NO.: SMPK/KDS/CIV/T/2622/1367 **DT. 09.12.2021**

CORRIGENDUM-II

Name of Work: DESIGN, ENGINEERING & CONSTRUCTION FOR REHABILITATION OF 7, NSD OLD BERTH INCLUDING DEVELOPMENT OF BACK YARD AT N.S. DOCK, KDS, SMP, KOLKATA".

NIT NO: SMPK/KDS/CIV/T/2622/60. DT. 29.10.2021

Corrigendum-I- SMPK/KDS/CIV/T/2622/1356 DT. 07.12.2021

An **additional Section 13- Design Basis Report** (Attached herewith) is to be read under **"Part C-Technical Bid"** of the tender document, which is a part of the tender document.

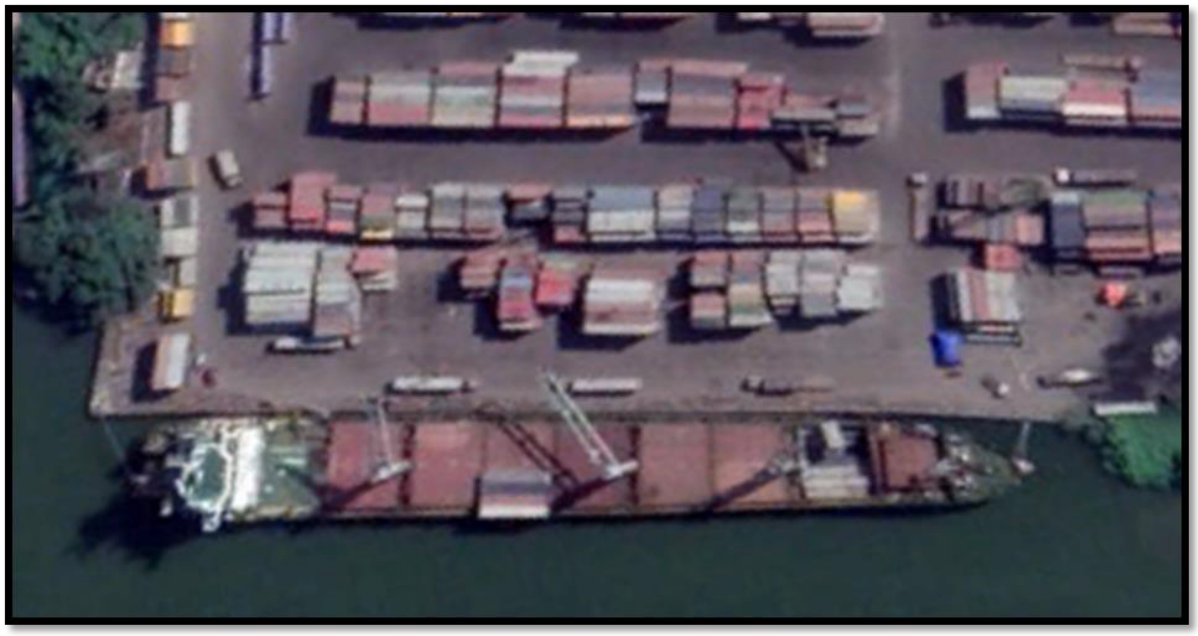
Bidders are requested to upload this **'CORRIGENDUM-II'** duly signed under office seal along with their Techno-Commercial Bid (Part-I) as an acknowledgement and acceptance.

All other terms & conditions and clauses will remain same as per original.

Superintending Engineer (Contract Cell)

For मुख्य अभियन्ता / **Chief Engineer, SMPK**

UPGRADATION OF BERTH NO 7 AT NETAJI SUBHAS DOCK UNDER KOLKATA DOCK SYSTEM SYAMA PRASAD MOOKERJEE PORT TRUST - KOLKATA



DESIGN BASIS REPORT

(TO BE TAKEN AS REFERENCE)

Doc No: IITM/DOE/SMPK/BN7/DBR/01

CLIENT:

Netaji Subhas Dock
Kolkata Dock System
Syama Prasad Mookerjee Port Trust

CONSULTANT:

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LIST OF ABBREVIATIONS

SMPK	Syama Prasad Mookerjee Port Kolkata (Erstwhile Kolkata Port Trust (KoPT))
KDS	Kolkata Dock System
NSD	Netaji Subhas Dock
HDC	Haldia Dock Complex
K.O.D.S	Kolkata Old Dock Sill Level
RCC	Reinforced Cement Concrete
PCL	Pile Cut off Level
CD	Chart Datum
DWT	Dead Weight Tonnage
DT	Displacement Tonnage
RMQC	Rail Mounted Quay Crane
HMC	Harbour Mobile Crane
IS	Indian Standards
IRC	Indian Road Congress

