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CONSTRUCTION & MAINTENANCE OF PORT STRUCTURES

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ABSTRACT

We have discussed here about the maintenance of port structure which includes breakwater facilities, marine fixtures, dredging techniques and disposal of dredged material and its impact on environment. Here, we have also discussed about the construction and strengthening of berth facilities in port area.

MARINEWORKS

1.1 Port

A port is a location on a coast or shore containing one or more Harbours, where ship can dock and transfer people or cargo to/from land. Repair works for ships are also carried out here.

OR

A terminus of great ocean trunk lines of communication a place where vessels may discharge or receive cargo; may be the commercial part of a harbour including its approaches and anchorages.

1.2 Harbour

Any protected water area affording a place of safety for vessels. A harbour is constructed artificially by protective works at a sea face.

OR

A harbour or haven is a place where ships, boats and barges can shelter through stormy weather or else are stored for further use.

Harbours are of three types:-

1) Artificial Harbour
2) Natural Harbour
3) Semi-Natural Harbour

Artificial harbours are constructed by dredging and have breakwaters, sea walls or jetty. Visakhapatnam Port Trust is a semi natural harbour because the inner harbour is protected by Dolphin's nose and Ross hill, outer harbour was created by construction of break waters.

1.3 Dock

A dock is a human-made structure or group of structures involved in the handling of boats or ships, usually on or close to a shore. DOCK may also refer to a dockyard or shipyard where the loading, unloading, building, or repairing of ships occurs.

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1.4 Berth

Berth is a term used in ports and harbours to define a specific location where a vessel may be berthed, usually for the purpose of loading and unloading. Berth is a structure which is constructed parallel to shore.

Most berths will be alongside a quarry or a jetty or pontoons (small harbours and marines). Berth are either general or specific to the type of vessel that use them in the process. The size of berth varies from 5-10 for a small boat in a marine to over 400m for the largest tankers.

1.5 Jetty

A Jetty is any of a variety of structure used in river, dock and maritime works which are generally carried out in pairs from rivers banks or in continuation of river channel at their outlets into deep water or out into decks and outside their entrance or for forming basin along the sea coast for port in tide less areas.

OR

A pier or breakwater constructed to protect a harbour or coast. Jetty is a structure which is perpendicular to shore. The loading and unloading is done on all the 3 sides of jetty.

1.6 Quay

A warf or quay is a structure on the shore of a harbour, where ships may dock to load or unload cargo or passengers. These include every facility for handling ships.

I INTRODUCTION

Port of Visakhapatnam is one of the 13 major ports of India is located In the East Central India on an embankment of the Bay of Bengal about 325 nautical miles north east of the port of Chennai (Formerly known as Madras) and about 468 kms. South West of the port of Paradeep . The port of Visakhapatnam is home to the headquarters of India's Eastern naval command . The port is located at latitude 17° 41'N and longitude of 83° 18'E on East coast of India in the Andhra Pradesh.

Fig. 1

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II HISTORY

Although the need for building a port on the east coast to access Central Provinces was felt by the British in the 19th century, the proposal of Col. H.Cartwright Reid of British Admiralty for constructing a harbour at Visakhapatnam was approved by the Government only after the First World War. The Inner Harbour was built by the Bengal Nagpur Railway between 1927 and 1933 to facilitate the export of manganese ore from the Central Provinces. The port, built at a cost of ₹378 lakhs was inaugurated by Lord Willingdon on 19 December 1933.

During the Second World War, the military significance of the port increased. After India's independence, the port witnessed growth under the various Five Year Plans. Over time, the port has grown from one with 3 berths handling 1.3 lakh tonnes per annum to one with 24 berths and annual traffic of 65 million tonnes. The port was notified as a major port in 1964 under the Major Port Trusts Act, 1963. Under the Act, the Visakhapatnam Port Trust is in charge of running the port.

Fig. 2

Visakhapatnam Port has three harbours - the outer harbour, inner harbour and the fishing harbour. The outer harbour has 6 berths capable of handling vessels with a draft up to 17 meters while the smaller inner harbour has 18 berths that are Panamax compatible. The Dolphin's Nose Hill to the north of the entrance channel protects the harbour from cyclones that strike the east coast.

