Detailed Project Report (DPR) for Ship Repairing Facility at Varanasi, Uttar Pradesh

DRAFT REPORT

Client

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INTRODUCTION

1.1 Preamble

The Inland Waterways Authority of India (IWAI) was established on 27th October 1986 with the primary objective of promoting a self-sustainable, cost-effective, safe, and environmentally friendly supplementary mode of transportation to support the country's economic growth. This initiative also aims to reduce congestion on overburdened road and rail networks. Key interventions by IWAI include fairway development through dredging, river training, conservancy operations, river marking, and bank protection works, along with the installation of navigational aids to ensure safe passage. Additionally, IWAI focuses on the development of Multi-modal Terminals (MMTs), Inter-modal Terminals (IMTs), and Ro-Ro Terminals, as well as the construction of navigational locks, ship repair facilities, and bunkering stations.

Due to lack of IWT ship repair facility in the entire North-eastern region, especially for under water repairs of the vessels, the IWT operators are put into substantial financial and economic losses since the vessels need to sail to Kolkata even for small repairs. Considering both time and cost, IWAI is planning to develop the Ship Repairing Facility at Ghazipur, Uttar Pradesh. For this purpose, Inland Waterways Authority of India (IWAI) vide the Work Order No: WAI/NW-1/SRF/Ghazi. /2024-25 dated on 15-01-2025 entrusted the work of "Preparation of Detailed Project Report for Ship Repairing Facility at Ghazipur, Uttar Pradesh to National Technology Centre for Ports Waterways and Coasts (NTCPWC), Department of Ocean Engineering, Indian Institute of Technology Madras, Chennai.

Ghazipur, located in south-eastern Uttar Pradesh, India, is endowed with a network of rivers that have historically influenced its culture and economy. The most prominent of these is the Ganges River, which flows along the district's northern boundary, providing both cultural significance and potential for economic activities. The Government of India, through the Inland Waterways Authority of India (IWAI), has initiated projects to augment the capacity of

NW-1. One such project involves fairway maintenance of the Ghazipur-Varanasi stretch, aiming to remove hard strata to facilitate the movement of larger vessels. Ghazipur is a landlocked district without direct access to major waterways. Consequently, it does not host dedicated ship repair facilities.

To achieve this objective, it was initially proposed to conduct detailed reconnaissance/site survey of the proposed site at Ghazipur, including geographical, environmental and socio-economic conditions and review of the existing data and previous study reports, details and type of inland vessels flying in the NW-1, other information, maps, charts etc., available with IWAI, public domain and any other sources, etc., The Location of the study area is depicted in Figure1.1.

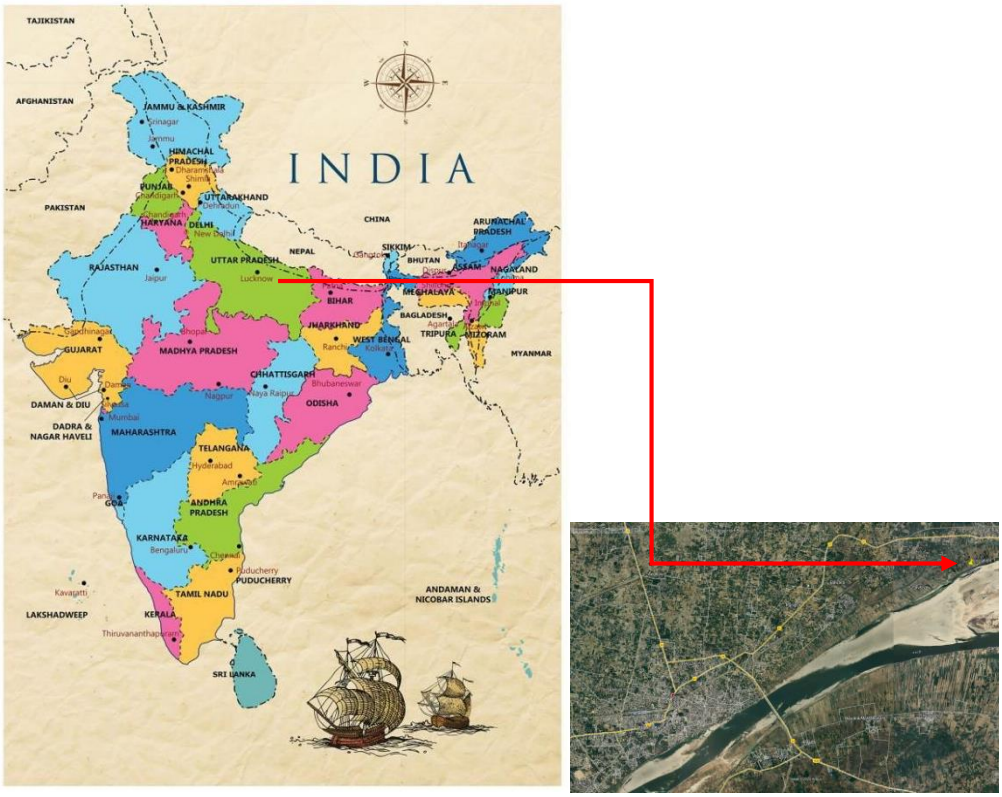


Figure 1. 1 Location of Proposed Ship Repair Facility

This report assesses the possibility of setting up a ship repair facility in Ghazipur, a district along the Ganges River and within the National Waterway 1 (NW-1) corridor. This facility will cater to the growing maritime traffic in the region, driven by inland waterway development projects, including the Ghazipur Inland Multi-Modal Terminal (IMT), which is expected to boost river-based cargo

transport. The facility will offer services like vessel maintenance, repairs, dry-docking, hull cleaning, and engine repairs.

1.2 Scope and Objectives of the Study

The present project is focused mainly on the following:

1.2.1 Site assessment & Review of existing data

- Reconnaissance/ Site Survey: To conduct a detailed reconnaissance/ site survey of the proposed site, including geographical, environmental, and socio-economic conditions.
- Review of existing data: Collection and examination/ review of previous studies, reports, data, information, maps, charts etc. available IWAI and any other sources. Provisions of the IV Act 2021, details and type of inland vessels flying in the NW- 1.

1.2.2 Market Analysis

- Demand Assessment: Analyze the current and projected demand for ship repair services in the region. This shall include assessment at the proposed ship yard facility for repair and maintenance of IWT vessels plying in NW-1 for the time-frame 2025, 2030, 2035 and 2045 in consultation with all nodal agencies like Uttar Pradesh Inland Waterways Authority, IWAI, tourist vessel operators, mechanized country boats and other relevant stakeholders/ private agencies.
- Competitive Analysis: Assess the competitive landscape, identifying existing ship repair facilities and potential competitors within the region of proposed facility.

1.2.3 Technical Design and Engineering

- Facility Layout: Develop the design and layout of the ship repairing facility, including dry docks, workshops, storage areas, and other necessary infrastructure. Such facilities include but not limited to revetment / bank protection work, ship lifting facility, winches, equipment to handle ship and its

parts, ship repair yard, workshop, store, hard stand, office building, internal road, water supply, firefighting, electricity etc.

- ❖ Technical Specifications: Provide detailed technical specifications for all equipment, machinery, and materials required for the proposed ship repairing facility. Develop detailed layout plan, engineering design & drawings, preparing specifications, bill of quantities, etc.

- ❖ Operational Plan: Outline the operational processes, including workflow, manpower requirements, and maintenance schedules.
- ❖ Proof checking design through a reputed agency/institution

1.2.4 Financial Analysis

- ❖ Cost Estimation: Prepare a detailed cost estimate for the project, including capital expenditure, operational costs, and maintenance expenses. Also provide basis for justification of such cost estimates.
- ✓ The consultant shall prepare a realistic construction schedule and estimated cost of development and O&M for the ship repair facility indicating the sequence of activities duly considering the river characteristics in different seasons and priority of work along with phasing of expenditure.
- ✓ Further, the estimated cost of development should be realistic and based on local schedule of rates/market rate and their basis/documentary proof should be included in the DPR with necessary details.
- ❖ Revenue Projections: Develop revenue projections based on market analysis and operational capacity of the proposed ship repair facility.
- ❖ Financial & Economic Viability: Workout Cost Benefit analysis, Financial Internal Rate of Return (FIRR) and Economic Internal Rate of Return (EIRR) based on current Indian /International norms, with sufficient backup calculations, basis, assumptions with their source, justification etc. The financial viability assessment should include project cash flow analysis, break-even analysis, and sensitivity analysis.

1.2.5 Risk Assessment and Management

- ❖ Risk Identification: Identify potential risks associated with the project, including technical, financial, and operational risks.
- ❖ Risk Mitigation Plan: Develop a risk mitigation plan outlining strategies to minimize or manage identified risks.

1.2.6 Implementation Plan

- ❖ Project Phasing: Propose a phased implementation plan, including timelines, milestones, and key deliverables.
- ❖ Resource Allocation: Outline the resources required for each phase of the project, including manpower, equipment, and materials.
- ❖ Monitoring and Evaluation: Propose a monitoring and evaluation framework to track the progress of the project during and after implementation.

1.2.7 Preparation of Tender Documents

a. Tender for capital works: Prepare tender documents containing General Conditions of Contract, Special Conditions of Contract, Technical Specifications and NIT etc. all complete to facilitate implementation of project for all capital works for development of proposed ship repair facility.

b. Tender for O&M: Prepare tender document for selecting O&M operator of ship repair facility through an open tender.

1.3 Assessment of The Identified Site at Ghazipur and Finalization of the Most Viable Location

1.3.1 Site Inspection and Reconnaissance Survey at Ghazipur Location

As part of the mandate to finalise the Detailed Project Report for the dedicated Ship Repairing Facility along National Waterway-1 (NW-1), a site visit and reconnaissance survey was carried out by the team headed by Prof K. Murali, Professor and Dean (Faculty) along with Mr. Sanjeeva kumar, Director (i/c) and Mr. Md. Aslam, Tech Assistant, IWAI on 21st April 2025, for technical feasibility assessment, site conditions & its environment, area availability and connectivity, of the proposed site of Ship repair facility at Ghazipur, Uttar Pradesh. This

National Waterway – 1 passing through Patna, Bihar is classified as Class VII Waterway, as defined in Gazette Notification CG-DL-E-17122022-241170 dated 16.12.2022. The location plan of the proposed ship repair facility identified and communicated by IWAI in shown in Figure 1.2.

Figure 1. 2 Google Image for available Land Location-1

During the Reconnaissance survey and subsequent discussions held with the IWAI officials, based on the documents shared, a conclusion has been reached that if, the ship repair facility must be developed in the identified area the following major challenges need to be addressed.

1. Land Acquisition
2. Manoeuvrability of the ships and other floating crafts

Further, Hydro morphological conditions observed at Location 1 indicate the need for a detailed study to understand riverbed behaviour, sediment transport patterns, and flow dynamics. The dry riverfront and disconnection from the main channel suggest that significant dredging will be required to establish navigable access. Considering the physical

site condition, it is opined that development of SRF at Location 1 requires dredging to create and maintain an approach channel and also a need for recurring maintenance dredging to preserve navigable depth for vessel operations.

1.3.2 Alternative Location - Location 2: Firozpur Kalan, Ghazipur District

Considering the difficulties and bottlenecks in establishing the ship repair facilities in the already identified area by IWAI (Location -1), further reconnaissance survey was conducted to scout any viable alternative location adjacent to the area proposed by IWAI. Based on the preliminary assessment considering accessibility of the road availability of the water body, land parcels for establishing the shore-based facilities and connectivity to the main road network, a location has been identified in the Firozpur Kalan area of the Ganga River. A location map indicated that the area already identified by IWAI and the new area now scouted (termed as Location 2) is presented in Figure 1.3.

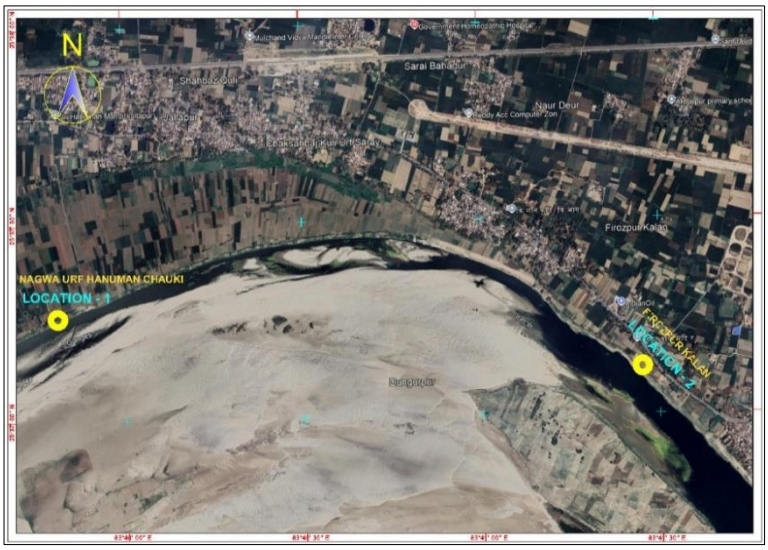


Figure 1. 3 Location map of Proposed Ship Repair facility

At Location 2 (Firozpur Kalan), consistent water presence and natural river depth were confirmed during the site visit. The absence of major sandbars and the proximity to the active channel make the site more favorable for direct vessel access without the need for extensive dredging. Also, Firozpur Kalan provides a more hydrologically suitable and cost-efficient

option based on field evidence. Minimal intervention for water access and the site's natural alignment with NW-1 enhance its suitability for developing a ship repairing facility. Site-specific infrastructure planning can consider local topography and river behavior. Layout orientation, access ramp positioning, and slipway alignment may be designed in response to bank gradients and the flow direction of the river.

However, there is no land available under the control of IWAI for establishing landside/ backup facilities and the available with IWAI is adjacent to Location -1, which is far away from the location-2, which necessitated acquisition of the sufficient backup land for setting up of the landside facilities from Government and/ or private owners.

1.4. Selected Site for establishment of Ship Repair Facility

When the pros and cons of the Ghazipur site were presented to IWAI in the form of a reconnaissance report on 03.05.2025, IWAI after discussions and deliberations had advised NTCPWC to consider MMT **Varanasi** location as an alternate site for the Ship Repair Facility in Uttar Pradesh vide their letter no. IWAI/NW-1/SRF/Ghazi./2024-25 (1) dated 07.05.2025, under the same scope of work as per the original work order for "Preparation of Detailed Project Report for Ship Repairing Facility at Ghazipur".

1.5 Organization of the report

The report has been organized as per the following sequence.

- **Section 1: Introduction**
- **Section 2: Project Background**
- **Section 3: Project Site Environment**
- **Section 4: Market Analysis**
- **Section 5: Development Plan**
- **Section 6: Proposed Ship Repair Facility**
- **Section 7: Proposed Structures Landside Development**
- **Section 8: MEP Services**
- **Section 19: Total Development Cost**


Project Back Ground

Chapter 2

Project Back ground

2.1 Site Inspection of the Proposed Site at Varanasi

As advised, detailed site visits were carried out by the representatives of NTCPWC and detailed interactions were held with the Project Director, IWAI and their team of officials Figure 2.1. The project team had shared various documents related to the newly identified site at Varanasi.

Figure 2. 1 Field Visit at Varanasi

2.2 Finalization of the Location of the proposed Ship Repair Facility at Varanasi

On submission of the site inspection report, IWAI had organized a joint discussion/ workshop on "Development of MMLP at Varanasi, Uttar Pradesh" to finalize the Masterplan prepared by

National Highways Logistics Management Limited (NHLML) inter-alia covering a suitable location for setting up of the Ship Repair facilities.

Various documents shared by NHLML during the interactive meeting and thereafter, have been examined and the following are the observations.

1. The modified Masterplan document shared by NHLML incorporating various decisions taken during the interactive meeting an earmarked space for establishing berthing jetty/ ship hoisting jetty along with a dedicated space admeasuring about 4 acres of land for development of Ship repair facilities. The location earmarked for Ship Repair Facility at Varanasi as per the Masterplan is shown in Figure 2.2.

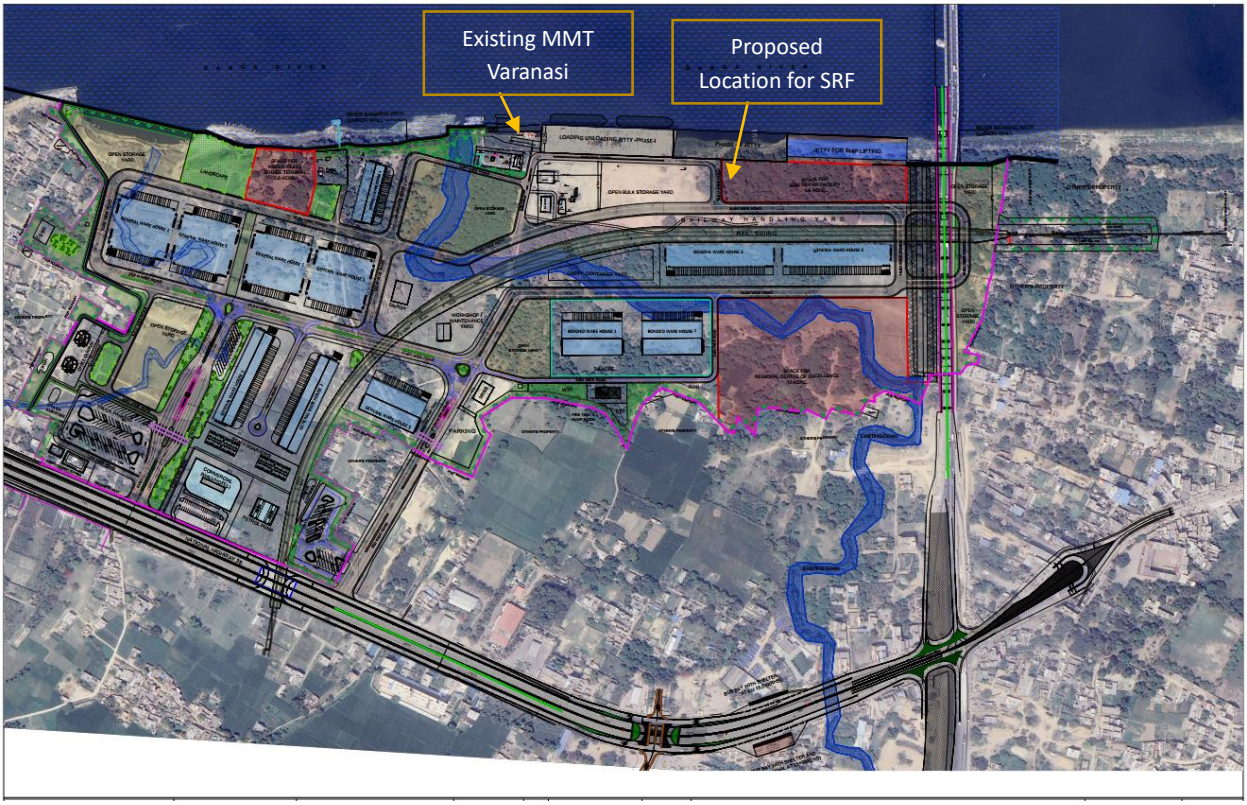


Figure 2. 2 Location earmarked for Ship Repair Facility at Varanasi as per the Masterplan

2. Sufficient water depth is available at the identified site to handle all the IWAI vessels having draft up to 2.5m. However, the water level is varying substantially and the average water level variation is around 10m. The details of water level during different periods at

Varanasi is attached as Annexure II for ready reference. Taking into account such variation and other limitations at site arising out of diversion of the existing nalah and column foundation of the adjoining bridge, a suitable design preferably, a boat hoisting jetty with other landside infrastructure can be designed towards north of the existing Multi Modal Terminal at Varanasi.

3. If the top of the proposed Boat Hoisting jetty is fixed, with sufficient free board over and above the highest high water level, preferably in line with existing MMT Varanasi terminal, or such elevation for ensuring seamless operation of Ship Repair Facilities (to be reconfirmed during the Detailed Project Report stage), the backup facilities such as repair bay, transfer bay and other landside infrastructures viz., workshops, substations, admin buildings, road & rail connectivity (if possible), etc., can be conveniently located behind the boat hoisting jetty and also in the area earmarked in the Masterplan for development of Ship repair Facilities.

Considering all these aspects, particularly availability of sufficient water spread area with required water depth and land for developing the backup infrastructure facilities, it is recommended that the Ship Repair Facilities can be established at the identified location Varanasi, Uttar Pradesh, which will result in both direct and indirect benefits and considerable savings in cost & time, and also create substantial employment potential for the country, as a whole and Uttar Pradesh/ Varanasi in particular.

SITE ENVIRONMENT

Chapter 3

Site environment

3.1 General

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.

3.2 Rainfall

The area is dominated by south-west monsoon during June to October rather than north-east monsoon during December to March. The area received almost 90 % of the rainfall during south-west monsoon. The average annual rainfall in the region is about 1003.3 mm. The month-wise distribution of the average rainfall recorded for each month of the year is as follows

Table 3. 1 Annual Rainfall Data of Varanasi

Month	Monthly Total (mm)	Number of Rainy Days	Heaviest Fall in 24 Hours (mm)	Year
January	20.3	1.8	69.6	1984
February	12.5	1.1	67.1	1990
March	10.4	1.0	37.1	1982
April	4.3	0.5	40.0	1993
May	11.5	0.9	31.6	1990

June	85.6	4.5	159.5	1999
July	303.8	12.5	288.3	1990
August	281.6	13.3	321.6	1988
September	214.9	9.4	349.5	1987
October	39.8	2.2	138.9	1996
November	15.5	0.3	161.5	1995
December	3.4	0.3	53.1	1995
Total	1003	47.8	1761.8	

3.3 Water Level

The maximum and minimum water levels observed at Varanasi over a period of 2018-2025 are tabulated in Table. 3.2. The observed Highest Flood level at Varanasi is 73.901m and Chart Datum at Varanasi is 57.165 m.

Table 3. 2 Water Levels in meter at Varanasi

	2018	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025(up to 25th April)**
Maximum (m)	65.95	69.97	68.63	72.3	66.35	68.3	70.72	59.85
Minimum(m)	57.73	57.06	54.47	58	56.55	58.33	57.6	58.83
Difference	8.22	12.91	14.16	14.3	9.8	9.97	13.12	1.02
Warning Level(m)				71.262	70.262	70.262	70.262	70.262
Danger level (m)	71.262	71.262	71.262	71.262	71.262	71.262	71.262	71.262
H. F. L (m)	73.901	73.901	73.901	73.901	73.901	73.901	73.901	73.901
C.D. (m)	57.165	57.165	57.165	57.165	57.165	57.165	57.165	57.165

3.4 Current

Hydrodynamic observations indicate that the flow velocity of the Ganga River in the Varanasi stretch varies considerably with the season approximately 0.2 m/s under low-flow conditions, increasing up to 4 m/s during flood periods, subject to local depth and channel geometry.

3.5 Temperature

There is no meteorological observatory in the district. but with the help of observatory in Geography Department, P.G. College. May-June are hottest month with mean daily max. temp. at about 41° C and mean daily minimum about 26° C. January is generally the coldest month with mean daily maximum temp. at about 23° C and mean daily minimum at about 9° C. According to Sankh Partika 1997, the Max. Temp. 42.7° C and minimum Temp. 2.0° C of District.

3.6 Subsurface Soil Conditions – SRF Varanasi

The geotechnical investigation report (ASL139/2016–2017) prepared by Arun Soil Lab Pvt. Ltd., Lucknow, for the IWAI Multimodal Terminal at Varanasi provides a reliable reference for the subsurface conditions at the SRF site, located within the same hydraulic and geological setting on the right bank of the Ganga River at Ramnagar.

