employer: 15days Detailed Design: 15 days Certification (design appraisal) by a third-party certification agency like Lloyds Register, DNV, BV, IRS, TUV etc: 15 days Manufacturing Phase: 8-9 months Installation Commission of machine: 4-5 months Phase I Final Phase 2 Delivery,	



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16	Employers requirement (Vol III) Material control		26 of 61	Material procurement documentation is to be submitted to the Employer's representative prior to final placing of the order(s), to assure that all material specifications, testing and quality control requirements are met. To this extent, the procurement document should specify.	Not acceptable. The majority of the components and materials for our Boat Hoist are standards and already stocked in our warehouse. These materials and components have been selected over the years, optimized and adapted for our machines. A list of main components will be included in our technical specification, and we'll also include the drawings and specs. of the main ones.	



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17	Employers requirement (Vol III)		22 of 61	Relationship with Civil works design	In the document, it is stated that "The boat hoist Contractor shall interact with the Consultant as required to collect information about the civil design loads and civil works executed, and the Contractor should take that information into consideration while designing the boat lift system." We would like to clarify that the ground reactions and dimensions of the Boat Hoist will be included in the tender documentation (preliminary drawing) and will also be confirmed during the final design phase. The Contractor is not able to take on any additional activities, checks, or verifications related to the civil works.	



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18	COC (Vol II) Delay damages	Sub Clause 8.7	14 of 26		In Sub-Clause 8. 7, the sum referred to in the second sentence shall be 0.05% of the Contract Price as delay damages in respect of the Works, payable (per day) In the proportions of currencies in which the Contract Price is payable. The maximum amount of delay damages shall be ten percent (10%) of the Contract Price stated in the Contract Agreement. We propose the following: In Sub-Clause 8.7, the sum referred to in the second sentence shall be 0.05% of the Contract Price as delay damages in respect of the Works, payable (per day) in the proportions of currencies in which the Contract Price is payable. The maximum amount of delay damages shall be five percent (5%) of the Contract Price stated in the Contract Agreement.	



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19	Employers requirement (Vol III) Key milestone dates		57 of 61		OEM propose the following: 2: B = A+ 90 days 3: C = B + 30 days ** 4: D = C + 240/270 days 5: E = D + 120 /150 days	
20	Corrigendum I dated 22.08.2025	Clause 2.12			Due to the limited time available between the Pre- Tender Meeting (10th September 2025) and the deadline for receiving the tender documents (19th September 2025), and considering the long shipping times for foreign bidders as well as the potential amendments arising from the Pre-Tender Meeting and the consequent adjustments required in the tender documents, we kindly request the possibility to extend the submission deadline to the first week of October.	HCSL already issued response under Corrigendum-2 dated 17/09/2025.
21	Corrigendum I dated 22.08.2026			Load tests	Since we are facing difficulties in sourcing the 1000 tons of loads required to perform the tests (static & dynamic), we kindly request whether it would be possible to exclude from the scope of supply the part related to the load tests and, alternatively, to receive support from the Employer who, being a local shipyard, may have easier access to such loads such as a suitable boat/barge or other types of heavy loads.	The request cannot be accepted. Further the employer cannot guarantee extension of the requested support at aplace of testing. It is the responsibility of the successful bidder to scout a suitable mechanism to perform the intendent test.



DESIGN PROJECT REPORT FOR SHIP REPAIR FACILITY TO HANDLE INLAND WATERWAYS VESSELS AT PANDU, GUWAHATI

OPEN PILED STRUCTURE



Client
Hooghly Cochin Shipyard Limited.

Consultants
Prof. S.A.Sannasiraj
Prof. K. Murali



National Technology Centre for Ports, Waterways and Coasts

Department of Ocean Engineering
Indian Institute of Technology Madras
Chennai – 600 036

Client	Cochin Shipyard Limited	Date	26/03/2022
Project	Design Project Report for Ship Repair Facility to handle Inland waterways Vessels at Pandu, Guwahati	Consultant	IITM/ NTCPWC



Contents

1.0	Introduction	5
2.0	Scope and Objective of the Project.....	7
3.0	Revisions and standards.....	9
3.1	Revision History	9
	Drawings:.....	9
	Report:.....	9
3.2	Changes to this Revision.....	10
3.3	Codes and Standards	11
3.4	Reference.....	11
4.0	Outline of the Report.....	12
5.0	Project Site Environment.....	13
5.8	Seismicity	17
5.9	Layout	18
6.0	Design Information's for Ship Repair Facility	21
6.1	General.....	21
6.2	Basic Design considerations	25
6.2.1	General	25
6.2.2	Design Life.....	25
6.2.3	Design assumptions	25
6.2.5	Design deck Level.....	26
6.2.6	Berthing Criteria	26
6.2.7	Mooring Loads	26
6.2.8	Structural Design	27
6.2.9	Materials and Cover	27
6.2.9.5	Vessel Specifications	28
6.2.9.6	Deflection	28
6.2.9.7	Crack Width.....	28
7.0	General Arrangement and Structural Model for Proposed Structure	29
7.1	Structural Arrangement of boat hoist jetty, transfer bay and repair bay.....	29
7.2	Analysis Model.....	33
7.3	Structural Sizes.....	35
8.0	Loadings for Ship repair facilitates	36
8.1	Dead Loads	36

Client	Cochin Shipyard Limited	Date	26/03/2022
Project	Design Project Report for Ship Repair Facility to handle Inland waterways Vessels at Pandu, Guwahati	Consultant	IITM/ NTCPWC



8.2 Live Load.....	36
8.3 Seismic Force	36
8.4 Berthing Force.....	37
8.5 Mooring Force.....	38
8.6 Wind	40
8.7 Temperature & Shrinkage	41
8.8 Boat Hoist Crane	41
8.9 Calculation of Soil Spring Values	42
9.0 Structural Analysis Results	44
9.1. Pile-1300mm dia.....	44
9.2. Pile-1200mm dia.....	45
9.3. Column-1750x1750mm	47
9.4. Beam-1500x2000mm	48
9.5. Beam-1750x2000mm	50
9.6. slab-700mm.....	51
9.7. slab-800mm.....	52
10.0 Results and Discussions	54
10.1 Piles.....	54
11.0 Summary.....	57

-

Client	Cochin Shipyard Limited	Date	26/03/2022
Project	Design Project Report for Ship Repair Facility to handle Inland waterways Vessels at Pandu, Guwahati	Consultant	IITM/ NTCPWC



List of Figures

S. No	Description	Page. No
1.1	Pandu port – Aerial view	5
1.2	Location of ship repair facility	6
1.3	Cross-section of ship repair facility	10
5.1	Topography details of site	16
5.2	Details of Hydrographic Survey near shiprepair facility	17
5.3	Seismic Zoning Map of India as per IS-1893 Part 1-2016	17
5.4	Development of Phase –I layout	19
5.5	Development of Phase –II layout	19
6.1	Plan view of boat hoist jetty	22
6.2	Cross-section of boat hoist jetty	22
6.3	Plan view of the transfer bay	23
6.4	Cross-section of transfer bay	23
6.5	Plan view of the ship repair bay	24
6.6	Cross-section of Ship repair bay	24
7.1	Plan view of boat hoist jetty	30
7.2	Cross-section of boat hoist jetty	30
7.3	Plan view of the transfer bay	31
7.4	Cross-section of transfer bay	31
7.5	Plan view of the ship repair bay	32
7.6	Front-section of Ship repair bay	32
7.7	Structural model for boat hoist jetty	33
7.8	Structural model for transfer bay	34
7.9	Structural model for repair bay	35
8.1	Response spectra for rock and soil and sites for 5% damping	37
8.2	Technical data	41

Client	Cochin Shipyard Limited	Date	26/03/2022
Project	Design Project Report for Ship Repair Facility to handle Inland waterways Vessels at Pandu, Guwahati	Consultant	IITM/ NTCPWC



List of Tables

Table. No	Description	Page. No
5.1	Maximum and Minimum water levels observed at Pandu	13
5.2	Maximum & Minimum Mean Velocities (m/s) of the River Brahmaputra at Pandu	14
5.3	Details of Borehole	15
6.1	Berthing Criteria	26
6.2	Grade of concrete & steel	27
6.3	Vessel specifications	28
6.4	Maximum Crack Width in Different Zone	28
7.1	Structural components	35
8.1	Parameters for calculation of Berthing Energy	38
10.1	Reinforcement summary for 1500mm	56
10.2	Reinforcement summary for 1400mm	56
10.3	Reinforcement summary for column (1750x1750mm)	57
10.4	Reinforcement summary for beams	57
10.5	Reinforcement summary for slab	58

Client	Cochin Shipyard Limited	Date	26/03/2022
Project	Design Project Report for Ship Repair Facility to handle Inland waterways Vessels at Pandu, Guwahati	Consultant	IITM/ NTCPWC



1.0 Introduction

Pandu Port is a riverine port in the Indian state of Assam, serving North Eastern states of Assam and Guwahati in particular. This port has been developed on the bank of the Brahmaputra River. The port is strategically important and one of the largest river port in the north eastern state of the country wherein, in order to accommodate ship anchorage, a naval terminal or permanent jetty is existing. In addition, many passenger ships are anchored with the tourists at this port. Considering the huge demand for repair of the vessels plying in this route and also the additional cost and time consuming before reaching the other ship repair yards nearby, the state government has embarked an ambitious plan to develop the port with emphasis on development of ship repair facilities and also allocated funds for the modernization of the port under the National Waterways development projects. The Port is also included in the 'Port of call' agreement between India and Bangladesh.

The ship repair facility is proposed on the eastern side of existing jetty at Pandu Port at a distance of about 350m. The latitude and longitude of the ship repair facility is 26°10'15.01"N and 91°40'59.87"E. The aerial view of Pandu port and the location of ship repair is shown in **Fig. 1.1** and **Fig. 1.2** , respectively.



Fig. 1.1: Pandu port – Aerial view

Client	Cochin Shipyard Limited	Date	26/03/2022
Project	Design Project Report for Ship Repair Facility to handle Inland waterways Vessels at Pandu, Guwahati	Consultant	IITM/ NTCPWC



Fig. 1.2: Location of ship repair facility

Client	Cochin Shipyard Limited	Date	26/03/2022
Project	Design Project Report for Ship Repair Facility to handle Inland waterways Vessels at Pandu, Guwahati	Consultant	IITM/NTCPWC



2.0 Scope and Objective of the Project

a) Visit the proposed site and collect the data available with IWAI/HCSL and other authorities, required for the design of Ship repair facility.

b) Identification of additional investigation / collection of data, if any required.

c) HCSL will directly carry out Soil Investigation and Topographical Survey. Consultant has to do supervision of this Soil Investigation and Topographical Survey. Consultant has to also immediately submit to HCSL the detailed scope of soil investigation/topographical survey with layout of boreholes along with detailed specification for soil investigation and Topographical Survey.

d) Carry out Structural stability study of the existing foundations I structures, buildings, etc. which are intended for further use, as per the tentative master plan. Submit recommendations for refurbishment/ restoration of above facilities, if the present structural condition of these are not complying with currently acceptable standards.

e) Preparation of an Inception Report.

f) Review existing layout plan of the ship repair facility.

g) Preparation of final layout Plan/ land use plan.

h) Preparation of Basis of design.

i) Preparation of Detailed Project Report.

j) Taking approvals for statutory authorities for the project. Design & Detailed Engineering.

k) Preparation of EIA report and providing Consultancy for obtaining.

l) Environmental Clearance from appropriate authorities.

m) Preparation of Detailed cost estimate.

n) Preparation of tender drawings (for each packages like civil, electrical & mechanical).

o) Preparation of Tender documents along with Pre-qualification of contractors. (For each packages like civil, electrical & mechanical).

p) Evaluation of Technical and Financial Bids. (For each packages like civil, electrical & mechanical).

q) Preparation of Work Order / Purchase Order and all necessary agreements with the Contractors. (For each packages like civil, electrical& mechanical).

r) Preparation and issuance of Good for Construction drawings.

s) Site Project Management and Supervision during construction & commissioning.

Client	Cochin Shipyard Limited	Date	26/03/2022
Project	Design Project Report for Ship Repair Facility to handle Inland waterways Vessels at Pandu, Guwahati	Consultant	IITM/ NTCPWC



t) Review, Comment and Approval of drawings and design calculations, if any submitted by the contractors.

u) Render professional advice as and when required.

v) Prepare and submit as- built drawings at the end of construction.

w) Inspection during Defect Liability Period of Contractor.

x) Assist HCSL on Audit queries.

y) Responsibility on technical details, overall performance of the system and timely completion of project.

The present report covers the design project report, cost estimation and drawings for ship repair facility to handle the inland water ways vessels.

Client	Cochin Shipyard Limited	Date	26/03/2022
Project	Design Project Report for Ship Repair Facility to handle Inland waterways Vessels at Pandu, Guwahati	Consultant	IITM/ NTCPWC



3.0 Revisions and standards

3.1 Revision History

Drawings:

S. No.	Report No	Description	Revision	Issued On	Remarks
1	IITM-PU-SR-001	Issued	A		

Report:

S. No	Report No	Description	Revision	Issued On	Remarks
1	IITM-PU-RPT-001	Issued	A		

Client	Cochin Shipyard Limited	Date	26/03/2022
Project	Design Project Report for Ship Repair Facility to handle Inland waterways Vessels at Pandu, Guwahati	Consultant	IITM/ NTCPWC



3.3 Codes and Standards

The codes and standards for the design of the ship repair facility structure are given below.

Code	Description
IS: 875 Part 3	Code of Practice for Design Loads for Building and Structures Wind Load
IS: 456	Code of Practice for Plain and reinforced Concrete
IS: 1893 Part 1	Criteria for Earthquake-resistant Design of structures
IRC 6 – 2014	Standard specifications and code of practice for roads, bridges, section II Loads and stresses.
IS: 4651 Part 1	Site Investigation.
IS: 4651 Part 2	Earth Pressure.
IS: 4651 Part 3	Loadings
IS: 4651 Part 4	Design Considerations
IS: 4651 Part 5	Layout and Functional requirements
IS 2911-2010	Design and construction of Pile Foundations – Concrete Piles.
Part 1 / Sec 2	
SP16	Design aids to IS: 456
SP34	Handbook on Concrete Reinforcement and Detailing
IS 800	General Construction in Steel

Note: Unless noted otherwise, the latest edition of the above codes & standards shall be used.

3.4 Reference

- [1] Foundation Analysis and Design by Joseph E. Bowels- 5th edition McGraw Hill book.
- [2] Safe Berthing and Mooring – Trelleborg Marine Systems.
- [3] Limit State design of reinforced concrete by P.C. Varghese.

Client	Cochin Shipyard Limited	Date	26/03/2022
Project	Design Project Report for Ship Repair Facility to handle Inland waterways Vessels at Pandu, Guwahati	Consultant	IITM/ NTCPWC



4.0 Outline of the Report

The report has been organized as per the following sequence.

Section 1: Introduction.

Section 2: Scope and Objective of the Project.

Section 3: Revisions and Standards.

Section 4: Outline of the Report.

Section 5: Project Site Environment.

Section 6: Design Information's for Ship repair facility structures.

Section 7: General Arrangement and Structural Model for Proposed Structure.

Section 8: Loadings for Ship repair facility structures .

Section 9: Structural Analysis Results.

Section 10: Results and Discussions.

Section 11: Summary.

Client	Cochin Shipyard Limited	Date	26/03/2022
Project	Design Project Report for Ship Repair Facility to handle Inland waterways Vessels at Pandu, Guwahati	Consultant	IITM/ NTCPWC



5.0 Project Site Environment

The analysis of the prevailing environmental aspects of the project site is essential for the better understanding of the site that will help in development and modification of the ship repair facility. Hence an overall environmental data on the location, connectivity, meteorological parameters, geotechnical aspects, and basic details of the project site are reproduced from the earlier reports for better appreciation.

5.1 Water level

The maximum and minimum water levels observed at Pandu over a period of 2004-2014 are tabulated in **Table. 5.1**. The observed Highest Flood level at Pandu is 50.05 m and lowest water level at Pandu is 40.31 m with reference to the mean sea level.

Table. 5.1: Maximum and Minimum water levels observed at Pandu

		Year								
		2004	2005	2006	2007	2008	2009	2010	2011	2012
January	Max.	41.43	41.56	41.04	40.94	41.74	-	41.16	41.52	40.89
	Min.	41.26	41.20	40.50	40.41	41.38	-	40.52	41.10	40.38
February	Max.	41.26	42.33	41.11	40.79	41.78	-	40.50	41.45	40.70
	Min.	41.11	41.06	40.31	40.39	41.43	-	40.35	40.99	40.52
March	Max.	44.64	44.28	42.21	40.98	42.57	-	43.43	43.66	41.34
	Min.	41.06	41.75	40.92	40.51	41.43	-	40.40	40.94	40.60
April	Max.	45.39	45.15	-	-	42.92	-	47.26	44.13	44.24
	Min.	42.48	43.21	-	-	42.92	-	43.13	42.28	41.31
May	Max.	47.09	44.91	44.91	47.18	-	44.51	48.05	44.98	46.13
	Min.	43.03	43.60	44.01	44.57	-	42.61	44.16	42.94	43.19
June	Max.	48.21	46.84	48.70	48.34	-	45.29	48.79	46.27	48.87
	Min.	44.85	44.46	46.20	46.09	-	43.64	46.21	44.17	44.59
July	Max.	49.20	47.73	48.42	50.05	-	47.42	48.91	47.84	48.47
	Min.	46.88	46.02	47.24	47.16	-	45.40	48.30	45.71	47.22
August	Max.	47.56	47.89	47.45	50.05	-	47.78	49.39	47.79	48.16
	Min.	46.73	46.02	45.57	47.63	-	46.53	47.41	46.22	46.35
September	Max.	47.54	47.41	48.59	48.13	-	46.75	49.92	46.88	49.40
	Min.	45.42	44.38	45.87	46.17	-	45.05	48.09	45.21	46.18
October	Max.	47.64	45.39	46.15	45.92	-	46.22	-	46.58	48.23
	Min.	43.65	43.44	45.42	44.40	-	42.86	-	42.87	44.17
November	Max.	43.82	43.76	-	44.19	-	43.36	-	42.81	-
	Min.	42.12	42.00	-	42.62	-	42.45	-	41.65	-
December	Max.	42.15	41.96	-	42.56	-	41.90	-	41.63	-
	Min.	41.57	41.07	-	41.76	-	41.19	-	40.93	-

Client	Cochin Shipyard Limited	Date	26/03/2022
Project	Design Project Report for Ship Repair Facility to handle Inland waterways Vessels at Pandu, Guwahati	Consultant	IITM/ NTCPWC



It could be observed that during the months of December to March the water levels are lowest, while during the months of April to October these are highest.