The hinterland of the Visakhapatnam Port extends to Telangana and north eastern Andhra Pradesh, Chhattisgarh, south eastern Madhya Pradesh, southern Orissa and the Vidarbha region of Maharashtra. Iron ore, manganese ore, steel products, general cargo, coal and crude oil are the main commodities handled at this port.

III MAINTENANCE OF PORT STRUCTURE

3.1 Inner and Outer Harbour Works In Berths

Visakhapatnam port has two harbours.

- Inner harbour
- Outer harbour

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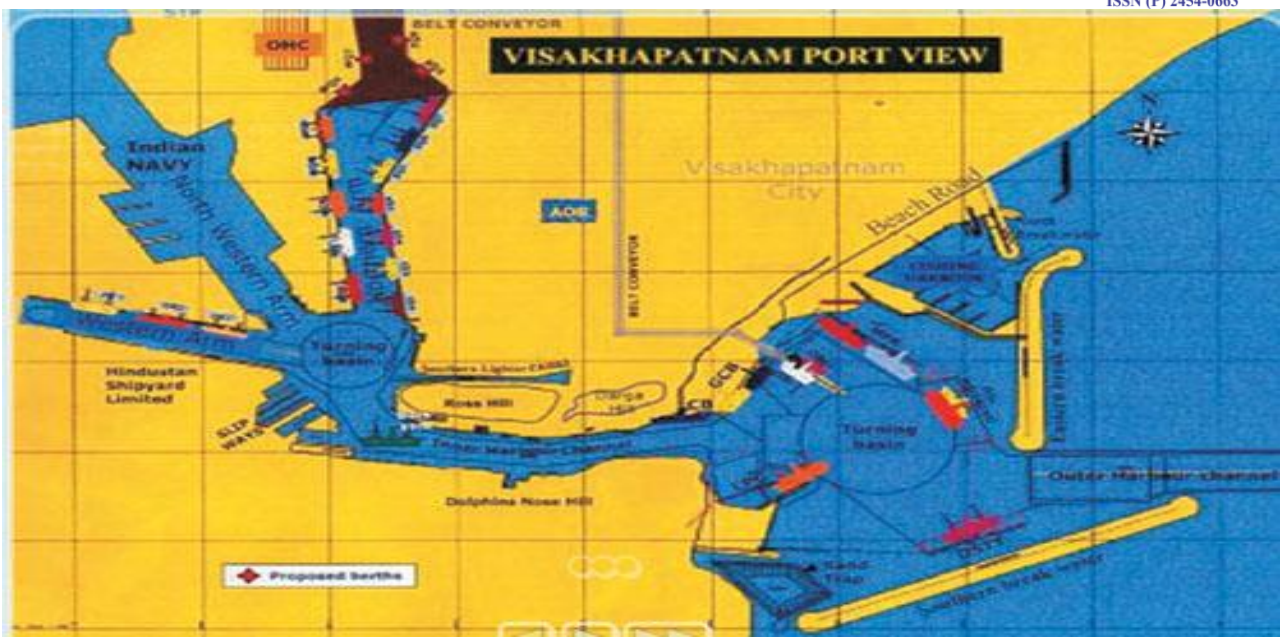

Fig. 3

Map showing berths of outer harbour and inner harbour.

3.1.1 Inner Harbour

The inner harbour is the natural harbour and is protected by the dolphin nose and Ross hill. It has 18 berths while outer harbour has 6 berths. The inner harbour has 3 arms.

- Northern arm
- Western arm
- North western arm

The North western arm is used by Indian navy. The North arm 9 berths on East side i.e., EQ-1 to EQ-9 and 6 berths on west side i.e., WQ-1 to WQ-5 and WQ RE

The Western arm has 3 berths 2 oil refinery berths i.e., OR1, OR2 and a fertilizer berth.