Project Background

The Port of Kolkata is a riverine and oldest operating port in India, it and was constructed by the British East India Company. Syama Prasad Mookerjee Port comprises of two dock systems one at Kolkata and other at Haldia. Kolkata Dock System comprises of three sub components, i.e., KidderPore Dock (KPD), Netaji Subash Dock (NSD) and Budge Budge Oil Jetties. On that, NSD comprises of dock basin with a single lock entrance and has 10 berths and 2 dry docks.

There are 5 container berths in NSD. Of these 5 berths, Berth 3, 4, 5, & 8 have HMCs operated by PSA, and Berth 7 operate as crane-less berths. The productivity of HMC berths is already meeting benchmarks, thus converting the other 1 crane-less berths into HMC berths will help increase capacity. Berth no 7 does not have the berth strength to hold an HMC, therefore, it needs to be operated as a crane less berth, so they want to upgrade berth no 7 and to introduce RMQC/HMC operation.

1.0 SITE PARTICULARS

1.1 Project location

The Port of Kolkata is a riverine port in the city of Kolkata, India, located around 203 km (126 mi) from the sea. It is the oldest operating port in India and constructed by the British East India Company. The Syama Prasad Mookerjee Port Trust (SMPK) manages two separate dock agglomerations - the Kolkata Dock System (KDS) and the Haldia Dock Complex (HDC).

Figure 1.1.1: Netaji Subhas Dock layout

KDS is situated on the left bank of the Hooghly River at 22°32′53″N 88°18′05″E about 203 km (126 mi) upstream from the sea. The pilotage station is at Gasper/ Sagar roads, 145 km to the south of the KDS (around 58 km from the sea). The system consists of:[12]

- KidderPore Docks (K.P. Docks) : 18 Berths, 6 Buoys / Moorings and 3 Dry Docks
- Netaji Subhas Docks (N.S. Docks) (Figure 1.1.1): 10 Berths, 2 Buoys / Moorings and 2 Dry Docks
- Budge Budge River Moorings: 6 Petroleum Wharves
- Anchorages: Diamond Harbour, Sagar Road, Sandheads