5.2 Rainfall

Annual rainfall in the catchment area varies widely from over 250 cm in the Assam Valley to less than 50 cm in Tibet. Rainfall in the region is negligible from November to March. The rainfall commences from April and reaches its peak towards end of May. The average annual rainfall is about 160 cm at Pandu.

5.3 Current

From available data on river velocities, the mean velocity during the normal and flood periods has been observed to be about 1 m/s and 4 m/s respectively. The annual records of maximum and minimum mean velocities of the river Brahmaputra at Pandu are tabulated in **Table. 5.2**. It could be observed that during months of higher discharge viz. June to September the maximum velocities could reach 3.0 to 5.0 m/s. These velocities are too high for the vessel to align along the slipway. However during these months minimum velocities are well below 2.0 m/s which could be considered as limit upto which the vessels could be handled at the slipway safely. The ship/vessel would be placed in position using tug boats of adequate capacity during monsoon season so as to transfer it to trolley for hauling upto slipway. Additional mooring structure such as buoy shall be installed during slipway operation.

Table. 5.2: Maximum & Minimum Mean Velocities (m/s) of the River Brahmaputra at Pandu

Months		1959	1961	1977	1978
Jan.	Max.	0.52	0.53	1.16	0.83
	Min.	0.39	0.47	0.83	0.73
Feb.	Max.	0.54	0.53	1.10	0.86
	Min.	0.34	0.47	0.76	0.75
Mar.	Max.	0.58	0.80	1.31	0.93
	Min.	0.38	0.47	0.89	0.72
Apr.	Max.	1.19	1.35	1.49	1.28
	Min.	0.47	0.68	1.02	0.86
May	Max.	2.21	2.74	2.05	1.76
	Min.	0.76	0.95	1.05	1.12
June	Max.	3.14	2.50	2.61	3.63
	Min.	1.28	1.52	1.76	1.29
Jul.	Max.	2.14	3.21	3.00	2.57
	Min.	1.55	1.50	2.00	1.70
Aug.	Max.	5.57	5.85	3.11	2.58

Client	Cochin Shipyard Limited	Date	26/03/2022
Project	Design Project Report for Ship Repair Facility to handle Inland waterways Vessels at Pandu, Guwahati	Consultant	IITM/NTCPWC



	Min.	1.61	1.84	2.55	1.63
Sept.	Max.	2.10	2.19	2.90	2.16
	Min.	1.36	1.24	1.65	1.60
Oct.	Max.	1.50	1.53	2.40	1.84
	Min.	1.08	0.92	1.16	1.20
Nov.	Max.	1.15	0.97	1.14	1.33
	Min.	0.64	0.57	0.95	0.97
Dec.	Max.	0.66	0.64	1.12	1.02
	Min.	0.32	0.45	0.82	0.78

5.4 Temperature

Guwahati enjoys moderate weather with average high temperature of 29°C and average minimum is 19°C. Summer (April-May) has a maximum of 40°C and winter (October to March) has a minimum 5°C.

5.5 Geotechnical Data

The geotechnical investigations at the proposed shiprepair location were carried and considered marine borehole details is given in **Table. 5.3** below.

Table. 5.3: Details of Borehole

SOIL TEST BORE HOLE CHART						
RELIANT ENGINEERS, SIX-MILE, GUWAHATI-22						
BORE HOLE NO.: MAH-1			DATE OF STARTED: 23/01/2022			
TYPE OF BORING: Wash & Drilling			DATE OF COMPLETED:			
NAME OF PROJECT: Port.			GROUND WATER LEVEL:			
LOCATION: Pandu						
R.L. OF BH:						
SOIL STRATA	Depth (M)	Sample No.	type	S.P.T.		
				15cm	15cm	15cm
Grayish Silty clay from 1.5 to 2.0 m	1.5			1	1	2
	2.0			2	2	3
Grayish Silty clay from 2.0 to 4.5 m	4.5			8	11	14
	6.0			11	12	21
Grayish fine sand from 4.5 to 6.0 m	7.5			12	19	24
	9.0			13	24	27
Grayish medium to fine sand from 6.0 to 9.0 m	10.5			15	27	29
	12.0			16	26	35
- do -	13.5			18	28	36
- do -	15.0			20	31	32
- do -	16.5			22	33	42
- do -	18.0			24	35	45
Grayish Brown colour medium to fine sand from 18.00 m to 35.00 m	19.5			23	37	43
	21.0			27	38	48
	22.5			30	38	47
Grayish Brown colour Silty fine sand from 35.00 m to 37.00 m	24.0			23	36	40
	25.5			26	38	47
	27.0			31	42	48
	28.5			33	44	46
	30.0			30	41	45
	31.5			29	47	49
	33.0			31	49	52
	34.5			32	48	50
	36.0					
	37.50					
	39.0					
	40.50					

Client	Cochin Shipyard Limited	Date	26/03/2022
Project	Design Project Report for Ship Repair Facility to handle Inland waterways Vessels at Pandu, Guwahati	Consultant	IITM/NTCPWC



5.6 Topographic Information

The topographical survey of the proposed slipway at Pandu was carried out and the levels of existing surface are found to vary from 40.0 m to 52.0 m with respect to mean sea level. The topographic details of Project site as shown in **Fig. 5.1**.

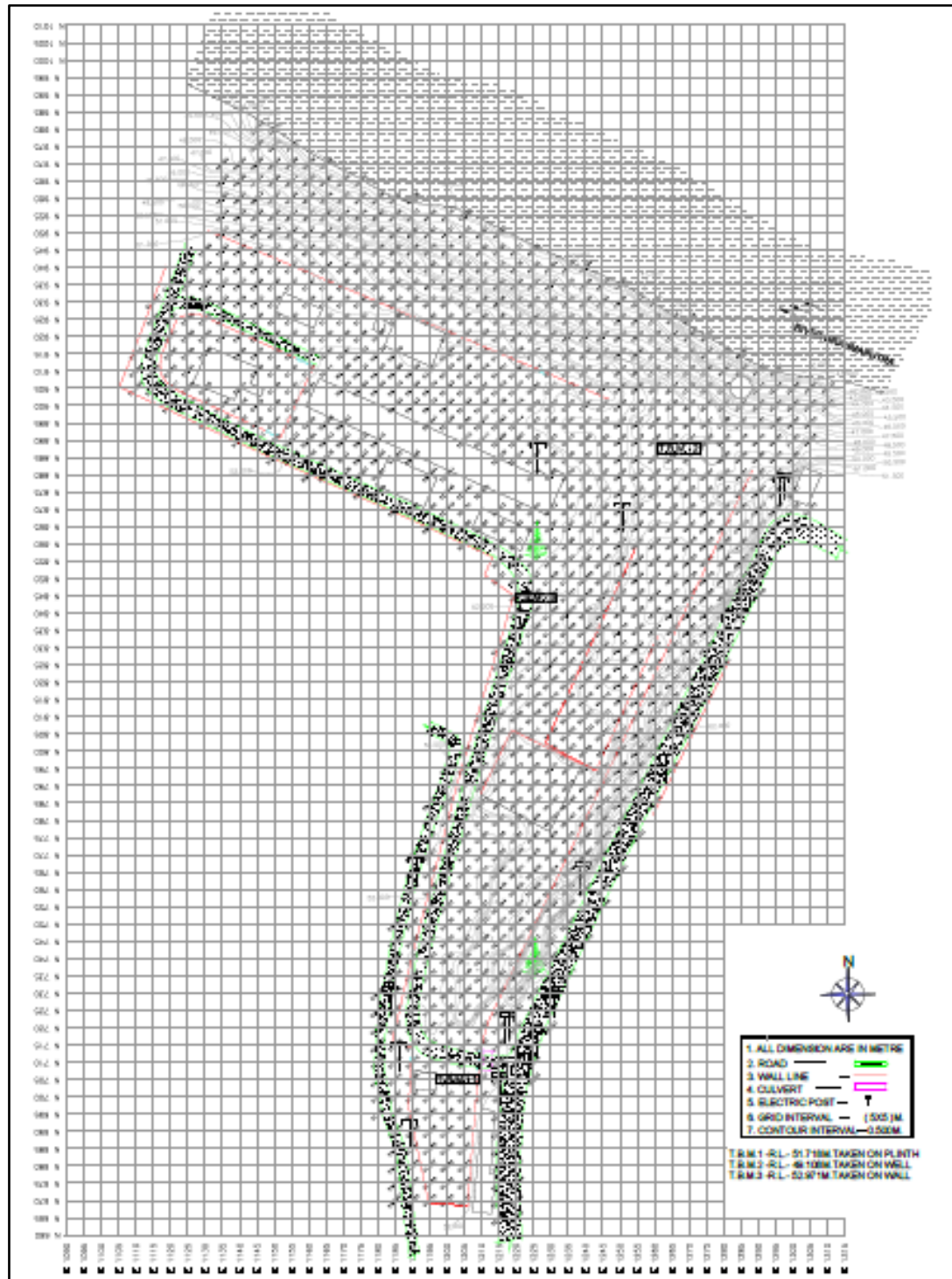


Fig. 5.1: Topography details of site

Client	Cochin Shipyard Limited	Date	26/03/2022
Project	Design Project Report for Ship Repair Facility to handle Inland waterways Vessels at Pandu, Guwahati	Consultant	IITM/NTCPWC



5.7 Hydrographic Information

The hydrographic survey of river Brahmaputra near the slipway location was collected by IWAI and details are shown in **Figure. 5.2**.

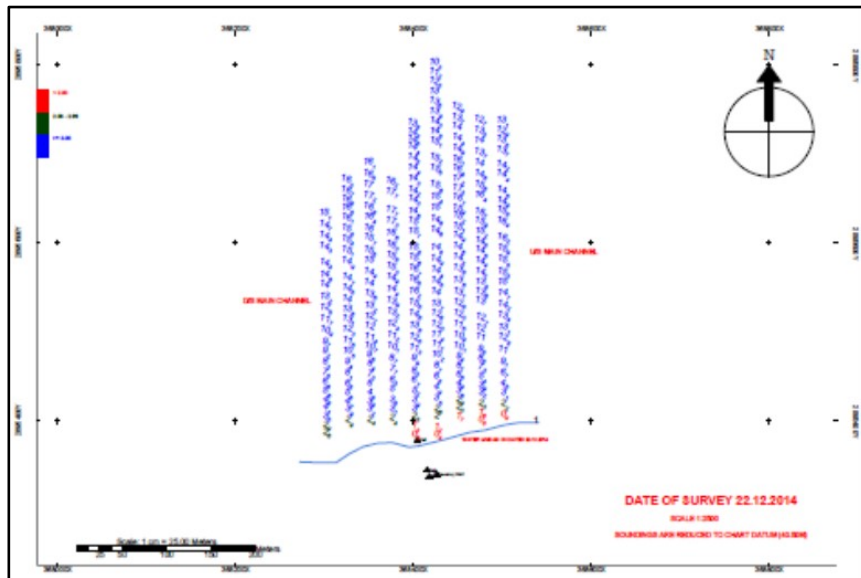


Fig. 5.2: Details of Hydrographic Survey near shiprepair facility

5.8 Seismicity

Pandu is in Zone V of Indian Map of Seismic zones (IS-1893 Part-1 2016) which is a very severe risk seismic intensity zone (**Fig.5.3**).

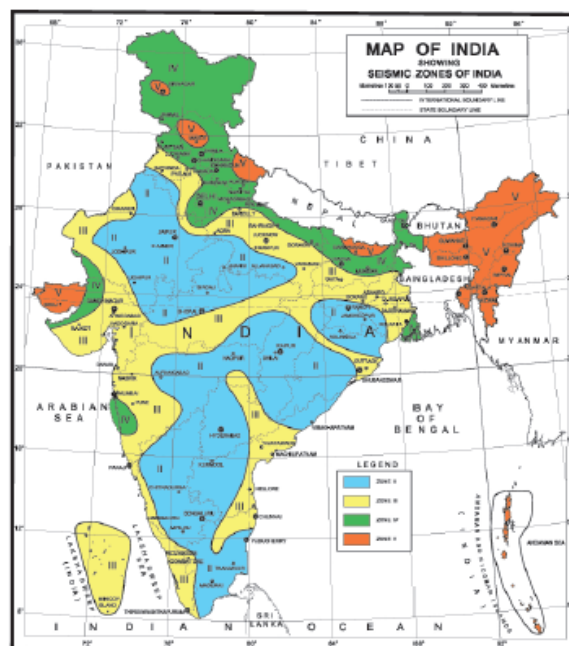


Fig. 5.3: Seismic Zoning Map of India as per IS-1893 Part 1-2016

Client	Cochin Shipyard Limited	Date	26/03/2022
Project	Design Project Report for Ship Repair Facility to handle Inland waterways Vessels at Pandu, Guwahati	Consultant	IITM/ NTCPWC



5.9 Layout

The proposed layout consists two phase of development and it is shown in **Fig. 5.4** and **Fig. 5.5**.

The phase-I development consist of open piled structure of ship repair facility having length of 128m and width of 70m. The facility consist of boat hoist jetty of 60m length and width of 10m parallel to the river and the transfer bay consist of berthing jetty provisions along the river side. The transfer bay has length of 68m and width of 37.5m. The repair yard length is 68m and width is 32.5m. In phase-I, 60m length of vessels can be handled in ship repair facility. The light weight of ship is approximately 500T for 60m vessels.

The phase-II development consist of open piled structure of ship repair facility having length of 217m and width of 133m. The facility consist of boat hoist jetty of 90m length and width of 10m parallel to the river and the transfer bay consist of berthing jetty provisions along the river side. The transfer bay has length of 116 m and width of 37.5m. The repair yard length is 116m and width is 95.5m. Further, the existing wet basin shall be converted as ship repair yard in Phase-II development to handle the higher size of vessels. In phase-II, 90m length of vessels can be handled in ship repair facility. The light weight of ship is approximately 800T for 90m vessels. Accordingly, the crane dimesions shall be customised to lift the vessels.

Client	Cochin Shipyard Limited	Date	26/03/2022
Project	Design Project Report for Ship Repair Facility to handle Inland waterways Vessels at Pandu, Guwahati	Consultant	IITM/ NTCPWC

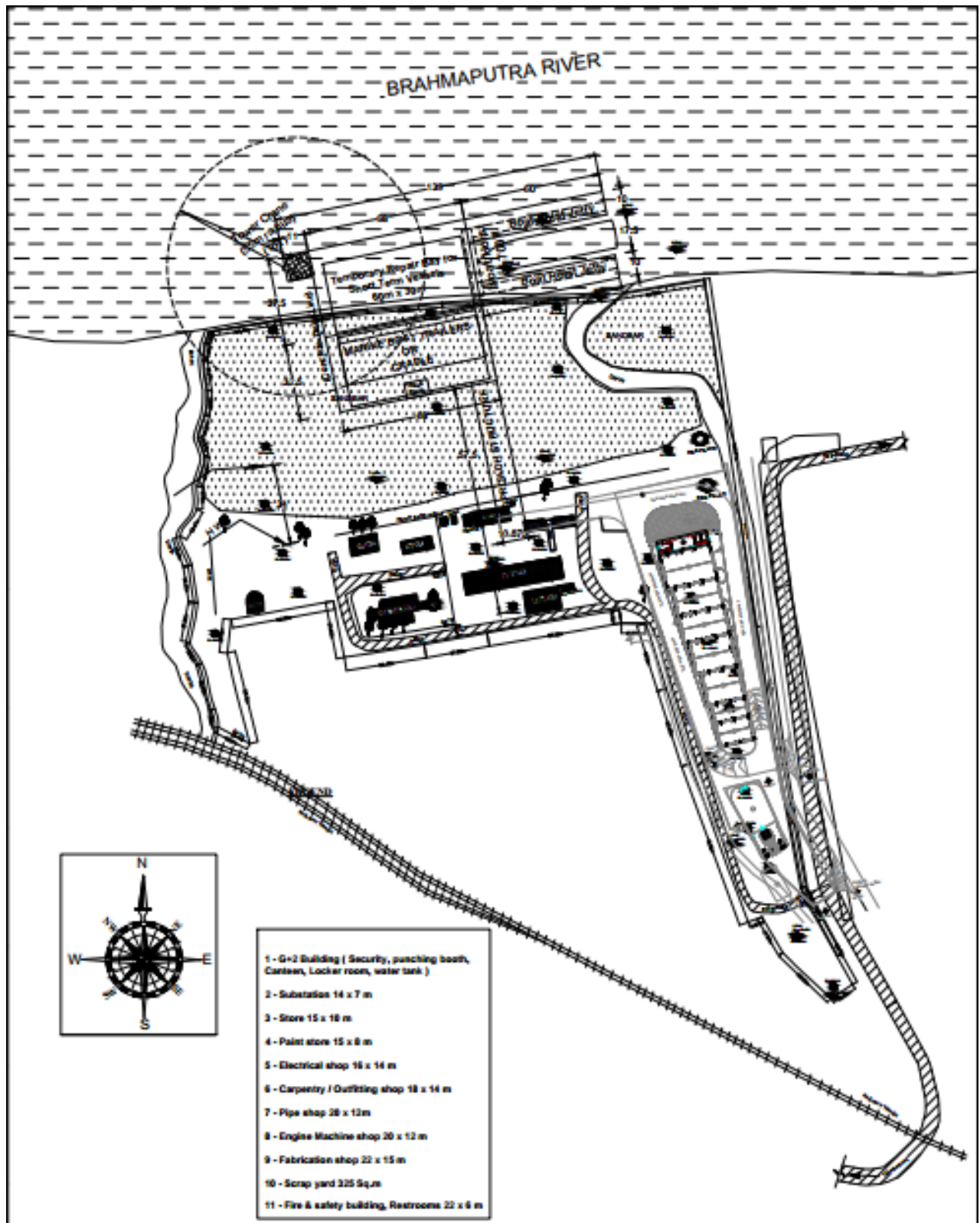


Fig. 5.4: Development of Phase –I layout

Client	Cochin Shipyard Limited	Date	26/03/2022
Project	Design Project Report for Ship Repair Facility to handle Inland waterways Vessels at Pandu, Guwahati	Consultant	IITM/ NTCPWC