3.1.1.1 BERTHING FACILITY

- **INNER HARBOUR NORTHERN ARM – EAST SIDE**

Table 1

Quay berths	Berth length(mts.)	Permissible beam(mts.)	Permissible draft(mts.)	Crane development
East Quay-1	167.64	32.50	10.06	4 nos. 15T. wharf cranes
East Quay-2	167.64	32.50	10.06	4 nos. 10T. wharf cranes

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East Quay-3	167.64	32.50	10.06	4 nos. 10T. wharf cranes
East Quay-4	231.00	32.50	10.06	4 nos. 15T. wharf cranes
East Quay-5	167.64	32.50	11.00	4nos. 15T. wharf cranes
East Quay-6	182.90	32.50	10.06	3 nos. 10T. wharf cranes
East Quay-7	255.00	32.50	11.00	4 nos. 20T. wharf cranes
East Quay-8	255.00	32.50	11.00	3nos. 104T. wharf cranes
East Quay-9	255.00	32.50	11.00	---

- **INNER HARBOUR NORTHERN ARM – WEST SIDE**

Table 2

Quay Berths	Berths Length(mts.)	Permissible draft(mts.)
West Quay-1	212.00	11.00
West Quay-2	226.70	11.00
West Quay-3	201.12	11.00
West Quay-4	243.00	11.00
West Quay-5	241.70	11.00
RE WQ-1	170.00	8.00

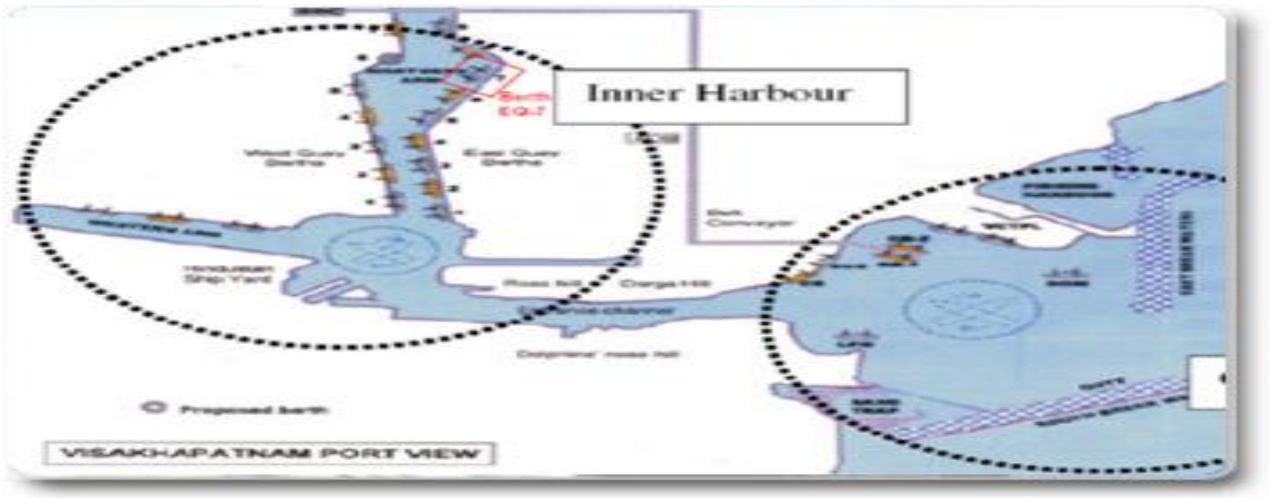

Fig. 4

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- **INNER HARBOUR NORTH WESTERN ARM**

Table 3

Quay Berths	Berths length (mts.)	Permissible draft (mts.)
Fertilizer berths	173.13	10.06
Oil REFINARY Berths-1@	183.00	10.06
Oil REFINARY Berths-1@	183.00	9075

3.1.2 OUTER HARBOUR

Table 4

Berths	Berth length (mts.)	Permissible beam (mts.)	Permissible draft (mts.)
Ore Berths-1	270.00	48.00	16.50 on rising tide of 0.3mts
Ore Berths-2	270.00	48.00	16.50
Oil Mooring	250.00	48.00	15.00
Off Shore Tank Terminal	408.00	48.00	17.00 on rising tide of 0.5mts
L.P.G.	370.92	42.00	14.00
Container Terminal	451.00	42.00	14.50
General Cargo Berth	365.00	42.00	14.50 on rising tide of 0.5 mts.