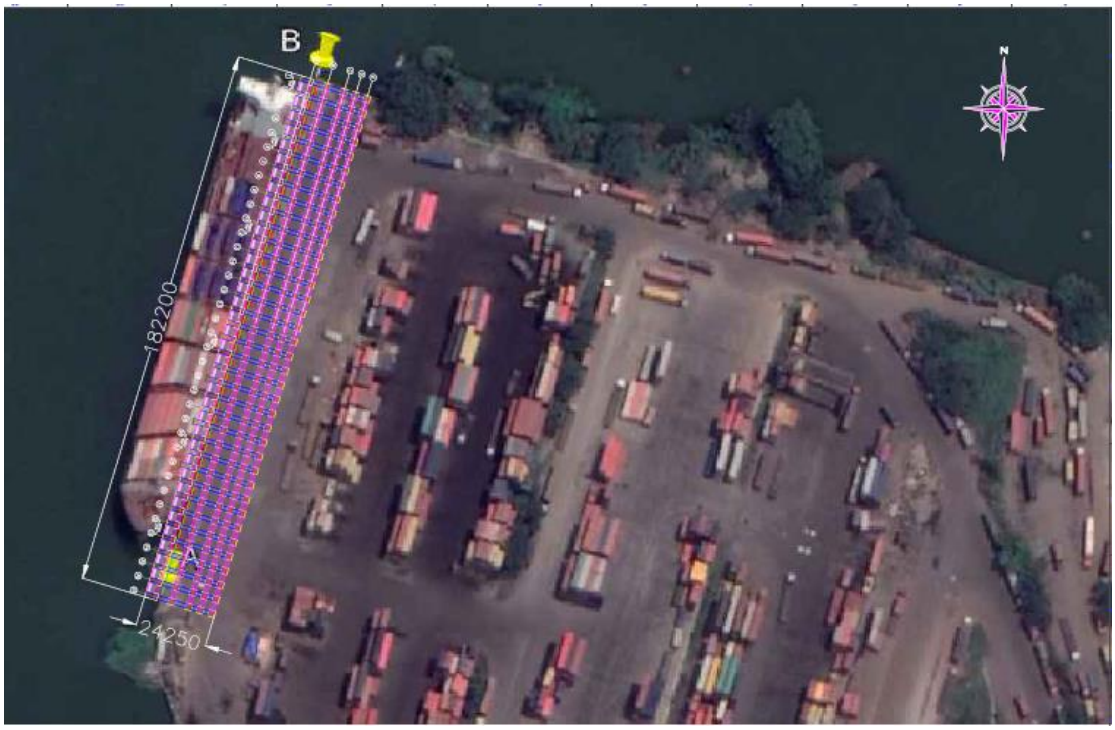

Figure 1.1.2: Location of the Proposed Berth number 7

1.2 Existing Structure

The existing berth 7-NSD (Figure 1.1.2) is to be converted to container Terminal – II. It is initially designed for 2.7 t/m2. The existing bed / dredge level in the location of the berth is approximately (-) 5.18m K.O.D.S. The width of the existing jetty is approximately 88m and it was constructed through Frankie pile. There are total of 14 rows of pile in the longitudinal direction and 28 rows of pile along the berthing phase. From the row P-J the jetty is rested on filled soil up to the deck level and from row J-A the filling slopes gradually up to the dredge level.

1.3 Proposed Structure

The proposed phase 3 (piled structure) 7-NSD berth size is 182.2×24.25m. It is proposed to remove the deck structure and drive piles in between the existing piles. The 1200 mm dia. piles shall be driven in-between the existing pile arrangement. The new structure shall cater a maximum live load of 5 t/m^2.

2.0 METEOROLOGICAL AND OCEANOGRAPHIC DATA

2.1 Meteorological data

2.1.1 Climate

The climate of the West Bengal is tropical having four well-marked seasons, i.e., summer (March – May); monsoon (June – September); post monsoon (October – November); winter (December – February).

2.1.2 Temperature

The month of May is the hottest, whereas December and January are colder months Kolkata. According to the IMD data between 1961 and 1990, the highest temperature recorded in 30 years is 40.6°C at Kolkata while 36.1°C at Sagar Island, which is closer to the lowest temperature was observed to be 9.7°C for Kolkata.

2.1.3 Rainfall Data

This region is mainly exposed to Southwest monsoon from June to September and an annual rainfall of more than 1700 mm were reported for the two locations. The IMD data suggests that the months of July and August are the wettest months having monthly rainfall of more than 350 mm. During northwest monsoon from November to March, monthly average rainfall of less than 50 mm is experienced.

2.1.4 Visibility

The area is free from industrial smoke. At times due to heavy rainfall poor visibility is reported during the southwest monsoon. On an average, fog is reported on 5-7 days in each month from November to February during morning hours.

2.1.5 Wind

The predominant wind direction reported at Alipur, Kolkata and Sagar Island, is from south and southwest. About 25 % of the time wind was reported to be blowing from north and northeast. The highest wind speed of 16 knots was reported in the month of May. During the months of April to August, wind speed was found to be higher than 10 knots.

2.2 Oceanographic data

2.2.1 Tidal data

The below mentioned tidal data was collected from external resources and references,

The tidal details at Kolkata are as follows:

The top level of 7-NSD Berth is at a level of (+)7.32m above K.O.D.S while the dredged bed level of dock basin is at a level of (-)5.18m below K.O.D.S. The Dock water level varies from (+) 5.33m to (+)5.18m below K.O.D.S. Incidentally, the K.O.D.S level is 2.82m below M.S.L.

2.2.2 Current Data

As the berth is within an impounded dock system and in a tranquil condition, so there is no flow velocity.

3.0 GEOTECHNICAL DATA

3.1 General

The Civil Engg. Dept of SMPK, Kolkata has completed the soil investigation through M/s. Constell Consultants Pvt. Ltd, Kolkata and submitted the final soil report on 19th Jan 2021. (For detail refer separate Soil Investigation Report).

4.0 GENERAL ARRANGMENTS

The proposed structure is designed to cater 5 t/m2. Since the existing deck slab is in very bad shape. Due to excessive heavy loading applied more than the designed load had led to cracks on the structural elements. The corrosion in reinforcement has developed very intensely due to the cracks in the structural elements. From visual inspections chlorination effects are very high such that the structural elements cannot be used.

The up gradation will take place in three phases (Figure 4.1):

(i) **Phase -I**: Container stacking area (i.e) area between pile row P and row J of existing berth.