3.6.1. Field Investigation Summary

- Number of Boreholes: 5 (BH-1 to BH-5)
- Depth of Exploration: 65.0–70.0 m below existing ground level
- Field Work Period: 7 June – 26 June 2016
- Conducted for: Afcons Infrastructure Ltd., for IWAI
- Standards Used: IS 1892:1974, IS 2131:1981, IS 6403:1981, IS 1904:1986

3.6.2. Stratigraphic Description

The site exhibits alternating layers of cohesive and non-cohesive alluvial deposits typical of the Ganga basin. The generalized soil profile inferred from the bore logs is shown in Table 3

Table 3. 3 Bore logs Details of Varanasi

Depth (m)	Description of Strata	IS Classification	SPT N-Value	Remarks
0 – 5	Stiff to very stiff silty clay / clayey silt	CI / CL	10 – 24	Surface alluvium, low compressibility
5 – 25	Hard clay to very stiff clay	CI	24 – 67	High strength cohesive layer
25 – 45	Very dense silty sand	SM–SP	50 – 90	Excellent bearing stratum for piles
45 – 65	Fine to medium dense sand with silt	SP / SM	50 – 90+	Dense layer, non-plastic, stable under cyclic load
Below 65	Continuation of dense sand	SM	>90	Deep stable stratum

3.6.3. Groundwater Conditions

- Observed Water Table (June 2016):
  At 18.9–19.5 m below ground level for boreholes on land.
- River Boreholes (BH-1 & BH-2): Submerged under river water.
- Seasonal Variation: Water table may rise by 2.5–3.5 m during monsoon (post-flood condition).
- Design Groundwater Level: Adopted at 16.0 m below EGL for structural design of buildings and foundations.

3.6.4. Strength Parameters

- **Clay Layers:**
  - Unconfined compressive strength (qu): 1.2 – 1.9 kg/cm^2

- Undrained cohesion (Cu): 60 – 90 kN/m²
- Angle of internal friction (φ): 7° – 10°

- **Sandy Layers:**
  - φ = 33° – 35° (direct shear tests)
  - For very dense sand (N > 50), φ up to 40° – 45°
  - Cohesion (c): Nil

3.6.5. Bearing Capacity and Settlement

- **Safe Bearing Capacity (SBC):**
  - Shallow foundation: 180 – 220 kN/m² at 2.0–3.0 m depth (for light structures)
  - Pile foundation: 350–500 kN/m² (for heavy structures such as boat hoist and jetty)
- **Allowable Settlement: <25 mm for raft or pile caps.**
- **Scour Depth (for riverfront structures):** Observed up to RL 44.00 m, below which very dense sand is encountered — suitable for pile toe termination.

3.6.6. Soil Classification

The soils at the site belong to the following IS classification groups:

- Cohesive soils: CI (Inorganic clay of medium plasticity), CL (low plasticity), ML (silty clay).
- Non-cohesive soils: SM (silty sand), SP (poorly graded sand), SM–SP (sand-silt mixture).

The subsoil profile at SRF Varanasi consists of stiff clay overlying dense sand strata, with good bearing capacity and limited compressibility. The site conditions are favourable for heavy-duty marine structures, provided the foundations are designed to account for:

- Seasonal groundwater rise (~3 m),
- Riverbed scour near jetty structures,
- Cyclic loading from boat hoist and cranes.

The 2016–17 IWAI geotechnical study thus provides a robust baseline for detailed foundation design and confirms the suitability of the Ramnagar site for SRF development.

The S.P.T. values obtained in the respective clayey layer region present as per bore-log charts enclosed are found to range from 06 to 60 indicating 'Medium' to 'Hard' consistency. The S.P.T. values obtained in the respective sandy layer region present as per bore-log charts enclosed are found to range from 06 to 28 indicating 'Loose' to 'Medium Dense' relative density.

3.7 WATER TABLE

Water Table at the Site was observed at a depth from 3.10 metre to15 metre below ground level on the day of soil investigation. However, the existing water table may rise by 3.00 metre in the post-monsoon period in general and corresponding water table may has been used for calculation purposes.

The Ramnagar Viswasundari Road Bridge is Located Up stream of IWT Terminal Varanasi Location and the Bridges Clearances with respect to High Flood Level water level details are given below the f ollowing Tables 4& 5.

The Ganga River at Ramnagar (Varanasi), forming part of National Waterway–1 (NW–1), exhibits significant seasonal variation in water levels due to its monsoon-fed hydrology and upstream regulation by barrages and reservoirs. Understanding these variations is critical for the planning and design of the Ship Repair Facility (SRF), including the boat hoist approach, slipway gradient, and operational elevations.

Table 3. 4 Ramnagar Viswasundari Road Bridge Location Details

S.No	Bridge Name	Chainage (KMs)	Latitude	Longitude
1.	Ramnagar Viswasundari Road Bridge	1318	25°15'23.3348" N	83°01'12.0943" E

Table 3. 5 Ramnagar Viswasundari Road Bridge Clearances with Respect to H.F.L)

S.No	Bridge Name	Month& Year	Vertical Clearance from HFL(m)	HFL/ MHWS at Gauge Station (m)	Horizontal (m)
1.	Ramnagar Viswasundari Road Bridge	April & 2025	13.00	73.90	116.00
2.	Ramnagar Viswasundari Road Bridge	May & 2025	13.00	73.90	116.00
3.	Ramnagar Viswasundari Road Bridge	June & 2025	13.00	73.90	116.00
4.	Ramnagar Viswasundari Road Bridge	July& 2025	13.00	73.90	116.00

3.8 SEISMICITY

Varanasi is in Zone III of Indian Map of Seismic zones (IS-1893 Part-1 2023) which is a moderate risk seismic intensity zone Figure 3.1. Accordingly, while carrying out the design

this aspect shall be taken into account and all the relevant codal provision in this regard shall be followed.

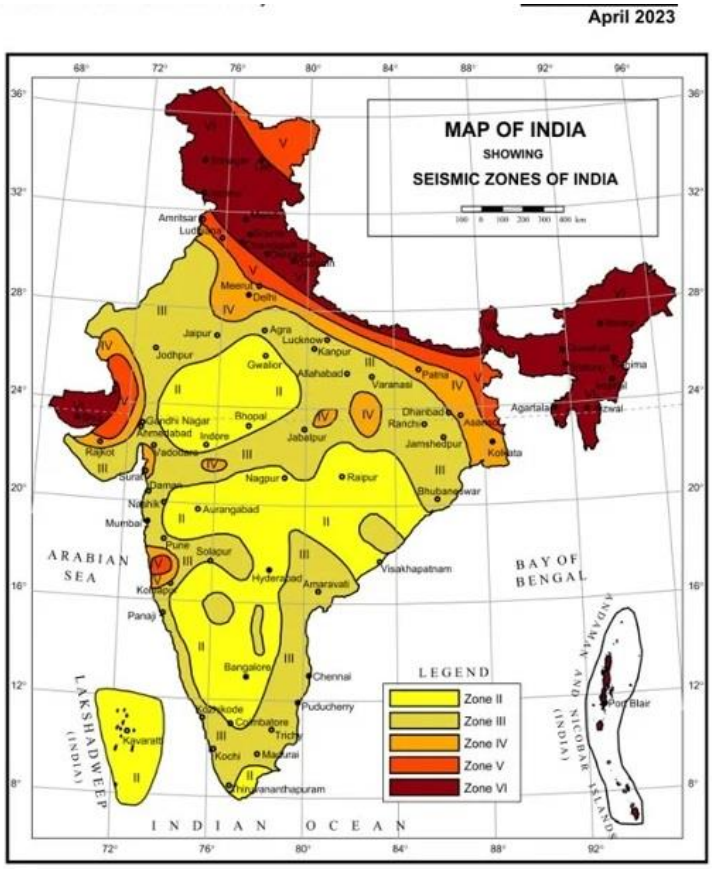


Figure 3. 1 Seismic Zoning Map of India as per IS-1893 Part 1-2023

3.9 Satellite imagery

The Varanasi Multi-Modal Terminal also called the IWAI terminal in Ramnagar, Varanasi, is a part of the Jal Marg Vikas Project (JMVP) under the development of National Waterway-1.

The satellite imagery of the Ramnagar reach of River Ganga (Google Earth, imagery years 2018–2025-depicted in Figure Nos 3.2-3.9 hereunder, illustrate the existing and expanding inland waterway infrastructure under the Inland Waterways Authority of India (IWAI). The image clearly identifies the IWAI Varanasi Terminal, Ramnagar Multi-Modal Port, and proposed SRF location along the right bank of the Ganga River, approximately 1.2 km downstream of the Varanasi DGPS station and adjacent to the National Highway (NH–31).

Figure 3. 2 Satellite Image Showing Sand Bar Development in 2018 (Source: Google earth)

Figure 3. 3 Satellite Image Showing Sand Bar Development in 2019 (Source: Google earth)

Figure 3. 4 Satellite Image Showing Sand Bar Development in 2020 (Source: Google earth)

Figure 3. 5 Satellite Image Showing Sand Bar Development in 2021 (Source: Google earth)

Figure 3. 6 Satellite Image Showing Sand Bar Development in 2022 (Source: Google earth)

Figure 3. 7 Satellite Image Showing Sand Bar Development in 2023 (Source: Google earth)

Figure 3. 8 Satellite Image Showing Sand Bar Development in 2024 (Source: Google earth)

Figure 3. 9 Satellite Image Showing Sand Bar Development in 2025(Source: Google earth)

The inclusion of this satellite imagery helps establish the geospatial context of the proposed SRF, supporting the site suitability assessment and integration with existing IWAI facilities for optimized operational synergy.

As may be seen that, over the last decade, the area has witnessed rapid growth in cargo handling operations, vessel movement, and associated infrastructure development under the Jal Marg Vikas Project (JMVP). However, no dedicated ship repair and maintenance facility presently exists along the Varanasi–Patna–Haldia stretch of National Waterway–1 (NW–1). Vessels operating on this corridor are required to undertake repair and maintenance at distant locations such as Kolkata or Haldia, resulting in higher downtime and operational costs.

3.10 Bathymetry Survey

Bathymetry along the Ganga River near Varanasi, at the proposed Ship Repair Facility (SRF) location, was assessed based on hydrographic surveys and seasonal hydrological data from the Inland Waterways Authority of India (IWAI). The bathymetric profile is critical in understanding navigability, dredging requirements, and structural design elevations of the jetty and boat hoist basin.

The IWAI survey department provided the bathymetry survey chart at the location of the proposed ship repair facility at NW-1, Ramnagar Multi Modal Port, Varanasi. The bathymetry charts for the location during the flood season during September 2021 and September 2025 are placed at Figures 3.10, Figures 3.11 and Figures 3.12.

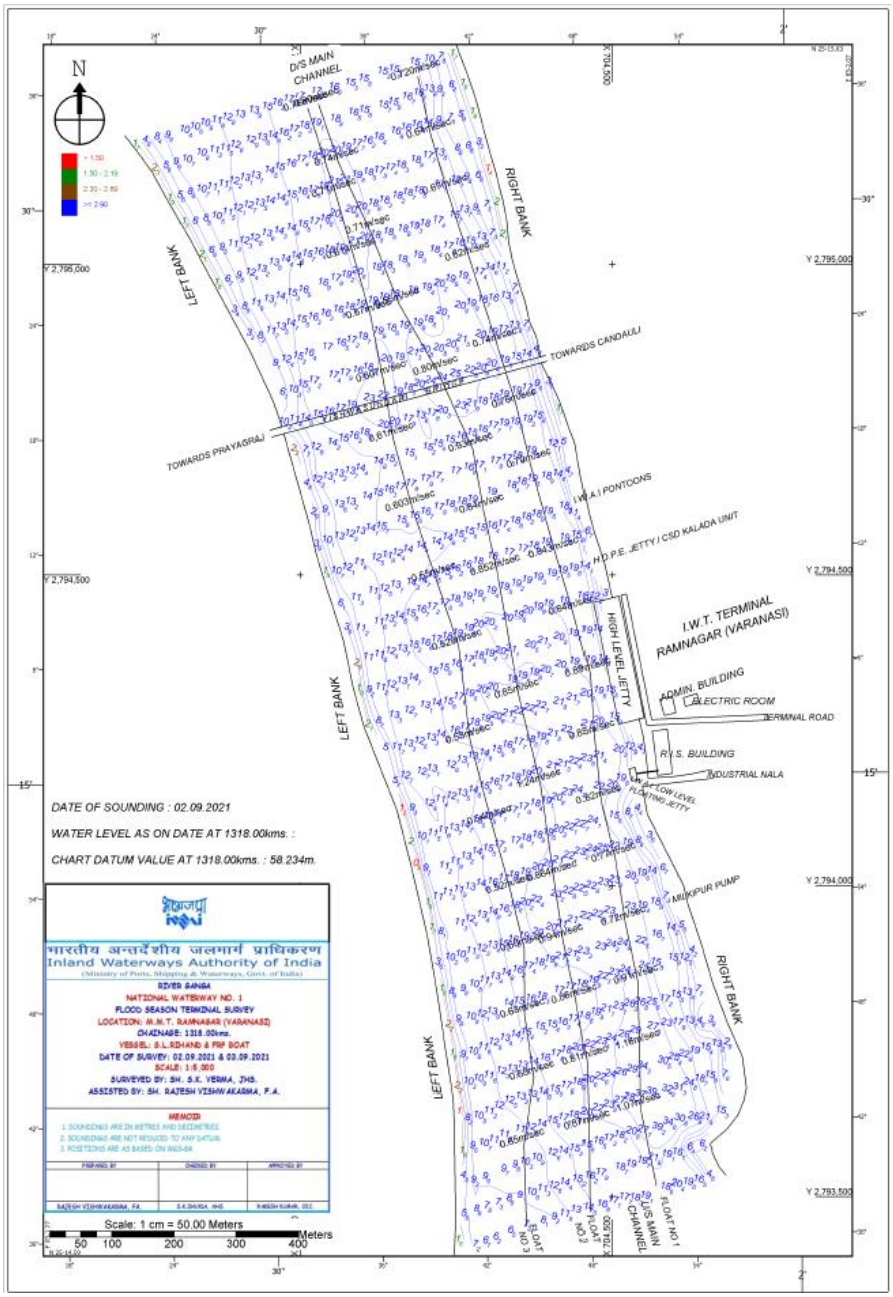


Figure 3. 10 Bathymetry chart near IWT Terminal Ramnagar Varanasi during flood September 2&3

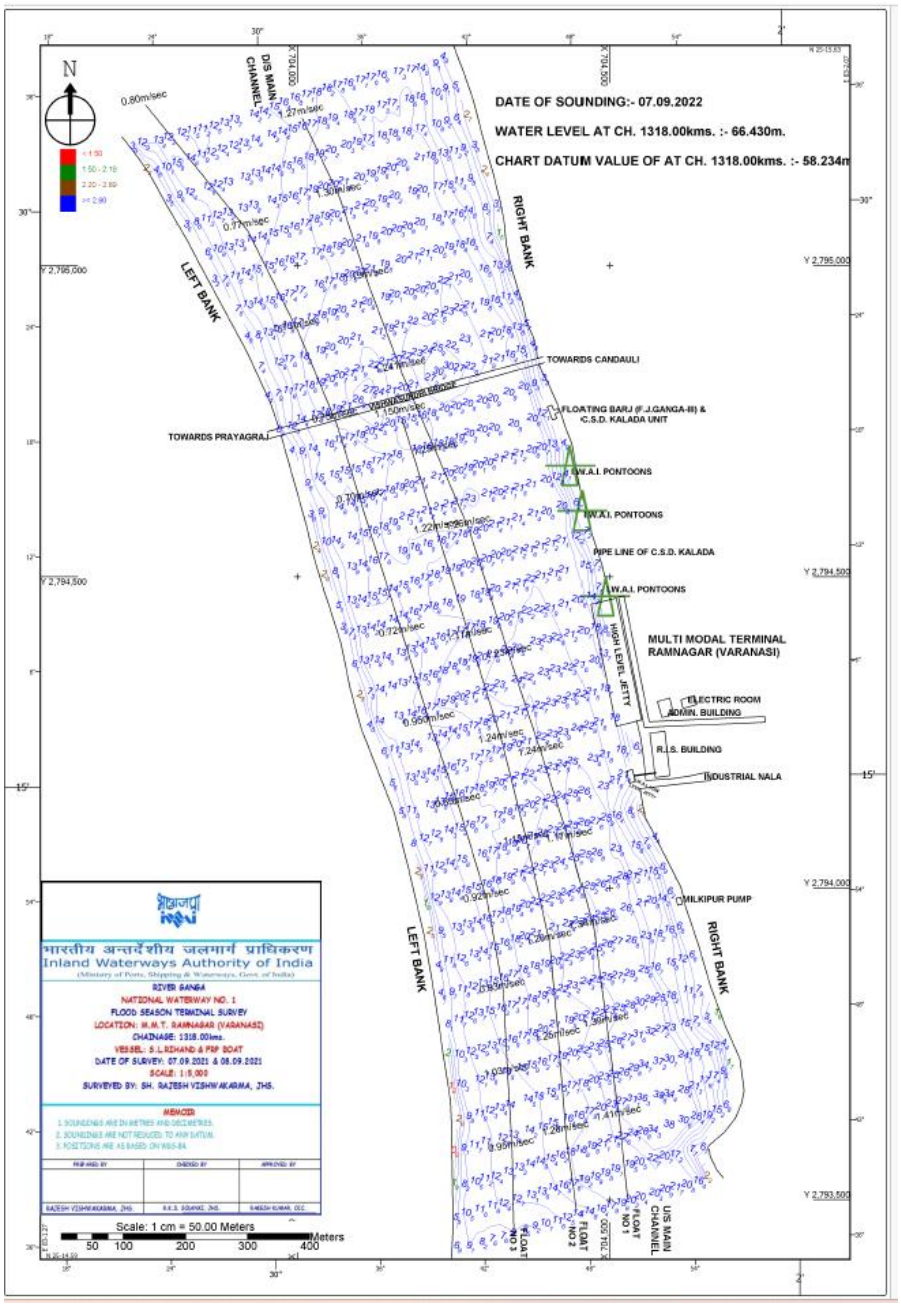


Figure 3. 11 Bathymetry chart near IWT Terminal Ramnagar Varanasi during flood September 7&8 2021

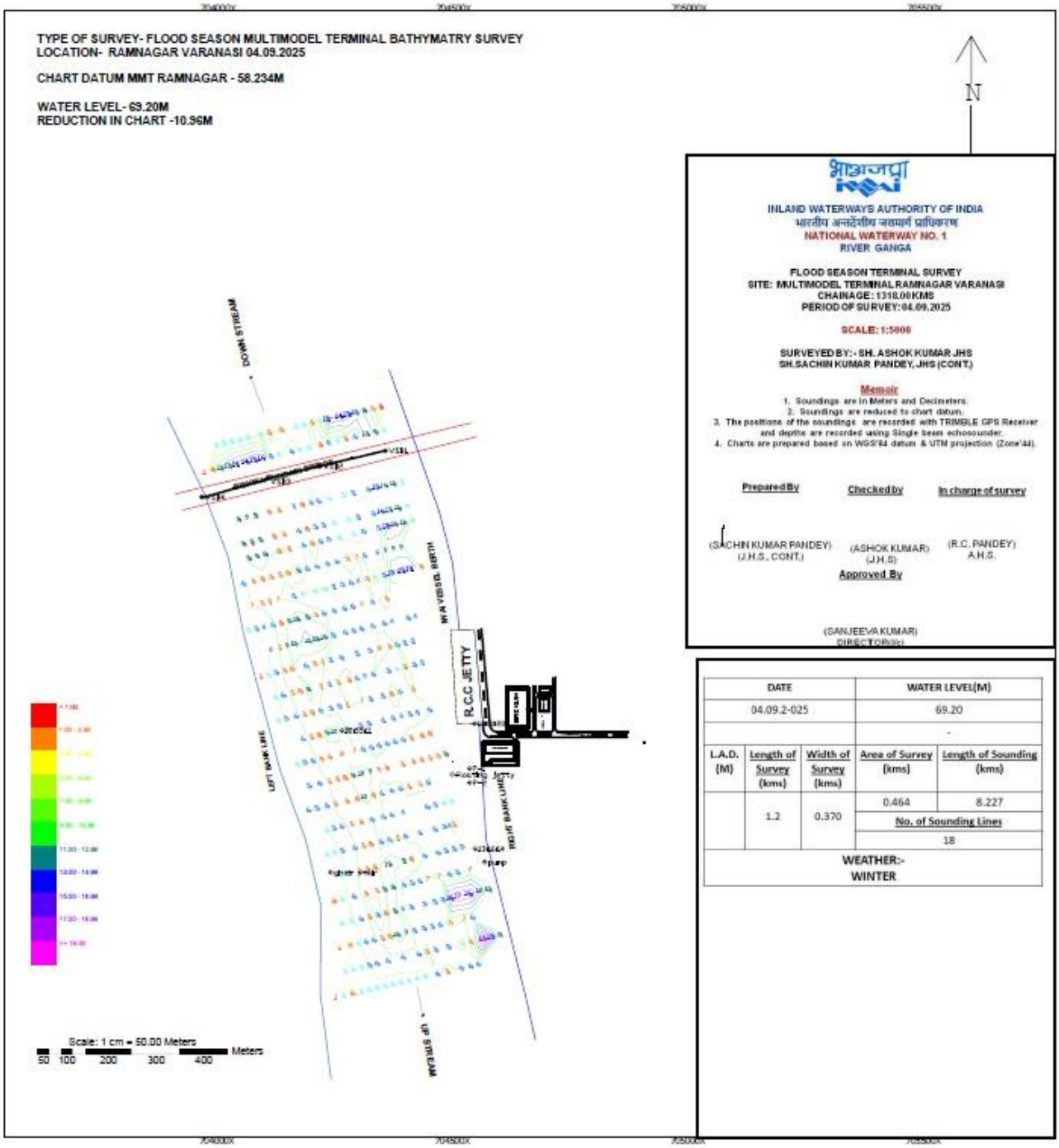


Figure 3. 12 Bathymetry chart near IWT Terminal Ramnagar Varanasi during flood September 4, 2025

From the above bathymetry charts it can be seen that along the Ramnagar Viswasundari Road Bridge the depth varies during flood seasons are 2m to 23 m. The existing depths are considered sufficient for the approach channel and maneuvering area during flood and post-

monsoon seasons. During dry season, depths may reduce to around 3–4 m, requiring maintenance dredging near the jetty and boat hoist bay. The right bank offers a relatively stable bed profile suitable for the proposed slipway / boat hoist foundation, minimizing scour risk.

Flood-stage depths and high velocities lead to local scouring along the jetty and right-bank toe region. These conditions must be considered in the SRF's structural and dredging design for flood resilience.

The flood-season bathymetry confirms adequate navigable depth for large vessels accessing the SRF and IWAI terminal during monsoon and post-monsoon months. However, bed fluctuation up to 2 m due to scouring and siltation is expected and should be monitored through biannual bathymetric surveys.

During lean season, bathymetry of the IWT terminal Ramnagar Varanasi for the year 14 & 15 October 2020, 16& 17 February 2021, 29 & 30 November 2022 and 23 June2025 are depicted at Figures 3.13, to Figure 3.16.