3.2 Breakwaters

A protective structure of stone or concrete extends from shore into the water to prevent a beach from washing away.

Fig. 5

They are constructed on coast to safeguard an anchorage (a place where ship is secured) from the consequence of weather and shore drift.

The purpose of break water is to maintain tranquility condition in the sea. There are three break waters in Visakhapatnam Port Trust.

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1. East break Water of length 1050 mts.
2. South break water of length 1534 mts.
3. North break water of length 412 mts.

- A minimum of depth of (-) 20.00 m is to maintain in the Outer Harbour.
- The turning basin of the Outer Harbour is 610 m and the depth is (-) 19.00 m.
- A minimum depth of (-) 12.00 m is to maintain in the inner harbour.
- The turning basin of the inner harbour is 440 m and the depth is (-) 12.35 m.

3.3 Marine Fixtures

3.3.1 Bollards

These are either wooden or iron posts found on berths or decks used to fasten ropes for mooring.

Types of Bollards

SINGLE CRUCIFORM BOLLARD

R-TYPE BOLLARD

STAGHORN BOLLARD

Fig. 6

3.3.2 Mooring Rings

It is such a mode of anchoring a vessel by means of fastening in the ground, either an anchor or something heavy, and a chain and buoy, as will allow of the vessel picking up the buoy when she returns to it.

"There is the temporary anchoring by means of an anchor, which is lifted when necessary, and there is the more permanent mode by means of mooring ring."

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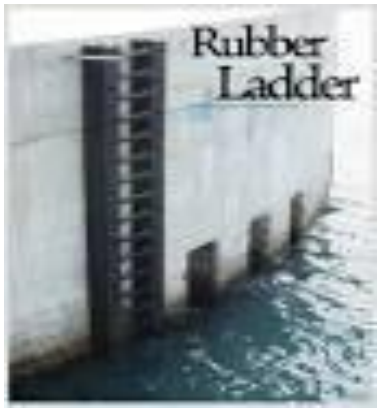
MOORING RINGS

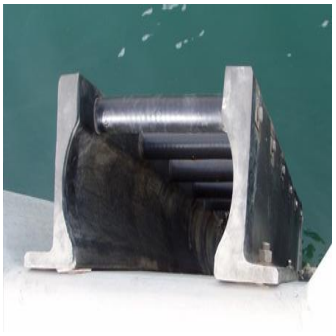
Fig. 7

3.3.3 LADDERS

Ladders are available in stainless steel moulded rubber as per customer's requirements. Ladders are of different types from 2m to12m length.

Types of ladders





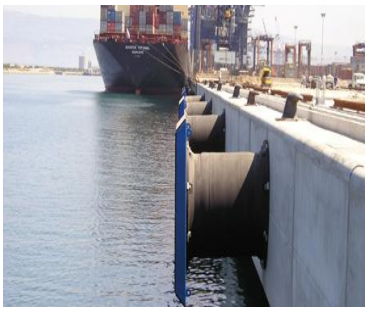
RUBBER LADDER **S.S. LADDER** **FENDER LADDER**

Fig. 8

3.4 FENDERS

Marine fenders are a type of marine equipment that are used to prevent boats, ships and other naval vessels from colliding against each other or against docks, wharfs and piers. In other words marine fenders can be simply termed as a marine bumper.

Types of fenders



CYLINDRICAL FENDERS **SUPER ARCH FENDERS** **CELL FENDERS**

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CONE FENDERS

SQUARE FENDERS

KEYHOLE FENDERS

D- FENDER

Fig. 9

3.5 Dredging in Visakhapatnam Port Trust

- Dredging is carried out in Vishakhapatnam to enhance the moment of large capacity vessels and cargos.
- Dredging is carried out round the clock 24/7 process done by Vishakhapatnam premises.
- Maintenance dredging is undertaken over the inner harbor of the Vishakhapatnam.
- The dredging tender have been layout by the Vishakhapatnam premises and came under the open bidders through online category basis.
- Hence the agreement is ended by the cost economy and time efficient bidders for making the inner harbor channel process the gateway for the various cargo ships to pass by, hence the maintenance dredging is carried out.