(ii) **Phase-II**: Transit area (i.e) area between pile row J and row E of existing berth.

(iii)**Phase-III**: Berthing area (i.e) area between pile row E and row A of existing berth.

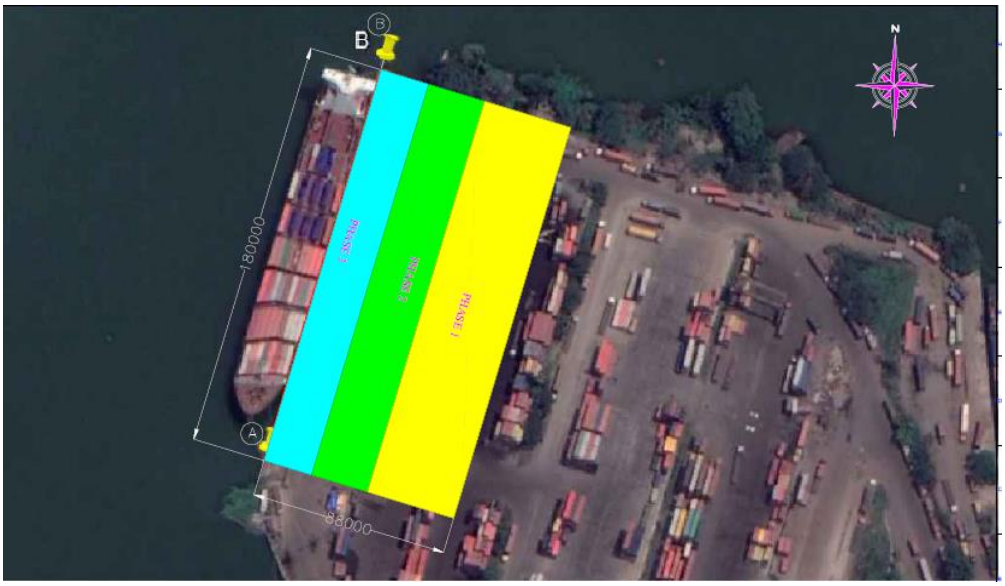

Figure: 4.1 Image shows the phase wise construction

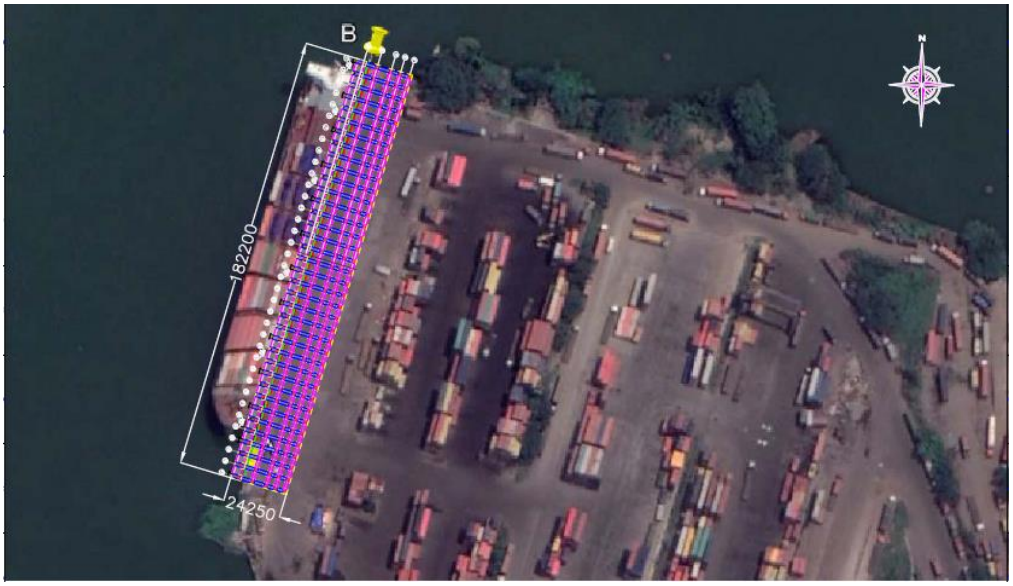

Figure: 4.2 Layout of the Proposed Berth Structure (in Phase III)

Table 4.1.1 Dimensions of structural component of berth no – 7-NSD berthing phase