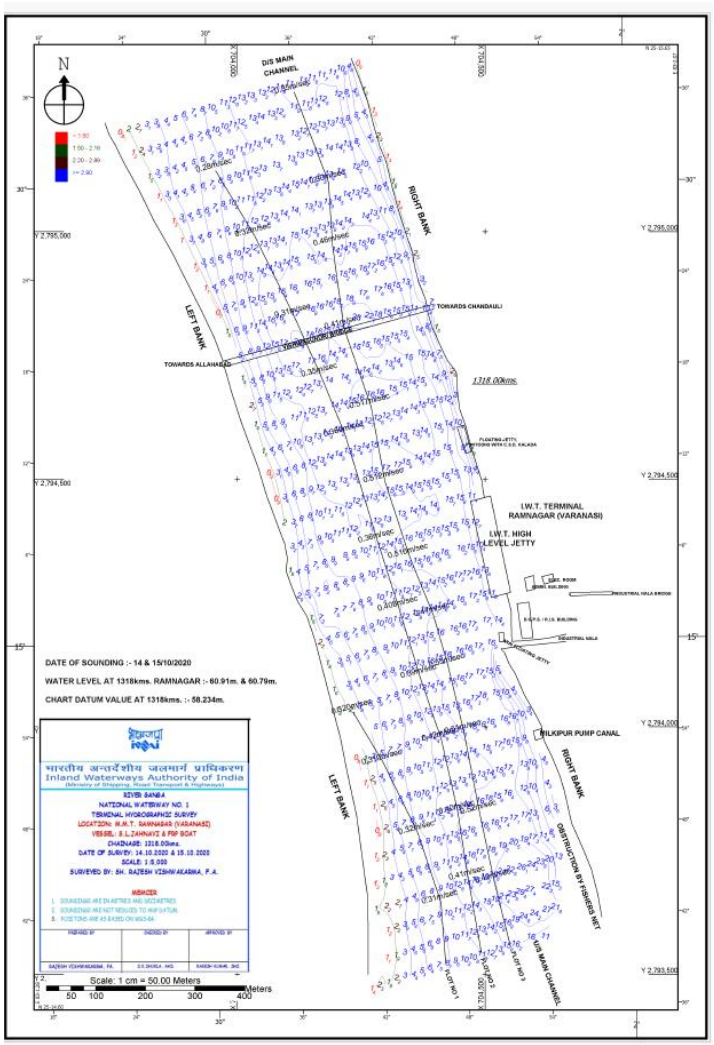


Figure 3. 13 Bathymetry chart near IWT Terminal Ramnagar Varanasi during lean season 14 & 15 October 2020

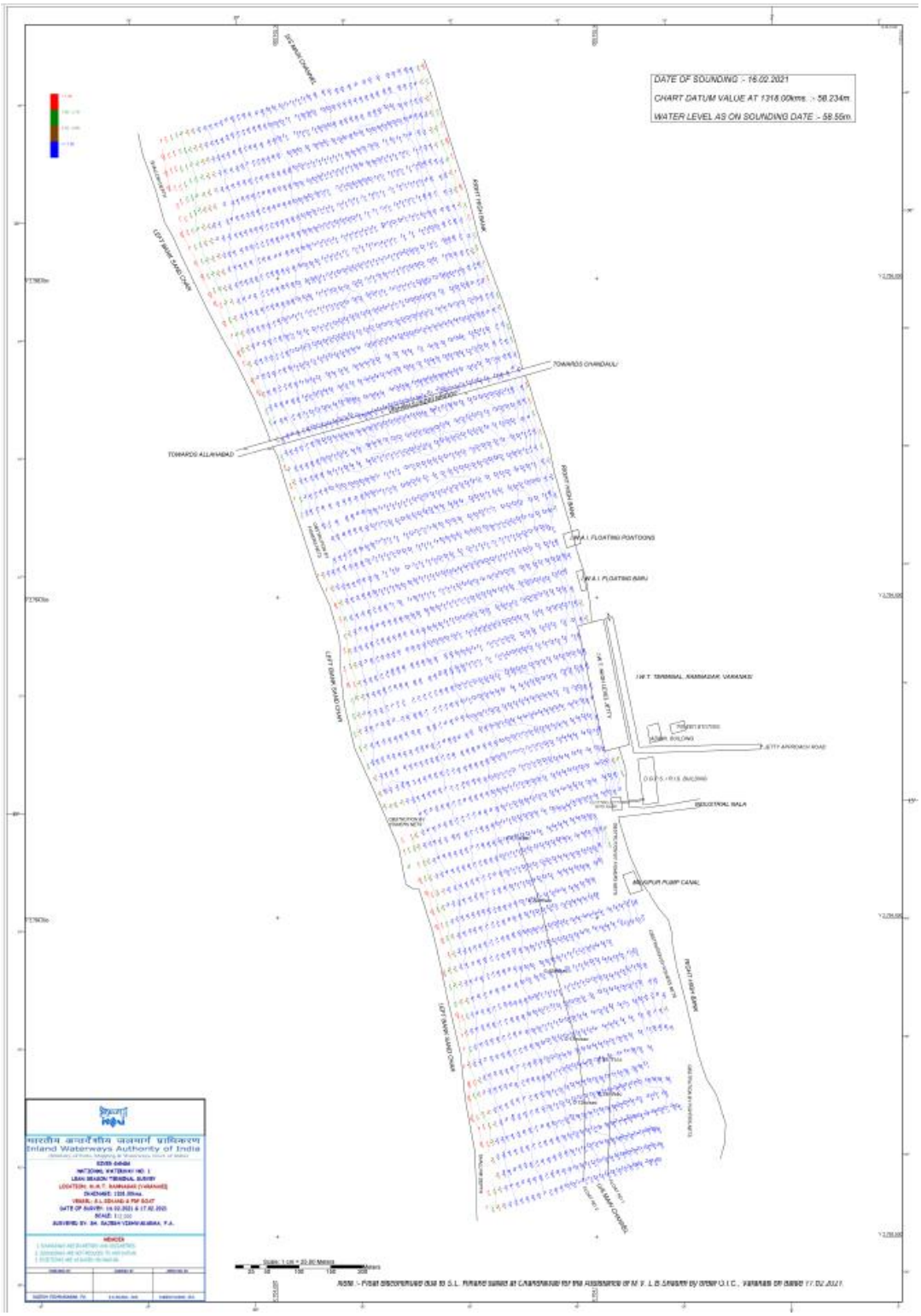


Figure 3. 14 Bathymetry chart near IWT Terminal Ramnagar Varanasi during lean season 16 & 17 February 2021

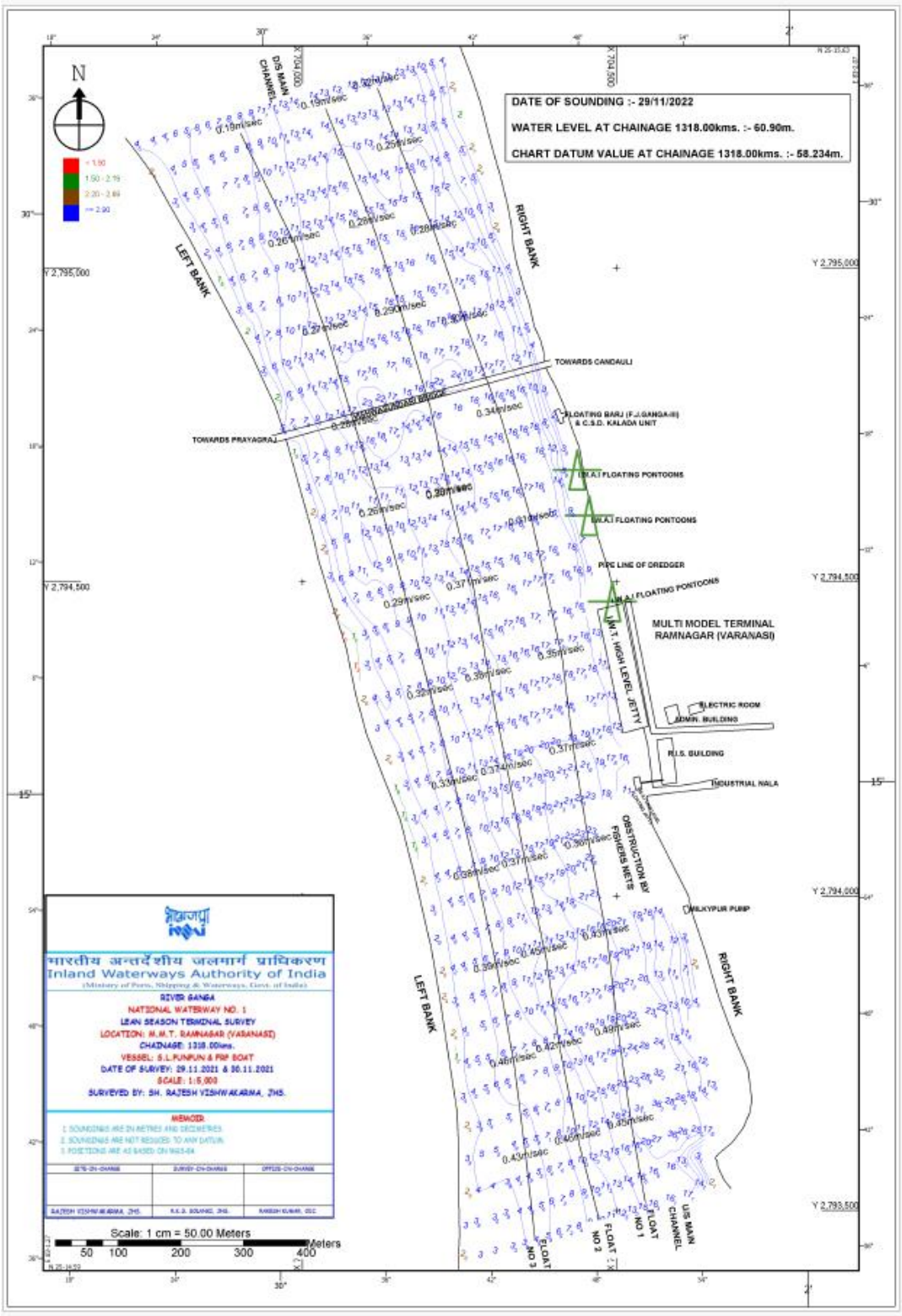


Figure 3. 15 Bathymetry chart near IWT Terminal Ramnagar Varanasi during lean season 29 & 30 November 2022

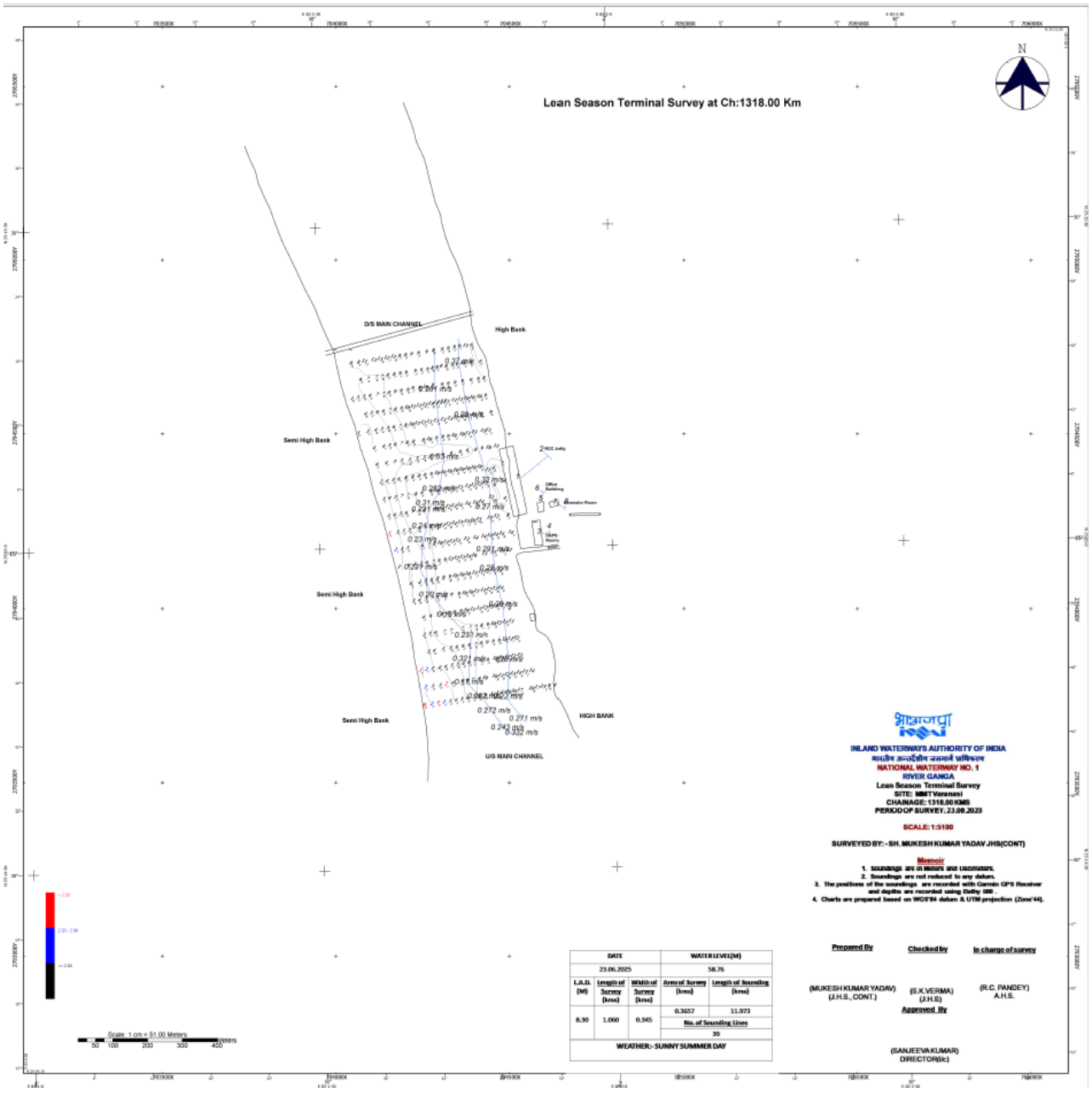


Figure 3. 16 Bathymetry chart near IWT Terminal Ramnagar Varanasi during lean season 23 June 2025

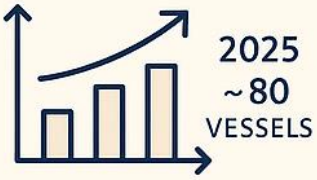
From the above charts, it may be seen that, along the Ramnagar Viswasundari Road Bridge the depth varies during flood seasons are 1m to 19 m based on the following chart. The available dry-season depth is adequate for light vessel movement but will require periodic dredging near the boat hoist approach and launch bay to maintain operational draft. The right bank zone, where the SRF is proposed, is hydrologically stable, with negligible lateral migration risk or scour hazard during low-flow conditions.

MARKET ANALYSIS

OVERVIEW

Supports inland IWT vessels, dredgers operating on NW-1 (Haldia to Prayagraj)

DEMAND FORECAST



2030 ~150 VESSELS

2040 ~150 VESSELS

2033 >< 250 VESSELS

MARKET SEGMENTS

- Government
- Private Operators
- Ancillary Services

COMPETITIVE ADVANTAGE

Close location significantly reduces transit time for repairs

Chapter 4

Market Analysis

4.1 Details of Vessels Plying in NW 1

The inland water transport network in India is supported by a wide fleet of registered vessels, operating under the jurisdiction of various **State Maritime Boards** and the **Inland Waterways Authority of India (IWAI)**.

The fleet composition includes cargo barges, passenger ferries, dredgers, tugs, survey vessels, and mechanized boats serving both cargo and tourism sectors across navigable river systems. As of the latest compiled data, a total of approximately 12,241 inland vessels are operational under different state authorities, reflecting a robust national inland fleet with significant regional concentration. It Is shown in Table 4.1.

Table 4. 1 Registered vessels Under the State Government

SL No.	State Authority	No. of vessels
1	No. of Vessels registered with Maharashtra Maritime Board (MMB)	1716
2	No. of vessels registered with Gujarat Maritime Board (GMB)	28
3	No. of vessels registered with Assam IWT	168
4	No. of vessels registered with IWT Kerala	20
5	No. of vessels registered with Tamil Nadu Maritime Board (TNMB)	13
6	No. of vessels registered with Depart. of IWT & Ports of Karnataka	344
7	No. of vessels registered with Captain of Ports of Goa	160
8	No. of vessels registered with Kolkata including IWAI	176
9	No. of inland vessels including launches and dredges serve the Inland waterways in India.	12,241

4.2 Analysis and Relevance to SRF Varanasi

Fleet Distribution: Maharashtra and IWAI–Kolkata regions together represent the largest inland operational fleets, highlighting the need for multiple regional repair facilities to support vessel maintenance.

NW–1 Corridor (Haldia–Varanasi): The presence of ~200 active vessels (cargo, survey, and dredger types) under IWAI and private operators indicates high utilization of the Varanasi terminal and future SRF demand.

Strategic Need: Currently, most inland vessel repairs are undertaken in Kolkata or Haldia, leading to downtime for vessels operating in the upper Ganga reaches.

Proposed SRF at Varanasi will serve as a centralized maintenance and overhaul base for vessels operating between Patna, Sahibganj, and Haldia, drastically improving operational efficiency and turnaround time.

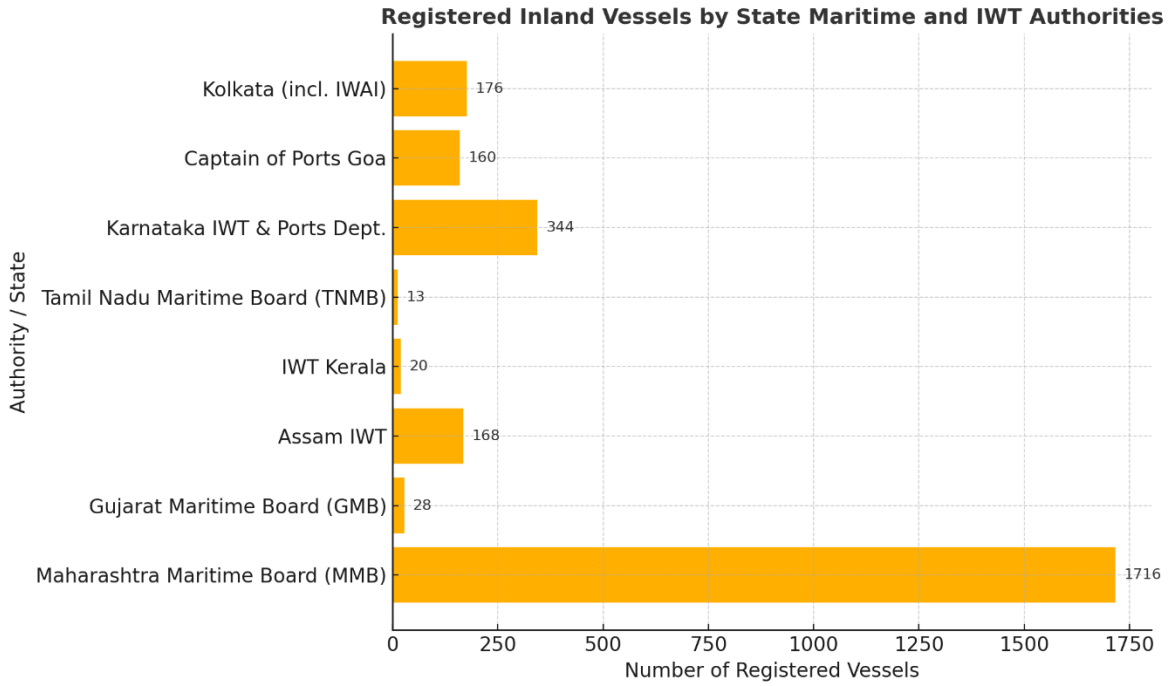


Figure 4. 1 Registered Vessels Under the State Government

The details of cargo vessel, Cruise vessel and various vessels passes through MMT Varanasi Give below the following Table 4.2.

Table 4. 2 Summary of Vessels Operating on MMT Varanasi

Details of Cargo Vessel/ Cruise Vessel? Mech. Cont.boats Passes through MMT Varanasi						
Cargo Vessel	**S. No**	**Name of Vessels**	**Length (m)**	**Breadth (m)**	**Height (m)**	**Vessel Draft (m)**
	1	M.V.R.N. Tagore	54.75	9.59	2.3	1.4
	2	M.V.Homi Bhabha	54.6	9.6	2.4	1.4
	3	M.V.L B Sastri	54.6	9.6	2.4	1.4
Dredger	1	CSD Jalangi	40.3	7	2.46	1.2
	2	CSD Kallada	16.25	4.25	1.3	1.2
Tug	1	PT Birsamunda	21.5	6.5	2	1.2
	2	WB Jasmine	26.5	7.75	2.75	1.5
	3	C L Kasturba	28	6.21	1.5	1.5
Hause Boat	1	AB Kailash	26.5	9	2	0.8
Survey Launch Vessel	1	SL Gandak	25	5.8	2.8	1.2
	2	SL Jahnvi	28.88	7.5	2.8	1.5
	3	SL Ghaghra	25	5.8	2.8	1.2
	4	SL Punpun	25	5.8	2.8	1.2
	2	MV Bengal Ganga	54.86	10.6		1.5
Other	1	Barge Bahak-25	35	8	2	0.8
Mech.Cont. Boat	1	Small Size	4.5	1.2	0.2	0.4
	2	Medium Size	7.9	1.5	0.3	0.7
	3	Large Size	12.5	2.1	0.5	1.1

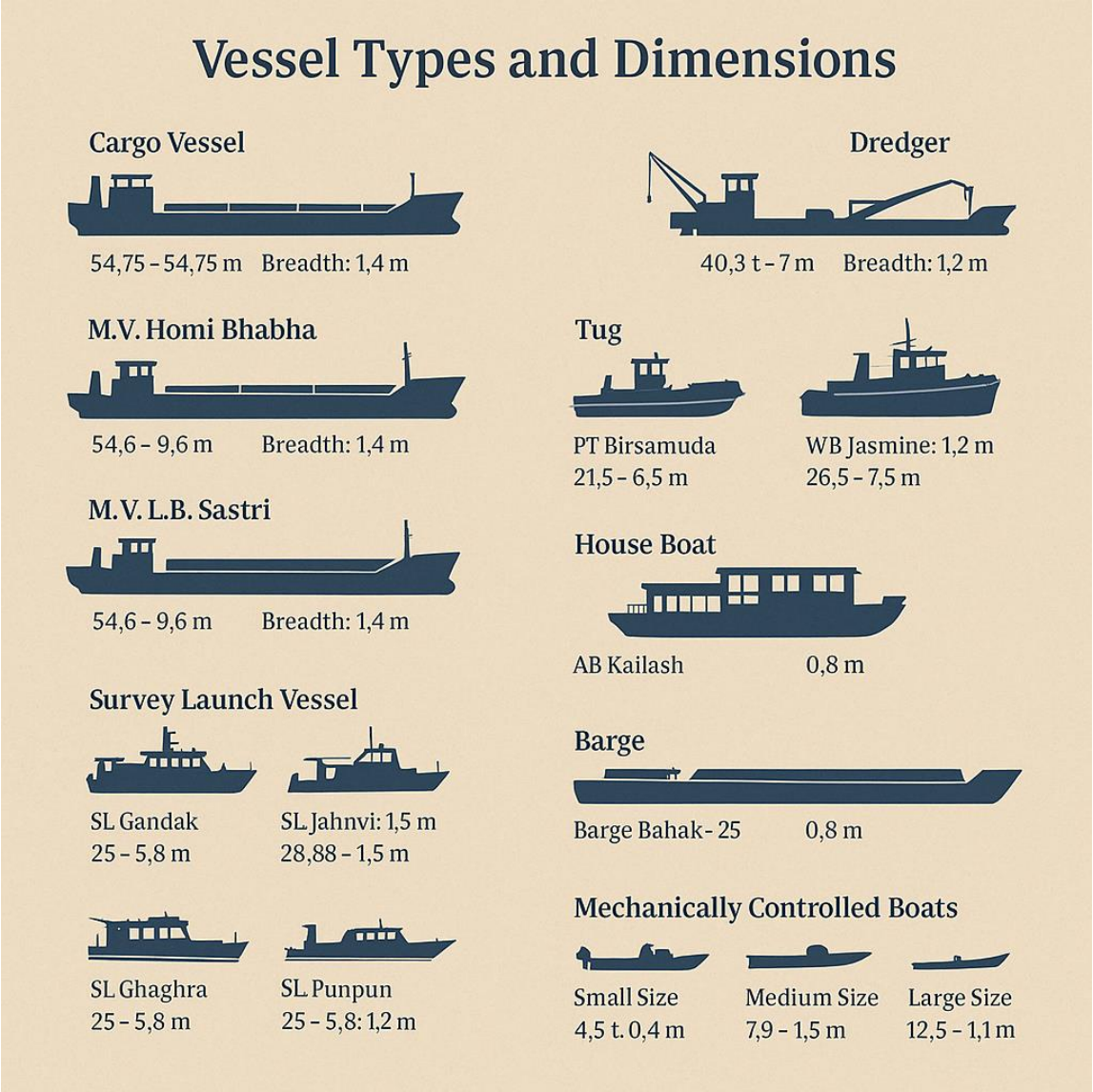


Figure 4. 2 Vessels operating on MMT Varanasi

4.3 Infrastructure Gaps and Facility Needs

Currently, there are no major ship repair facilities in or around the Ghazipur stretch of NW-1. In the absence of such facilities, inland vessels must travel long distances to receive routine maintenance and emergency services. This not only increases fuel consumption and crew

deployment times but also reduces overall fleet efficiency. The establishment of a dedicated ship repair unit in Varanasi would drastically improve operational turnaround, especially during peak navigation seasons.

Repair facilities must be tailored to the needs of the inland vessel fleet operating in this region. Based on IWAI data and projected traffic, the proposed site should include both afloat repair infrastructure and dry-docking capabilities. A typical layout should accommodate:

- One or more dry docks to handle vessels of up to 80 meters in length.
- Slipways for mid-size barge and tug maintenance.
- Floating jetties for emergency afloat repair.
- Covered workshops for mechanical, electrical, and hull repairs.
- Equipment for bilge water treatment and hazardous waste handling.

The selection of technologies and design criteria must consider flood-level variations, riverbank stability, and environmental compliance. Environmental impact mitigation measures such as erosion-resistant structures, storm water drainage, and sediment control systems should be embedded into the project layout. In addition, adequate firefighting systems, lighting, and navigation aids must be planned to ensure safe round-the-clock operations.