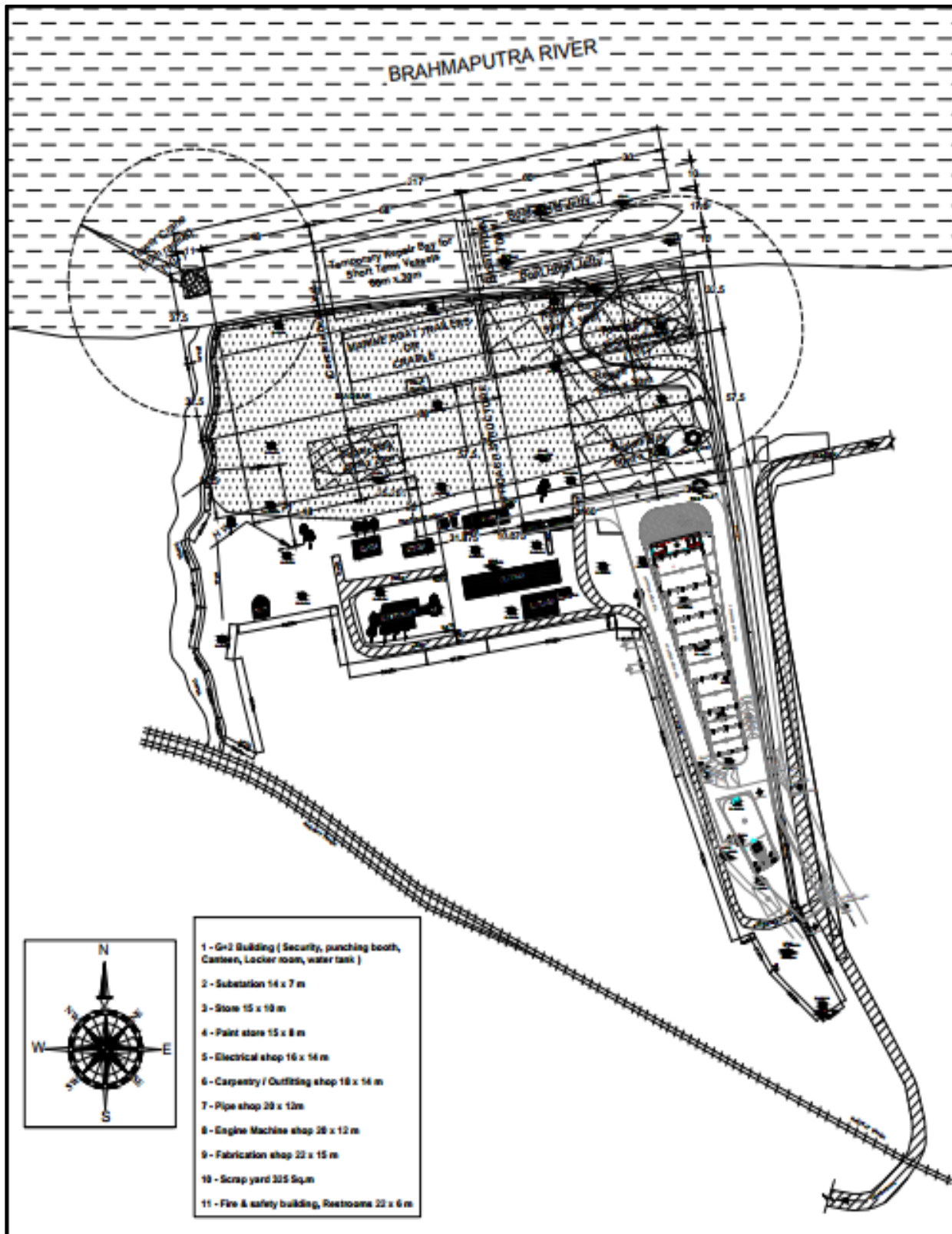


Fig. 5.5: Development of Phase –II layout

Client	Cochin Shipyard Limited	Date	26/03/2022
Project	Design Project Report for Ship Repair Facility to handle Inland waterways Vessels at Pandu, Guwahati	Consultant	IITM/ NTCPWC



6.0 Design Information's for Ship Repair Facility

6.1 General

The ship repair facility consist of boat hoist jetty, transfer bay and repair bay. The proposed cross section of boat hoist jetty consists of open piled type of jetty and the pile diameter is 1.3m. The length of jetty is 60m and width is 10m. The transvers and longitudinal beam dimension is 1.5m x 2.0m and 1.75m x 2m. The adopted thickness of deck slab is 700mm and the wearing coat of 100mm is provided. The deck level of jetty is +53.50m (CD). The plan view and cross-section of the typical jetty is shown in **Fig. 6.1** and **6.2** respectively.

The proposed cross section of transfer bay consists of open piled type of jetty and the pile diameter is 1.3m. The length of jetty is 68m and width is 37.5m. The transvers and longitudinal beam dimension is 1.5m x 2.5m and 1.75m x 2m. The adopted thickness of deck slab is 800mm and the wearing coat of 100mm is provided. The deck level of jetty is +53.50m (CD). The plan view and cross-section of the typical jetty is shown in **Fig. 6.3** and **6.4** respectively.

The proposed cross section of repair bay consists of open piled type of jetty and the pile diameter is 1.2m. The length of jetty is 68m and width is 32.5m. The transvers and longitudinal beam dimension is 1.5m x 2m. The adopted thickness of deck slab is 700mm and the wearing coat of 100mm is provided. The deck level of jetty is +53.5m (CD). The plan view and cross-section of the typical jetty is shown in **Fig. 6.5** and **6.6** respectively. The general arrangements of ship repair facility structure is attached in **Annexure-I**.

Client	Cochin Shipyard Limited	Date	26/03/2022
Project	Design Project Report for Ship Repair Facility to handle Inland waterways Vessels at Pandu, Guwahati	Consultant	IITM/ NTCPWC

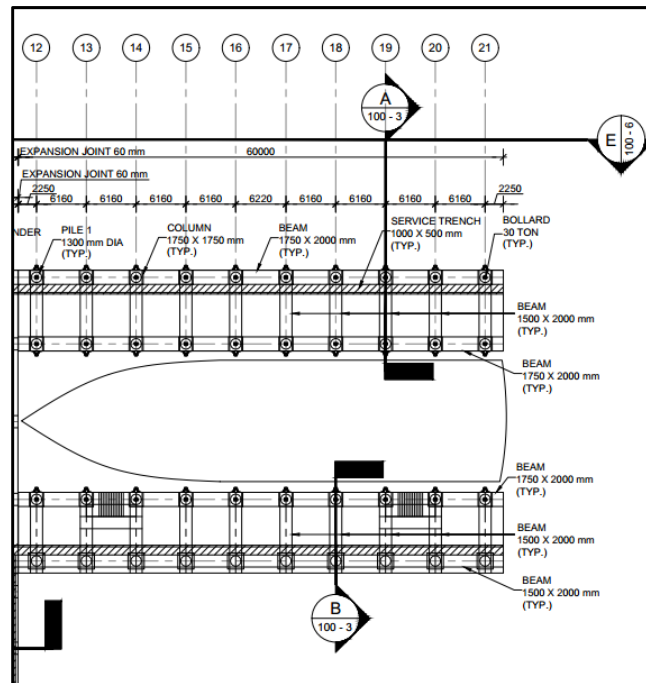


Fig. 6.1: Plan view of boat hoist jetty

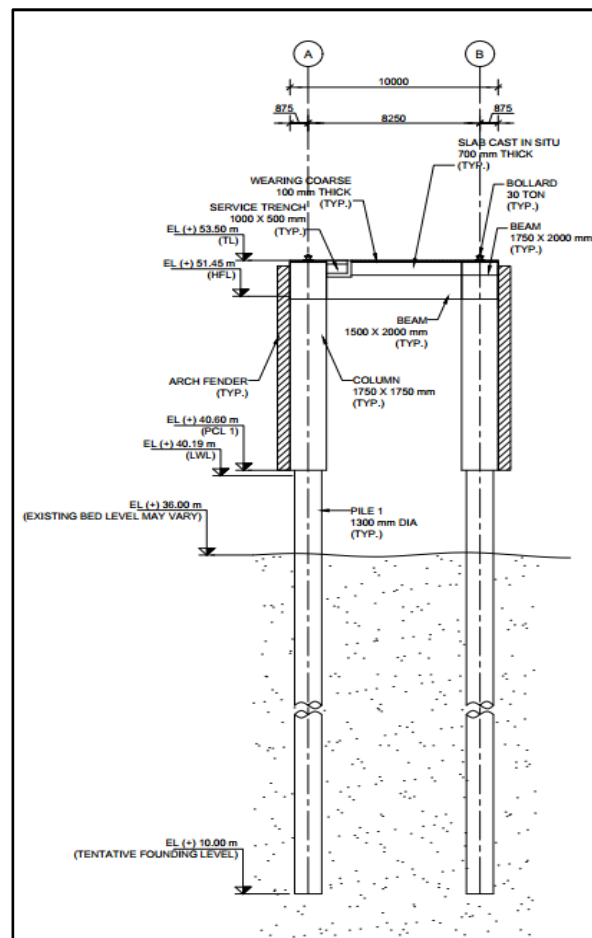


Fig. 6.2: Cross-section of boat hoist jetty

Client	Cochin Shipyard Limited	Date	26/03/2022
Project	Design Project Report for Ship Repair Facility to handle Inland waterways Vessels at Pandu, Guwahati	Consultant	IITM/ NTCPWC

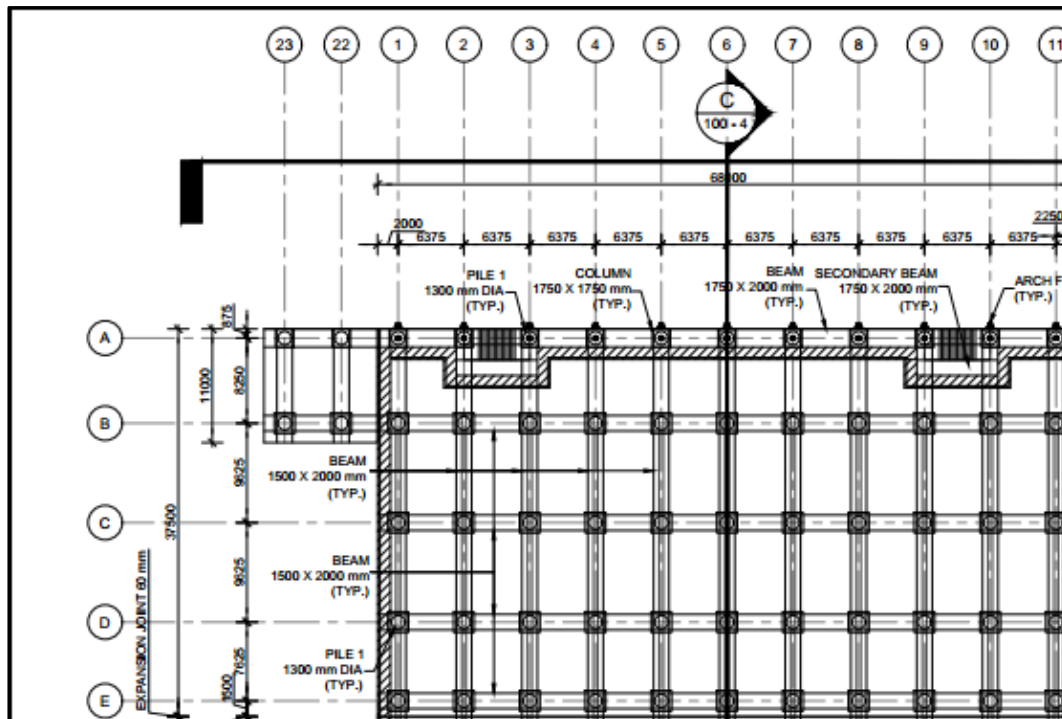


Fig. 6.3: Plan view of the transfer bay

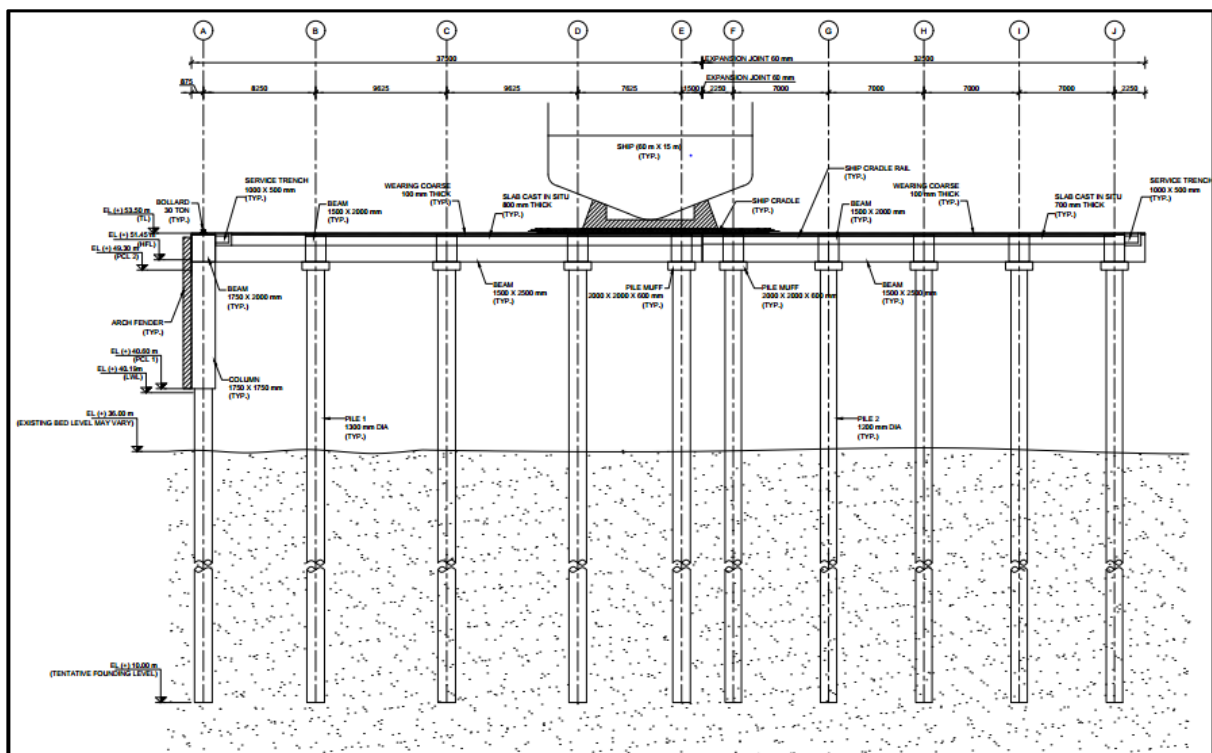


Fig. 6.4: Cross-section of transfer bay

Client	Cochin Shipyard Limited	Date	26/03/2022
Project	Design Project Report for Ship Repair Facility to handle Inland waterways Vessels at Pandu, Guwahati	Consultant	IITM/ NTCPWC

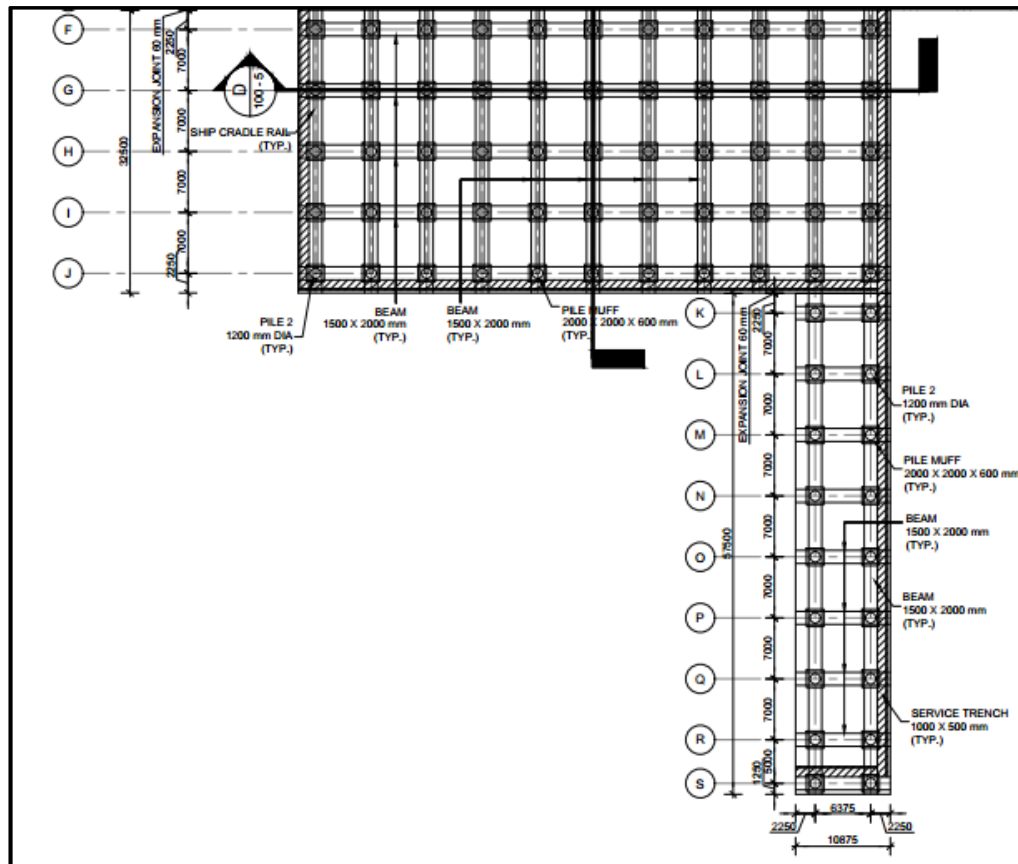


Fig. 6.5: Plan view of the ship repair bay

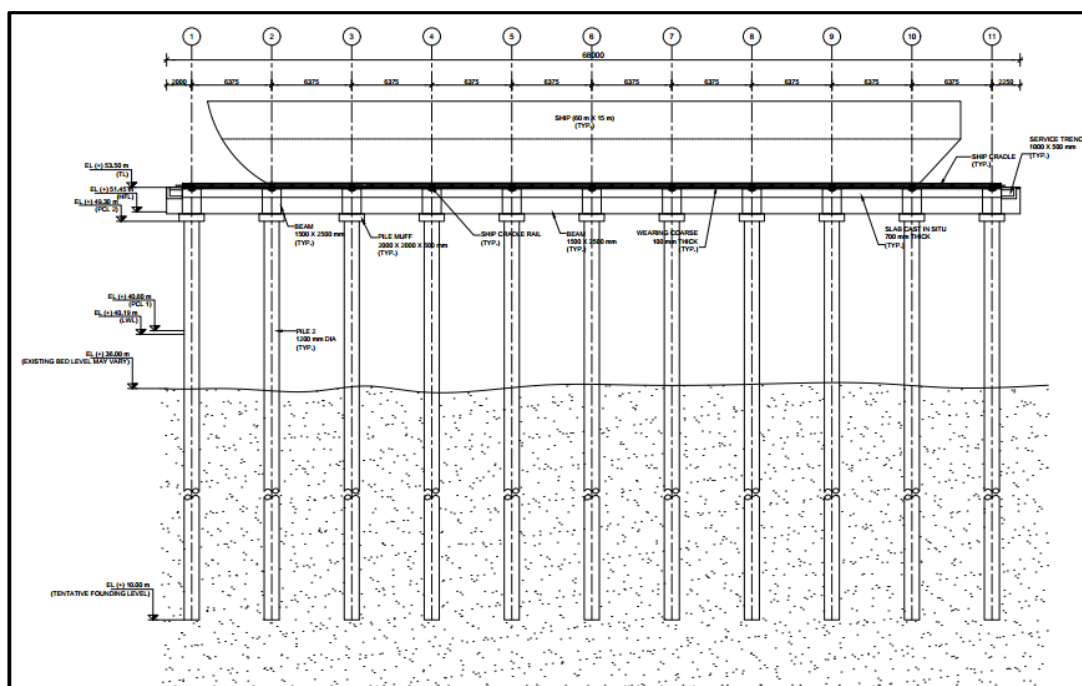


Fig. 6.6: Cross-section of Ship repair bay

Client	Cochin Shipyard Limited	Date	26/03/2022
Project	Design Project Report for Ship Repair Facility to handle Inland waterways Vessels at Pandu, Guwahati	Consultant	IITM/ NTCPWC



6.2 Basic Design considerations

6.2.1 General

The facilities for the berthing structure consist of the following.