S. No	Description	Dimensions
1.	Pile	1200 mm dia
2.	Pile Muff - 1	3750 x 2200 x 500 mm
3.	Pile Muff - 2	1600 x 1600 x 450mm
4.	Main beam	1500 x 1400 mm
5.	Long beam	1500 x 2000 mm
6.	Crane Beam	800 x 1400 mm
7.	Coping Beam	1500 x 1400 mm
8.	Fender Beam	1000 x 1400 mm
9.	Service Trench	1250 x 600 mm
10.	Precast Slab	250 mm Thick
11.	Cast - Insitu Slab	250 mm Thick
12.	Wearing coat	40 mm Thick

***The above dimensions/sizes information only.**

5.0 DESIGN LOADS

5.1 Dead Loads

The dead load shall be assessed considering the following unit weight of materials.

- Plain Concrete : 24.0 kN/m^3
- Reinforced Concrete : 25.0 kN/m^3
- Sea water : 10.25 kN/m^3
- Steel : 78.5 kN/m^3
- Oil : 930 kg/m^3

5.2 Live load

Following type of various live loads shall be considered in the design of berth structures. No live load shall be considered in the event of cyclone.

5.2.1 Uniformly distributed live load on berth

Uniformly distributed live load (UDL) of 5 t/m^2 shall be considered on the deck area. UDL shall be reduced to half under the RMQC while considered simultaneously with crane load. On the front sea side cantilever portion (beyond sea side crane rail). UDL of 1 t/m^2 shall be considered.

5.2.2 Stacking of containers

Berth structure shall be designed for live load due to stacking of 5 high containers between crane rails/transit area/stack yards. Gross weight and self-weight of container are considered as 35 t gross weight (Containers of 40TEU & 20TEU).

Corner loads of containers shall be applied over a casting area of 178mm×168mm. Maximum corner load will be at the junction of 4 containers.

5.3 Seismic Force

Seismic force shall be calculated according to IS 1893-2016, considering 100 % dead load + 50 % live load acting on the structure. The basic horizontal seismic coefficient (Ah) is calculated as given below:

$$A_h = \frac{(Z/2)(S_a/g)}{(R/I)}$$

Where,

Zone factor	:	Z = 0.24	(Table 3 – IS 1893 (Part-I) 2016)
Importance factor	:	I = 1.5	(Table 8 – IS 1893 (Part-I) 2016)
Response reduction factor	:	R = 3	(Table 9 – IS 1893 (Part-I) 2016)
Avg. response acceleration coefficient	:	S_a/g	(Depends on natural time period of structure)

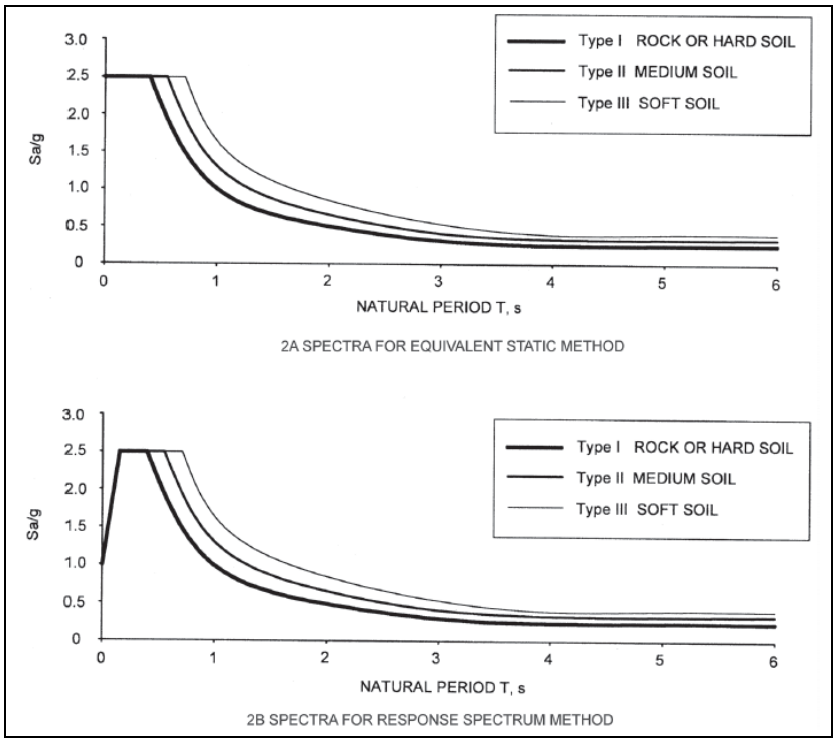

Figure 6.1: Design acceleration coefficient corresponding to 5% damping

5.4 Current Force

The berth is housed inside impounded dock basin. Thus, there is no impact of river current here and the basin itself in a tranquil state.