A major gap observed in the current waterway infrastructure is the unavailability of rapid-response repair units. The proposed facility at Varanasi can bridge this by including mobile repair teams and floating workshops that can travel upstream or downstream for on-site diagnostics and minor interventions. Prioritization will be given to areas with high vessel density and significant repair needs but lack adequate facilities. It is also necessary to determine the type of facilities needed depending on the nature of repair to be carried out, either afloat repair or dry docking repairs.

The proposed Ship Repair Facility (SRF) at Varanasi serves as a pivotal support infrastructure along National Waterway-1 (NW-1) — India's longest inland waterway, stretching from Haldia (West Bengal) to Prayagraj (Uttar Pradesh).
With the operationalization of the Varanasi Multi-Modal Terminal, cargo movement along the

Ganga River has been steadily increasing, necessitating a localized and reliable repair ecosystem to maintain fleet operability and reduce downtime. The SRF will cater to Inland Water Transport (IWT) vessels, dredgers, survey craft, and support boats operating under IWAI, as well as private operators, state irrigation departments, and riverine transport agencies.

4.4 Existing Scenario

At present, the nearest ship repair facilities are located at:

- Kolkata (Garden Reach, GRSE)
- Haldia Dock Complex
- Patna (minor repair yard)

This geographic gap approximately 600 km between Patna and Varanasi results in:

- High vessel ferrying costs for maintenance,
- Significant downtime (up to 15–30 days for transit + repair),
- Inefficient fleet utilization for IWAI and private cargo vessels.

Thus, the Varanasi SRF fills a critical infrastructure void in the middle reach of NW-1.

4.5 Target Users and Market Segments

A. Government and Institutional Users

- **IWAI vessels** (survey boats, tugs, dredgers)
- **Dredging Corporation of India** units operating in NW-1
- **Port and Irrigation Department crafts** (barges, inspection launches)

B. Private Operators

- **Cargo vessels** under PPP models on NW-1
- **Tourism and Cruise boats** operating between Varanasi and Prayagraj
- **Small passenger ferries and local transport boats**

C. Ancillary Services

- Engine maintenance and dry docking
- Propeller alignment and painting
- Electrical and outfitting works
- Hull plate fabrication and corrosion repair
- Safety and certification support (IRS/Statutory checks)

4.6 Demand Estimation

Based on IWAI's operational data and projected vessel traffic:

Figure 4. 3 Projected Vessel Traffic

Year	Expected No. of Active Vessels on NW-1	Annual Repair Demand (No. of Vessels)	Repair Type Split
2025	~80	20–25	Minor (70%), Medium (30%)
2030	~150	40–50	Minor (60%), Medium (35%), Major (5%)
2040	~250	70–90	Minor (55%), Medium (35%), Major (10%)

This demand translates into a sustained utilization rate of 70–80% for the facility by Year 5 of operation.

4.7 Competitive Advantage

The Varanasi SRF enjoys several natural and strategic advantages:

Central location between Haldia and Prayagraj — minimizing ferry distances.

1. **Direct road connectivity** via NH-19 for logistics and spare part movement.
2. **Proximity to IWAI's operational base** and dry dock vessels.
3. **Synergy with IIT Madras – NTCPWC technical support** for quality assurance.
4. **Potential for future PPP operation**, enabling private participation and local skill development.

4.8 Existing Ship Repair Facilities in the Region

A review of the existing facilities along National Waterway-1 (NW-1) reveals a substantial infrastructure gap between Varanasi and Kolkata.
While the Hooghly–Howrah stretch in the lower reaches of NW-1 hosts multiple dry docks and workshops, no dedicated ship repair yard exists in the central and upper reaches of the corridor.
As a result, operators from Varanasi, Patna, and Prayagraj depend on distant facilities in Kolkata / Howrah, leading to prolonged downtime and high logistics costs.

This facility will therefore play a pivotal role in realizing the national goal of a sustainable and efficient inland waterway logistics network**.**

4.9 Stakeholder Interest

The proposed Ship Repair Facility (SRF) at Varanasi has attracted strong interest across the inland water transport ecosystem**.** Stakeholders from both public and private sectors view it as an essential infrastructure to improve the reliability, safety, and economic efficiency of vessel operations on NW-1.

4.9.1 Inland Waterways Authority of India (IWAI)

As the nodal agency for inland water transport, IWAI is the primary proponent of the project. The SRF supports IWAI's vision under the Jal Marg Vikas Project (JMVP) by providing in-situ

maintenance capability, thereby enhancing operational readiness and reducing dependency on distant repair facilities in Kolkata.

4.9.2 Private Vessel Operators and Logistics Companies

Private operators engaged in cargo, dredging, and towing operations have expressed strong interest in a Varanasi-based repair hub**,** emphasizing the need for:

- Competitive pricing,
- Quick service turnaround, and
- Technical reliability.

  This would enable consistent fleet availability and higher vessel utilization rates on NW-1.

4.9.3 Terminal Operators

Multi-modal terminals at Patna**,** Varanasi, and Sahibganj depend on support vessels, barges, and tugs.

The absence of local repair facilities currently disrupts cargo movement and increases maintenance costs.

A nearby SRF will directly improve operational continuity and efficiency across these terminals.

(iv) Local Industries and Shipbuilders

Regional fabrication shops, mechanical workshops, and small industrial units can act as vendors or sub-contractors for the SRF, fostering local industrial participation and employment generation**.**

This aligns with the 'Make in India' initiative and encourages a self-reliant marine support ecosystem in eastern U.P.

(V) Academic and Research Institutions

Though Varanasi has not traditionally hosted large shipyards, the region is now witnessing growing interest in inland vessel maintenance research and digitalized marine systems. Institutions such as NTCPWC-IIT Madras**,** collaborating under IWAI programs, can support the SRF with design validation, training, and monitoring systems. Parallel initiatives—like the proposed Ghazipur repair and maintenance hub, the Maritime Single Window (MSW) system, and the Amrit Kaal Vision 2047—further reinforce national emphasis on expanding inland repair and logistics infrastructure**.**

4.10 Summary

The Varanasi Ship Repair Facility is not merely a maintenance center — it is a strategic enabler for the entire NW-1 corridor. Its establishment will: Reduce operational disruptions for vessel operators, Strengthen India's inland water transport infrastructure, and Support sustainable economic growth across the Ganga basin.

From the foregoing analysis it can be reasonably concluded that it would be suffice to develop the proposed ship repair facility at Varanasi for handling vessels up to a maximum of 60 m LOA.


Development Plan
MARINE BOAT
& TRAILER AREA
BOAT HOIST
JETTY
REPAIR BAY
FIRE & SAFETY
BUILDING
FIPB
APPROACH
STRUCTURE
(SCARP) STORE BUILDING
PARKING /
STOCKYARD

Chapter 5

Development Plan

5.1 Major Components in a ship repair facility

A ship repair facility is designed to undertake inspection, maintenance, refurbishment, and modification of vessels ranging from small crafts to large ocean-going ships. A typical layout for a Ship Repair Facility for Varanasi is shown in Figure5.1. Table 5.1 show the Details about Major components in the ship repair facility

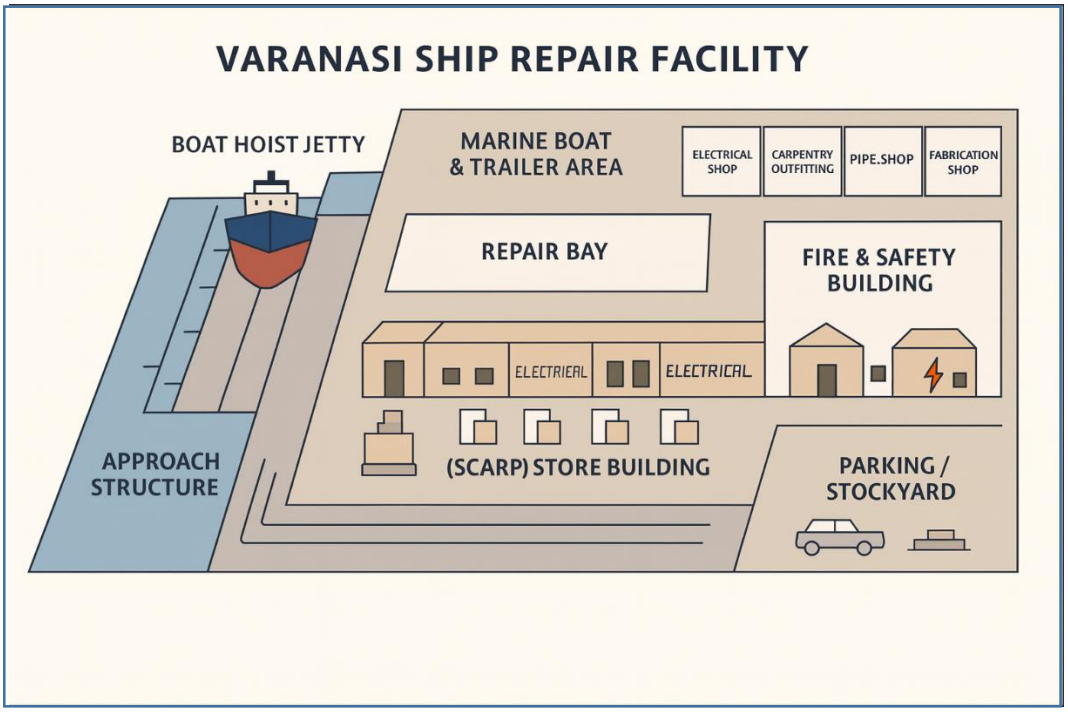


Figure 5. 1 Layout for a Ship Repair Facility

Table 5. 1 Major Components in the Ship Repair Facility

S.No	Component	Description
1.	Ship Lift Facility	Ship hoisting facility submerged in the river and lifted vertically using synchronized winches. Designed for vessels up to 600 T.
2.	Cradle Trolleys	Self-propelled or chain-driven trolleys that move vessels along rail lines into the onshore repair area.
3.	Transfer rails	Embedded rail system extending from the lift platform to the onshore repair bays.
4.	Workshops	Onshore maintenance areas for hull, engine, and electrical repair works.
6.	Safety Systems	Includes overload cutouts, emergency stops, alarms, and synchronized lift monitoring systems
6.	Administrative Building	Housing the offices for carrying out the administrative functions.
7.	Electrical Substation	Receiving the power from the main grid and distribute to workshop and other ship repair units.

5.2 Ship Lift and Transfer Bay – Varanasi SRF (600 T)

The Ship Lift and Transfer Bay at the proposed Varanasi Ship Repair Facility (SRF) is designed to haul vessels out of the river and transfer them safely onto land for repair and maintenance operations. This 600 T capacity system replaces traditional dry docks and allows for flexible,

Efficient and cost effective vessel handling.

1.The ship lift platform is submerged below the vessel's draft level.

2.The vessel is positioned above the platform.

3. The synchronized winches lift the platform and vessel vertically.

4. Cradle trolleys move under the vessel to transfer it onto the onshore rails.

5. The vessel is moved along the rails into the transfer bay for repair.

6. After maintenance, the process is reversed for re-launching.

A Ship lift and transfer system is illustrated in the Figure 5.2 and design parameters shown in Table 5.2.

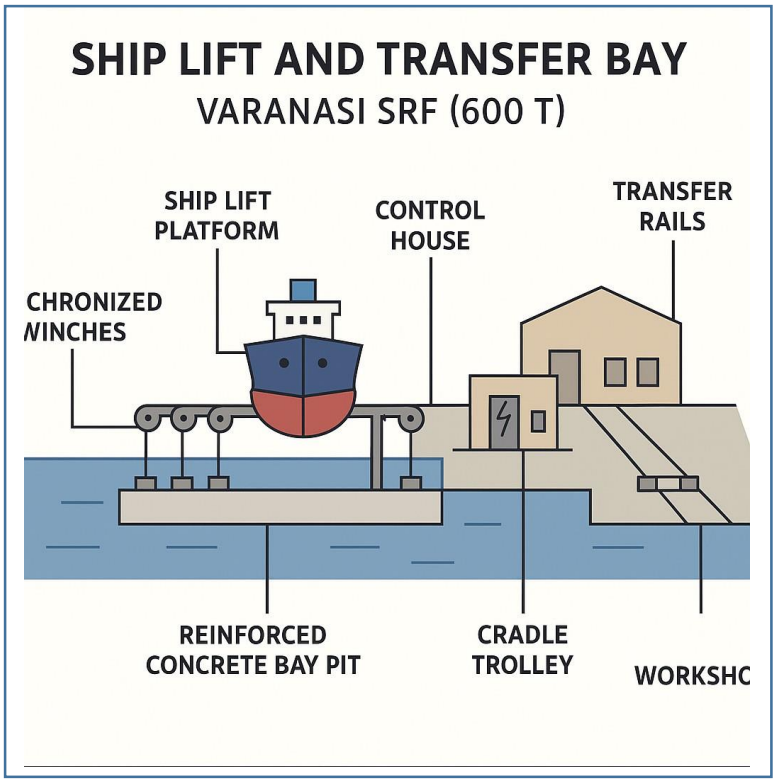


Figure 5. 2 Typical Ship lift and transfer system in Ship Repair Facility

Table 5. 2 Typical Design Parameters Ship lift and Transfer bay

S.No	Parameter	Value	Remarks
1	Lifting Capacity	600 T	For mid-size inland vessels
2	Platform Size	35 m × 12 m	Suitable for up to 70 m LOA vessels
3	Lifting Stroke	8 m	Depending on draft variation
4	No. of Winches	8 Nos	Each rated ~75 T
5	Transfer Rail Gauge	7 m	Between rail centres
6	Transfer Bay Length	40–60 m	For 3–4 vessels side by side
7	Foundation Depth	9 m	Below jetty deck level
8	Power Requirement	350–400 kW	Includes winches and transfer system
9	Operation Time	15–25 min	For full lift or lowering cycle

5.3 Boat Trailers

Boat Trailers

Boat trailers are used to transport small and medium vessels between water and storage areas. They come in roller, bunk, and aluminum frame types suitable for different hull shapes and load capacities. (Figure 5.3)

a. Roller-Type Boat Trailer

Equipped with adjustable rollers for hull support during loading and unloading; ideal for smaller crafts.

b. Heavy-Duty Trailer (Dual Axle)

Used for larger boats; offers greater stability and load capacity for longer transport distances.

c. Aluminum Frame Trailer

Lightweight and corrosion-resistant trailer designed for long-term use in marine environments.

d. Compact Trailer for Small Boats

Designed for 12–15 ft. aluminum boats; easy to maneuver and store when not in use.

Figure 5. 3 Boat Trailers in Ship Repair Facility

5.4 Repair Bays

The Repair Bay forms the primary onshore zone where vessels are positioned after being hauled out from the river using the 600 T boat hoist system. This area is designed to facilitate inspection, maintenance, repair, and outfitting of vessels in a safe and accessible environment. The bay is directly connected to the boat hoist jetty through transfer rails and cradle trolleys, allowing smooth, synchronized movement of vessels from the water to the work area. (Figure 5.4)

- Area: Approximately 1,800 m^2 within the 3-acre facility.

- Capacity: Can accommodate two medium-sized vessels (up to 60–70 m LOA) simultaneously.
- Surface: Heavy-duty reinforced concrete pavement, designed for 20–25 t/m^2 load bearing.
- Transfer System:
    - ✓ Rail gauge matching cradle system.
    - ✓ Embedded rail lines aligned to the boat hoist jetty.
    - ✓ Detachable cradles for flexible vessel positioning.
- Drainage: Floor slopes toward peripheral trench drains with oil–water separator pits.
- Lighting & Power: Industrial LED floodlights with power outlets for portable tools, welding machines, and pumps.
- Access: Direct access for forklifts, trailers, and maintenance equipment.
- Safety: Fire extinguishers, emergency showers, spill containment, and demarcated pedestrian pathways.

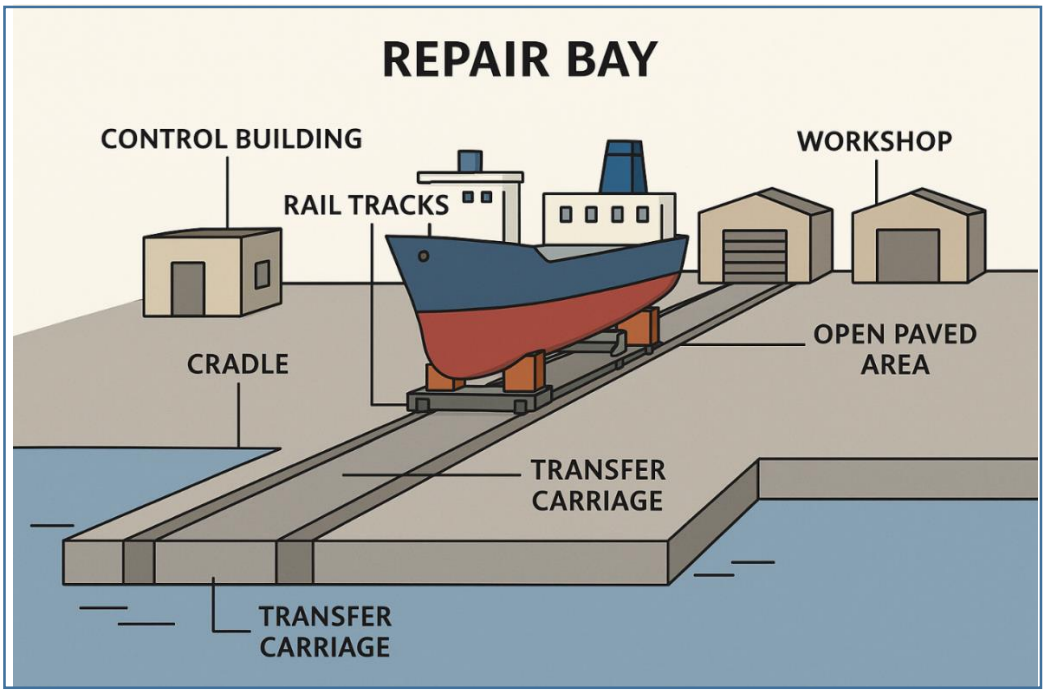


Figure 5. 4 Typical Repair Bay in Ship Repair Facility

Figure 5. 5 Typical Mechanical Workshop in Ship Repair Facility

5.5 Open Yard Facilities

The Open Yard Facilities form the operational backbone of the Ship Repair Facility (SRF), providing space for outdoor activities such as vessel storage, equipment laydown, fabrication, and pre/post-repair staging. These areas are strategically located behind the repair bay and workshops, ensuring smooth movement of materials, vehicles, and heavy equipment. In the Varanasi SRF layout, the open yard occupies about 4,000–4,200 m^2, roughly one-third of the total site area. (Figure 5.6)

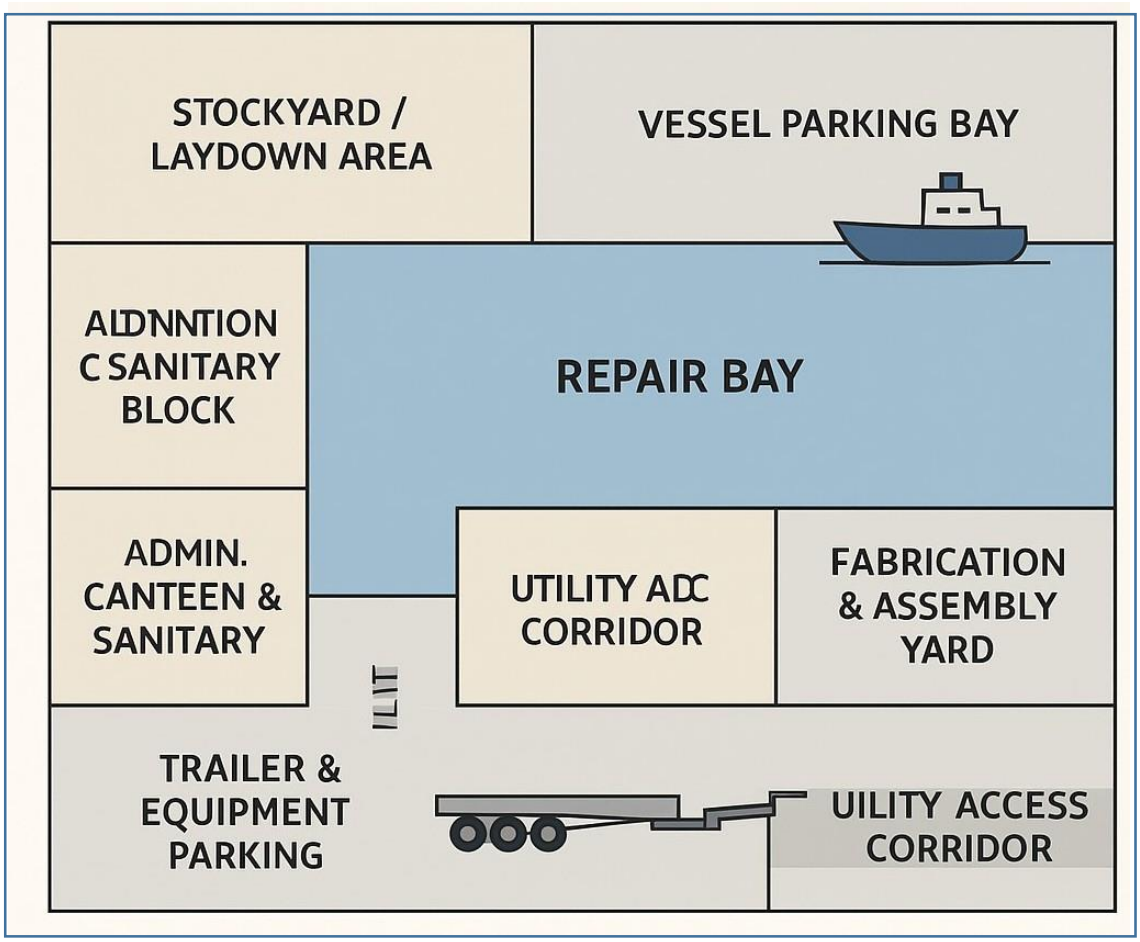


Figure 5. 6 An Open Yard Facilities in Ship Repair

5.6 Boat Hoist Jetty

The Boat Hoist Jetty serves as the principal interface between the waterway and the onshore repair facility. It is designed for a 600-ton mobile travel lift to lift vessels from the river and move them onto the onshore repair bays. This jetty allows safe haul-out, launching, and temporary berthing of vessels and acts as the central feature of the Varanasi SRF. **(Table 5.3)**

- Lifting and launching vessels: The boat hoist moves along the jetty and lowers slings into the river to cradle vessels for lifting.
- Transfer to repair bay: Once lifted, the hoist carries the vessel inland through the ramp and rails to the repair bay.
- Maintenance access: The jetty provides easy access for minor cleaning and inspections during haul-out operations.

Table 5. 3 Structural configuration of Boat Hoist Jetty

S.No	Feature	Specification / Description
1	Structure Type	Reinforced concrete jetty with ramp and turning apron.
2	Design Load	600-ton travel lift, ~50–60 T per wheel including dynamic factor (1.25).
3	Length	Approximately 70m (depending on hoist span and wheel layout).
4	Width	16–18 m between fenders for safe dual-lane movement.
5	Deck Level	+75 m considering the river fluctuation.
6	Water Depth	2.0 m to 3.5m at face for safe vessel alignment.
7	Approach Ramp	5–6% gradient reinforced concrete ramp with roughened surface.
8	Fenders & Bollards	Rubber fenders and mooring bollards for vessel positioning.
9	Surface Finish	Grooved or epoxy-coated non-slip deck.
10	Drainage	Scuppers connected to sump with oil-water separator.