- The length of the boat hoist jetty is 60m and the width is 10m.
- The length of the transferbay is 68m and the width is 37.5m.
- The length of the repairbay is 68m and the width is 32.5m.
- The jetty structure consists of a beam deck system and it is supported on pile.
- The ship repair facility is designed for various loads as described below.

6.2.2 Design Life

This design life criterion is based on the maintenance system as follows:

- The design life of the proposed new facility is assumed as 50 years.
- The frequency of inspection & repairs of work is 5 years.
- The design life of the fender is 15 years.
- The design life of the bollard is 10years.

6.2.3 Design assumptions

Following assumptions were considered for the design of the berthing structure.

- While berthing the vessel, the berthing contact to the structure is quarter-point ($L/4$) berthing and the energy has been distributed to the structure as per code.
- Berthing shall be allowed only after the deck beam achieves its full strength for 28 days.
- The design shall be carried out considering soil parameters at the structure location. The static capacity of the pile is derived based on IS 2911. The following points have been taken into consideration for designing the piles.
 - a) A minimum factor of safety of 2.5 will be considered for arriving at the safe pile bearing capacity.

Client	Cochin Shipyard Limited	Date	26/03/2022
Project	Design Project Report for Ship Repair Facility to handle Inland waterways Vessels at Pandu, Guwahati	Consultant	IITM/ NTCPWC



6.2.4 Design Loads

The ship repair facility structure shall be designed adequately for the following loads and appropriate combinations of the loads.

- Dead loads
- Live loads
- Berthing Force
- Mooring Force
- Boat Hoist Crane
- Seismic Force
- Temperature
- Wave and current force

6.2.5 Design deck Level

The design deck level for the jetty is taken as (+) 52.0m CD.

6.2.6 Berthing Criteria

The berth is located in a river location. Hence, the berthing condition is assumed in moderate conditions. The design berthing velocities to be adopted during the design of berthing structures are summarized in **Table. 6.1**.

Table. 6.1: Berthing Criteria

Items	1260DWT
Berthing Velocity (m/sec)	0.45
Berthing angle (deg)	10

6.2.7 Mooring Loads

Mooring conditions define the prevailing wind and current at the berth location during the presence of the ship. Following conditions shall be assessed.

Wind: 49 m/sec

Current: 3m/sec

Mooring bollard loads shall be arrived as per IS 4651. References shall be made to the report for details and the mooring bollard capacity of 30T is provided for the berthing structure.

Client	Cochin Shipyard Limited	Date	26/03/2022
Project	Design Project Report for Ship Repair Facility to handle Inland waterways Vessels at Pandu, Guwahati	Consultant	IITM/ NTCPWC



6.2.8 Structural Design

The main considerations for the design of structures are:

- Structural safety, stability & durability.
- Availability of material, equipment and expertise.
- Constructability and ease of maintenance.
- Maximum DWT of the ship, which will be berthed during the lifetime of the structure.

6.2.9 Materials and Cover

6.2.9.1 Concrete

For all structural elements, an M40 grade concrete mix can be adopted.

6.2.9.2 Reinforcement

High yield strength deformed bars of Fe 500D grade according to IS 1786-(2008) can be used. **Table. 6.2** shows the list of concrete and steel grades to be adopted for structural elements.

Table. 6.2: Grade of concrete & steel

Structures	Materials	
	Concrete	Steel
Pile	M40	Fe500D
Beam	M40	Fe500D
Slab	M40	Fe500D

6.2.9.3 Cement

For all structural elements, OPC 53- grade cement according to IS: 12269 or 43 –grade cement according to IS: 8112 can be used.

6.2.9.4 Clear Covers

The following clear cover shall be adopted for the outermost reinforcement of the structural members.

Client	Cochin Shipyard Limited	Date	26/03/2022
Project	Design Project Report for Ship Repair Facility to handle Inland waterways Vessels at Pandu, Guwahati	Consultant	IITM/ NTCPWC



Pile	75mm
Pilemuff	60mm
Beam	50mm
Slab	50mm

6.2.9.5 Vessel Specifications

The following table shows the vessel specifications which are going to be handled in the new proposed structure.

Table. 6.3: Vessel specifications

Description	Vessel
Vessel capacity	1260DWT
Draft	1.2m or 1.8m
Overall Length	90m
Width	15m

6.2.9.6 Deflection

Deflection due to all loads including creep and shrinkage should not exceed span/250 as given in Clause 23.2 of IS 456:2000 and also as per client requirements.

6.2.9.7 Crack Width

Crack width is checked under IS 4651 (Part 4)-2014. As a guide, assessed surface width of cracks at points nearest to the main reinforcement should not exceed 0.004 times the cover of the main reinforcement or maximum crack width in different zones are given in **Table. 6.4**, whichever is minimum. Limit state of serviceability load combinations is considered for crack width calculation.

Table. 6.4: Maximum Crack Width in Different Zone

(Clause 8.3.4) All dimensions in millimetres.			
Sl No. (1)	Exposure Zone (2)	Maximum Crack Width	
		Sustained Load (3)	Transient Load (4)
i)	Atmospheric zone — above splash zone and where direct wave or spray impingement is infrequent	0.2	0.3
ii)	Splash zone — zone between the chart datum and the design wave height above the mean high water springs	0.1	0.2
iii)	Continuous seawater immersion zone — below splash zone upto seabed level	0.2	0.3
iv)	Below seabed level	0.3	0.3
NOTES			
1 Sustained load — Dead load plus 50 percent of full uniformly distributed live load + earth pressure.			
2 Transient load — Dead load plus berthing load and full crane load or full live load uniformly distributed + earth pressure.			

Client	Cochin Shipyard Limited	Date	26/03/2022
Project	Design Project Report for Ship Repair Facility to handle Inland waterways Vessels at Pandu, Guwahati	Consultant	IITM/ NTCPWC



7.0 General Arrangement and Structural Model for Proposed Structure

The ship repair facility consist of boat hoist jetty, transfer bay and repair bay. The proposed boat hoist jetty length is 60m and width is 10m. The transfer bay length is 68m and width is 37.5m. The repair bay length is 68m and width is 32.5m.

7.1 Structural Arrangement of boat hoist jetty, transfer bay and repair bay.

The proposed cross section of boat hoist jetty consists of open piled type of jetty and the pile diameter is 1.3m. The length of jetty is 60m and width is 10m. The transvers and longitudinal beam dimensions are 1.75m x 2m and 1.5m x 2m. The centre to centre pile spacing is 6.16m in longitudinal direction and 8.25m in transvers direction. The adopted thickness of deck slab is 700mm and the wearing coat of 100mm is provided. The deck level of jetty is +53.50m (CD). The founding level of pile is +10m(CD). The plan view and cross-section of the typical jetty is shown in **Fig. 7.1** and **7.2** respectively.

The proposed cross section of transfer bay consists of open piled type of jetty and the pile diameter is 1.3m. The length of jetty is 68m and width is 37.5m. The transvers and longitudinal beam dimensions are 1.75m x 2m and 1.5m x 2m. The centre to centre pile spacing is 6.375m in longitudinal direction and 7.625m and 9.625m in transvers direction. The adopted thickness of deck slab is 800mm and the wearing coat of 100mm is provided. The deck level of jetty is +53.50m (CD). The founding level of pile is +10m(CD). The plan view and cross-section of the typical jetty is shown in **Fig. 7.3** and **7.4** respectively.

The proposed cross section of repair bay consists of open piled type of jetty and the pile diameter is 1.2m. The length of jetty is 68m and width is 32.5m. The transvers and longitudinal beam dimension is 1.5m x 2m. The centre to centre pile spacing is 6.375m in longitudinal direction and 7.0m in transvers direction. The adopted thickness of deck slab is 700mm and the wearing coat of 100mm is provided. The deck level of jetty is +53.50m (CD). The founding level of pile is +10m(CD). The plan view and cross-section of the typical jetty is shown in **Figure. 7.5** and **7.6** respectively.

Client	Cochin Shipyard Limited	Date	26/03/2022
Project	Design Project Report for Ship Repair Facility to handle Inland waterways Vessels at Pandu, Guwahati	Consultant	IITM/ NTCPWC

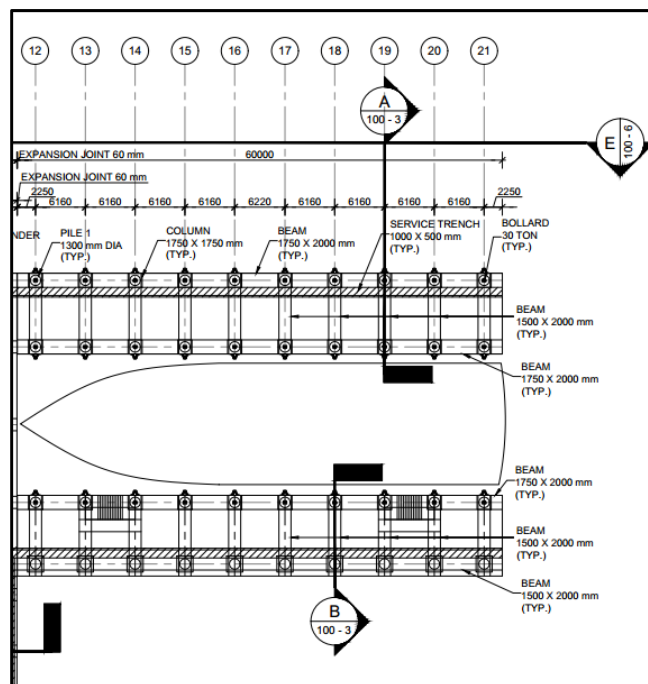


Fig. 7.1: Plan view of boat hoist jetty

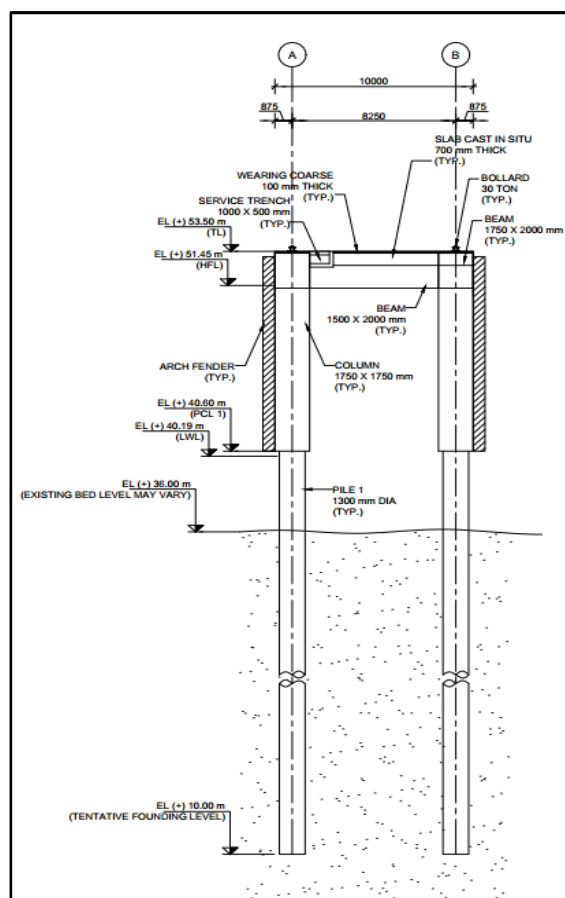


Fig. 7.2: Cross-section of boat hoist jetty

Client	Cochin Shipyard Limited	Date	26/03/2022
Project	Design Project Report for Ship Repair Facility to handle Inland waterways Vessels at Pandu, Guwahati	Consultant	IITM/ NTCPWC

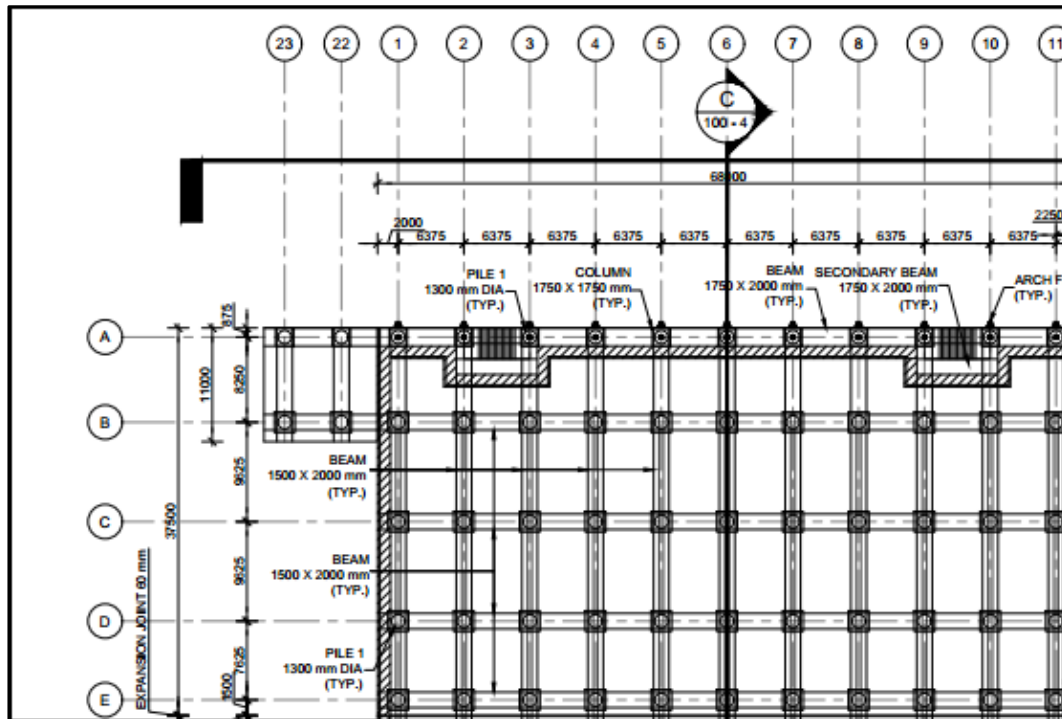


Fig. 7.3: Plan view of the transfer bay

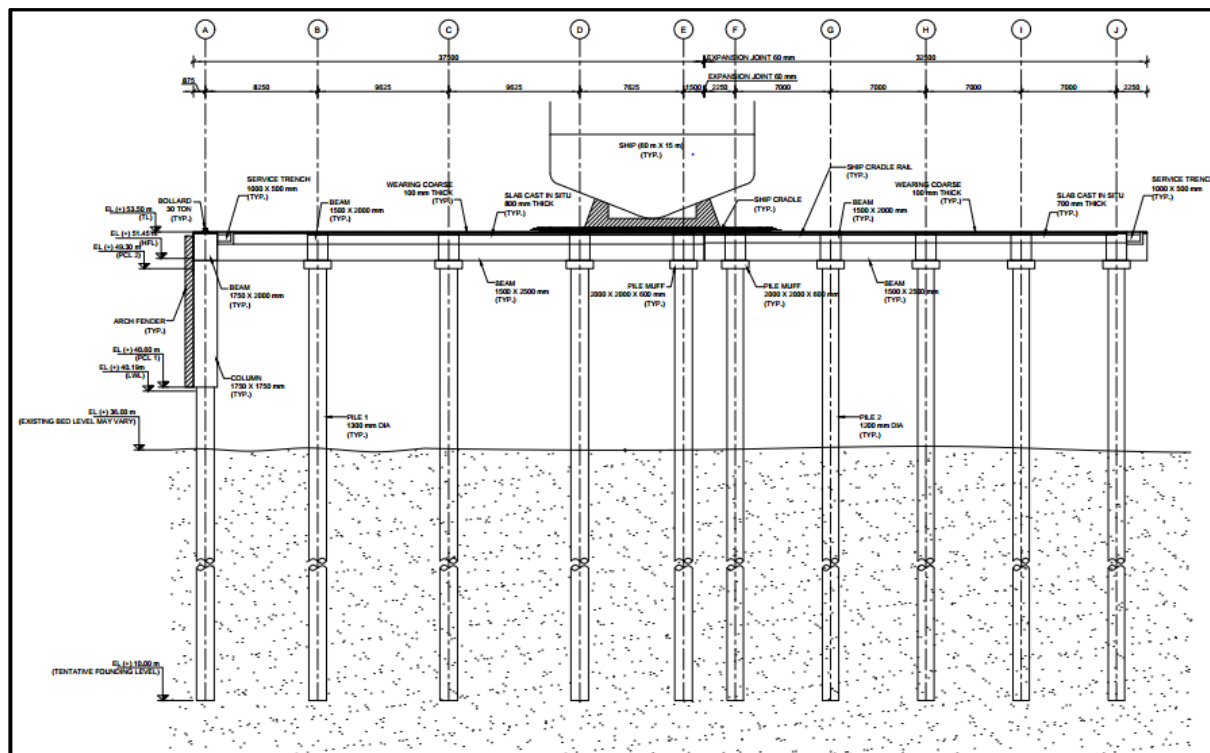


Fig. 7.4: Cross-section of transfer bay

Client	Cochin Shipyard Limited	Date	26/03/2022
Project	Design Project Report for Ship Repair Facility to handle Inland waterways Vessels at Pandu, Guwahati	Consultant	IITM/ NTCPWC