Fig. 10

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3.4.1 Surveying of the Inner Harbour

- It is mostly done by hydrographic survey.
- The dredging activities are carried out during the window period.

3.4.2 TYPES OF DREDGERS USED IN VISHAKHAPATNAM PORT

- Grab Dredger
- Rock Dredger

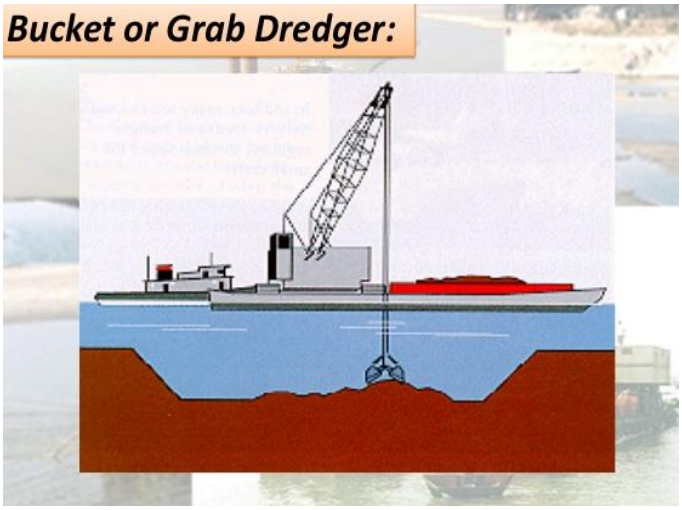

Fig. 11

GRAB DREDGER

3.4.3 BLASTING PROCESS

- Ammonia nitrate is used.
- Weighing 2-8 kgs.
- This equipment is drowned in the sea bed where it is blasted.
- In blasted area a depth is developed over the sea bed.
- Hence the depth increases.

3.4.4 DRILLING

- Drilling process is carried out therefore to enhance a greater depth.
- The water level changes in the drilling process.
- Dredging equipments are used to drill over the sea bed.
- The colour of the water changes from dusty mud to pure aqua which indicates the depth level of the sea bed.

3.4.5 Disposal of Materials

In a "hopper dredger", the dredged materials end up in a large onboard hold called a "hopper." A suction hopper dredger is usually used for maintenance dredging. A hopper dredge usually has doors in its bottom to empty the dredged materials, but some dredges empty their hoppers by splitting the two halves of their hulls on giant

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hydraulic hinges. Either way, as the vessel dredges, excess water in the dredged materials is spilled off as the heavier solids settle to the bottom of the hopper. This excess water is returned to the sea to reduce weight and increase the amount of solid material (or slurry) that can be carried in one load. When the hopper is filled with slurry, the dredger stops dredging and goes to a dump site and empties its hopper.

Some hopper dredges are designed so they can also be emptied from above using pumps if dump sites are unavailable or if the dredge material is contaminated. Sometimes the slurry of dredging and water is pumped straight into pipes which deposit it on nearby land. Other times, it is pumped into barges (also called scows), which deposit it elsewhere while the dredge continues its work.

A number of vessels, notably in the UK and NW Europe de-water the hopper to dry the cargo to enable it to be discharged onto a quayside 'dry'. This is achieved principally using self discharge bucket wheel, drag scraper or excavator via conveyor systems.

When contaminated (toxic) sediments are to be removed or large volume inland disposal sites are unavailable, dredge slurries are reduced to dry solids via a process known as dewatering. Current dewatering techniques employ either centrifuges, Geotube containers, large textile based filters or polymer flocculant/congealant based apparatus.

In many projects, slurry dewatering is performed in large inland settling pits, although this is becoming less and less common as mechanical dewatering techniques continue to improve.

Similarly, many groups (most notable in East Asia) are performing research towards utilizing dewatered sediments for the production of concretes and construction block, although the high organic content (in many cases) of this material is a hindrance toward such ends.

3.4.6 Environmental Impacts

Dredging can create disturbance to aquatic ecosystems, often with adverse impacts. In addition, dredge spoils may contain toxic chemicals that may have an adverse effect on the disposal area; furthermore, the process of dredging often dislodges chemicals residing in benthic substrates and injects them into the water column.