5.5 Crane and Vehicular Load

The design of the berth and yard has to be undertaken for the following **FIVE c**ases:

Case –I: With MHC of Liebherr LHM425

with four pads each having size of 1.8m×5.5m spacing between center line of pads on either direction as 12.5m with extreme pad pressure of 18.5 t/m^2

Case –II: With RMQC, Only provision for installation RMQC on rail to be made.

Case –III: With RST.

Case –IV: Combination of case I & Case III

Case –V: Combination of case II & Case III

Along with that the following IRC vehicular live load shall be considered in the design of berth structure and stackyard:

- IRC class 70R

- IRC class AA
- IRC class A

5.6 Berthing Force

Berthing loads is calculated in accordance with IS 4651 (part III) - 1974. The berthing velocity and berthing angle for the design of fender system is given Table 6.4.1. The fender system is designed to accommodate the design vessel as specified in Table 6.4.1.

5.7 Mooring Load

Mooring loads is calculated in accordance with IS 4651 (part III) –1974. Mooring force is calculated based on the vessel size. The mooring force for proposed upgradation of berths is chosen from IS 4651 (part III) –1974, as shown in figure 5.7.1.

TABLE 4 BOLLARD PULLS
(Clauses 5.3.4 and 6.1)

Displacement (Tons)	Line Pull (Tonnes)
(1)	(2)
2 000	10
10 000	30
20 000	60
50 000	80
100 000	100
200 000	150
Greater than 200 000	200

Figure 5.7.1: Line pull as per IS 4651(Part-III)-1974

5.8 Soil Spring Value

The soil springs are used to idealize the pile soil interaction. The following formula is used to calculate the individual spring constants.

Top spring value

$$K_1 = \frac{BL}{24}(7Ks_1 + 6Ks_2 - Ks_3)$$

Intermediate spring value

$$K_i = \frac{BL}{12}(Ks_{i-1} + 10Ks_i + Ks_{i+1})$$

Bottom spring value

$$K_n = \frac{BL}{24}(7Ks_n + 6Ks_{n-1} - Ks_{n-2})$$

Where,

B : Diameter of pile/ Width of the Diaphragm wall

L : Segment length of pile (Spacing between springs)

K_s : Modulus of sub grade

$$K_s = \frac{0.65}{D}\sqrt[12]{\frac{E_s \times B^4}{E_b \times I}}\frac{E_s}{1-\mu^2}$$

where,

E_s : Elastic modulus of the soil

E_b : Elastic modulus of the pile

I : Moment of inertia

D : Diameter of pile

μ : Poisson's ratio

5.9 Load Combinations

Load combination factors for the analysis shall be considered as per IS 4651 (Part-IV) 2014. The load combinations for each structure varies with respect to the loads considered to be acting on the structure as shown in figure 5.9.1

Table 1 Partial Load Factors for Loads in Limit State Design
(*Clauses* 5.1 and 7.1.2)

Sl No.	Loading	Partial Load Factor					
		Limit State of Serviceability		Limit State of Collapse			
		Short Term	Long Term	Normal	Extreme/ Survival	Temporary	Reversal
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
i)	Dead load (DL)	1.0	1.0	1.5	1.2	1.2	0.9
ii)	Vertical live load:						
	a) Impact or dynamic load (DyL)	1.1	0.5	1.5	1.2	1.2	0.9
	b) Static(LL)	1.0	0.5	1.5	1.2	1.2	0.9
iii)	Earth pressure (EP)	1.0	1.0	1.2	1.0	1.0	1.0
iv)	Hydrostatic force (HyF)	1.0	-	1.0	1.0	1.0	1.0
v)	Wave and current force (WL and CL)	1.0	-	1.2	1.0	1.0	1.0
vi)	Berthing force(BF)	1.0	-	1.5	1.0	-	1.5
vii)	Mooring force(MF)	1.0	-	1.5	-	-	1.5
viii)	Working wind force (WWiF)	1.0	-	1.0	-	-	-
ix)	Extreme wind force (EWiF)	-	-	-	1.2	-	1.5
x)	Shrinkage	-	1.0	-	-	-	-
xi)	Creep	-	1.0	-	-	-	-
xii)	Temperature (TempL)	-	1.0	-	-	-	-
xiii)	Seismic force (EL)	1.0	-	-	1.2	-	1.5
xiv)	Tsunami force (TL)	-	-	-	1.2	-	-
xv)	Secondary stresses (SS)	1.0	-	-	-	-	-

Figure 5.9.1: Load combinations

6.0 GENERAL DESIGN CRITERIA

6.1 Structural Design

The main considerations followed in the design of structures are:

a. Structural safety and stability.

b. Availability of material, equipment and expertise.

c. Constructability and ease of maintenance.

d. Durability.

e. Maximum DWT of ship, which will be berthed during life time of the structure.