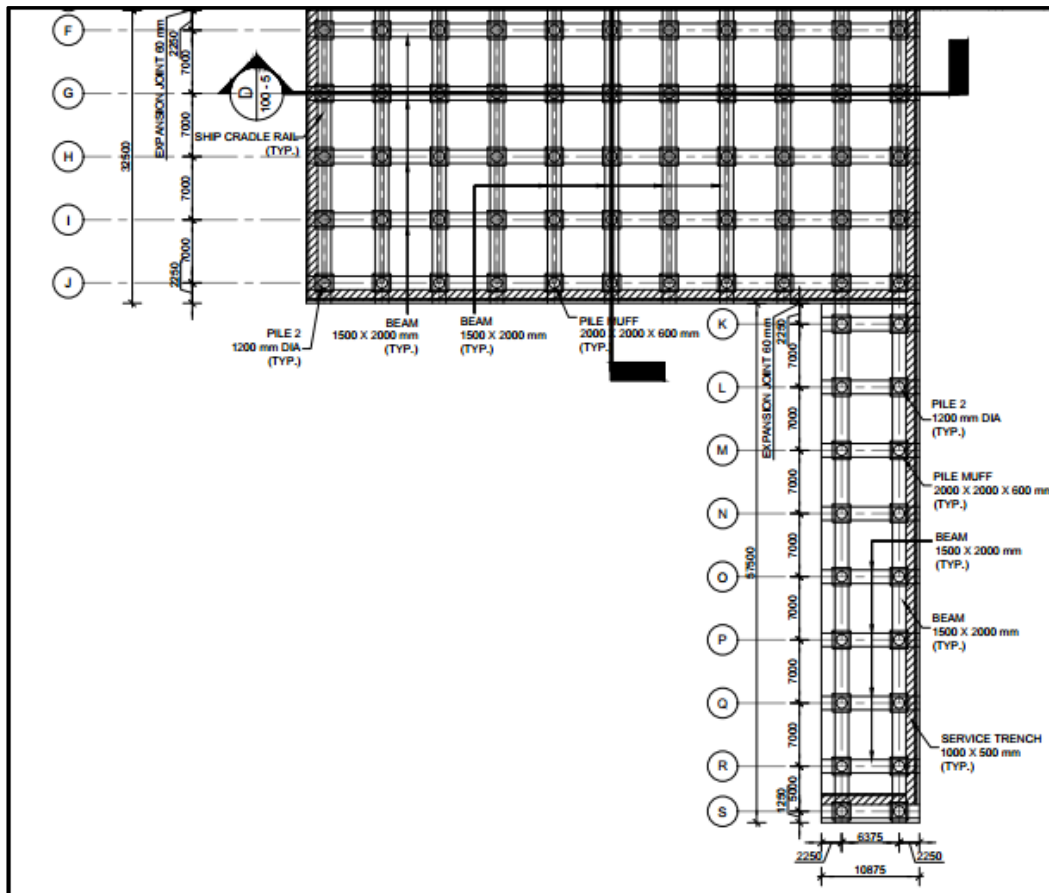


Fig. 7.5: Plan view of the ship repair bay

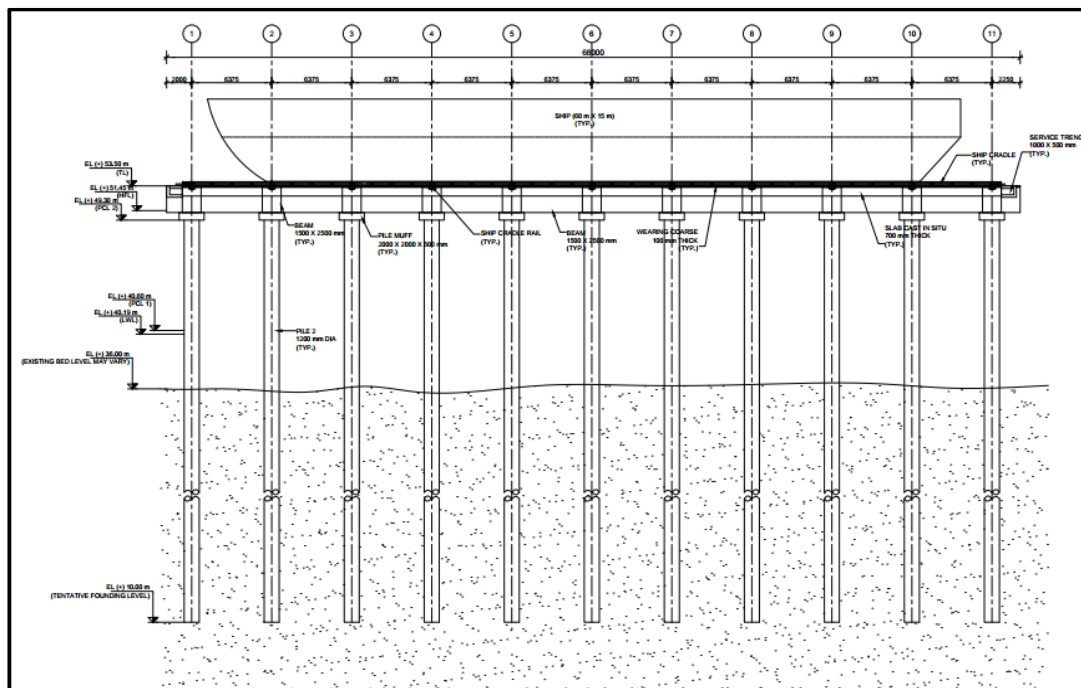


Fig. 7.6: Front-section of Ship repair bay

Client	Cochin Shipyard Limited	Date	26/03/2022
Project	Design Project Report for Ship Repair Facility to handle Inland waterways Vessels at Pandu, Guwahati	Consultant	IITM/ NTCPWC



7.2 Analysis Model

The computer model of boat hoist jetty, transfer bay, repair bay and approach structure are considered as a three-dimensional frame that includes the pile and beam along with provided soil springs. The structure is modeled as a single unit. The pile is supported by soil springs. The pile is modeled as beam elements with appropriate properties of RCC sections. The slab modeled as plate elements and it is supported by beam elements. This represents the stiffness of the structure and soil simulated. The analysis is carried out using the conventional STAAD ProV8i package for various critical load combinations. The P- δ analysis is carried out; Soil-Structure interaction analysis is performed by using springs as a representation of soil. The boat hoist jetty structural model is shown in **Fig. 7.7** and transfer bay is shown in **Fig. 7.8**. The repair bay and approach structural model is shown in **Fig. 7.9**.

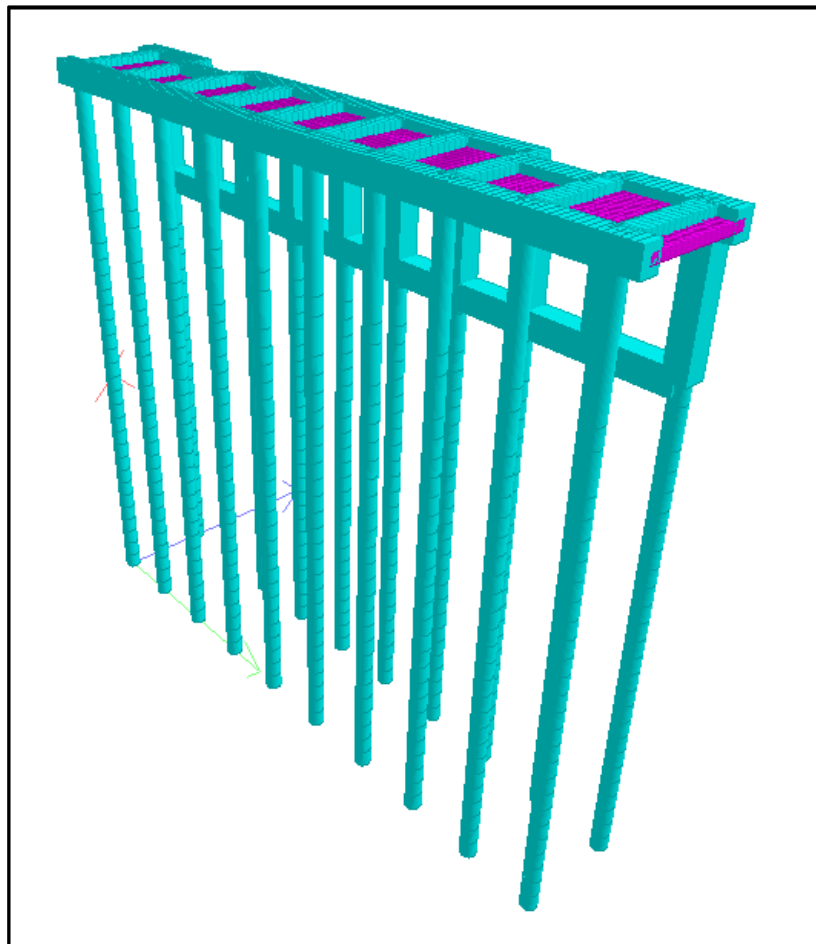


Fig. 7.7: Structural model for boat hoist jetty

Client	Cochin Shipyard Limited	Date	26/03/2022
Project	Design Project Report for Ship Repair Facility to handle Inland waterways Vessels at Pandu, Guwahati	Consultant	IITM/ NTCPWC

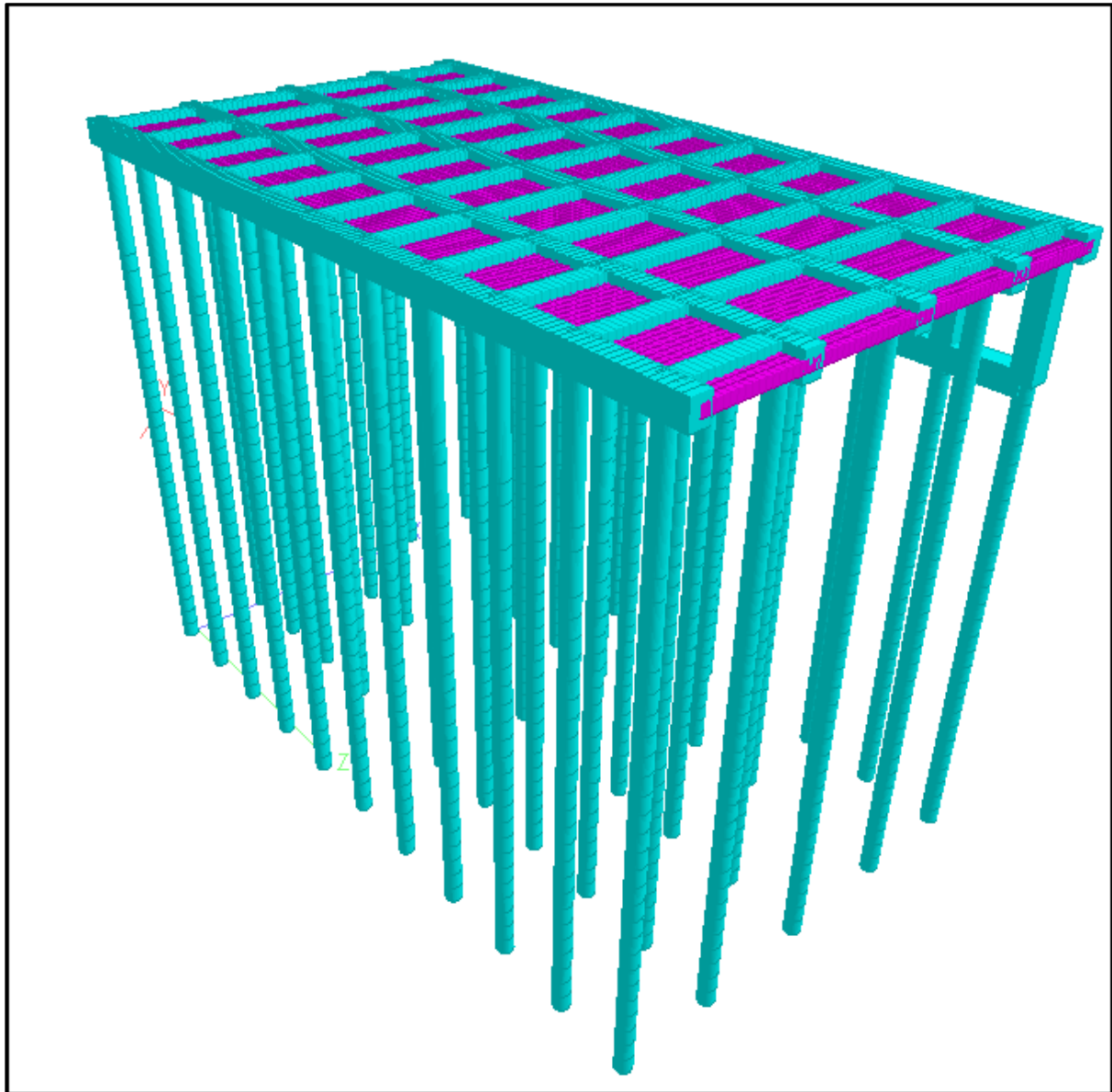


Fig. 7.8: Structural model for transfer bay

Client	Cochin Shipyard Limited	Date	26/03/2022
Project	Design Project Report for Ship Repair Facility to handle Inland waterways Vessels at Pandu, Guwahati	Consultant	IITM/ NTCPWC

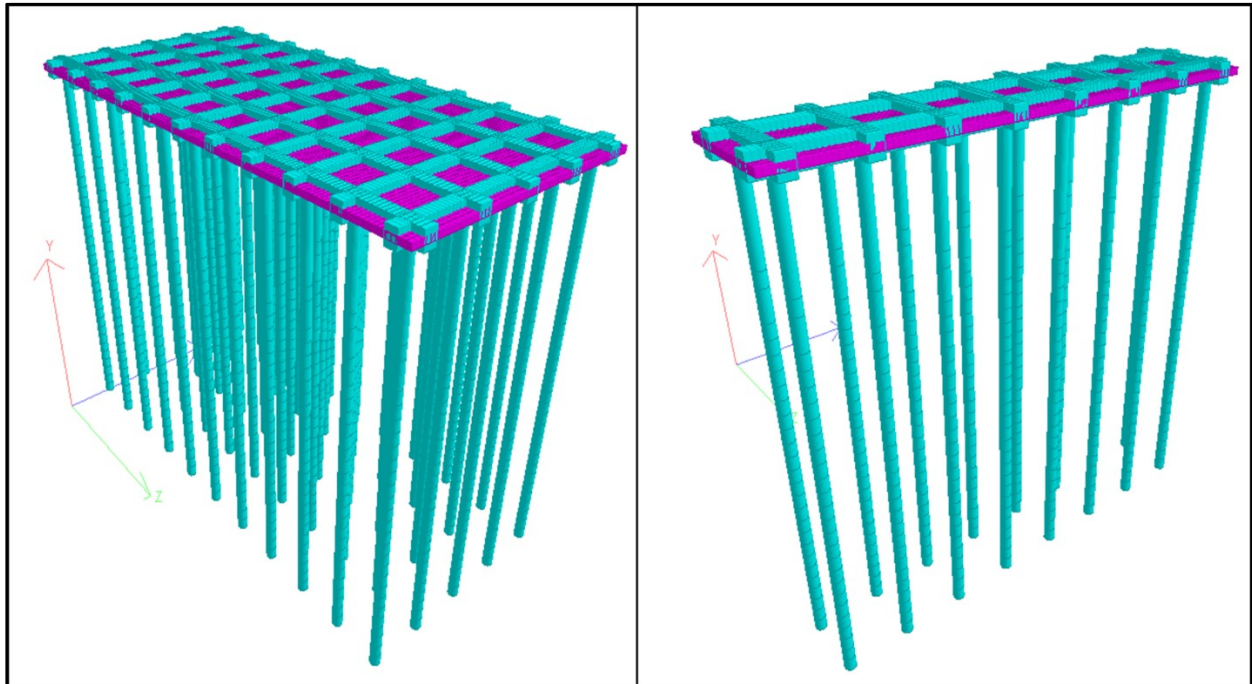


Fig. 7.9: Structural model for repair bay

7.3 Structural Sizes

The proposed structure is a RCC-framed structure and the proposed sizes are summarised in **Table. 7.1**. These sizes are used in the simulation for structural analysis to generate the dead loads.

Table. 7.1: Structural components

S: No	Structural member	Dimension
Combined sheet pile wall jetty		
1	Piles	1300mm&1200mm
2	Beams	1750mmx2000mm&1500mmx2000mm
3	Slab	700mm & 800mm
4	Pilemuff	2000mmx2000mmx600mm

Client	Cochin Shipyard Limited	Date	26/03/2022
Project	Design Project Report for Ship Repair Facility to handle Inland waterways Vessels at Pandu, Guwahati	Consultant	IITM/ NTCPWC



8.0 Loadings for Ship repair facilities

8.1 Dead Loads

Dead loads will consist of the weights of structure and all equipment of a permanent or semi-permanent nature. Unit weight of various materials used in the structural members is given as follows:

- | | | |
|----|-----------------|--------------|
| a. | Water | = 1.0 T/cum |
| b. | Sea water | = 1.03 T/cum |
| c. | RCC | = 2.5 T/cum |
| d. | Soil | = 1.8 T/cum |
| e. | Steel | = 7.85 T/cum |
| f. | Sand | = 2.0 T/cum |
| g. | Concrete pavers | = 2.4 T/cum |
| h. | Foam Concrete | = 0.6 T/cum |

8.2 Live Load

A live load of 50kN/ m² is adopted for design.

8.3 Seismic Force

Pandu is in **Zone V** of the Indian Map of Seismic zones (IS-1893 Part-1 2016), which is a severe risk of the seismic zone. Seismic force is calculated according to IS 1893-2002, considering 100 % dead load + 50 % live load acting on the structure. As per IS code, the site is under (Zone III) and the basic horizontal seismic coefficient is calculated accordingly. The seismic force calculations are given below. **Fig. 8.1** shows the response spectra for rock and soil and sites for 5% damping.

Horizontal seismic coefficient

$$A_h = Z I S_a/g$$

Where,

Z = 0.36, Zone factor (Table 2 of IS: 1893-2016)

I = 1.5, Importance factor (Table 6 of IS: 1893-2016)

R = 3.0, Response reduction factor (Table 7 of IS: 1893-2016)

S_a/g = Average Response acceleration coefficient

Client	Cochin Shipyard Limited	Date	26/03/2022
Project	Design Project Report for Ship Repair Facility to handle Inland waterways Vessels at Pandu, Guwahati	Consultant	IITM/ NTCPWC



(Depends on the natural time period of the structure from STAAD Pro analysis).