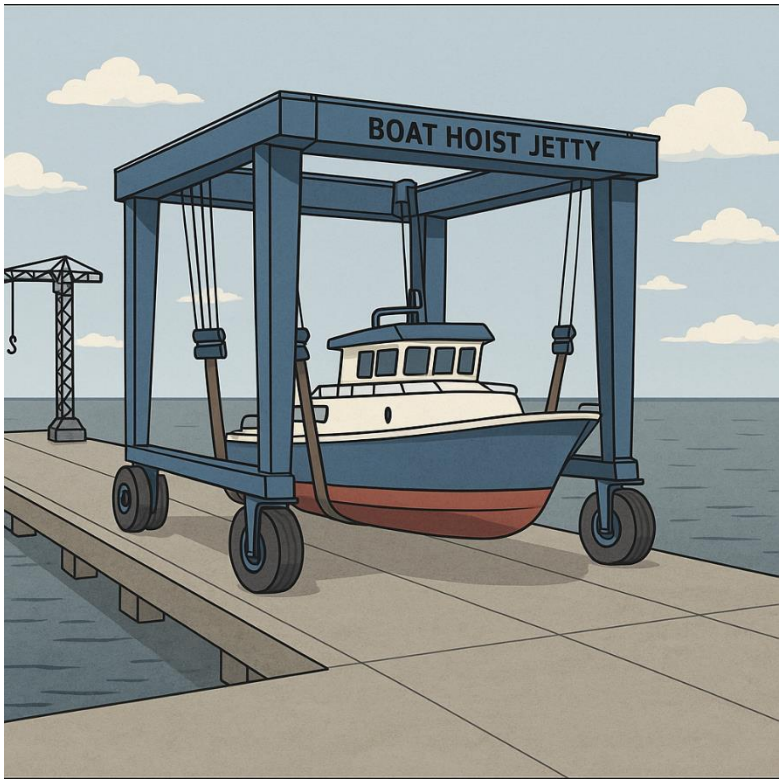


Figure 5. 7 Marine Boat Hoist Jetty

5.7 Size of Boat Hoisting Jetty and Capacity of Marine Boat Hoist

As per the details shared by IWAI regarding the vessels plying in the NW-1, about 98.5% of the

vessels are having LOA less than 60m. However, there are proposals to handle 60 m LOA vessels in this route. Since the majority of the vessels are less than 60m it is recommended that the Boat hoisting jetty can be constructed. However, in the case of marine boat hoist, capacity may be fixed as 600 Tonnes.

5.8 Details of the Vessels considered

The data on the existing vessels plying in the reroute to Varanasi has been analysed and the following are the observations. About 451 vessels are plying in the route. The vessel details are given in

Table 5. 4**5.4.**

Table 5. 4 Details of Vessel movement under IWAI, Varanasi

Sl. No.	Particulars	Year (FY)	Vessels (Nos)	Total
1	IWAI Vessel in Varanasi Sector		83	83
2	Private Vessel in Patna Sector	2020-21	132	368
3		2021-22	58	
4		2022-23	54	
5		2023-24	68	
6		2024-25	56	
Total				451
Note:-	Maximum Length of Vessel - 60m (MV AAI)			
	Maximum Width of Vessel - 15m (MV AAI)			

The vessels plying in NW-1 can be classified into following categories based on the LOA and furnished hereunder:

- 13.2 % vessels have LOA ≤ 20 m
- 22.1 % vessels have 20 m > LOA ≤ 25 m
- 15.4% vessels have 25 m > LOA ≤ 30 m
- 47.8% vessels have 30m > LOA ≤ 60 m

5.9 Development of the Ship repair facility

The development of the proposed ship repair facility at Varanasi, Uttar Pradesh are depicted in Figure 30. The boat hoist is placed in the flow direction along the Ganga river.

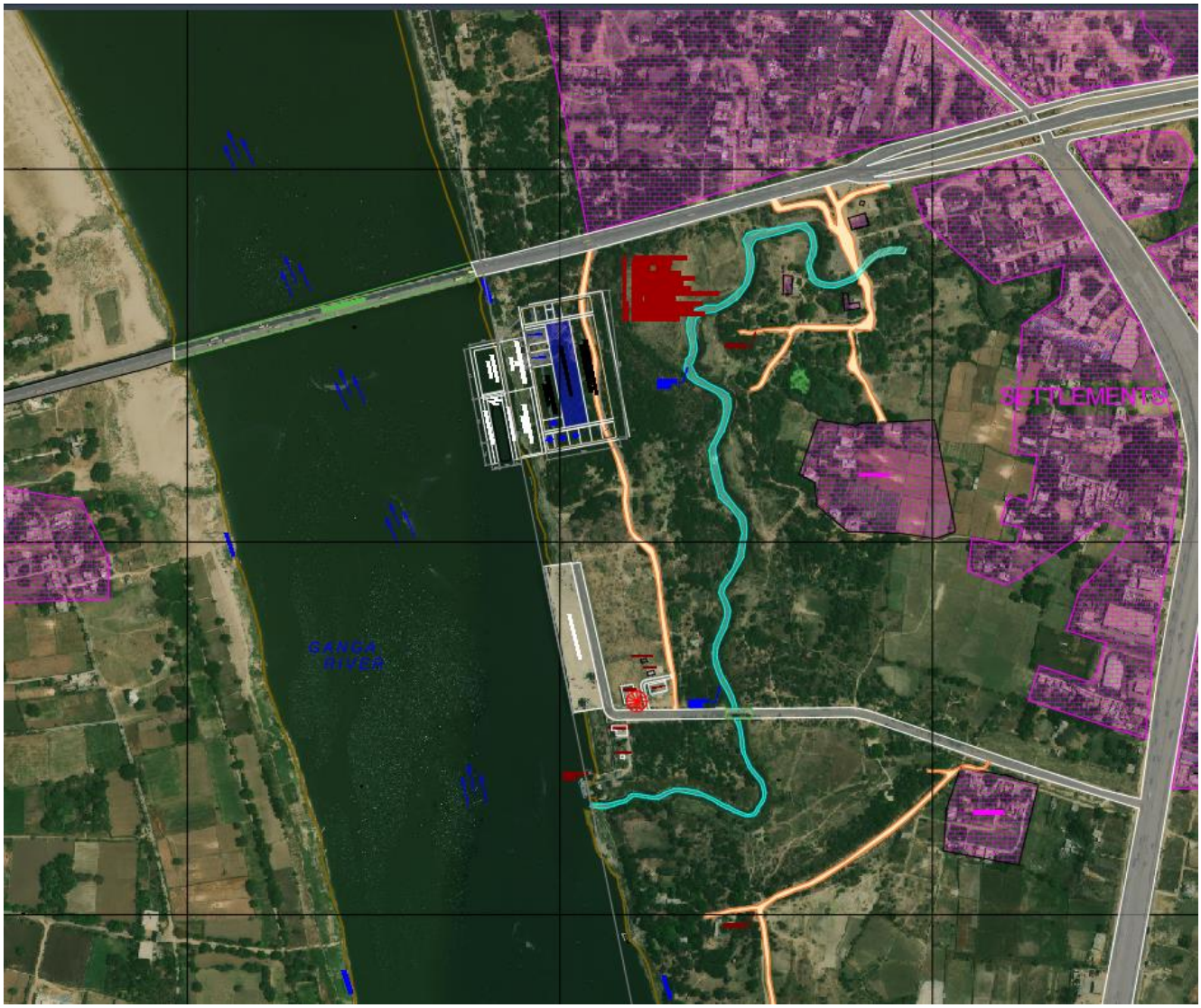


Figure 5. 8 Typical layout of Ship Repair Facility in Varanasi

The proposed Ship Repair Facility (SRF) is located on the right bank of the Ganga River, adjacent to the existing IWAI Multimodal Terminal at Ramnagar, Varanasi. The site extends between National Waterway–1 (NW–1) on the west and the Varanasi–Kolkata National Highway (NH–31) on the east, covering an approximate area of 4 acres. The layout integrates waterfront infrastructure, internal circulation roads, utilities, and connection corridors to the existing port and city network.

Table 5. 5 Description of Component in the proposed layout

S.NO	Component	Description
1	Ganga River Front	Located on the western boundary; provides navigational access to NW–1 for launching and retrieval operations. The SRF jetty and boat hoist bay are aligned parallel to the IWAI terminal wharf to ensure operational synergy.
2	IWAI Terminal (Existing)	Shown north of the SRF site, connected by an internal service road. The terminal handles cargo and dredging vessels currently operating on NW–1.
3	Proposed SRF Facility Zone (Marked in Blue)	Encloses dry dock/boat hoist area, workshop sheds, administrative building, and storage yard. The configuration ensures direct access from the main service road to the hoist apron.
4	Approach Channel / Slipway Alignment	A straight approach channel from the river to the hoist bay ensures safe vessel maneuvering. The width and orientation are designed to accommodate vessels up to 55 m length and 10.6 m breadth.
5	Internal Roads (Orange Lines)	Internal bituminous roads provide connectivity between SRF, IWAI terminal, and ancillary units. Total internal road length ≈ 2.1 km.
6	Drainage Network (Cyan Lines)	Surface and stormwater drains follow the site contours, discharging into the river via silt traps to prevent sediment inflow.
7	Utility and Admin Area (Red Blocks)	Includes the administrative building, electrical substation, fire pump house, and mechanical workshop block, placed on elevated ground near EGL 78–79 m, ensuring flood safety.

8	Access Road to NH–31	The site connects directly to NH–31 through a paved access corridor, enabling transportation of machinery, parts, and heavy components from industrial areas of Varanasi.
9	Settlements (Purple Shaded Zone)	Residential and urban settlements lie toward the northeast boundary, approximately 250–300 m away from the operational zone, minimizing environmental conflict.
10	Green Buffer / Vegetation Zone	The southern and eastern fringes of the site are reserved as a green belt, providing environmental buffering and visual screening from nearby settlements.

5.10 Summary of Development

The development details are provided in the Table 5.6.

Table 5. 6 Details of the components in the Ship Repair Facility in Varanasi

Sl. No.	Description	Remarks / Basis
1	Boat Hoist Jetty (600 T)	Compact single-lane 600 T travel-lift jetty with servicing strip.
2	Repair Bay (Onshore Transfer Area)	Two-vessel workable bay via rails/cradle; tight but functional.
3	Marine Boat & Trailer Area	Trailer parking, cradle staging and manoeuvre area.
4	Approach Structure / Ramp	Reinforced ramp + security/egress lane.
5	Admin Building + Canteen + Sanitary	Two-storey to save footprint (offices + staff facilities).
6	Store Room (General)	Compact stores near workshops.
7	Paint Store Room (Hazmat)	Fire-rated cell, isolated corner.

8	Substation / DG Set Area	Compact transformer + DG room with bund.
9	Electrical Workshop	Diagnostics, panel work, small rewinds.
10	Carpentry / Outfitting Shop	Combined light carpentry/outfitting area.
11	Pipe Shop	Covered fabrication for pipe spools/valves.
12	Engine & Machine Shop	Lathe/milling footprint + testing bay.
13	Fabrication Shop	Welding bays & small plate work area.
14	Fire & Safety Building	Fire control, equipment & tender parking.
15	Scrap Yard	Segregated skips and compact sorting zone.
16	Parking / Stockyard / Assembly Area	Shared open paved area for vehicles, laydown, heavy lifting.

The general layout and typical cross-section of the ship lift facility are illustrated in Figure 5.9

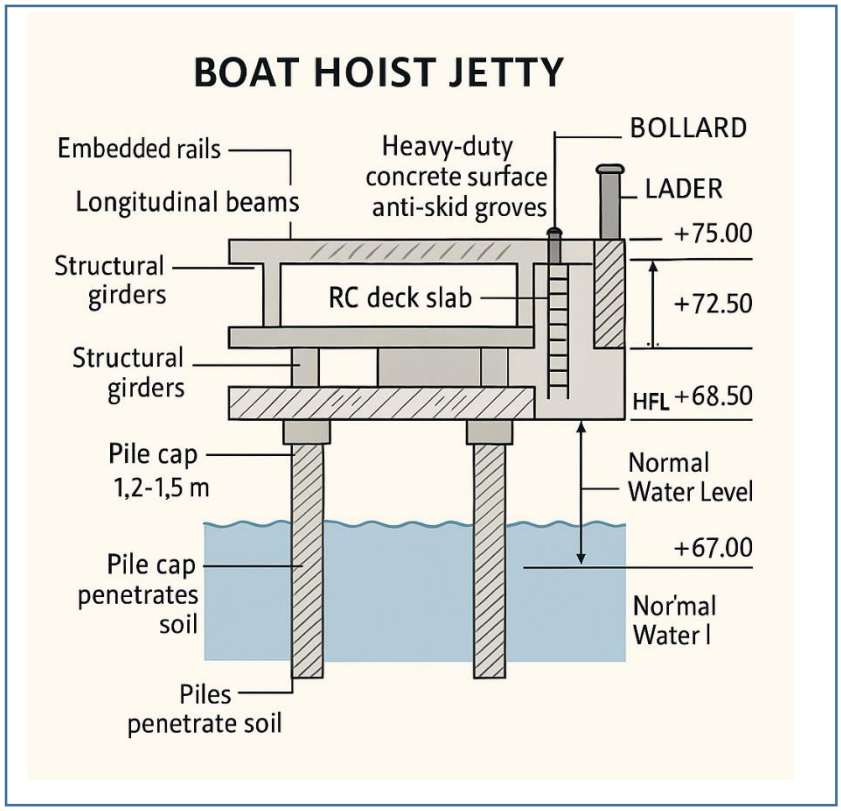


Figure 5. 9 Typical Cross section of Boat Hoist Jetty Loadings for Ship repair facilitates

5.11 Various Infrastructural development compatible with the ship lift facility

5.11.1 Foundation & pile work

- Pile type: Bored cast-in-situ RCC piles (socketed into dense silty sand)
- Pile diameter: 1300 mm where machine or structural checks require)
- Pile length: 50 m (as per site geotech)
- Test/allowable capacity (design assumption): 1,800 – 2,000 kN per pile (use IS 2911 factoring and FOS = 2.5 as code)
- Number of piles (prelim): 8 piles for the 600 T travel-lift (2 piles per wheel cluster). Increase if vendor wheel loads exceed assumed values.
- Pile spacing in group: ≥ 3×D (i.e., ≥ 3.6 m c/c for D=1.2 m)
- Pile cap under each wheel cluster: Example cap size 3.0 × 3.0 × 1.2 m (L×B×H) — adjust after structural check.

5.11.2 Jetty & travel-lift geometric dimensions

- Jetty length (alongshore): 30 – 35 m (face length for travel lift operation and fendering)
- Jetty clear width (between fenders): 16 – 18 m (to accommodate travel lift wheels + operator/service clearance)
- Jetty deck thickness: 300 mm (0.30 m) RCC slab over adequate beams (increase if concentrated loads demand)
- Jetty elevation: Deck M.S.L =74m.

5.11.3 Travel lift / rails / transfer

Wheel reaction (prelim): design vertical =1.84 MN per

Rail gauge between rail centers (transfer cradles): = 6.5 – 7.0 m Transfer bay length (onshore rails): 40 – 60 m

Cradle trolley length: matches vessel LOA — typical cradle footprint 12–18 m depending on vessel sizes handled

Rail embedded into deck: heavy steel rails with welded embedment plates and stiff longitudinal girders.

5.11.4 Repair Bay & transfer area

Repair Bay area (prelim for 2 vessels): ≈ 1,800 m^2

Pavement section (for heavy wheel loads): 250–300 mm RCC slab over compacted subgrade (design for 25 t/m^2 to 30 t/m^2)

Floor slope / drainage: 1–1.5% slope to trench drains; oil/water separator at discharge points

Lighting: LED floodlights on 8–12 m masts, spaced for 100–150 lux in working areas

5.11.5 Workshops, stores & other buildings

Admin + canteen + sanitary: 600 m^2 (2-storey: footprint ≈ 300 m^2)

Fabrication shop: 300 m^2 (single bay, welding + plate storage)

Engine & machine shop: 220–300 m^2 (lathe/mill bays & testing)

Pipe shop: 180–250 m^2

Electrical shop: 200–250 m^2

Carpentry/outfitting: 160–200 m^2

Paint store (hazmat): 120–200 m^2, segregated, fire-rated with ventilation

Substation / DG area: 180–250 m^2 with bunding for fuel tank

5.11.6 Open yard / parking / stockyard

- Parking / stockyard / assembly area: ≈ 4,260 m^2 (shared — allow turning radii for trailers)
- Scrap yard: ≈ 200 m^2 (fenced and segregated)
- Trailers/equipment parking bay: provide truck turning circle (min turning radius 12 m for heavy trucks)

5.11.7 Safety & service dimensions

- Minimum clear walkway / safety strip along jetty edge: 1.0 – 1.5 m (guardrail height 1.1 m)
- Minimum separation between paint store & DG/fabrication: ≥ 10 m (or fire-rated barrier to reduce separation)
- Fire tender / access lane width: 4.5 – 6.0 m (single lane), ensure full site loop if possible

5.11.8 Structural / material

- **Concrete:** M40 for exposed deck; M30 for substructure.
- **Reinforcement:** Fe-500 TMT (design as per IS).
- **Corrosion protection:** Chloride-resistant concrete cover; use epoxy coatings on exposed rebar/embedded steel.
- **Scour protection:** Provide riprap / gabion apron around piles / jetty toe where required.


Proposed Ship Repair Facilty

Chapter 6

Proposed Ship Repair Facility

The proposed Ship Repair Facility (SRF) at Varanasi is a key infrastructure initiative under the Inland Waterways Authority of India (IWAI) to support vessel maintenance operations on National Waterway–1 (NW-1). Located strategically along the Ganga River, near the existing Varanasi Multi-Modal Terminal, the facility will serve as a critical hub for vessel repair, maintenance, and servicing for the growing inland water transport fleet operating between Haldia and Prayagraj.

6.1 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 transverse and longitudinal beam dimensions are 1.75m x 2m and 1.5m x 2m. The centre to centre pile spacing is 6.160m 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 +75 (MSL). The founding level of pile is +25 m (MSL).

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 are 1.5m x 2.0m and 1.75m x 2m. The centre to centre pile spacing is 6.375m in longitudinal direction and 7.625m and 10.875m 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 75m (MSL). The founding level of pile is +25m (MSL).

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 are 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 ,75 m (MSL). The founding level of pile is +25m (MSL).

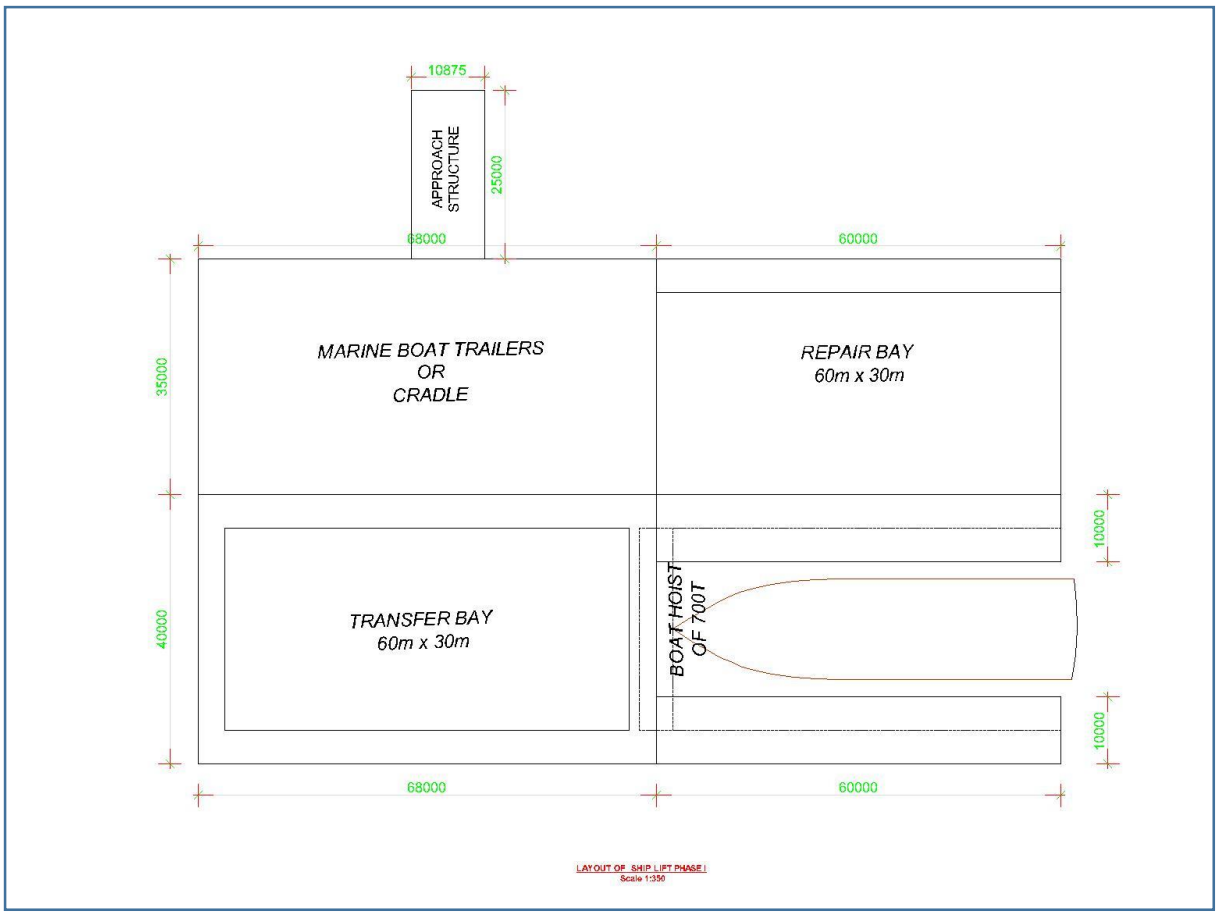


Figure 6. 1 Proposed Layout of Ship Repair Facility in Varanasi

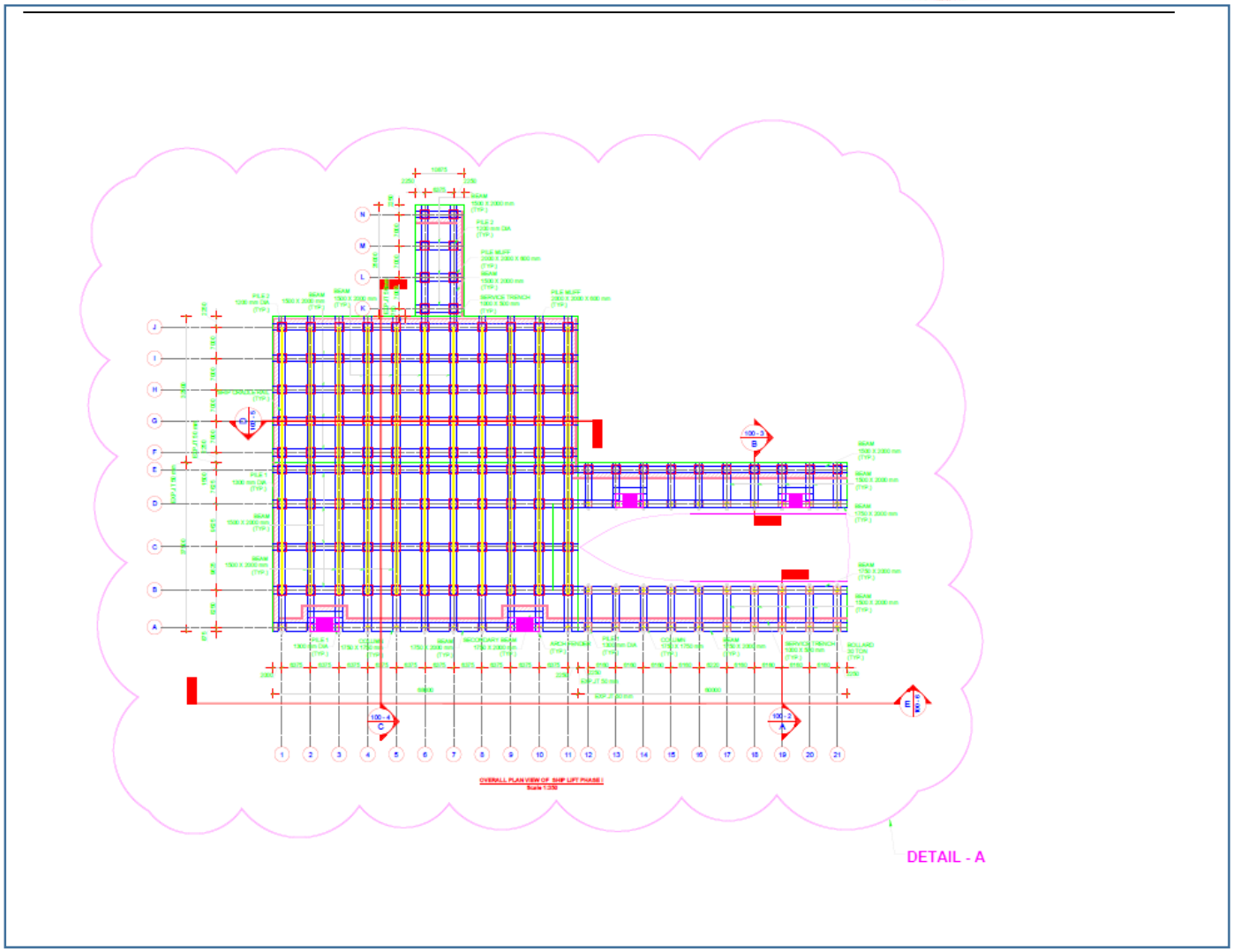


Figure 6. 2 Overall plan view of Ship Repair Facility in Varanasi

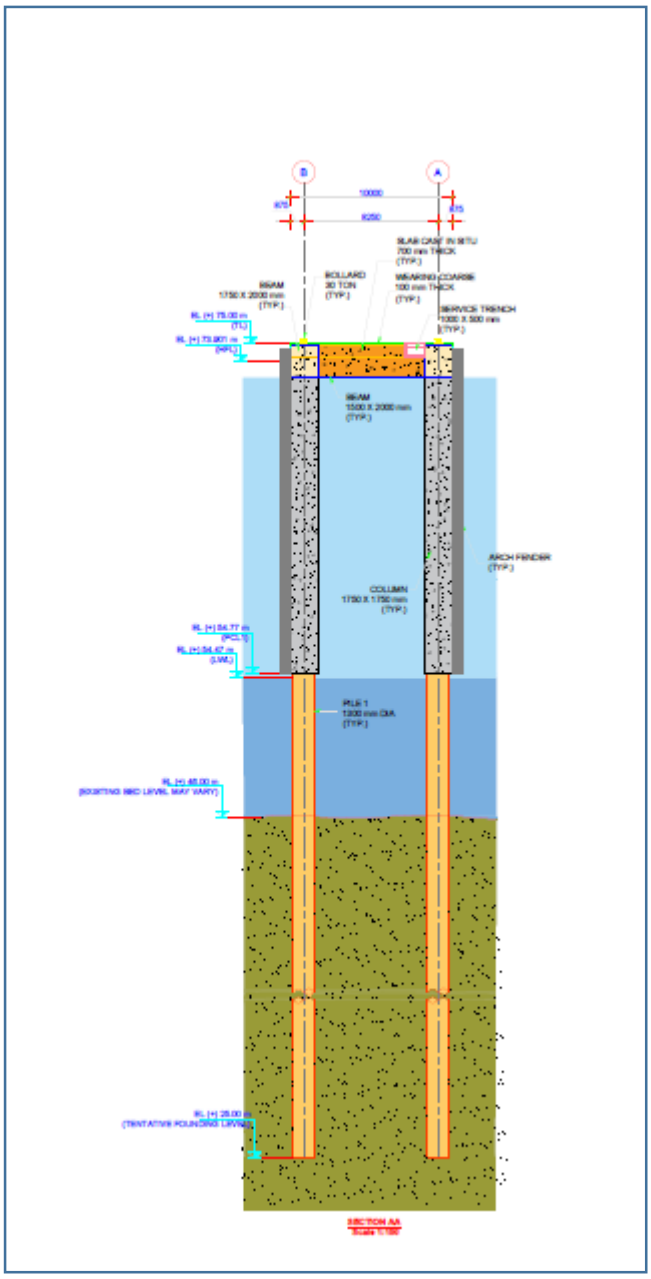


Figure 6. 3 Cross-Section of Boat Hoist Jetty(Section-AA) of Ship Repair Facility in Varanasi