6.2 Materials and Cover

6.2.1 Concrete

M40 grade of concrete shall be used for all the structural elements of the proposed structure. Blast furnace slag cement shall be used for construction.

6.2.2 Reinforcement

High yield strength deformed bars of grade Fe 500 D conforming to IS 1789 shall be used.

6.2.3 Clear cover to reinforcement

The clear cover to the reinforcement for the structural components is furnished below:

Pile	:	75 mm
Pile & Column muff	:	60 mm
Column	:	60 mm
Beam	:	50 mm
Slab	:	40 mm

6.3 Design Life

- The design life of the proposed new facility is 50 years
- This design life criterion is based on maintenance system as follows:
  a. Frequency of inspection & repairs of work is 5 years.
  b. The design life of the fender is 10 years.
  c. The design life of the Bollard is 10 years.

6.4 Vessel specifications

The port expects container vessels with length of 172m. The entire arrangement of the proposed berth no 7-NSD container handling jetty is to be planned taking this range of length of ship into consideration. The design vessel specification is tabulated below:

Table 6.4.1 Vessel specifications

Description	Size
DWT	18,000 t
Length	172 m
Beam	25 m
Draft	6.13m
Berthing velocity	0.2 m/s
Berthing angle	10 °

*As per NSD/KoPT letter vide No.**HT/1443/NSD/349 dated 12.07.19** and **HT/1443/NSD/542 dated 04.09.2019**. The berthing angle is considered as per the document sent to IITM vide Mail dated 04 Sep 2019. Also, consideration of IS 4651 (Part-III): 1974, with moderate berthing condition and considering the site condition with moderate wind and swells, the berthing velocity is considered as 0.2 m/s.

6.5 Indian Standards

The design shall be carried out in accordance with the applicable Indian codes and standards. Wherever, Indian standards are not available for a particular application, other reputed international codes or guidelines may be used. List of recommended codes and standards are given below:

LIST OF STANDARDS

IS 456-2000	:	Plain And Reinforced Concrete - Code Of Practice
IS 2911-2010 (Part 1/ Sec 2)	:	Design And Construction Of Pile Foundations — Code Of Practice
SP-16	:	Design Aids For Reinforced Concrete To IS 456-1978.
IS 4651 – 1974 Part I	:	Ports And Harbours - Planning And Design - Code Of Practice- Site Investigation
IS 4651 – 1989 Part II	:	Ports And Harbours - Planning And Design - Code Of Practice- Earth Pressure
IS 4651 – 1974 Part III	:	Codes Of Practice For Planning And Design Of Ports And Harbours - Loading.

IS 4651 – 2014 Part IV	:	Planning And Design Of Ports And Harbours - Code Of Practice - General Design Considerations
IS 4651 – 1980 Part V	:	Code Of Practice For Planning And Design Of Ports And Harbours -Layout & Functional Requirements
IS 12269 – 2013	:	Ordinary Port Land Cement – Grade 53
IS 1786 – 2008	:	High Strength Deformed Bars
IS 875 - 1987(Part I)	:	Code Of Practice For Design Loads - Unit Weights Of Building Materials And Stored Materials
IS 875 - 1987(Part II)	:	Code Of Practice For Design Loads-Imposed Loads
IRC 6 : 2000	:	Code Of Practice For Road Bridges - Loads & Stresses
IRC 21: 2000	:	Code Of Practice For Road Bridges - Cement Concrete (Plain & Reinforced)
IS 1893 (Part 1) :2016	:	Criteria For Earthquake Resistant Design of Structures
AASTHO	:	Guide For Design of Pavement Structures
GE14	:	Guidelines For Earthwork In Railway Projects

6.6 Analysis

3D analysis shall be carried out using STAAD ProV8i package for various critical load combinations. The P-δ analysis will be carried out. The springs are used to idealize the soil structure interaction. The soil is considered with respect to the bed level/scour level depending on the location of the structure.