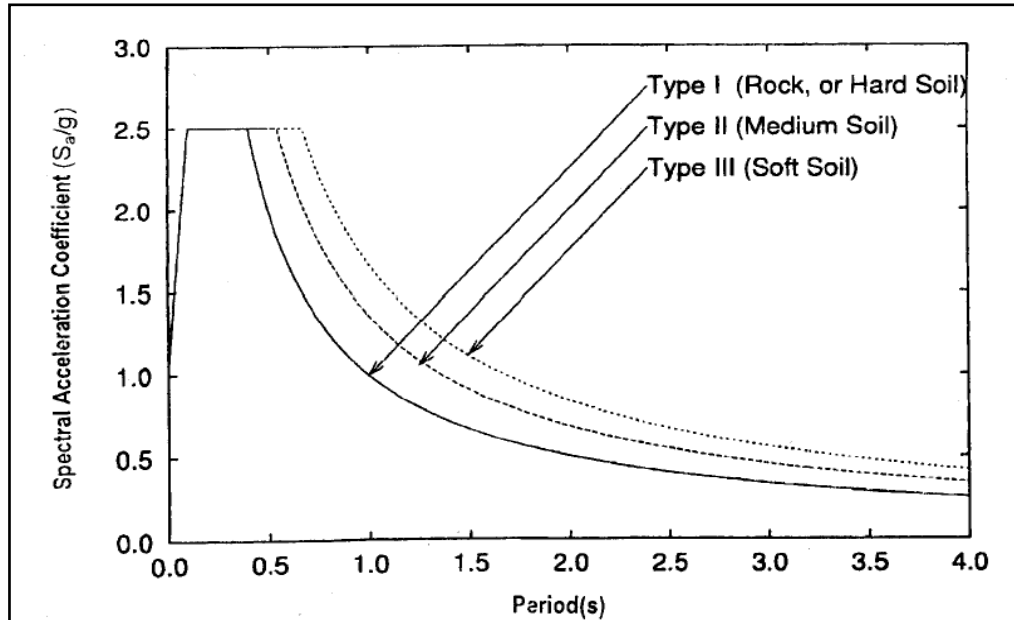


Fig. 8.1: Response spectra for rock and soil and sites for 5% damping

8.4 Berthing Force

It is proposed to handle 1260 DWT vessels and the design of the berthing structure considers under moderate conditions. Berthing loads shall be determined under IS 4651-III (2020) for the design vessels. Approach velocities and angles of approach for design vessels shall be considered as per the table given below.

Client	Cochin Shipyard Limited	Date	26/03/2022
Project	Design Project Report for Ship Repair Facility to handle Inland waterways Vessels at Pandu, Guwahati	Consultant	IITM/NTCPWC



Table. 8.1: Parameters for calculation of berthing energy

S No	Description	Vessel Size in 1260 DWT
1	Berthing velocity (m/sec)	0.45
2	Berthing angle (degrees)	10
3	Mass Coefficient	1.21
4	Displacement Tonnage (Tonne)	1665
5	Eccentricity Coefficient	0.52
6	Softness Coefficient	0.9
7	Normal berthing Energy (Tonne.m)	10.1
8	Factor of Safety	2
9	Abnormal berthing Energy (Tonne.m)	20.2
10	Design berthing Energy (Tonne.m)	22.01
11	Fender Selected	Trelleborg Arch Fender-1000(E1.5)
12	Maximum Energy Absorption (Tonne.m)	22.1
13	Maximum Rated Reaction (Tonne)	567

8.5 Mooring Force

Vessel specifications

Dead Weight Tonnage	DT = 1665	T
Overall Length	LOA = 90	m
Length between perpendiculars	L _p = 85	m
Width of the vessel	B = 15	m
Moulded depth	D _m = 2.5	m
Average light draft	D _l = 1.2	m
Other data		
Basic Wind Speed	V _b = 47	m/s
Current velocity	v = 3	m/s

Client	Cochin Shipyard Limited	Date	26/03/2022
Project	Design Project Report for Ship Repair Facility to handle Inland waterways Vessels at Pandu, Guwahati	Consultant	IITM/NTCPWC



Unit weight of sea water	w	$=$	10.25	kN/m
Acceleration due to gravity	g	$=$	9.81	m/s ²
No. of mooring lines		$=$	8	
No. of mooring lines resisting the system		$=$	2	

Coefficients

Shape Factor	C_w	$=$	1.3
--------------	-------	-----	------------

Coefficients for wind force calculation

Probability factor	k_1	$=$	1
Terrain roughness and height factor	k_2	$=$	1.05
Topography factor	k_3	$=$	1
Importance factor	k_4	$=$	1
Wind directionality factor	K_d	$=$	1
Area averaging factor	K_a	$=$	0.8
Combination factor	K_c	$=$	0.9

Force due to wind

Force due to wind	F_w	$=$	$C_w A_w P$	
Shape Factor	C_w	$=$	1.3	
Windage Area	A_w	$=$	$1.175 * L_p (D_m - D_l)$ $= 1.175 * 85 (2.5 - 1.2)$ $A_w =$	129.84 m ²
Design Wind Speed	V_z	$=$	$V_b * k_1 * k_2 * k_3 * k_4$ $= 47 * 1 * 1.05 * 1 * 1$ $V_z =$	49.35 m/s
Wind Pressure	P_z	$=$	$0.6 * V_z^2$ $= 0.6 * 49.35^2$ $P_z =$	1461.250 N/m ²
Design wind pressure	p_d	$=$	$K_d * K_a * K_c * p_z$ $= 1 * 0.8 * 0.9 * 1461.25$ $p_d =$	1052.1 N/m ²

The value of p_d , however shall not be taken less than $0.70 p_z$

$$0.7 p_z = 0.7 * 1461.25$$

$$= 1022.88$$

Client	Cochin Shipyard Limited	Date	26/03/2022
Project	Design Project Report for Ship Repair Facility to handle Inland waterways Vessels at Pandu, Guwahati	Consultant	IITM/NTCPWC



Wind pressure to be considered,	=	1052.1	N/m ²	
	P	=	1.05	kN/m ²
Force due to wind	F _w	=	C _w A _w P	
		=	1.3*129.838*1.05	
		=	177.23	kN
Force due to current				
Force due to current	F _c	=	(wv ² /2g)*A _p	
Area of ship under water	A _p	=	B*D _l	
		=	15*1.2	
		=	18	m²
Force due to current	F _c	=	(wv ² /2g)*A _p	
		=	((10.25*3 ²)/(2*9.81))*18	
		=	84.63	kN
Resultant Mooring force	F	=	(F _w ² + F _c ²) ^{0.5}	
		=	(177.23 ² + 84.63 ²) ^{0.5}	
Resultant Mooring force	F		196.40	kN
<i>Assuming vessel to be moored by 8 mooring lines and considering only 50 % of the lines resist the force</i>				
Mooring force on each mooring line		=	196.4 / 2	
		=	98.20	kN
		~	300	kN

8.6 Wind

The wind forces on structures are calculated as per IS 875 Part 3 with the following wind speed consideration (assumed).

The basic maximum wind speed under the operating condition: 47 m/s.

The design wind speed to be obtained from the formula is given below:

Design wind speed, V_z = k₁ x K₂ x k₃ x V_b

Where,

k₁ = Risk Co efficient = 1.06 (Table 1),

k₂ = Terrain, Height and Structure size factor = 1.05 (Category 2, Class C, Height < 10m (Table 2)),

k₃ = Topography factor = 1.0 (Clause: 5.3.3.1).

Client	Cochin Shipyard Limited	Date	26/03/2022
Project	Design Project Report for Ship Repair Facility to handle Inland waterways Vessels at Pandu, Guwahati	Consultant	IITM/ NTCPWC



8.7 Temperature & Shrinkage

Temperature and Shrinkage forces considered for adequacy check are as follows.

- Min / Max temperature : + 5°C / 40° C
- The coefficient of thermal expansion for RCC structures is taken as $11.7 \times 10^{-6} / ^\circ\text{C}$.

8.8 Boat Hoist Crane

The ship repair structure is designed for 800T capacity of boat hoist crane. The technical details are furnished in **Fig. 8.2**. The customized crane should have 32 wheels with spacing of 4.9m centre to centre.

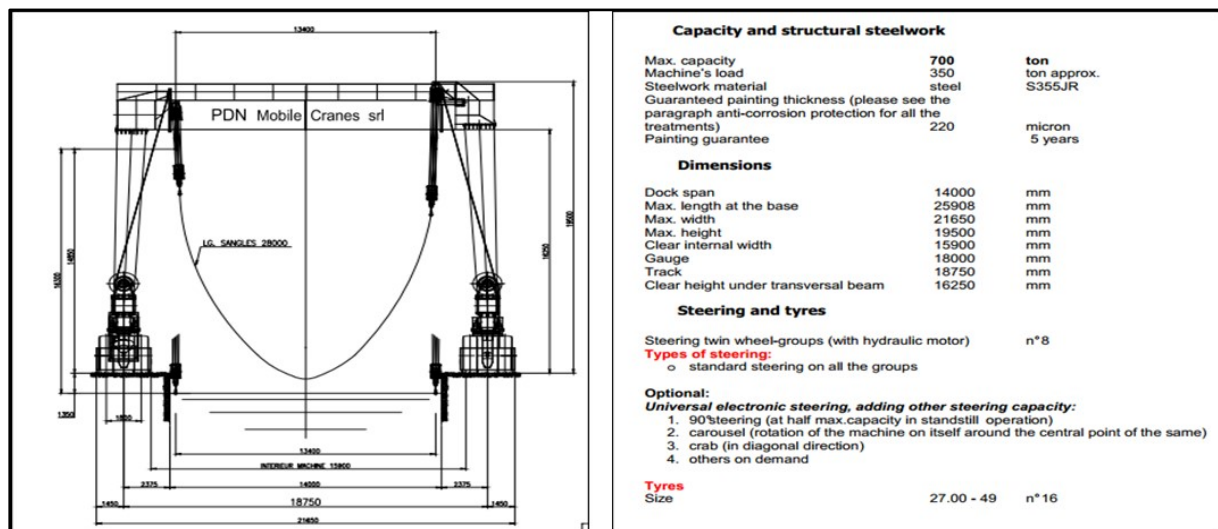


Fig. 8.2: Technical data

Client	Cochin Shipyard Limited	Date	26/03/2022
Project	Design Project Report for Ship Repair Facility to handle Inland waterways Vessels at Pandu, Guwahati	Consultant	IITM/ NTCPWC



8.9 Calculation of Soil Spring Values

SPRING VALUE CALCULATION FOR CIRCULAR SECTION												
<i>General Data:-</i>												
	Grade of concrete	= 40		MPa		Soil level		36		from CD		
S.No.	Soil Level	Segment length	Wall thickness	Poisson ratio for soil	Elastic modulus of Pile	Moment of Inertia	N	Elastic modulus of soil	$E_s/(1-m_s^2)$	$(E_s D^4 / (E_p I_p))^{1/12}$	Modulus of subgrade reaction	Spring value
	Top	L	B or D	μ_s	$E_p = 5000 (f_{ck})^{0.5}$	I_p		E_s			k_s	
	m	m	m		kN/m^2	m^4		KPa			kN/m^3	kN/m
1	36.000	1.50	1.3	0.25	31622776.6	0.1401	10	49030	52299	0.75	39216.3	37540.1
2	34.500	1.50	1.3	0.25	31622776.6	0.1401	10	49030	52299	0.75	39216.3	77863.4
3	33.000	1.50	1.3	0.25	31622776.6	0.1401	10	58836	62758	0.76	47780.0	92482.7
4	31.500	1.50	1.3	0.25	31622776.6	0.1401	10	63739	67988	0.77	52108.1	102327.4
5	30.000	1.50	1.3	0.25	31622776.6	0.1401	10	73545	78448	0.78	60846.0	117945.9
6	28.500	1.50	1.3	0.25	31622776.6	0.1401	10	78448	83678	0.78	65252.4	126526.2
7	27.000	1.50	1.3	0.25	31622776.6	0.1401	10	78448	83678	0.78	65252.4	127242.2
8	25.500	1.50	1.3	0.25	31622776.6	0.1401	10	78448	83678	0.78	65252.4	127242.2
9	24.000	1.50	1.3	0.25	31622776.6	0.1401	10	78448	83678	0.78	65252.4	127242.2
10	22.500	1.50	1.3	0.25	31622776.6	0.1401	10	78448	83678	0.78	65252.4	127242.2
11	21.000	1.50	1.3	0.25	31622776.6	0.1401	10	78448	83678	0.78	65252.4	127242.2
12	19.500	1.50	1.3	0.25	31622776.6	0.1401	10	78448	83678	0.78	65252.4	127242.2
13	18.000	1.50	1.3	0.25	31622776.6	0.1401	10	78448	83678	0.78	65252.4	127242.2
14	16.500	1.50	1.3	0.25	31622776.6	0.1401	10	78448	83678	0.78	65252.4	127242.2
15	15.000	1.50	1.3	0.25	31622776.6	0.1401	10	78448	83678	0.78	65252.4	127242.2
16	13.500	1.50	1.3	0.25	31622776.6	0.1401	10	78448	83678	0.78	65252.4	127242.2
17	12.000	1.50	1.3	0.25	31622776.6	0.1401	10	78448	83678	0.78	65252.4	127242.2
18	10.500	1.50	1.3	0.25	31622776.6	0.1401	10	78448	83678	0.78	65252.4	127242.2
19	9.000	1.50	1.3	0.25	31622776.6	0.1401	10	78448	83678	0.78	65252.4	127242.2
20	7.500	1.50	1.3	0.25	31622776.6	0.1401	10	78448	83678	0.78	65252.4	127242.2
21	6.000	1.50	1.3	0.25	31622776.6	0.1401	10	78448	83678	0.78	65252.4	127242.2
22	4.500	1.50	1.3	0.25	31622776.6	0.1401	10	78448	83678	0.78	65252.4	127242.2
23	3.000	1.50	1.3	0.25	31622776.6	0.1401	10	78448	83678	0.78	65252.4	127242.2
24	1.500	1.50	1.3	0.25	31622776.6	0.1401	10	78448	83678	0.78	65252.4	127242.2
25	0.000	1.50	1.3	0.25	31622776.6	0.1401	10	78448	83678	0.78	65252.4	63621.1

Client	Cochin Shipyard Limited	Date	26/03/2022
Project	Design Project Report for Ship Repair Facility to handle Inland waterways Vessels at Pandu, Guwahati	Consultant	IITM/ NTCPWC



8.10 Load Combinations

Load Combination factors for the analysis are under IS 4651(Part 4)-2014. The following load combination has been considered in the analysis.

Limit state of serviceability

$1DL+1.1LL+1.1DYN+1.0WF+1.0B.F$
 $1DL+1.1LL+1.1DYN+1.0WF+1.0M.F$
 $1DL+1.1LL+1.1DYN+1.0WF+1.0S.F$
 $1DL+0.5LL+0.5DYN+1.0TEM$

Limit state of collapsibility

$1.5DL+1.5LL+1.5DYN+1.2WF+1.5B.F$
 $1.5DL+1.5LL+1.5DYN+1.2WF+1.5M.F$
 $1.5DL+1.5LL$
 $1.2DL+1.2LL+1.2S.F$
 $1.5DL+1.5S.F$
 $1.2DL+1.2LL+1.2DYN+1.0WF+1.0B.F$ or $M.F$
 $1.2DL+1.2LL+1.2DYN+1.0WF+1.2S.F$
 $1.2DL+1.2LL+1.2DYN+1.0WF+1.2T.F$
 $0.9DL+0.9LL+0.9DYN+1.0WF+1.5B.F$ or $M.F$
 $0.9DL+0.9LL+0.9DYN+1.0WF+1.5S.F$

Where,

D.L	-	Dead Load
L.L	-	Live Load
M.F	-	Mooring Force
B.F	-	Berthing Force
S.F	-	Seismic Force
DYN	-	Vehicle load
T.F	-	Temperature

Client	Cochin Shipyard Limited	Date	26/03/2022
Project	Design Project Report for Ship Repair Facility to handle Inland waterways Vessels at Pandu, Guwahati	Consultant	IITM/ NTCPWC



9.0 Structural Analysis Results

9.1. Pile-1300mm dia

Limit state of collapse

Beam Force Detail Summary

Sign convention as diagrams: - positive above line, negative below line except Fx where positive is compression. Distance d is given from beam end A.

	Beam	L/C	d (m)	Axial Fx (kN)	Shear Fy (kN)	Fz (kN)	Torsion Mx (kN·m)	Bending My (kN·m)	Mz (kN·m)
Max Fx	3967	2056:NORMAL	1.500	11.3E+3	0.006	0.000	-0	-0.000	0.000
Min Fx	1633	3499:REVERS,	0	-2.78E+3	-991.443	1.85E+3	0.000	-7.3E+3	-922.835
Max Fy	1635	3081:REVERS,	3.100	5.81E+3	1.67E+3	-445.427	0.000	-273.123	-6.09E+3
Min Fy	1635	3283:REVERS,	3.100	-826.459	-1.54E+3	416.338	-0.000	293.700	5.91E+3
Max Fz	2924	3459:REVERS,	3.100	3.2E+3	278.402	2.08E+3	0.000	1.02E+3	-870.611
Min Fz	3068	3696:REVERS,	3.100	2.93E+3	-221.539	-2.08E+3	-0.000	-1.04E+3	1.09E+3
Max Mx	4006	3477:REVERS,	0	5.05E+3	12.787	-102.193	0.000	90.945	49.997
Min Mx	4006	3679:REVERS,	0	2.69E+3	-13.016	100.783	-0.000	-89.037	-50.992
Max My	3066	3696:REVERS,	0	2.84E+3	-215.517	-2.06E+3	-0.000	8.5E+3	84.501
Min My	2922	3459:REVERS,	0	3.11E+3	272.379	2.06E+3	0.000	-8.5E+3	396.184
Max Mz	1637	3283:REVERS,	1.500	-783.544	-1.26E+3	245.380	-0.000	659.654	7.79E+3
Min Mz	1637	3081:REVERS,	1.500	5.86E+3	1.37E+3	-266.063	0.000	-670.101	-8.14E+3

Limit state of Serviceability

Beam Force Detail Summary

Sign convention as diagrams: - positive above line, negative below line except Fx where positive is compression. Distance d is given from beam end A.