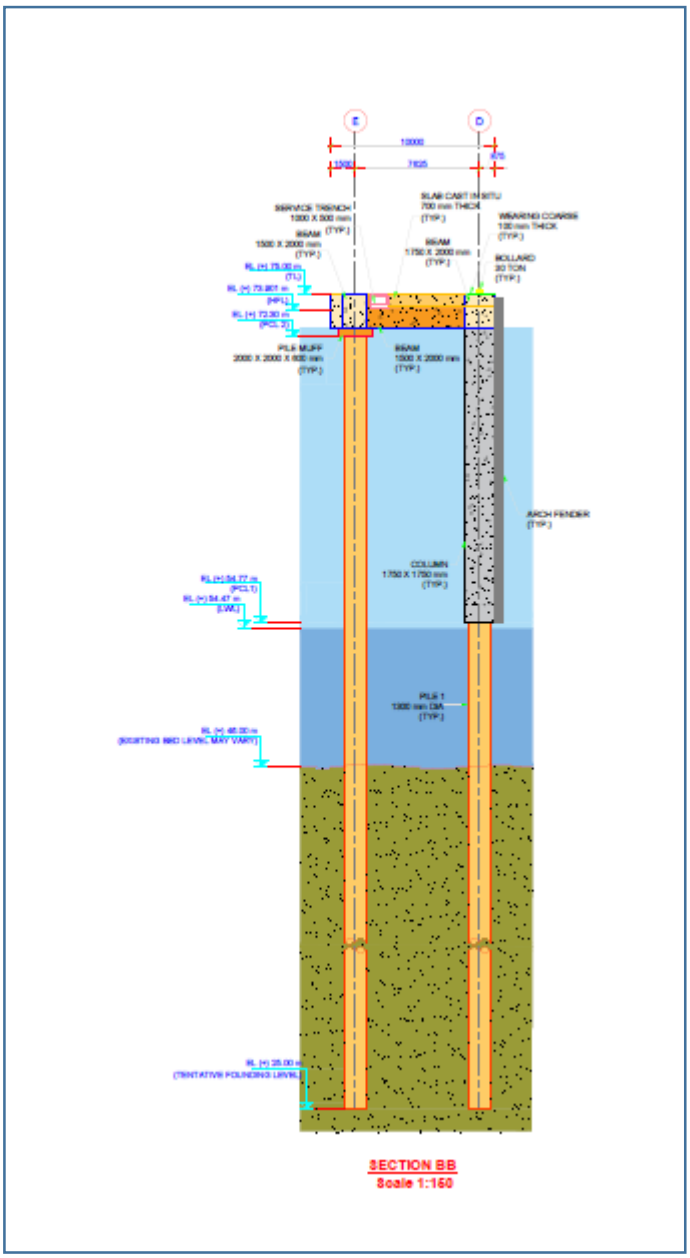


Figure 6. 4 Cross-Section of Boat Hoist Jetty(Section-BB) of Ship Repair Facility in Varanasi

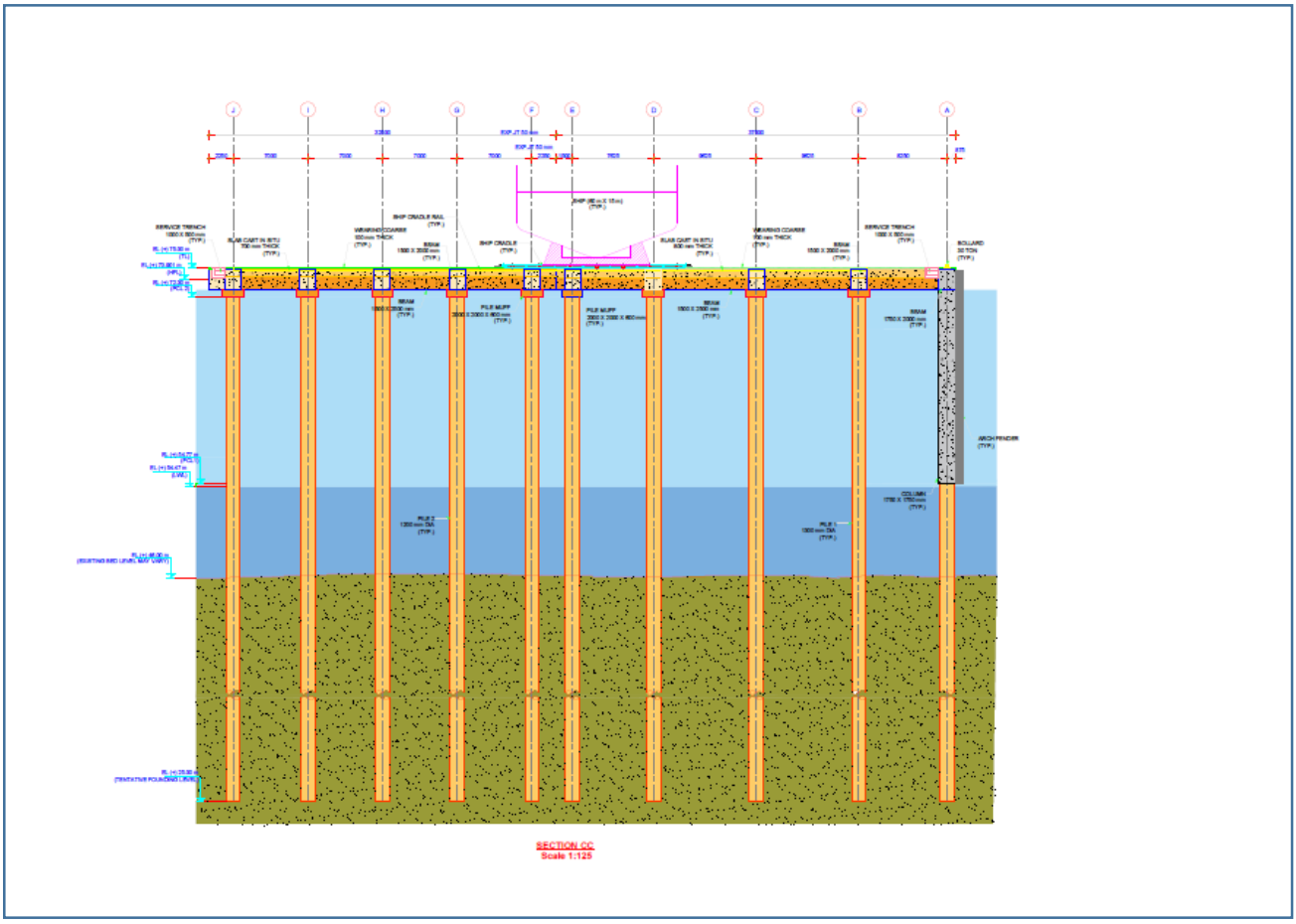


Figure 6. 5 Cross-Section of Transfer Bay(Section-CC) of Ship Repair Facility in Varanasi

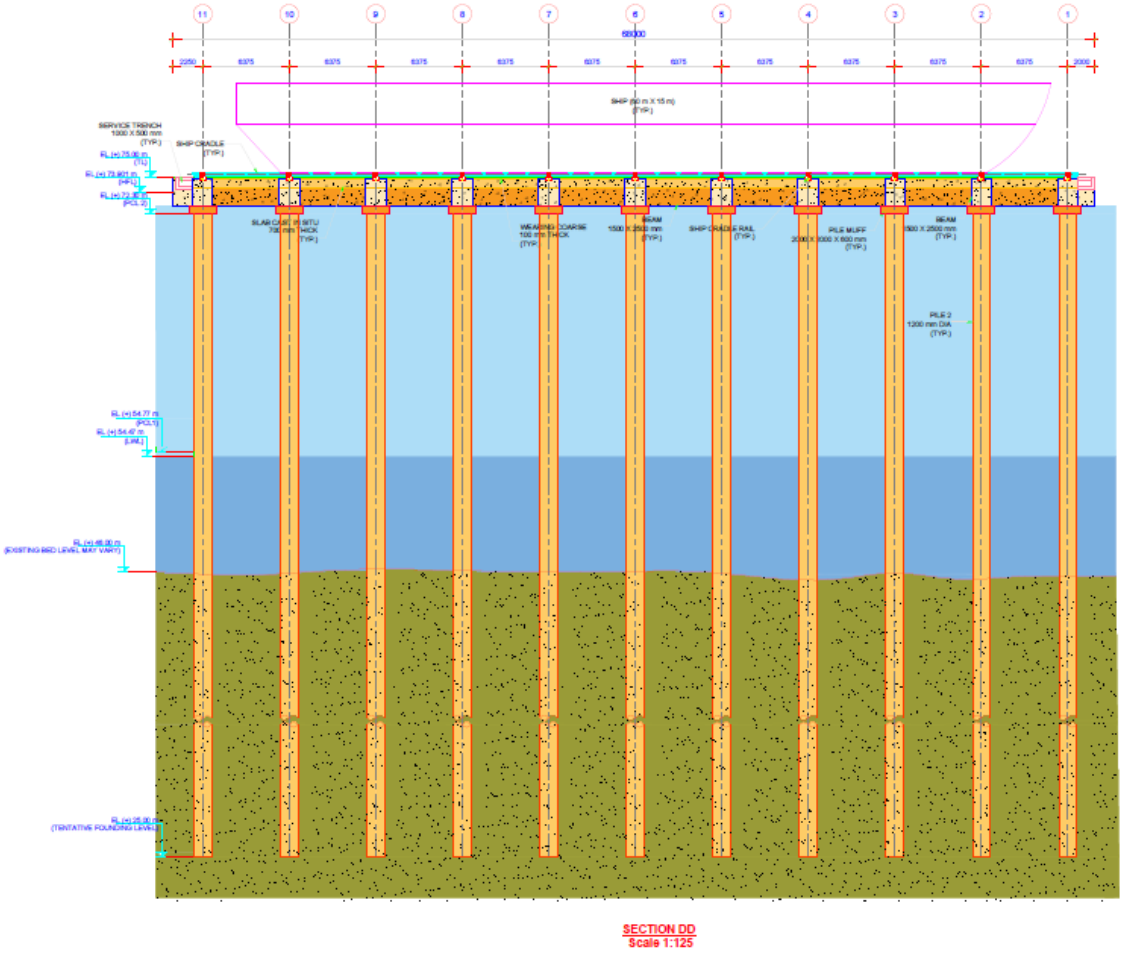


Figure 6. 6 Cross-Section of (Section-DD) of Ship Repair Facility in Varanasi

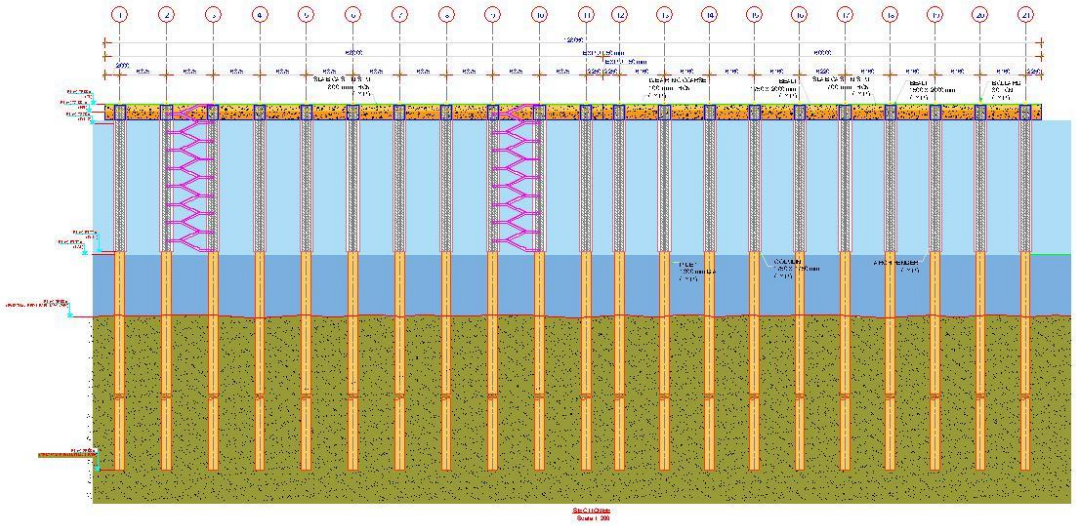


Figure 6. 7 Cross-Section of Transfer Bay(Section-EE) of Ship Repair Facility in Varanasi

6.2 Structural sizes (Based on Preliminary design)

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

Table 6.1 Structural Components

Sl. No	Structural member	Dimension
1	Piles	1300mm&1200mm
2	Beams	1750mmx2000mm & 1500mmx2000mm
3	Slab	700mm & 800mm
4	Pilemuff	2000mmx2000mmx600mm

6.2.1 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

6.2.3 Live Load

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

6.2.4 Seismic Force

Varanasi is in Zone III of the Indian Map of Seismic zones (IS-1893 Part-1 2016), which is a moderate 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. Figure 32 shows the response spectra for rock and soil and sites for 5% damping.

Horizontal seismic coefficient

Ah= Z I Sa/g

Where,

Z = 0.16, Zone factor (Table 3 clause 6.4.2 of IS: 1893 (Part-1) -2016)

I = 1.5, Importance factor (Table 8 clause 7.2.3 of IS: 1893 (Part-1)-2016)

R = 3.0, Response reduction factor (Table 9 clause 7.2.6 of IS: 1893-2016)

Sa/g = Average Response acceleration coefficient

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

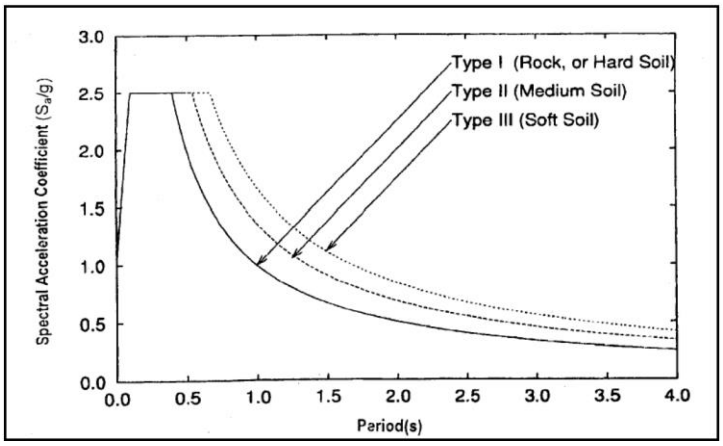


Figure 6. 8 Response spectra for rock and soil and sites for 5% damping

6.2.5 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.

Table 6.2 Parameters for calculation of berthing energy

Sl.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	20.2
10	Design berthing Energy (Tonne.m)	22.01
11	Fender Selected	Trelleborg Arch Fender-
12	Maximum Energy Absorption	22.1
13	Maximum Rated Reaction (Tonne)	567

Mooring Force

The mooring force calculations are given below.

Vessel specifications

Dead Weight Tonnage	DT	=	1665	T
Overall Length	LOA	=	90	m
Length between perpendiculars	Lp	=	85	m
Width of the vessel	B	=	15	m
Moulded depth	Dm	=	2.5	m
Average light draft	Dl	=	1.2	m

Other data

Basic Wind Speed	Vb	=	47	m/s
Current velocity	v	=	3	m/s
Unit weigth 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	Cw	=	1.3	
Coefficients for wind force calculation				
Probability factor	k1	=	1	

Terrain roughness and height factor	k2	=	1.05	
Topography factor	k3	=	1	
Importance factor	k4	=	1	
Wind directionality factor	Kd	=	1	
Area averaging factor	Ka	=	0.8	
Combination factor	Kc	=	0.9	

Force due to wind

Force due to wind	Fw	=	CwAwP	
Shape Factor	Cw	=	1.3	
Windage Area	Aw	=	1.175*Lp(Dm -Dl)	
		=	1.175*85(2.5-1.2)	
	Aw	=	129.84	m2
Design Wind Speed	Vz	=	Vb*k1*k2*k3 *k4	
		=	47*1*1.05*1* 1	
	Vz	=	49.35	m/s
Wind Pressure	Pz	=	2	
		=	0.6*Vz	
		=	0.6*49.35^2	

	Pz	=	1461.25	N/m^2
Design wind pressure	pd	=	Kd*Ka*Kc*pz	
		=	1*0.8*0.9*1461.25	
	pd	=	1052.1	N/m^2
The value of pd, however shall not be taken less than 0.70 pz				
	0.7pz	=	0.7*1461.25	
		=	1022.88	
Wind pressure to be considered,		=	1052.1	N/m^2
	P	=	1.05	kN/m^2
Force due to wind	Fw	=	CwAwP	
		=	1.3*129.838*1.05	
		=	177.23	kN

Force due to current

Force due to current	Fc	=	$(wv^2/2g)*Ap$	
Area of ship under water	Ap	=	B*Dl	
		=	15*1.2	
		=	18	m2
Force due to current	Fc	=	$(wv^2/2g)*Ap$	
		=	((10.25*3^^2)/(2*9.81))*18	

		=	84.63	kN
Resultant Mooring force	F	=	$(Fw^2 + Fc^2)^{0.5}$	
		=	$(177.23^2 + 84.63^2)^{0.5}$	
Resultant Mooring force	F	=	196.4	kN

Assuming vessel to be moored by 8 mooring lines and considering only 50 % of the lines resist the force

Mooring force on each mooring line	=	196.4 / 2	
	=	98.2	kN
	~	300	kN

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, Vz = k1 x K2 x k3 x Vb

Where,

k1 = Risk Co efficient = 1.07 (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).

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 x 10- 6 / °C.

Boat Hoist Crane

The ship repair structure is designed for 800T capacity of boat hoist carne. The technical details are furnished in Figure 6. 9. The customized crane should have 32wheels with spacing of 4.9m centre to centre.

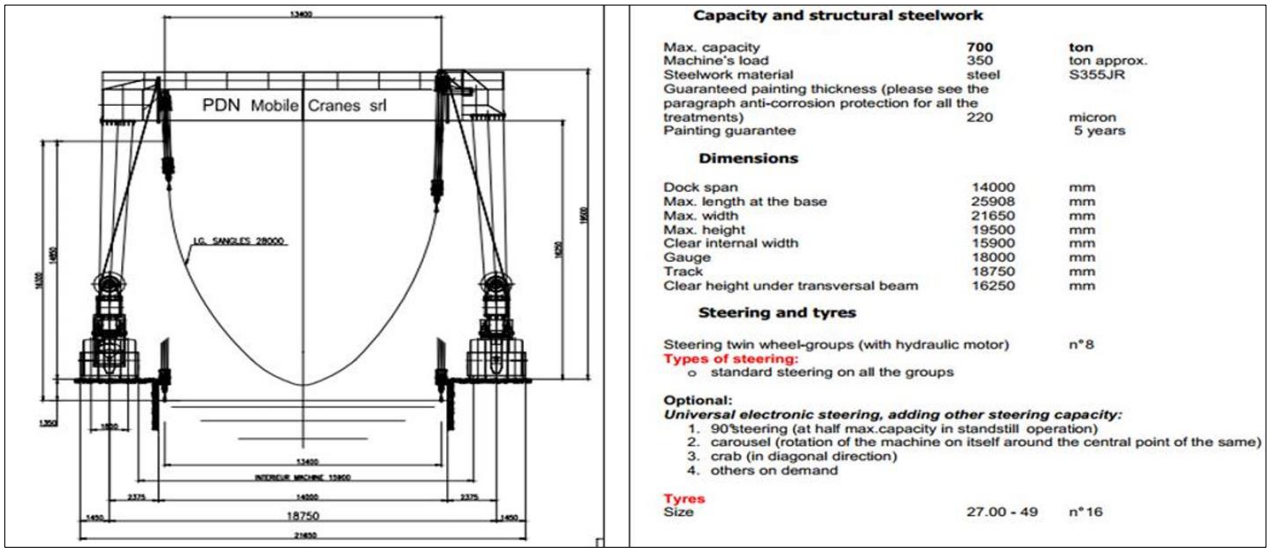


Figure 6. 9 Technical specifications for Boat Hoist Crane

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.

Structural members

Piles

Based on the Preliminary design adopting the data shared by IWAI, the tentative size of the piles along with the reinforcement have been arrived, at which is summarized in Table 6. 3.

Table 6. 3 Reinforcement summary for 1300mm & 1200mm dia Pile

Pile Dia (mm)	No of bars provided	% of reinforcement provided	Lateral ties provided	Crack width (mm)
				Short term
1300	2 x 33 T32	4.0%	12mm# @150mm spacing c/c	0.159
1200	2 x 25 T32	3.56%	12mm# @150mm spacing c/c	0.159

Column

Based on the Preliminary design adopting the data shared by IWAI, the tentative size of the column along with the reinforcement have been arrived, at which is summarized in Table 6. 4.

Table 6. 4 Reinforcement summary for column (1750x1750mm)

Size of Beam (mm)	No of bars provided	% of reinforcement provided	Lateral ties provided	Crack width (mm)
				Short term
1750x1750	1 x 34 T32 on each side	3.5%	12mm# @150mm spacing c/c	0.18

Beam

Based on the Preliminary design adopting the data shared by IWAI, the tentative size of the beams along with the reinforcement have been arrived, at which is summarized in Table 6. 5.