6.7 Design Methodology

The various components of the structure will be designed according to various standards mentioned in section 6.6. All the elements shall be designed as per Limit State of Collapse and checked for Limit State of Serviceability.

6.8 Deflection

Deflection due to all loads including creep and shrinkage should not exceed span/350 as given in Clause 23.2 of IS 456:2000 and also as per vendor requirements.

6.9 Crack Width

Crack width will be checked in accordance with IS 4651 (Part 4)-2014. As a guide, assessed surface width of cracks at points nearest to the main reinforcement should not exceed 0.004 times the cover of the main reinforcement or maximum crack width in different zones given in Figure 6.9.1, whichever is minimum. Limit State of Serviceability load combinations is considered for crack width calculation.

Table 3 Maximum Crack Width in Different Zones

(*Clause* 8.3.4)

All dimensions in millimetres.

Sl No.	Exposure Zone	Maximum Crack Width	
		Sustained Load	Transient Load
(1)	(2)	(3)	(4)
i)	Atmospheric zone — above splash zone and where direct wave or spray impingement is infrequent	0.2	0.3
ii)	Splash zone — zone between the chart datum and the design wave height above the mean high water springs	0.1	0.2
iii)	Continuous seawater immersion zone — below splash zone upto seabed level	0.2	0.3
iv)	Below seabed level	0.3	0.3

NOTES

1 *Sustained load* — Dead load plus 50 percent of full uniformly distributed live load + earth pressure.

2 *Transient load* — Dead load plus berthing load and full crane load or full live load uniformly distributed + earth pressure.

Figure 6.9.1: Crack width as per IS 4651 (Part 4) – 2014

7.0 PILE FOUNDATION

The weakest soil profile from the geotechnical investigation report is considered for the analysis and arriving at the pile capacity. Following points were taken into consideration when designing the piles.

a) Foundation capacity calculations are calculated as per IS 2911(Part I/ Section II):2010 guidelines for bored cast-in-situ RC piles.

b) A minimum spacing of 3 times the diameter of pile is maintained between piles to avoid pile group effect. When this is not possible, the piles were checked for group effect.

c) Reinforcement detailing is done as per IS 2911 guidelines.

The allowable load Q_{ap} on the pile is given by the equation

1) ***For Granular soils***

$$Q_u = KP_{di} \tan\delta A_{si} + A_p(½ D\gamma N\gamma + P_d N_q)$$

Where

A_p – Cross section area of pile toe in cm^2

D – Stem diameter in m

P_d – Effective over burden pressure at pile in kg/cm^2

$N\gamma$, N_q – Bearing capacity factors depending upon the angle of internal friction φ at toe

K – Coefficient of earth pressure

P_{di} – Effective overburden pressure in kg/cm^2 for i^{th} layer where I varies from 1 to n

δ – Angle of wall friction between pile and soil in degrees (may be taken equal to φ)

A_{si} – Surface area of pile shaft in cm^2

2) For Cohesive Soils

$$Q_u = A_p N_c C_p + \alpha\, c\, As$$

where,

A_p– Cross section area of pile toe in m^2

N_c– Bearing Capacity factor usually taken as 9

C_p– Average Cohesion at pile tip kg/cm^2

α – Adhesion factor (Refer IS: 2911)

c – Average cohesion throughout the length of pile in kg/cm^2

A_s – Surface area of pile shaft in cm^2

3) For Rock

$$Qu = C_{ub} N_c A_b + C_{us} A_s$$

where,

C_{ub} – Average shear strength of rock below the base of the pile in kg/cm^2

N_c– Bearing Capacity factor usually taken as 9

A_b – Cross section area of base of pile in m^2

C_u – Ultimate shear strength of the rock in the socketted length of the pile

A_s – Surface area of socket.

8.0 SUMMARY

This report gives outline and sufficient details of the general arrangement of each structure; design loads considered and design criteria for the structural components for the construction of upgradation of berth No 7 (Phase 3) at Netaji Subhas Dock (NSD). The design shall be prepared to satisfy all relevant Indian Standards.

The details of upgradation plan and structural arrangements for berth No. 7-NSD are discussed in this report and the design and drawing may vary, if existing substructure will obstruct while construction of new proposed structure.

(Dr. NILANJAN SAHA) **(Prof. R. SUNDARAVADIVELU F.N.A.E)**