	Beam	L/C	d (m)	Axial Fx (kN)	Shear Fy (kN)	Fz (kN)	Torsion Mx (kN·m)	Bending My (kN·m)	Mz (kN·m)
Max Fx	3967	112:SHORT-CF	1.500	7.53E+3	0.005	0.000	-0	-0.000	0.000
Min Fx	2	229:SHORT-CF	0	941.588	-4.869	-3.476	-0.000	43.507	855.435
Max Fy	3066	228:SHORT-CF	0	4.23E+3	513.681	-4.201	-0.000	18.490	652.782
Min Fy	3786	67:SHORT-CR/	0	1.85E+3	-414.315	23.020	-0.000	-105.340	-457.831
Max Fz	3498	72:SHORT-CR/	0	3.62E+3	130.914	464.276	0.000	-1.92E+3	301.461
Min Fz	3498	171:SHORT-CF	0	2.83E+3	23.216	-475.997	-0.000	1.95E+3	109.969
Max Mx	4034	165:SHORT-CF	0	4.96E+3	-1.716	-23.021	0.000	20.956	-7.457
Min Mx	3659	79:SHORT-CR/	0	3.05E+3	3.464	17.949	-0.000	-15.996	15.053
Max My	3498	171:SHORT-CF	0	2.83E+3	23.216	-475.997	-0.000	1.95E+3	109.969
Min My	3498	72:SHORT-CR/	0	3.62E+3	130.914	464.276	0.000	-1.92E+3	301.461
Max Mz	3790	67:SHORT-CR/	1.500	2E+3	-339.589	14.876	-0.000	22.868	1.96E+3
Min Mz	2638	225:SHORT-CF	1.500	4.33E+3	417.090	-4.421	0.000	-11.632	-2.34E+3

Client	Cochin Shipyard Limited	Date	26/03/2022
Project	Design Project Report for Ship Repair Facility to handle Inland waterways Vessels at Pandu, Guwahati	Consultant	IITM/ NTCPWC



Beam Displacement Detail Summary

Displacements shown in italic indicate the presence of an offset

	Beam	L/C	d (m)	X (mm)	Y (mm)	Z (mm)	Resultant (mm)
Max X	3726	225:SHORT-CF	0	23.221	-4.986	0.496	23.755
Min X	3726	65:SHORT-CR/	1.015	-21.235	-5.625	-1.096	21.994
Max Y	54	57:SHORT-CR/	1.500	-0.000	0	0	0.000
Min Y	3941	112:SHORT-CF	0	-19.813	-11.804	0.057	23.063
Max Z	3582	165:SHORT-CF	0	10.728	-5.628	24.910	27.700
Min Z	3582	79:SHORT-CR/	0	-9.238	-3.705	-23.509	25.529
Max Rst	3726	165:SHORT-CF	0	13.042	-5.367	24.910	28.625

9.2. Pile-1200mm dia

Limit state of collapse

Beam Force Detail Summary

Sign convention as diagrams:- positive above line, negative below line except Fx where positive is compression. Distance d is given from beam end A.

	Beam	L/C	d (m)	Axial	Shear		Torsion	Bending	
				Fx (kN)	Fy (kN)	Fz (kN)	Mx (kN'm)	My (kN'm)	Mz (kN'm)
Max Fx	3967	2013:NORMAL	1.500	8.4E+3	0.000	0.011	-0	-0.000	0.000
Min Fx	1631	3497:REVERS,	0	18.220	-152.942	369.569	0.000	-4.6E+3	-1.25E+3
Max Fy	3886	3081:REVERS,	3.100	3.76E+3	732.416	-140.490	-0.000	-755.476	-4.72E+3
Min Fy	3886	3280:REVERS,	3.100	3.12E+3	-732.803	119.946	0.000	696.006	4.72E+3
Max Fz	3448	3585:REVERS,	0	2.68E+3	32.433	678.825	-0.000	-2.78E+3	39.699
Min Fz	3016	3496:REVERS,	0	3.06E+3	-40.757	-678.616	0.000	2.78E+3	-49.525
Max Mx	2	3183:REVERS,	0	2.84E+3	143.043	-403.893	0.000	3.81E+3	2.12E+3
Min Mx	2	3274:REVERS,	0	2.34E+3	-163.980	384.926	-0.000	-3.59E+3	-2.34E+3
Max My	3438	3585:REVERS,	0	2.32E+3	105.365	-416.052	-0.000	5.1E+3	876.457
Min My	3006	3496:REVERS,	0	2.73E+3	-135.268	418.232	0.000	-5.14E+3	-1.14E+3
Max Mz	3887	3280:REVERS,	1.500	3.16E+3	-549.828	3.837	0.000	700.216	5.54E+3
Min Mz	3887	3081:REVERS,	1.500	3.8E+3	549.542	-10.459	-0.000	-769.619	-5.54E+3

Client	Cochin Shipyard Limited	Date	26/03/2022
Project	Design Project Report for Ship Repair Facility to handle Inland waterways Vessels at Pandu, Guwahati	Consultant	IITM/ NTCPWC



Limit state of Serviceability

Beam Force Detail Summary

Sign convention as diagrams: - positive above line, negative below line except F_x where positive is compression. Distance d is given from beam end A.

	Beam	L/C	d (m)	Axial F_x (kN)	Shear F_y (kN)	F_z (kN)	Torsion M_x (kN·m)	Bending M_y (kN·m)	M_z (kN·m)
Max F_x	3967	69:SHORT-CR/	1.500	5.6E+3	0.000	0.009	-0	-0.000	0.000
Min F_x	2	239:SHORT-CF	0	1.18E+3	-4.345	-7.282	-0.000	-1.06E+3	-47.316
Max F_y	3208	226:SHORT-CF	4.060	2.17E+3	188.382	2.348	0.000	-23.817	825.747
Min F_y	3583	64:SHORT-CR/	4.060	2.5E+3	-188.935	0.639	0.000	-9.043	-831.186
Max F_z	13	75:SHORT-CR/	0	4.01E+3	-1.187	192.659	-0.000	-794.868	-1.401
Min F_z	3074	69:SHORT-CR/	0	2.73E+3	2.932	-194.082	-0.000	803.181	3.461
Max M_x	1632	117:SHORT-CF	0	3.19E+3	4.275	-14.792	0.000	-966.825	46.312
Min M_x	1632	244:SHORT-CF	0	3.63E+3	3.618	-7.346	-0.000	1.23E+3	40.990
Max M_y	3884	75:SHORT-CR/	0	3.75E+3	0.095	-7.491	-0.000	1.23E+3	0.793
Min M_y	3064	69:SHORT-CR/	0	2.35E+3	10.021	12.174	-0.000	-1.3E+3	113.645
Max M_z	2724	111:SHORT-CR	1.500	4E+3	-140.603	0.407	-0.000	-6.067	1.4E+3
Min M_z	3214	226:SHORT-CF	1.500	2.42E+3	140.639	1.324	0.000	3.265	-1.4E+3

Beam Displacement Detail Summary

Displacements shown in *italic* indicate the presence of an offset

	Beam	L/C	d (m)	X (mm)	Y (mm)	Z (mm)	Resultant (mm)
Max X	3726	154:SHORT-CF	0	27.752	-3.848	-0.267	28.019
Min X	3784	63:SHORT-CR/	0	-28.206	-3.804	-0.167	28.462
Max Y	54	57:SHORT-CR/	1.500	0	0	0	0
Min Y	3941	69:SHORT-CR/	0	-0.099	-10.127	38.933	40.229
Max Z	2	167:SHORT-CF	0	0	-3.702	39.250	39.425
Min Z	3006	75:SHORT-CR/	0	-0.268	-7.103	-39.638	40.270
Max Rst	3969	76:SHORT-CR/	0	-0.037	-10.015	-39.528	40.777

Client	Cochin Shipyard Limited	Date	26/03/2022
Project	Design Project Report for Ship Repair Facility to handle Inland waterways Vessels at Pandu, Guwahati	Consultant	IITM/ NTCPWC



9.3. Column-1750x1750mm

Limit state of collapse

Beam Force Detail Summary

Sign convention as diagrams:- positive above line, negative below line except Fx where positive is compression. Distance d is given from beam end A.

	Beam	L/C	d (m)	Axial Fx (kN)	Shear Fy (kN)	Fz (kN)	Torsion Mx (kN'm)	Bending My (kN'm)	Mz (kN'm)
Max Fx	1688	2309:EXTREME	10.150	5.65E+3	1.35E+3	-426.584	194.398	-2.06E+3	1.31E+3
Min Fx	1631	3283:REVERSE	0	-1.01E+3	-1.14E+3	142.952	-234.318	-977.674	-14.2E+3
Max Fy	1631	3081:REVERSE	10.150	4.66E+3	1.54E+3	-370.103	247.130	-1.55E+3	1.26E+3
Min Fy	1631	3283:REVERSE	10.150	-555.759	-1.42E+3	172.533	-234.318	623.412	-808.967
Max Fz	2920	3423:REVERSE	10.150	2.79E+3	228.816	2.31E+3	-871.071	11.1E+3	439.622
Min Fz	3208	3696:REVERSE	10.150	2.24E+3	-300.142	-2.26E+3	782.808	-10.8E+3	13.032
Max Mx	2632	3678:REVERSE	0	3.27E+3	734.027	-1.88E+3	840.926	10.6E+3	8.28E+3
Min Mx	2776	3477:REVERSE	0	1.63E+3	-401.123	2.01E+3	-904.895	-11.3E+3	-4.33E+3
Max My	3208	3696:REVERSE	0	1.79E+3	-270.561	-1.99E+3	782.808	11.1E+3	-2.88E+3
Min My	2920	3423:REVERSE	0	2.3E+3	199.235	2.04E+3	-871.071	-11.4E+3	2.61E+3
Max Mz	1688	3081:REVERSE	0	4.58E+3	1.26E+3	-450.913	245.539	2.41E+3	15.9E+3
Min Mz	1631	3283:REVERSE	0	-1.01E+3	-1.14E+3	142.952	-234.318	-977.674	-14.2E+3

Limit state of Serviceability

Beam Force Detail Summary

Sign convention as diagrams:- positive above line, negative below line except Fx where positive is compression. Distance d is given from beam end A.

	Beam	L/C	d (m)	Axial Fx (kN)	Shear Fy (kN)	Fz (kN)	Torsion Mx (kN'm)	Bending My (kN'm)	Mz (kN'm)
Max Fx	3352	228:SHORT-CF	10.150	3.81E+3	519.572	18.248	-37.852	105.701	582.073
Min Fx	1631	115:SHORT-CF	0	869.249	-95.775	-71.157	3.659	365.238	-2.37E+3
Max Fy	3352	132:SHORT-CF	0	3.16E+3	808.431	26.756	-21.582	-124.165	4.71E+3
Min Fy	3640	90:SHORT-CR/	9.135	1.89E+3	-703.852	75.574	-23.510	303.809	-719.354
Max Fz	3496	72:SHORT-CR/	4.060	2.91E+3	152.258	637.445	-240.222	-914.394	1.18E+3
Min Fz	3496	171:SHORT-CF	4.060	2.04E+3	23.095	-598.410	120.479	839.220	260.486
Max Mx	3784	101:SHORT-CF	0	2.36E+3	3.827	22.683	297.192	547.565	15.912
Min Mx	3496	96:SHORT-CR/	0	2.74E+3	225.883	450.333	-336.649	-2.95E+3	2.21E+3
Max My	3496	72:SHORT-CR/	10.150	3.23E+3	152.258	637.445	-240.222	2.97E+3	255.823
Min My	3496	72:SHORT-CR/	0	2.7E+3	152.258	459.695	-240.222	-3E+3	1.8E+3
Max Mz	2632	225:SHORT-CF	0	3.2E+3	348.033	-1.009	-38.550	4.769	5.42E+3
Min Mz	3784	67:SHORT-CR/	5.075	1.26E+3	173.301	66.043	-120.901	-0.743	-2.75E+3

Client	Cochin Shipyard Limited	Date	26/03/2022
Project	Design Project Report for Ship Repair Facility to handle Inland waterways Vessels at Pandu, Guwahati	Consultant	IITM/ NTCPWC



Beam Displacement Detail Summary

Displacements shown in *italic* indicate the presence of an offset

	Beam	L/C	d (m)	X (mm)	Y (mm)	Z (mm)	Resultant (mm)
Max X	2430	153:SHORT-CF	3.045	10.422	-8.395	-0.283	13.386
Min X	1557	65:SHORT-CR/	3.045	-10.984	-9.615	-0.435	14.604
Max Y	1631	120:SHORT-CF	10.150	-0.05271	-2.201	3.088	3.793
Min Y	2430	119:SHORT-CF	0	-0.440	-10.750	5.017	11.871
Max Z	1224	167:SHORT-CF	1.015	0.825	-9.029	6.486	11.148
Min Z	1335	78:SHORT-CR/	0	-2.365	-5.547	-6.003	8.508
Max Rst	1557	65:SHORT-CR/	2.030	-10.887	-9.734	-0.387	14.609

9.4. Beam-1500x2000mm

Limit state of collapse

Beam Force Detail Summary

Sign convention as diagrams: - positive above line, negative below line except F_x where positive is compression. Distance d is given from beam end A.

	Beam	L/C	d (m)	Axial	Shear		Torsion	Bending	
				F_x (kN)	F_y (kN)	F_z (kN)	M_x (kN·m)	M_y (kN·m)	M_z (kN·m)
Max F_x	14454	3083:REVERS,	0.412	662.448	-2.37E+3	-113.542	544.510	-145.150	12.5E+3
Min F_x	14454	3283:REVERS,	0.412	-604.804	1.13E+3	83.538	-219.329	117.992	-11.6E+3
Max F_y	14382	2493:EXTREME	0	-135.841	1.85E+3	-2.441	172.620	1.339	-1.98E+3
Min F_y	14454	2309:EXTREME	0.412	565.121	-2.41E+3	-101.719	584.349	-124.194	10.8E+3
Max F_z	14454	3499:REVERS,	0.412	-392.323	496.615	262.336	-874.540	345.300	-6.3E+3
Min F_z	14454	3588:REVERS,	0.412	447.928	-1.74E+3	-292.912	1.2E+3	-372.807	7.15E+3
Max M_x	14533	3298:REVERS,	0	29.010	-951.626	-124.283	1.87E+3	-21.519	434.620
Min M_x	14616	3063:REVERS,	0	-48.536	-1.04E+3	138.231	-1.86E+3	29.322	546.363
Max M_y	14454	3499:REVERS,	0.412	-392.323	496.615	262.336	-874.540	345.300	-6.3E+3
Min M_y	14454	3588:REVERS,	0.412	447.928	-1.74E+3	-292.912	1.2E+3	-372.807	7.15E+3
Max M_z	14454	3081:REVERS,	0.412	661.895	-2.38E+3	-113.550	556.188	-143.496	12.5E+3
Min M_z	14454	3283:REVERS,	0.412	-604.804	1.13E+3	83.538	-219.329	117.992	-11.6E+3

Client	Cochin Shipyard Limited	Date	26/03/2022
Project	Design Project Report for Ship Repair Facility to handle Inland waterways Vessels at Pandu, Guwahati	Consultant	IITM/ NTCPWC



Limit state of Serviceability

Beam Force Detail Summary

Sign convention as diagrams:- positive above line, negative below line except F_x where positive is compression. Distance d is given from beam end A.

	Beam	L/C	d (m)	Axial F_x (kN)	Shear F_y (kN)	F_z (kN)	Torsion M_x (kN·m)	Bending M_y (kN·m)	M_z (kN·m)
Max F_x	3529	195:SHORT-CF	0	516.495	-193.187	15.319	-2.022	35.359	115.097
Min F_x	2343	148:SHORT-CF	0	-442.783	353.547	24.751	52.592	-66.249	443.118
Max F_y	112	135:SHORT-CF	0	-9.044	1.49E+3	8.788	45.496	-15.448	689.281
Min F_y	4232	201:SHORT-CF	0.500	-74.915	-1.75E+3	7.243	-11.847	-28.879	4.33E+3
Max F_z	4546	190:SHORT-CF	0	-122.077	-853.176	145.119	-175.920	106.669	1.07E+3
Min F_z	4546	123:SHORT-CF	0	-51.736	-811.005	-135.596	393.369	-123.386	-820.843
Max M_x	4546	219:SHORT-CF	0	-41.677	-951.776	-130.647	410.098	-132.640	34.066
Min M_x	4309	165:SHORT-CF	0	-54.134	-984.566	110.844	-410.921	125.718	-40.599
Max M_y	4309	166:SHORT-CF	0.500	-51.019	-729.000	124.257	-307.783	192.579	267.667
Min M_y	4546	219:SHORT-CF	0.500	-41.677	-987.118	-130.647	410.098	-197.964	518.790
Max M_z	4622	153:SHORT-CF	0.500	-80.078	-1.56E+3	24.518	0.651	63.363	4.41E+3
Min M_z	2812	135:SHORT-CF	0.521	-18.884	44.644	1.011	19.533	-1.243	-3.99E+3

Beam Displacement Detail Summary

Displacements shown in *italic* indicate the presence of an offset

	Beam	L/C	d (m)	X (mm)	Y (mm)	Z (mm)	Resultant (mm)
Max X	4653	202:SHORT-CF	0.512	39.129	-2.155	-2.754	39.285
Min X	2669	63:SHORT-CR/	0	-32.688	-3.665	0.105	32.893
Max Y	2670	154:SHORT-CF	0	38.947	-1.910	2.660	39.085
Min Y	2798	147:SHORT-CF	0.521	-1.518	-7.131	-9.534	12.002
Max Z	2670	166:SHORT-CF	0.250	23.733	-2.651	12.809	27.099
Min Z	3033	219:SHORT-CF	0.257	11.490	-4.294	-13.136	17.973
Max Rst	4653	202:SHORT-CF	0.512	39.129	-2.155	-2.754	39.285

Client	Cochin Shipyard Limited	Date	26/03/2022
Project	Design Project Report for Ship Repair Facility to handle Inland waterways Vessels at Pandu, Guwahati	Consultant	IITM/ NTCPWC



9.5. Beam-1750x2000mm

Limit state of collapse

Beam Force Detail Summary

Sign convention as diagrams:- positive above line, negative below line except F_x where positive is compression. Distance d is given from beam end A.