Table 6. 5 Reinforcement summary for beams

Sl. No.	Size(mm)	Reinforcement		% of reinforcement		Stirrups (mm)	Crack width (mm)	
							Top	Bottom
		Bottom	Top	Bottom	Top		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

Slab

Based on the Preliminary design adopting the data shared by IWAI, the tentative size of the slabs along with the reinforcement have been arrived, at which is summarized in

Table 6. 6.

Table 6. 6 Reinforcement summary for slab

Sl. No.	Description	Reinforcement	% of reinforcement	Stirrups (mm)	Crack width (mm)	
					Top	Bottom

		Bottom	Top	Bottom	Top		Short	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

Tower Crane

In order to move/handle heavy goods, materials or tools around a site, it is proposed to install one tower cranes of 10T capacity.

Summary & Cost estimate

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 development. The total cost of the project based on requirements is about ₹ 277.43 Crore. The total cost of project is ₹321.39 crores Crores (excluding GST).

NAME OF THE WORK : CONSTRUCTION OF SHIPLIFT AT VARANASI					
ABSTRACT					
SUBSTRUCTURE - SHIPLIFT					
Sl	**Description of work**	**Quantity**	**Unit**	**Rate**	**Amount**

No				Rs.	Rs.
1	**Mobilization and Demobilization**				
a	Provide and bring on site sufficient numbers of piling rigs with all required ancillary equipment and personnel for installing 1300mm dia and 1200mm dia vertical bored cast insitu piles as per specifications and Remove from site all piling plant & equipment in item-1 above, after completion of work.	**LS**	**LS**	1,50,00,000.00	1,50,00,000.00
2	**Positioning and setting upon** and/or shifting and setting up piling equipment required for piling work at each piling locations as shown in the drawing and as directed including all labour, materials, fuel, tools, equipments etc., complete. **For 1300mm**	202.00	Nos	1,50,000.00	3,03,00,000.00

	and 1200mm Piles				
3	**Supplying, fabricating and providing steel cylindrical liners of 8 mm thick M.S plate** to the required depth, 1300mm and 1200mm piles as shown in the drawing including gas cutting ,bending, welding at yard & site, transporting, driving of liners, all labour, materials, tools, equipments, fuel etc., complete				
	Note:-				
	1.The stiffener shall be measured under this item.				
	In case the soil strata found to be not good in the founding level of the liner, extra depth may be provided as per site condition.				
	Liner 8mm thick	1135.00	Te	1,12,200.00	12,73,47,000.00
4	Lowering and pitching of	202.00	Nos	1,56,000.00	3,15,12,000.00

	fabricated liners of 8mm at each pile location				
5	Placing, Driving the M.S liners of the specifications as per item 2 above for1300mm dia and 1200mm dia vertical bored piles. The cost inclusive of charges for transporting to the pile location, aligning, lowering, pitching and driving the liners etc. complete as per standard specification and as directed by the Departmental officers	5053.18	Rm	3,480.00	1,75,85,066.40

6	**Boring for the piles** to the required depth through all types of soil strata including cemented sand, boulder layers , weathered rock and hard rock if any upto the founding level and stacking the bored soil at convenient place and transported to the low lying area anywhere inside /outside the harbour area within a lead of 4 km or as directed by the Engineer's representative and pile shaft cleaning and keeping of all records etc. including bentonite solution, labour, tools, equipment, fuel etc..all as per drawing, specification etc complete as directed. **Note:** i)In case the soil stratum at the founding level is loose the Engineer or his representative may direct the contractor to carryout				

	additional length of boring. ii)The sample of bored materials of regular interval shall be collected and produced for the verification of the Engineer or his representative at no extra cost in the event of any dispute about the type of strata bored the samples so collected shall be referred to an authorized laboratory / agency identified by the Engineer and the decision of such authorized laboratory / agency is final and binding on both parties. However the cost of such testing shall be borne by the contractor iii)Boring through all type of soil strata means soft soil, weathered rock, cemented sand, boulders and hard rock etc., iv)The boring in all type of				

	soil measurement will be made on the basis of depth of boring from encountered soft soil level to founding/pile termination level. Then boring in hard rock shall be measured from level of encountered hard rock to pile termination level. v) All the boring depths shall be jointly measured actually at site and Engineer in-charge decision is final.				
	Boring for 1300mm dia pile	3712.50	Rm	41,051.00	15,24,01,837.50
	Boring for 1200mm dia pile	3862.50	Rm	33,709.00	13,02,01,012.50
7	**Trimming of pile heads** built up above the cut off level (casted minimum 1m above the required cut off level) and/ or as directed and stacking the debris at convenient place and transported to the low	202.00	Nos	15,120.00	30,54,240.00

	lying area anywhere inside/ outside the port premises with in a lead of 4 K.M or all as directed by the engineers representative and all associated cleaning of projecting reinforcements including all labour cutting the excess liner up to cut off level, materials, tools, equipments, fuel, shifting of scrap liner to the designated location etc. complete all as directed.(The excess liner scrap material is property of the contractor)				
8	**Dynamic pile load test** (High strain Dynamic testing) perform Non-Destructive Integrity test of piles of size 1300mm dia and 1200mm dia according to the approved Specifications and as directed by the Engineer or his representative all as per	2.00	Nos	4,80,000.00	9,60,000.00

	relevant BIS/ASTM codes including all labour, tool. Equipments, plant, etc., complete.				
	Providing, conducting of routine Dynamic high strain testing using pile Driving analyzer by impacting a 1.5 percent weight of capacity of pile with a fall varying from 1m to 3m including preparing head, providing ply and steel plates, fixing strain gauges etc. all conforming to ASTMD4945. Further include evaluating and submitting report covering				
	Providing, conducting of routine Dynamic high strain testing using pile Driving analyzer by impacting a 1.5 percent weight of capacity of pile with a fall varying from 1m to 3m including preparing head, providing				

	ply and steel plates, fixing strain gauges etc. all conforming to ASTMD4945. Further include evaluating and submitting report covering				
	i) True static capacity of the pile at the time of testing				
	ii) Simulated static load test curve				
	iii) Total skin friction and end bearing of pile				
	iv) Skin friction variation along the length of the pile				
	v) Compressive and tensile stresses developed in pile during testing				
	vi) Net and total displacement of the pile				
9	**INTEGRITY TEST ON WORKING PILES** Conduct non-destructive integrity test on working piles using low strain	202.00	Nos	11,400.00	23,02,800.00

	sonic diagnostic system as specified and as directed by the Engineer for 1300 mm dia and 1200mm dia piles				
10	**ROUTINE AND INITIAL VERTICAL LOAD TEST** Supply necessary kentledge and perform vertical load tests on the marine piles 1300mm dia	1.00	Nos	33,70,202.22	33,70,202.22
	1200mm dia	1.00	Nos	24,21,254.00	24,21,254.00
11	**Providing and placing in-situ concrete of grade M40 for piles** using tremmie method up to cut off level underneath the bentonite slurry including all sampling testing and records and all labour, materials, tools, equipment, fuel, etc., complete.,	12415.04	m^3	21,120.00	26,22,05,680.01
	Note:				
	Supply, fabrication of steel reinforcement shall be measured and paid				

	under relevant item. (Rate shall include the cost of providing additional concrete above the cut-off level)				
12	**Providing and placing precast concrete of grade M40 for pile muff** using tremmie method up to cut off level underneath the bentonite slurry including all sampling testing and records and all labour, materials, tools, equipment, fuel, etc., complete., **Note:** Supply, fabrication of steel reinforcement shall be measured and paid under relevant item.	255.04	m3	16,980.00	43,30,538.28
13	**Providing and placing precast concrete of grade M40 for columns** using tremmie method up to cut off level underneath the bentonite	1303.71	m3	18,240.00	2,37,79,602.00

	slurry including all sampling testing and records and all labour, materials, tools, equipment, fuel, etc., complete., **Note:** Supply, fabrication of steel reinforcement shall be measured and paid under relevant item.				
14	**Supplying, fabricating and placing of TMT, Fe500D grade steel for pile** reinforcement cage in piles including welding, binding, with binding wire all as per drawing, technical specifications and including all labour, materials, tools transport, cage lowering, equipments, fuel etc., complete	3103.76	Te	1,01,400.00	31,47,21,306.26
15	**Supplying, fabricating and placing TMT, Fe500D grade steel for reinforcement of pile**	44.63	Te	1,01,400.00	45,25,642.03

	muff including welding, binding, with binding wire all as per drawing, technical specifications and including all labour, materials, tools transport, cage lowering, equipments, fuel etc., complete.				
16	**Supplying, fabricating and placing TMT, Fe500D grade steel for reinforcement of columns** including welding, binding, with binding wire all as per drawing, technical specifications and including all labour, materials, tools transport, cage lowering, equipments, fuel etc., complete.	391.11	Te	1,01,400.00	3,96,58,744.13
DECK STRUCTURES					
17	**Casting of Precast and cast in situ cement concrete Beams of grade M40** of various sizes as	6705.50	m3	19,920.00	13,35,73,560.00

	shown in the drawing and or any other size as directed to suit the site condition including shuttering,/ formwork mixing, transporting, placing, vibrating, curing the concrete and all labour, materials, tools, equipment, fuel, all sampling, testing and records etc., complete. Note: 1.Supply , Fabrication of steel reinforcement shall be measured and paid under relevant item of Bill no: 1 2.Placing the precast units shall be measured and paid under relevant item of Bill No:2				
18	**Providing and placing Precast and cast in situ concrete of grade M40 for slabs** all as per drawing and or as directed by the Engineer	5299.20	m^3	19,920.00	10,55,60,064.00

	including provision of shuttering, mixing, transporting ,placing, vibrating, curing the concrete including all labour, materials, tools, equipment, fuel and all sampling, testing and records etc., complete.				
	Note:				
	Supply , Fabrication of steel reinforcement shall be measured and paid under relevant item of Bill no: 1				
19	**Supplying, fabricating and placing of TMT, Fe500D grade steel bars for Cast in situ beams** including lifting hooks for precast units and cutting, bending, welding, binding wire all as per technical specification, drawing, including all labour, materials tools, equipment, fuel and all sampling, testing and	1173.46	Te	1,05,600.00	12,39,17,640.00

	records etc., complete.				
20	**Supplying, fabricating and placing of TMT, Fe500D grade steel bars for Cast in situ slabs** including lifting hooks for precast units and cutting, bending, welding, binding wire all as per technical specification, drawing, including all labour, materials tools, equipment, fuel and all sampling, testing and records etc., complete.	1193.00	Te	1,05,600.00	12,59,80,800.00
21	**Providing and placing in-situ grade M30 for wearing coat concrete over the deck slab**, all as per drawings with necessary shuttering, mixing, transporting, placing, vibrating, finishing and curing the concrete including all labour, materials tools,	812.70	m^3	18,000.00	1,46,28,600.00

	equipment, fuel and all sampling, testing and records etc., complete				
22	Supplying, handling, transporting and fixing in position of Arc fender (800) with anchor bolts, U hooks, Chains, cutting, concrete chipping, drilling, grouting, necessary welding with deck reinforcement steel and necessary coal tar painting(wherever required) including all materials, labour, consumable items, machineries, tools, tackles, transportation etc... and complete as per Engineer In charge.				
		41.00	Nos	23,99,366.00	9,83,74,006.00

23	Supplying, handling, transporting and fixing in position of Bollard (30 ton capacity)with necessary cutting, concrete chipping, drilling, grouting, welding with deck reinforcement steel and necessary coal tar painting(wherever required) including all materials, labour , consumable items etc. Complete as per drawing and specifications as directed by the EIC.				
		41.00	Nos	1,20,000.00	49,20,000.00
24	600T Mobile Hoist Crane	1.00	Nos	31,00,00,000.00	31,00,00,000.00
25	Tower Crane 10 T	1.00	Nos	4,55,00,000.00	4,55,00,000.00
26	Flatbed Trolley for transfer the boat to the repair yard	1.00	Nos	9,30,00,000.00	9,30,00,000.00
27	Indian Standard Crane Rail	653.68	RM	41,569.00	2,71,72,616.08
28	Curbs - Rubber	128.00	RM	15,554.00	19,90,912.00
29	Expansion Joint				
	1. M.S angles and Plate	3.00	Te	1,21,054.00	₹ 3,63,162.00
	2. Bituminous pad 25mm	30.00	m2	6,374.00	₹ 1,91,220.00

	thick				
30	Sealing component	120.00	RM	310.00	₹ 37,200.00
31	Mooring rings	2.00	Nos	6,930.00	₹ 13,860.00
32	Safety chains	40.00	RM	1,232.00	₹ 49,280.00
33	M.S Inserts	2.00	Te	1,26,856.00	₹ 2,53,712.00
Total					**₹ 2,25,12,03,557.40**
Electrical work, Plumbing work & Firefighting (5%)					**₹ 22,51,20,355.74**
Contingency (5%)					**₹ 12,38,16,195.66**
PMC + Work Charge establishment (7%)					**₹ 17,33,42,673.92**
Round off					**₹ 8,23,101.11**
Total Amount Rs.(INR)					**₹ 2,77,43,05,883.83**

Note : Above Quoted Price is Exclusive of GST on Works Contract. The GST shall be paid Extra as per Actual during execution of the Works.

Any access road that may be required from the nearby Road/Highways upto the Ship repair facility is not covered under this DPR/Estimate.


Landside Development in Ship
Repair Facility

Chapter 7

Landside Development in Ship Repair Facility

7.1 Overview of Landside Development

The landside development of the proposed Ship Repair Facility (SRF) at Varanasi has been comprehensively planned to integrate operational, administrative, safety, and welfare functions in a phased and sustainable manner. The master layout ensures that marine engineering requirements, worker amenities, and provisions for future expansion are adequately addressed while maintaining efficient circulation for heavy vehicles, material handling, and equipment movement.

The Administrative Building will function as the central hub, accommodating management offices, meeting rooms, and essential services. This building is proposed as a framed concrete structure with dedicated spaces for security, a punching booth, canteen, and locker rooms for staff use.

To support repair and maintenance operations, dedicated workshops and service buildings are proposed within a 2100 m^2 Pre-Engineered Building (PEB) shed. This shed will be divided into fabrication, electrical, and outfitting shops, along with storage and scrap yard facilities. The PEB structure will be constructed using ISMC/ISMB steel members for columns and beams, with ISA sections used as purlins and rafters for galvalume sheet roofing. The main workshop will rest on a pile foundation with a 6 × 6 m grid, topped by an M30 grade concrete slab. Service trenches will be provided on both sides of the shop floor, edged with reinforced concrete fencing, with voids left unfilled below the PEB and trench system to ensure structural integrity and maintainability.

In addition to the PEB, the following approximate facilities are proposed:

- Store Room: 20 × 20 m for general material storage
- Paint Store Room: 20 × 15 m for safe handling of hazardous paints and chemicals
- Substation: 20 × 15 m with adjoining water tank to support power and utilities

- Electrical Shop: 20 × 20 m
- Carpentry / Outfitting Shop: 20 × 20 m
- Pipe Shop: 20 × 20 m
- Engine Machine Shop: 20 × 20 m
- Fabrication Shop: 20 × 20 m
- Fire & Safety Building: 20 × 9.5 m

For workforce welfare, facilities include:

- Canteen (approx. 20 × 10 m), designed to accommodate 50–70 workers at a time, ensuring hygienic dining and resting areas.
- Toilet Blocks (approx. 10 × 6 m each), gender-segregated, with modern water and sanitation provisions.

Additional functional zones include:

- Scrap Yard (approx. 20 × 20 m) for disposal and segregation of decommissioned parts and recyclable materials.
- Parking / Stockyard for equipment laydown and heavy vehicle circulation, supported by a 7.2 m wide driveway around the campus.
- Area for Private Operators, enabling PPP participation and shared use of the facility.
- Future Development Zone, earmarked for expansion or auxiliary industry requirements.

The entire landside facility will be developed at a top level of 75m, with all structures founded on piles to ensure stability against differential settlement and flood impact. The integrated layout not only ensures smooth operations and safe vessel servicing but also prioritizes worker welfare, sustainability, and operational resilience.

The summary of development details for landside structures is provided in Table 7. 1.

Table 7. 1 Summary of Landside Development of Ship Repair Facility Tentative area statement.

Sl.No	Description	Area (m^2)
1	Admin Building + Canteen + Sanitary	1500
2	Store room	396
3	Paint store room	396
4	Sub station	500
5	Electrical shop	395
6	Carpentry / Outfitting shop	395
7	Pipe shop	395
8	Engine Machine shop	395
9	Fabrication shop	399
10	Fire & Safety building	399
11	Scarp yard	399
12	Parking / Stockyard	4500

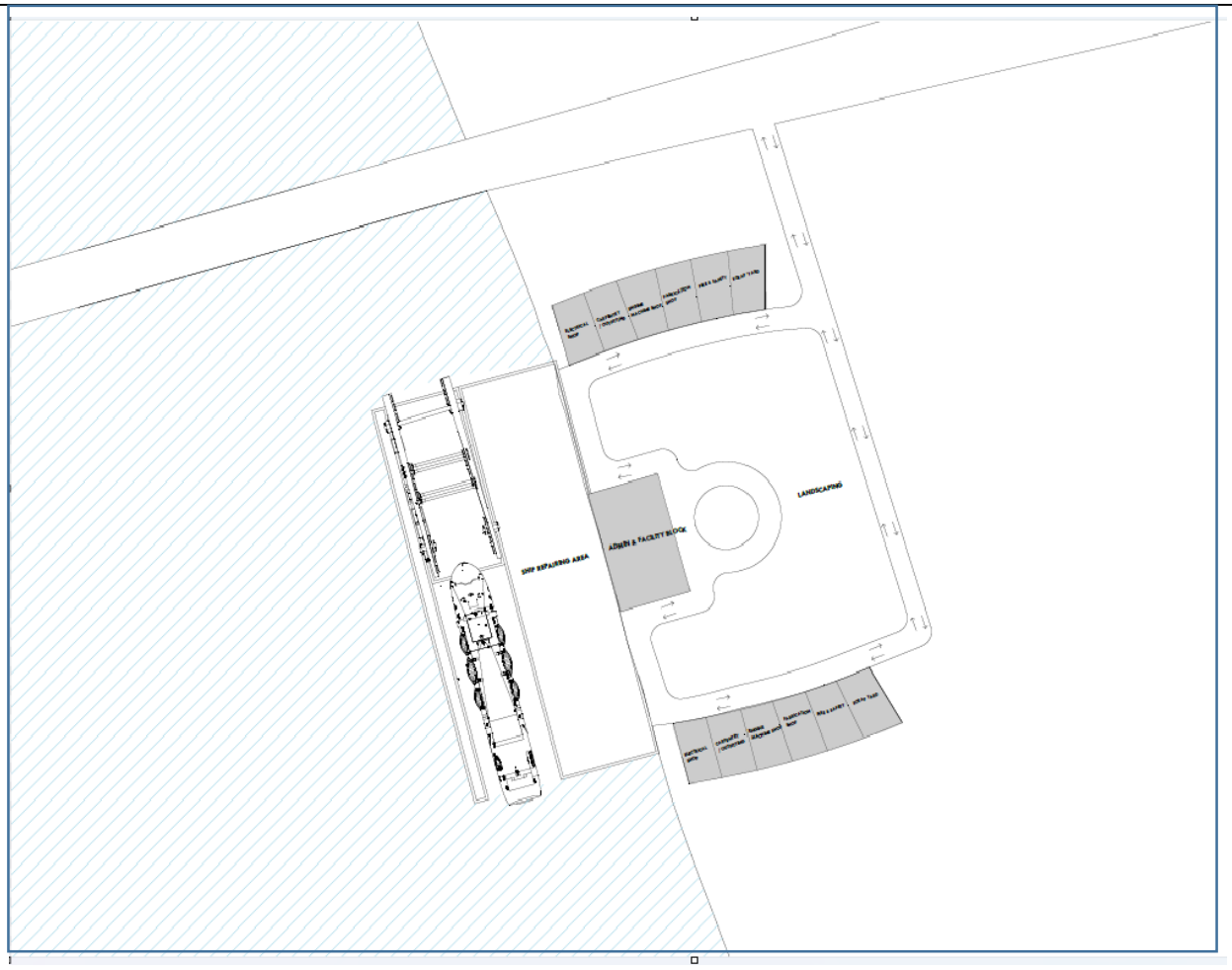


Figure 7. 1 Layout for Proposed ship repair facility land side structures

3D View of the Proposed Ship Repair facility

An 3D architectural walkthrough was created using the layout depicted in the previous chapters for a realistic animated view of the Ship Repair Facility, some of the screenshots are extracted hereunder for better understanding.

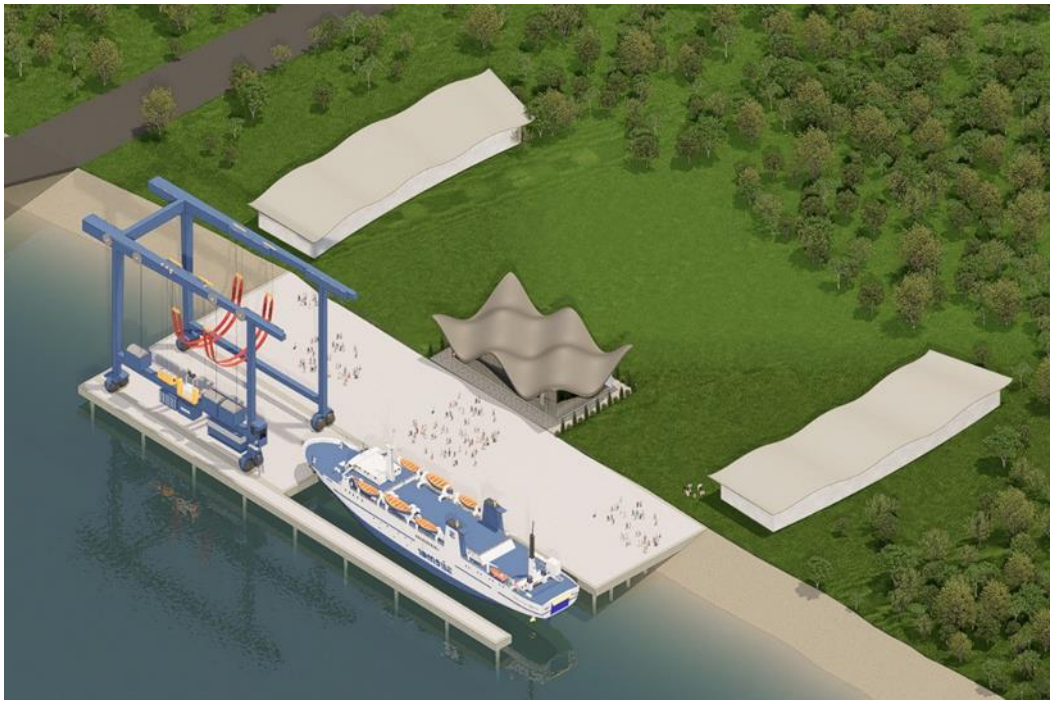


Figure 7. 2 Overall view of the Facility

Figure 7. 3 3D view of Admin Building

Cost Estimate

The capital cost estimates have been prepared for the proposed landside based on the assessed requirements, Accordingly, the total estimated cost for landside facilities amounts to ₹43 crores (excluding GST). The abstract of the estimate is presented in Table 7. 2.

Table 7. 2 Abstract of Capital Cost Estimate for Landside Structures

SHIP REPAIRING FACILITY AT VARANASI		
SUMMARY		
S. NO	**DESCRIPTION**	**AMOUNT**
1	Earth Works	₹ 37,94,922.63
2	Piling Works	₹ 8,01,64,769.00
3	Concrete Works	₹ 7,48,62,580.00
4	Masonry Works	₹ 45,97,538.50
5	Finishing Works	₹ 82,54,175.00
6	Door / Window/ Woodwork	₹ 41,37,876.00
7	Flooring / Cladding Works	₹ 68,79,429.67
8	Road / Paving Works	₹ 4,91,64,434.00
9	Elevation Works	₹ 48,04,632.34
10	Structural Steel	₹ 98,02,118.06
11	Site Development	₹ 7,26,22,217.06
12	Waterproofing Works	₹ 3,55,611.40
13	Metal Works	₹ 36,80,524.80
14	Electrical Works	₹ 5,30,76,283.33

15	Plumbing Works	₹ 1,75,46,415.83
16	Hvac Works	₹ 1,85,06,534.90
17	Fire Fighting Works	₹ 1,73,46,312.70
	GRAND TOTAL = 43 crores approx.	**₹ 42,95,96,375.22**


MEP SERVICES

Chapter 8

MEP Services

8.1 Design Basis for Electrical Works

This document outlines the standards and procedures to be followed for the design, supply, installation, and commissioning of the electrical power supply system for the proposed Ship Repair Facility (SRF) complex at Varanasi. The detailed engineering work shall be executed based on the fundamental design concepts developed in this report. The electrical system design shall conform to the latest editions of IEEE, IEC, and other relevant international standards. All applicable design data, environmental parameters, and site conditions shall be duly considered to ensure a technically sound and reliable design. The specifications and standards described herein shall apply to the electrical system during normal operation, emergency situations, planned maintenance, and under abnormal or fault conditions, ensuring safety, reliability, and operational continuity of the facility.