	Beam	L/C	d (m)	Axial F_x (kN)	Shear F_y (kN)	F_z (kN)	Torsion M_x (kN·m)	Bending M_y (kN·m)	M_z (kN·m)
Max F_x	3695	3495:REVERS,	6.375	958.160	-3.07E+3	-140.999	1.35E+3	-612.171	9.9E+3
Min F_x	2687	3423:REVERS,	0	-1.15E+3	-2.66E+3	-134.173	1.3E+3	665.589	-9.85E+3
Max F_y	3551	3657:REVERS,	0	-607.214	3.38E+3	123.075	-1.34E+3	-436.996	10.2E+3
Min F_y	3695	3426:REVERS,	6.375	902.920	-3.37E+3	-189.222	1.24E+3	-716.229	10.9E+3
Max F_z	14766	3426:REVERS,	0.563	-102.358	-229.088	280.795	-458.182	380.351	71.420
Min F_z	3695	2040:NORMAL	0	119.900	-701.105	-314.948	63.362	469.368	-2.84E+3
Max M_x	11282	3066:REVERS,	0	312.755	-1.18E+3	-189.574	1.91E+3	-82.740	1.19E+3
Min M_x	1685	3574:REVERS,	0	186.766	1.12E+3	185.466	-2.07E+3	-124.407	2.39E+3
Max M_y	2503	3499:REVERS,	0	-910.938	-2.54E+3	-155.092	1.04E+3	710.686	-11E+3
Min M_y	3695	2040:NORMAL	6.375	119.900	-1.49E+3	-314.948	63.362	-1.54E+3	4.14E+3
Max M_z	2503	3657:REVERS,	0	757.077	3.25E+3	128.892	-956.733	-678.260	12.1E+3
Min M_z	3839	3696:REVERS,	6.375	-870.790	2.69E+3	164.382	-975.746	677.977	-11.3E+3

Limit state of Serviceability

Beam Force Detail Summary

Sign convention as diagrams:- positive above line, negative below line except F_x where positive is compression. Distance d is given from beam end A.

	Beam	L/C	d (m)	Axial F_x (kN)	Shear F_y (kN)	F_z (kN)	Torsion M_x (kN·m)	Bending M_y (kN·m)	M_z (kN·m)
Max F_x	10295	144:SHORT-CF	0	352.691	-898.781	-121.307	637.751	-65.543	1.12E+3
Min F_x	2687	69:SHORT-CR/	0	-379.851	-365.474	-25.361	258.532	183.558	-2.04E+3
Max F_y	2503	171:SHORT-CF	0	51.423	1.1E+3	36.221	-106.304	-120.842	3.43E+3
Min F_y	3695	72:SHORT-CR/	6.375	135.895	-1.14E+3	-48.145	180.228	-21.156	3.29E+3
Max F_z	3839	102:SHORT-CF	0	-164.160	959.200	191.005	-110.383	-940.223	2.08E+3
Min F_z	3695	96:SHORT-CR/	0	122.421	-605.784	-217.722	98.459	333.197	-2.31E+3
Max M_x	11282	228:SHORT-CF	0	115.206	-785.425	2.780	953.241	6.539	-18.910
Min M_x	1685	244:SHORT-CF	0	109.595	893.788	-20.417	-844.391	36.088	1.56E+3
Max M_y	3695	77:SHORT-CR/	6.375	-275.904	362.366	57.050	-325.961	401.162	-1.9E+3
Min M_y	3695	96:SHORT-CR/	6.375	122.421	-1.13E+3	-217.722	98.459	-1.05E+3	3.23E+3
Max M_z	2503	171:SHORT-CF	0	51.423	1.1E+3	36.221	-106.304	-120.842	3.43E+3
Min M_z	3839	174:SHORT-CF	6.375	-176.158	488.776	37.367	-117.877	97.962	-2.57E+3

Client	Cochin Shipyard Limited	Date	26/03/2022
Project	Design Project Report for Ship Repair Facility to handle Inland waterways Vessels at Pandu, Guwahati	Consultant	IITM/ NTCPWC



Beam Displacement Detail Summary

Displacements shown in *italic* indicate the presence of an offset

	Beam	L/C	d (m)	X (mm)	Y (mm)	Z (mm)	Resultant (mm)
Max X	3870	225:SHORT-CF	0	23.267	-6.220	-0.242	24.085
Min X	3870	65:SHORT-CR4	0	-21.137	-5.752	0.465	21.910
Max Y	14463	121:SHORT-CF	0.500	-10.418	-2.298	12.866	16.714
Min Y	3870	239:SHORT-CF	0	13.807	-8.040	12.805	20.476
Max Z	13259	73:SHORT-CR4	0.266	4.825	-5.299	13.305	15.112
Min Z	9314	171:SHORT-CF	0.266	1.042	-5.677	-13.787	14.946
Max Rst	3870	225:SHORT-CF	0	23.267	-6.220	-0.242	24.085

9.6. slab-700mm

Limit state of collapse

Plate Center Stress Summary

	Plate	L/C	Shear (Local)		Membrane (Local)			Bending Moment (Local)		
			SQX (N/mm ²)	SQY (N/mm ²)	SX (N/mm ²)	SY (N/mm ²)	SXY (N/mm ²)	MX (kN·m/m)	MY (kN·m/m)	MX _Y (kN·m/m)
Max Qx	4014	3423:REVERS,	0.851	-0.201	-0.085	-0.082	0.204	-365.879	-92.407	-20.469
Min Qx	4119	2043:NORMAL	-0.874	-0.135	-0.006	-0.015	-0.078	-48.706	97.503	9.996
Max Qy	3030	3706:SEISMIC	-0.704	0.753	-0.121	-0.022	-0.071	-190.651	-64.172	114.324
Min Qy	4205	2103:NORMAL	-0.185	-1.102	-0.023	-0.016	0.040	-52.070	240.822	61.007
Max Sx	4282	3657:REVERS,	0.248	-0.558	0.754	0.094	-0.755	10.819	79.941	-95.173
Min Sx	4282	3460:REVERS,	-0.115	-0.324	-0.672	-0.093	0.691	-53.063	34.737	86.417
Max Sy	3849	2133:NORMAL	-0.122	0.231	0.640	0.176	-0.226	-19.268	32.365	21.611
Min Sy	4521	2026:NORMAL	-0.032	-0.582	-0.486	-0.225	-0.308	-48.852	-19.861	2.447
Max Sxy	4282	3460:REVERS,	-0.115	-0.324	-0.672	-0.093	0.691	-53.063	34.737	86.417
Min Sxy	4282	3657:REVERS,	0.248	-0.558	0.754	0.094	-0.755	10.819	79.941	-95.173
Max Mx	4014	3694:REVERS,	-0.549	0.091	0.039	0.065	-0.187	286.827	122.200	-7.855
Min Mx	3018	3585:REVERS,	-0.861	-0.224	0.081104	-0.050	-0.178	-373.532	-86.475	19.199
Max My	4205	3261:REVERS,	-0.357	-0.834	0.101	0.141	0.098	56.642	379.016	89.027
Min My	4249	3081:REVERS,	0.079295	-0.192	0.015	-0.080	0.029	-51.455	-291.359	8.255
Max Mxy	4205	3477:REVERS,	-0.488	-0.816	0.094	0.076	0.224	147.169	217.088	180.055
Min Mxy	4595	3657:REVERS,	0.531	-0.721	0.129	0.079	-0.236	190.319	197.733	-168.954

Client	Cochin Shipyard Limited	Date	26/03/2022
Project	Design Project Report for Ship Repair Facility to handle Inland waterways Vessels at Pandu, Guwahati	Consultant	IITM/ NTCPWC



Limit state of Serviceability

Plate Center Stress Summary										
	Plate	L/C	Shear (Local)		Membrane (Local)			Bending Moment (Local)		
			SQX (N/mm ²)	SQY (N/mm ²)	SX (N/mm ²)	SY (N/mm ²)	SXY (N/mm ²)	MX (kN·m/m)	MY (kN·m/m)	MXY (kN·m/m)
Max Qx	3267	165:SHORT-CF	0.465	0.059	0.022	0.001	0.027	-79.956	55.761	-1.447
Min Qx	4119	99:SHORT-CR/	-0.637	-0.104	-0.007	-0.010	-0.056	-34.498	68.772	6.187
Max Qy	2934	135:SHORT-CF	-0.570	0.440	0.009	0.006	0.025	-33.667	69.776	28.933
Min Qy	4205	159:SHORT-CF	-0.136	-0.750	-0.021	-0.008	0.022	-29.962	175.055	41.657
Max Sx	4521	69:SHORT-CR/	-0.163	-0.582	0.482	0.061	0.398	7.035	84.945	33.504
Min Sx	4521	100:SHORT-CF	-0.036	-0.419	-0.396	-0.135	-0.303	-25.176	56.513	-11.310
Max Sy	3849	189:SHORT-CF	-0.093	0.162	0.442	0.121	-0.153	-10.160	23.415	12.515
Min Sy	4521	82:SHORT-CR/	-0.010	-0.378	-0.325	-0.154	-0.205	-35.907	-28.463	0.245
Max Sxy	4521	189:SHORT-CF	-0.113	-0.547	0.473	0.092	0.415	-8.785	20.576	28.113
Min Sxy	4521	124:SHORT-CF	-0.077	-0.466	-0.373	-0.020	-0.357	-11.021	91.467	-6.922
Max Mx	3269	219:SHORT-CF	-0.179	-0.204	0.022	-0.000	0.001	102.738	130.512	-7.284
Min Mx	3007	213:SHORT-CF	0.358	-0.114	0.022	0.010	0.025	-125.318	-5.817	-9.685
Max My	4205	135:SHORT-CF	-0.142	-0.737	0.043	0.026	0.049	-25.874	187.524	41.332
Min My	4734	201:SHORT-CF	0.019	-0.260	-0.001	-0.020	0.000	-23.712	-180.080	5.899
Max Mxy	4205	165:SHORT-CF	-0.159	-0.732	-0.024	-0.019	0.047	-8.783	116.237	65.027
Min Mxy	4595	99:SHORT-CR/	0.231	-0.650	-0.160	-0.025	0.055	45.431	120.060	-59.227

9.7. slab-800mm

Limit state of collapse

Plate Center Stress Summary										
	Plate	L/C	Shear (Local)		Membrane (Local)			Bending Moment (Local)		
			SQX (N/mm ²)	SQY (N/mm ²)	SX (N/mm ²)	SY (N/mm ²)	SXY (N/mm ²)	MX (kN·m/m)	MY (kN·m/m)	MXY (kN·m/m)
Max Qx	11748	2010:NORMAL	0.884	0.646	-0.012	-0.010	0.005862	36.523	-101.622	75.808
Min Qx	14373	2058:NORMAL	-0.911	0.604	-0.002	0.015	-0.000	0.915	-44.440	-70.320
Max Qy	11748	2010:NORMAL	0.884	0.646	-0.012	-0.010	0.005862	36.523	-101.622	75.808
Min Qy	9727	2172:NORMAL	-0.853	-0.652	-0.007	-0.015	-0.003	-30.681	-97.353	70.848
Max Sx	11146	2163:NORMAL	0.039	-0.101	0.090	0.072278	-0.087	-25.422	5.720	2.041
Min Sx	11147	2088:NORMAL	0.111	-0.164	-0.120	-0.137	0.141	-67.200	-69.447	34.838
Max Sy	11146	2151:NORMAL	0.056	-0.060	0.047	0.082	-0.024	-46.369	76.413	5.810
Min Sy	10170	2052:NORMAL	-0.121	-0.376	-0.074	-0.203	-0.072	-114.475	-117.426	-49.596
Max Sxy	11147	2088:NORMAL	0.111	-0.164	-0.120	-0.137	0.141	-67.200	-69.447	34.838
Min Sxy	10169	2070:NORMAL	-0.107	-0.151	-0.113	-0.142	-0.142	-67.769	-23.091	-23.426
Max Mx	11598	2172:NORMAL	0.011	-0.009	-0.003	-0.009	-0.006	225.286	246.718	-9.420
Min Mx	14575	2110:NORMAL	-0.369	-0.041	0.001	0.026	-0.000	-210.645	85.749	-9.863
Max My	12079	2009:NORMAL	-0.019	-0.009	0.005	0.008	0.008	131.620	297.206	-2.499
Min My	14624	2081:NORMAL	-0.045	0.242	0.000	0.008	-0.001	-49.529	-241.218	-21.898
Max Mxy	11941	2082:NORMAL	-0.503	-0.483	-0.015	-0.024	-0.022	62.522	47.128	118.852
Min Mxy	7764	2055:NORMAL	0.550	-0.518	-0.003	-0.016	0.010	-29.559	-33.720	-118.171

Client	Cochin Shipyard Limited	Date	26/03/2022
Project	Design Project Report for Ship Repair Facility to handle Inland waterways Vessels at Pandu, Guwahati	Consultant	IITM/ NTCPWC



Limit state of Serviceability

Plate Center Stress Summary

	Plate	L/C	Shear (Local)		Membrane (Local)			Bending Moment (Local)		
			SQX (N/mm ²)	SQY (N/mm ²)	SX (N/mm ²)	SY (N/mm ²)	SXY (N/mm ²)	MX (kN·m/m)	MY (kN·m/m)	MX _Y (kN·m/m)
Max Qx	11748	66:SHORT-CR/	0.612	0.441	-0.008	-0.004	0.004	25.507	-73.245	49.409
Min Qx	14373	114:SHORT-CF	-0.635	0.421	-0.001	0.013598	-0.001	2.878	-31.924	-45.585
Max Qy	11748	66:SHORT-CR/	0.612	0.441	-0.008	-0.004	0.004	25.507	-73.245	49.409
Min Qy	11712	228:SHORT-CF	0.606	-0.442	-0.004	-0.010	-0.002	24.136	-66.052	-51.443
Max Sx	11146	219:SHORT-CF	0.023	-0.063	0.067	0.050	-0.070	-11.846	8.861	-0.533
Min Sx	11146	144:SHORT-CF	0.096	-0.247	-0.085	-0.121	0.102	-94.266	-53.488	45.516
Max Sy	14448	241:SHORT-CF	0.001	-0.059	-0.000	0.061	0.000	-0.755	11.282	6.831
Min Sy	10170	108:SHORT-CF	-0.082	-0.261	-0.047	-0.138	-0.049	-80.437	-94.871	-34.474
Max Sxy	11135	144:SHORT-CF	0.098	-0.086	-0.066	-0.092	0.105	-47.715	-9.247	25.233
Min Sxy	10157	126:SHORT-CF	-0.094	-0.077	-0.061	-0.093	-0.106	-46.812	21.519	-19.335
Max Mx	11598	228:SHORT-CF	0.003	-0.007	-0.002	-0.008	-0.004	153.949	168.655	-6.383
Min Mx	14575	166:SHORT-CF	-0.267	-0.029	0.001	0.020	0.000	-152.733	61.013	-7.519
Max My	12079	65:SHORT-CR/	-0.013	-0.003	0.004	0.008	0.005	88.374	209.147	-1.676
Min My	14624	137:SHORT-CF	-0.032	0.173	0.000	0.007	-0.001	-35.391	-173.871	-15.750
Max Mxy	11941	138:SHORT-CF	-0.337	-0.331	-0.009	-0.015	-0.015	48.964	38.932	83.042
Min Mxy	11497	228:SHORT-CF	-0.406	0.298	0.000	-0.007	-0.004	57.054	38.799	-80.475

Client	Cochin Shipyard Limited	Date	26/03/2022
Project	Design Project Report for Ship Repair Facility to handle Inland waterways Vessels at Pandu, Guwahati	Consultant	IITM/NTCPWC



10.0 Results and Discussions

The P- δ structural analysis was carried out to determine the structural responses such as member forces and deflections. The member loads will be used to design the RCC elements for ship repair facilities. The reinforcement results for each structural element are summarized in this section.

10.1 Piles

10.1.1 Pile-1300mm

The design of pile is done for the moment adopted from the analysis done by STAAD Pro. The reinforcement provided is summarized in **Table. 10.1**.

Table. 10.1: Reinforcement summary for 1300mm

Dia (mm)	No of bars provided	% of reinforcement provided	Lateral ties provided	crack width (mm)
				Short term
1300	2x33T32	4.0%	12mm# @150mm spacing c/c	0.159

10.1.2 Pile-1200mm

The design of pile is done for the moment adopted from the analysis done by STAAD Pro. The reinforcement provided is summarized in **Table. 10.2**.

Table. 10.2: Reinforcement summary for 1200mm

Dia (mm)	No of bars provided	% of reinforcement provided	Lateral ties provided	crack width (mm)
				Short term
1200	2x25T32	3.56%	12mm# @150mm spacing c/c	0.136

Client	Cochin Shipyard Limited	Date	26/03/2022
Project	Design Project Report for Ship Repair Facility to handle Inland waterways Vessels at Pandu, Guwahati	Consultant	IITM/NTCPWC



10.3 Column

The design of column is done for the moment adopted from the analysis done by STAAD Pro. The reinforcement provided is summarized in **Table. 10.3**.

Table. 10.3: Reinforcement summary for column (1750x1750mm)

Size (mm)	No of bars provided	% of reinforcement provided	Lateral ties provided	crack width (mm)
				Short term
1750x1750	1x34T32 on each side	3.5%	12mm# @150mm spacing c/c	0.18

10.4 Beams

The design of beam is done for the moment adopted from the analysis done by STAAD Pro. The reinforcement provided is summarized in **Table. 10.4**.

Table. 10.4: Reinforcement summary for beams

S. No.	Size(mm)	Reinforcement		% of reinforcement		Stirrups (mm)	Crack width (mm)	
		Bottom	Top	Bottom	Top		Top	Bottom
							Short	Short
1	1750x2000	30T32	30T32	0.73	0.73	12T 10 legged @125 c/c	0.061	0.038
2	1500x2000	30T32	30T32	0.85	0.85	12T 10 legged @100 c/c	0.101	0.091

Client	Cochin Shipyard Limited	Date	26/03/2022
Project	Design Project Report for Ship Repair Facility to handle Inland waterways Vessels at Pandu, Guwahati	Consultant	IITM/ NTCPWC



10.4 Slab

The design of slab is done for the moment adopted from the analysis done by STAAD Pro. The reinforcement provided is summarized in **Table. 10.5**.

Table. 10.5: Reinforcement summary for slab

S. No.	Description	Reinforcement		% of reinforcement		Stirrups (mm)	Crack width (mm)	
		Bottom	Top	Bottom	Top		Top Short	Bottom Short
1	Slab(700mm thick)	25@150c/c	25@150c/c	0.51	0.51	12T 6 legged @150 c/c	0.051	0.047
2	Slab(800mm thick)	25@100c/c	25@100c/c	0.44	0.44	12T 6 legged @100 c/c	0.035	0.016

Client	Cochin Shipyard Limited	Date	26/03/2022
Project	Design Project Report for Ship Repair Facility to handle Inland waterways Vessels at Pandu, Guwahati	Consultant	IITM/ NTCPWC



11.0 Summary

The proposed ship repair structure is found to be safe against the above mentioned forces. The capital cost estimates have been prepared for the proposed structure in phase wise development. The total cost of the project based on requirements, initial discussions and observation as per 2022 rates is about **Rs. 141.84 Crores for Phase-I and Rs. 266.40 Crores for Phase-II. The total cost of project is Rs. 404.60 Crores.** The bill of quantity is attached in **Annexure-II.** .

[Prof. S.A. Sannasiraj]