8.2 Codes Standards and Regulations

❖ Electrical systems design and supply, installation and commissioning shall be carried out in accordance with Local government of Varanasi, Uttar Pradesh and international Codes and Standards.

❖ Wherever Codes and Standards other than those of specified are applied, the necessary review and approval shall be obtained to ensure that they do not conflict with National or local regulations.

❖ Equipment of origin other than Patna shall have certification from international testing authorities. Evidence of the appropriate certification shall be obtained prior to commitment to purchase.

8.3 Codes Standards and Regulations

❖ The selection of electrical equipment shall be governed by fitness for purpose, safety, reliability, compatibility with future expansion design margins, suitability for environment, economic consideration, etc.

❖ English language shall be used for all drawings, texts and communications.

❖ The SI system of units shall be used.

8.4 Service Conditions

❖ All equipment, materials and installation shall be suitable for operation and their design duty under site conditions.

❖ Design ambient temperature is 45°C

❖ Safety Requirements shall be considered in design

- Safety to personnel and equipment during both operation and maintenance.
- Reliability of service.
- Minimal fire risk.
- Ease of maintenance and convenience of operation.
- Automatic protection of all electrical equipment through selective relaying system.
- Electrical supply to equipment and machinery within the design operating limits.
- Adequate provision for future extension and modification.
- Maximum interchange ability of equipment.
- Fail safe feature.
- Energy efficient equipment (motors, lighting fixtures).
- Suitability for applicable environmental factors.

8.5 Power Supply &Distribution Scheme

Power supply shall be received from Local power supply grid of Project Ship Repair Facility Varanasi at 33kv, 50Hz and hooked up to client's electrical system through 33kV grade power cables.

Necessary Energy meters with current & potential transformers shall be provided for measuring and recording the energy parameters for Tariff purpose. The accuracy level of energy meter, Current & Potential transformers shall be provided as per local grid guide lines.

Further the 33kV power supply to be extended to MV switch gear panel which consisting withdraw able type Vacuum circuit breaker of 630 Amps ,26.3kA fault rated complete with instrument transformers for both metering and protection, including microprocessor based protection relay and digital metering .The metering shall have communication port to integrate with PLC /SCADA system .The MV switch gear panel shall be provided with one no. of Incomer and two no's of outgoing feeders with one no as spare feeder.(Total-03Nos)

One of the feeders of the MV switch gear panel shall be connected to Distribution transformer through MV cable. The secondary of distribution transformer shall be extended to LV switch gear through LV bus duct of suitable rating.LV switch gear panel have Incoming and Outgoing feeders for distribution power at 415 Volts.LV switch gear panel shall be provided with two sections for Normal supply and emergency supply as per operational requirement .and coupled by a bus coupler. The emergency section bus shall be connected to Diesel operated engine Generator set for feeding the supply during the outage of normal supply.

Uninterrupted Power supply units are proposed for avoid the supply interruption for critical equipment &IT server and security system.

8.6 Distribution Transformer

Distribution transformers shall be of 1.6 MVA, 50Hz, 33kV/433 V, Dyn11vector group, ONAN cooling and suitable for outdoor /Indoor installation. The percentage impedance of the distribution transformer shall be 6.25% with no positive tolerance.

The distribution transformers shall be solidly grounded on the star side. Off Circuit Tap Changer (OCTC) range of with a range of - 12.5% to +7.5% in steps of 1.25% (16 steps). Distribution transformer shall be provided with all standard protection devices including Pressure relief device. Tap changer mechanism shall be operated from both transformer and remotely through PLC.

8.7 LT SWITCHBOARD / MOTOR CONTROL CENTRE

LT Switchboard / MCCs shall be metal clad, free standing, dust, and damp and vermin proof with cubicles designed on modular basis. Unless otherwise specified these shall be of single front construction. The degree of protection for all indoor Main distribution board (MDB) &Motor control centers (MCC) enclosures shall be IP-54 and that for outdoor shall be IP-55. The short time rating of MDB shall be 50KA for 1 sec.

The horizontal bus bars and vertical droppers shall be adequately sized, braced and supported to withstand mechanical and short circuit forces. The maximum rating of the bus bar, in case of MCCs, shall preferably be limited to 800 Amperes. Short circuit rating of LT boards shall be 50 kA for one second. The LT system shall be with neutral solidly earthed. Incomer of Main distribution board shall be suitable for top bus duct entry and all outgoing feeders shall be suitable for Top, cable entry.

The Main distribution board shall in general house feeders for Motor control centers, sub distribution switchboards, UPS, Lighting, EOT Crane, etc. Motors above 90kW shall be fed from Main distribution board.

The motor starters shall be suitable for direct on line starting of squirrel cage induction motors up to 7kW and star delta starter for motor ratings above 7kW comprising mainly of MPCB/MCCB, contactor and bimetallic relays.

Control circuit of motor starter and contactor units shall be supplied with 240V single phase and neutral derived from within each compartment, through separate control transformer. Auxiliary wiring shall not be routed near power buses.

All the MCCs shall have continuous earth bus bar of uniform size. Facilities shall be provided to ground the MCC at two separate points. Each bus bar vertical panel shall be provided with space heater to avoid moisture condensation. The space heater shall be suitable for 240V single phase 50Hz AC supply and thermostatically controlled.

All the starter modules shall be provided with ON, OFF and trip indication and stop PB and reset PB for bimetallic relay.

All the cable entries for power and control cables shall be from bottom/top of the MCC through removable gland plate.

The MCCs shall be installed in well ventilated room with a clear 800mm space behind each MCC.

8.8 Auxiliary Service Boards

Auxiliary services shall contain mainly switch fuse units. The board may be constructed in fixed execution, compartmentalized, dust, and damp and vermin proof. The boards shall be free standing type. The auxiliary service boards shall mainly feed welding loads and receptacle loads. All Incomers of switch board shall be provided MCCB with trip releases. The short circuit ratings of MCCBs shall be selected as per short circuit ratings shown in SLD. Auxiliary service boards shall normally be supplied from Main distribution board. The bus bars inside the boards shall be adequately sized, braced and supported. An earth bus shall be provided along the full length of the boards. Boards shall be complete with all necessary metering instruments, selector switches, control switch gear, push buttons, indicating lights etc. as required.

The height of auxiliary service boards shall be same as that of other panels located in the same room. The degree of protection for auxiliary service boards shall be IP-54.

L. T. Bus duct

Sandwich type 415V L.T. bus duct shall run between the distribution transformer and Main distribution board.

The bus duct shall be IP -55 enclosure suitable for weather, dust and vermin proof. Flexible bellow at termination points and expansion joints at straight run as required shall be provided Canopy / rain hoods shall be provided for outdoor area of the bus duct.

Fire barriers of 30 minutes rating shall be provided within bus duct enclosure where the bus duct passes through a wall.

Bus duct shall be Short time rating of 50 kA for 1 sec copper Flexible connectors made of copper shall be suitably silver plated.

L. T. CAPACITOR BANK

Automatic power factor-controlled panel shall be considered for maintain the power factor at of 0.98 to unity.

Capacitor cubicle shall be metal enclosed, free standing, floor mounting and flush fronted type. APFC relay shall be provided to measure, control and monitor the Capacitor bank. The capacitor panel shall have common bus bar section, LV control section and capacitors switched as per signal form APFC relay.

The capacitor unit shall be with polypropylene dielectric impregnated with NPCB. It shall be uniform in type and output to provide maximum interchange ability. The KVAR rating of capacitors panel shall be as per BOQ and SLD

Detuned Series reactor shall be provided along with each capacitor bank to restrict in rush current to capacitor bank during switching and blocking of prominent harmonics.

ELECTRIC MOTORS

Unless otherwise specified, all motors shall be single speed and suitable for direct online starting. All motors shall be supplied in Standard IEC frame sizes. Construction, performance and testing of motors shall satisfy the requirement of relevant Indian standards. All motors shall be of TEFC construction and shall have degree of protection IP55 with weather proof protection.

All unidirectional motors rated above 30kW (i.e. 37kW and above) shall be fitted with space heaters operating at 240V AC. All bi-directional motors shall be provided with space heaters. All 415V motors shall be delta connected All unidirectional motors shall be suitable to start at 80% of rated voltage. Winding insulation of all motors designed with suitable reinforcement to take care of frequent starting and over voltage experienced by the motor winding during automatic changeover of supply.

All LT motors shall be of Class `B' insulation with temperature rise limited to Class 'B'.

Lighting and Power Panel

Lighting and Power panels shall be fed from LDB/Auxiliary service boards. These panels shall be provided with miniature circuit breakers or switches and fuse combination for control

and protection of different outgoing circuits. Incomer of all lighting and power panels shall be provided with earth leakage circuit breaker (ELCB).

Lighting and Power panels shall be complete with necessary instrument, control and indication. Number of out goings circuit of lighting panels shall be, as far as possible, standardized to keep minimum inventory.

EMERGENCY SUPPLY ARRANGEMENT:

Diesel operated Generator sets with AMF panel are proposed to feed the power supply during local power grid supply failure.

Power supply from the DG sets shall be extend through Bus ducts to MDB's located at each floor level in electrical room.

Each MD- MDB panel shall be connected with adequate rated DG set to meet the demand.

UNINTERRUPTED POWER SUPPLY SYSTEM

The uninterrupted power supply shall be a complete reliable system including inverters, battery charger and battery bank.

The UPS system shall be of free standing, floor mounting, metal enclosed and vermin proof type having hinged door for front access and suitable for indoor use.

The UPS shall be operated on 415 V, 3 Phase, 4Wire, 50 Hz incoming supply and output shall be 415V, 3 Phase, 4Wire, 50Hz supply. However, the rating shall be BOQ and after detailed engineering.

Battery shall be VRLA type maintenance free and Ampere hour rating shall be selected for 30Min or 60Min back up.

The UPS shall consist of

- One 1 x 100% common battery shall be provided.
- Rectifier transformer
- Thyristor controlled rectifier cum charged with battery current limit.
- Filter circuit
- Static by pass switch
- Other associated accessories

- AC Distribution Board
- Electrical isolation enabling maintenance of each section without taking shutdown of complete system.

CONTROL STATION

Motor shall be provided with a control station in the field.

The enclosure of control station shall have suitable protection for site conditions.

The control station shall include the following equipment's as per individual requirements.

Start/Stop push button

Stop push button shall generally be stay put type with padlocking arrangement except in the case of critical drives.

ELECTRICALLY OPERATED OVERHEAD CRANE: (EOT CRANE)

Electrically operated overhead crane wherever required shall be supplied from 415V + 10%, 50 Hz, 3 phase 4 wire system. The overhead crane shall have its own control and facility e.g. forward/reverse, up/down, inching, etc. as per requirements. Control supply for each crane shall be derived from its power supply through individual control transformer.

CABLES AND CABLE INSTALLATION

Following types of cables shall be used.

33 kV Cables - XLPE / PVC insulated, 1100V Grade PVC Sheathed copper conductor, Armored.

All LT Power Cables - XLPE / PVC insulated, 1100V Grade PVC Sheathed copper conductor, Armored.

Lighting circuit cable - PVC insulated, copper conductor, Armored.

Control cables 1100V Grade - PVC insulated, PVC sheathed, copper Conductor, armored, multicore.

Fire protection system cable - Copper conductor armored, multicore and FRLS insulation

Public address system and communication - Unshielded twisted pair cables shall be used

Following minimum size of conductors shall be used.

- Lighting cables 2.5 Sq. mm Copper
- Control cables 2.5 Sq. mm Copper

The following shall be the routes and earthing grades of various voltage grade cable

- 33 kV cable shall run between the client's 33 kV feeder shall be buried in the ground/ laid in trench.
- 415 V cables shall be of 1100 V grade and shall run in cable trays on pipe sleeper or built up trenches, from L.T. switch gear to various loads.
    - Control cables shall be of 1100 V grade and shall run in separate trays or built up trenches, from L.T. switch gear to push buttons, PLC / DCS etc.
    - 1100 V grade copper conductors in fire retardant insulation shall connect all devices of fire protection system. Separate tray shall be provided for these cables.
    - P.A. system and communication cables shall be unshielded twisted pair armored cable and they shall connect the speakers and handsets to the P.A. system master console. Separate tray shall be provided for these cables.

Cable Sizing

Cables shall be sized considering the factors such as maximum continuous current, ambient temperature, grouping proximity, installation medium, voltage drop limitations and short circuit withstand criteria.

For the purpose of sizing of cables, following maximum allowable voltage drop in cables shall be considered.

Power feeders (MDB to MCC / SDB)	:	2%
Motor feeders at full load (MCC to motor terminal)	:	3%
Motor feeders during starting	:	15%
Lighting circuit (Lighting panel to farthest fitting)	:	2%
Instrumentation system	:	3%

CABLE INSTALLATION

In general, cable laying shall be done as follows:

- Overhead cable trays on the pipe rack wherever available. Otherwise concrete trenches for paved areas and directly buried in ground for unpaved areas shall be used.
- Ladder type cable tray supports shall be of galvanized steel, suitable for spanning 2.0 meters between supports when loaded.
- In unpaved areas, cables shall be directly buried in ground. Where underground cable cross roadways, pipe sleepers on grade etc. they shall be protected by pipe sleeves/ducts. Concrete duct banks shall be used for road crossing. In paved area concrete cable trench shall be used.
- Cables laid underground in concrete trenches shall have precast slab cover with special marking.
- Cable laid on the pipe rack, walk way shall be provided along with the cable trays to facilitate cable laying and maintenance.

Cable trays, racks and trenches shall be sized to allow for 40% future cable reserve.

All cable trays and accessories shall be prefabricated and hot dip galvanized to a thickness of 610 gms / Sq.m

LIGHTING

Entire plant lighting shall be divided into following two categories:

- Normal AC lighting
- Emergency lighting & Exit Signage

Normal lighting panels shall be supplied by three phase and neutral 415V power derived from Main Lighting Distribution Board. MLDB shall be supplied from MDB

The emergency lighting shall be supplied by 220V, AC from UPS system system having battery back-up.

The emergency lighting shall be normally `ON' and continue to operate without any interruption during normal power failure.

The average illumination level over the entire plant area shall be as follows:

a) Control room400 lux

b) Administration Building 300-400 lux

c) Instrument rack rooms 200 lux

d) Corridors 150 lux

e) Toilets & Lockets room 100 lux

f) Stores 100 lux

g) Switchgear rooms 250 lux

h) Workshops 300-400 lux

i) General access & stairs 100 lux

j) Road 5 - 10 lux

k) Outdoor area 30 lux

The following lighting fixtures shall generally be used in the plant:

a) 2x36W, industrial type LED lighting fixtures shall be used in switch gear room,

b) staircase, toilets, etc.

c) 4x18 W, LED fixtures shall be used for offices, control room, etc.

d) 125W High bay LED fixtures shall be used in assembling area.

e) 150W LED lighting fixtures shall be used for High bay areas

Maintenance factor for all indoor lights shall be 0.8 and 0.7 for all outdoor lights. Reflection factors for control rooms shall be 50% for Ceiling, 30% for Wall and 30% for Floor. For all other indoor areas reflection factor will be considered as 30% for Ceiling 30% for Walls and 10% for Floor. No reflection factor will be considered for outdoor areas.

Convenience receptacles shall have necessary mechanical interlocks and earthing facilities. Sockets for welding machines shall be rated for 63A at 415V 3 phase, 50Hz with a scrapping earth. 3 Pin 240 V, 50Hz Power receptacles of 5A and 15A ,3pin shall be provided in all buildings / areas.

EARTHING SYSTEM

Earthing system in general shall cover the following:

- Equipment earthing for personnel safety
- System neutral earthing
- Static and lightning protection

- Instrument signal earthing

The system shall envisage an earthing network of proper size of earthing conductor with designed number of earth electrodes attached to it. The following shall be earthed.

System neutral as follows:

- 33kV system earthed
- 415V System Solidly earthed

- Current and potential transformer secondary's.

- Metallic non-current carrying parts of all electrical apparatus such as transformer, switch gear, motor, lighting distribution board, lighting fixtures, cable trays, terminal boxes, junction boxes, instrument cabinets and cases etc.

- Steel structure

- Storage tanks and all equipment

- Cable shields

- Lightning protection system

For signal/case/intrinsically safe signal grounding of control room instruments, separate earth pit shall be provided and not connected to main ground grid. Control cabinets shall be connected to this separate earth pit.

The earth conductor shall be adequately sized to carry the maximum fault current without undue temperature rise. All joints shall be protected to prevent corrosion.

All electrical equipment operating above 250V shall have two separate and distinct connections to earth grid.

Earth bus bar will be provided in switch gear and MCC rooms, control rooms and similar rooms where major electrical equipment's are installed.

The earthing system shall be designed so that satisfactory operation of the earth fault protective devices of the electrical equipment connected to the system will be achieved.

The resistance to earth of any part of the earthing system shall not in any case exceed 1 ohm.

Lightning protection shall be provided for the equipment/structure and buildings which are higher than 20 meters. Separate ground electrode for this purpose shall be located and interconnected with the main electrical ground system

Communication System

The plant communication system shall include the following facilities.

a. Telephone system

b. Public address system

Plant communication system shall be fed from UPS system.

Telephone system shall include the following equipment.

a. A EPABX telephone exchange of 25 extensions with the interface facility to connect the existing P&T lines.

b. Power supply unit.

c. Telephone stations.

d. Field cable installation as necessary.

The public address system with talk back facility shall be provided around the plant.

The PA system shall have the following operational features.

- Over all or a group of speakers from central station.
- Two-way communication between any hand set station and central station.
- Conference facility through central station.
- Intercommunication between selected hand set stations through central station.
- Direct communication between selected hand set stations.
- Emergency siren over the page channel.

The PA system shall comprise the following principal items:

a. Central broadcast console

b. Amplifier units

c. Field loud speakers

Protection and Metering

The protective system shall be selected and coordinated so as to ensure the following:

Protection of equipment against damage which can occur due to internal or external short circuits or atmospheric discharges.

As far as possible, continuity of operation of those parts of the system not affected by the fault.

Personnel and plant safety.

In general, quick acting relays shall be used and all fault tripping shall be done by high speed tripping relays.

Fire Alarm System

The type of fire alarm system shall be conventional type. The fire detection and alarm system shall comprise the following: -

i. Automatic smoke and fire detectors

ii. Ionization smoke detectors

iii. Optical smoke detectors

iv. Heat detectors

v. Response indicators

vi. Manual call points

vii. Audio Visual hooters

viii. Fire alarm panels

viii. Repeater panels

The plant shall be divided into zones as per IS 2189 - 1998. The floor area of each zone shall not exceed 2000 sq.m.

There shall be two types of panels for the fire detection and alarm system Viz. Main fire Alarm Panel (MFAP) and repeater panel. The MFAP shall be located in the central control room of T-G building. The MFAP shall control fire detection and alarm system of a zone and receive annunciation of other zones. It shall have control over deluge systems and it shall trip air handling ventilation units if any in its zone.

The repeater panels shall be located in the guard house and it shall receive the annunciation of each zone.

The MFAP shall be individually connected to the repeater panels through multi-core cables.

No of detectors / devices in each zone shall not exceed 20 Nos as per IS 2189 -1988 Clause 3.1.1.

Area above false ceiling and below false floor shall also be covered by automatic detection system.

The manual call points shall be strategically located in such a way that the search distance shall not exceed 30 M.

Hooters shall be of audio-visual type. The xenon beacon (Flash light) of the hooter shall be an integral part of the hooter. The sound level of the hooter shall be minimum 75 dB (A).

The MFAP, and Repeater panels shall be micro-processor based, compact sleek, and self-standing type.

System shall operate on an input of 240 V single phase. 50 Hz A.C. In the event of A/C failure the standby secondary power supply shall automatically provide the power source.

The detectors shall be designed to operate on 24 V DC power supply (24 V DC supply shall be built in the MFAP and repeater panel).

All cables shall be of 1100 V grade PVC insulated FRLS over all sheathed 1.5 sq.mm armored copper cable.

ELECTRICAL EQUIPMENT LAYOUT

Transformers shall be mounted on transformer plinth of correct size such that no person may step on the plinth and inadvertently come close to the line parts.

A clear space of not less than 1000 mm should be provided around the transformer as measured from “the farthest point of transformer” to the coping of the structure supports.

Oil draining facilities should be provided for transformer if the capacity of oil in one transformer or the aggregate capacity of oil in all the transformers exceeds 2000 litres. The oil soak pit should be located at more than 5 meters from the transformer.

Spacing between MV. and L.V. switch gears located in the same room should be at least 2 meters.

MV. Cable trench depth shall be designed to account for the bending radius of the cables. The depth and width of the trench shall be as per the layout drawings. Directly buried

cables shall be placed on a layer of sand on the bottom of the trench. The cables shall be covered with 150 mm of sand on top of the largest diameter cable and sand shall be lightly pressed. A protective covering of 75 mm thick second-class red bricks shall then be laid flat. The remainder of the trench shall be back filled with soil rammed and levelled.

The tray stack shall have a vertical gap of 250 mm between trays. The tray supports shall be derived from insert plates located on the cable vault roof. The cable trays shall be galvanized and pre-fabricated and the accessories shall have adequate bending radius to suit the cables.


Overall
Development
Cost

Chapter 9

Overall Development Cost

The overall development cost for the proposed Ship Repair Facility has been estimated, covering waterside development, landside development, and MEP services. The estimated cost is ₹321.39 crores (excluding GST), with major allocations towards waterside works, landside infrastructure, and essential MEP services works along with supporting utilities.

These estimates form the basis for implementation, ensuring optimal utilization of resources while meeting immediate and future repair facility requirements.

Table 9. 1 Abstract of Estimate of Total Development Cost

S.No	Description	Amount in Crores
1.	Waterside Development (MEP Services included)	277.43
2.	Landside Development (MEP Services included)	43.96
Grand Total (Excluding GST)		321.39

Note: 1. If the project has to be developed by a third-party operator, like, CSL, additional handling cost of 15% may be included.

Recommendations and way forward

After detailed analysis of the site environment, data shared by IWAI and various discussions & deliberations held with IWAI Authorities, the following conclusions are arrived at.

1. Sufficient water depth is available at the identified site, even at the lean seasons, to handle all the IWAI vessels having draft up to 2.5m. However, the water level is varying substantially and the average water level variation is around 10.437m and the maximum level variation is 14.16m. In view of the such huge variation in the water level, it is recommended to develop a boat hoisting jetty with other landside infrastructure can be developed.
2. The top of the proposed Boat Hoisting jetty is fixed, with sufficient free board over and above the highest high water level, at a level of 75m (CD) or such elevation for ensuring seamless

operation of Ship Repair Facilities (to be reconfirmed during the Detailed Design stage). The backup facilities such as repair bay, transfer bay, are located immediately behind the boat hoisting jetty over the piles without affecting the natural water flow, while other landside infrastructure viz., workshops, substations, admin buildings, road & rail connectivity (if possible), etc., can be developed in the area identified by IWAI admeasuring 20,000 sq.m.

3. The project may be implemented inter-alia covering the boat hoisting jetty of 60m long, repair bay of 2100 sq.m, admin building, workshops, approach roads shall be developed as detailed in Figure 5. 8, at a total estimated cost of ₹ 304.87 Crores.

Considering all these aspects, particularly availability of sufficient water spread area with required water depth and land for developing the backup infrastructure facilities, it is technically feasible and financially viable to establish a Ship Repair Facilities at the identified location Varanasi. Uttar Pradesh, as shown in Figure 30 which will result in both direct and indirect benefits and considerable savings in cost & time, and also create substantial employment potential for the country, as a whole and Uttar Pradesh in particular.

Preliminary design for proposed structure are based on the Geotechnical data of the proposed site and Topographical survey charts as readily available with IWAI. However, the details shall be authenticated with Geo-Technical and Geo-Physical studies to be undertaken prior to invitation of Tenders.

Prof. K. Murali