The activity of dredging can create the following principal impacts to the environment:

- Release of toxic chemicals (including heavy metals and PCB) from bottom sediments into the water column.
- Collection of heavy metals lead left by fishing, bullets, 98% mercury reclaimed [natural occurring and left over from gold rush era].
- Short term increases in turbidity, which can affect aquatic species metabolism and interfere with spawing suction dredging activity is allowed only during non-spawing time frames set by fish and game (in-water work periods).
- Secondary impacts to marsh productivity from sedimentation
- Tertiary impacts to avifauna which may prey upon contaminated aquatic organisms
- Secondary impacts to aquatic and benthic organisms' metabolism and mortality
- Possible contamination of dredge spoils sites
- Changes to the topography by the creation of "spoil islands" from the accumulated spoil

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- Releases toxic compound Tributyltin, a popular biocide used in anti-fouling paint banned in 2008, back into the water.

The nature of dredging operations and possible environmental impacts cause the industry to be closely regulated and a requirement for comprehensive regional environmental impact assessments with continuous monitoring. The U.S. Clean Water Act requires that any discharge of dredged or fill materials into "waters of the United States," including wetlands, is forbidden unless authorized by a permit issued by the Army Corps of Engineers. As a result of the potential impacts to the environment, dredging is restricted to licensed areas only with vessel activity monitored closely using automatic GPS systems.

IV CONSTRUCTION AND STRENGTHENING OF BERTHS

4.1 Berth

Berth is a structure which is constructed parallel to the shore. A specified location where vessel may be berthed, purely for the purpose of loading and unloading. A berth is a location where a vessel can be berthed. The size of the berth varies from 5-10m for a small boat in a marine to over 400m for the largest tankers.

4.2 Type of Berths

Following is a list of berth types that can be found in a large port:

4.2.1 Bulk berth

Used to handle bulk cargo. Vessels are loaded using either excavators and conveyor belts or pipelines. Storage facilities for the bulk cargo are often alongside the berth - e.g. silos or stockpiles.

4.2.2 Container berth

Used to handle 20' and 40' standard intermodal containers. Vessels are loaded and unloaded by container cranes, designed specifically for the task. Alongside the quay there is often a large flat area used to store both the imported and exported containers.

4.2.3 General berth

Used to handle smaller shipments of general cargo. Vessels using these would usually have their own lifting gear, but some ports will provide mobile cranes to do this.

4.2.4 Lay berth

1. A berth used for idle (lay-up status) vessels.
2. A berth where no loading or unloading takes place. Lay berth and lay-by berth (below) may be used somewhat interchangeably for intermediate (two to seven day) periods.

4.2.5 Lay-by berth

A general berth for use by vessels for short term waiting until a loading or discharging berth is available.

4.2.6 Marina berth

Used to allow the owners of leisure craft on and off their boats. Generally alongside pontoons and accessed by hinged bridges (in tidal locations) to the shore.

4.2.7 Product berth

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Used to handle oil and gas related products, usually in liquid form. Vessels are loaded via loading arms containing the pipe lines. Storage facilities for the products are usually some distance away from the berth and connected by several pipes to ensure fast loading.

4.2.8 X berth

Suitable for nuclear-powered warships, and part of an operational Naval base or a building and refitting yard.

4.2.9 Z berth

Suitable for nuclear-powered warships, as a location for operational visits or stand offs.

V INTRODUCTION

Name of the Project **:** Proposed widening of WQ-7 & WQ-8 berths for operation of harbour mobile Cranes (LHM500).

Estimated cost	**:**	Rs.6,77,36,757/-
Total length of the Berth	**:**	280 mts.
Dia. of piles	**:**	750 mm
Total No of Piles	**:**	160 nos.

5.1 General Description and Scope of Work

The subject work site is located in the Western arm of Inner Harbour at Visakhapatnam Port.

Visakhapatnam Port is operating six berths on West side and nine berths in east side of the Northern arm for carrying out export and import cargo operations. At present, these berths are catering the vessels of size 210 m LOA, 32.50m beam and 10.50 draft.

The berths WQ-7 & WQ-8 were constructed during 1966. These are gravity type structures and cement concrete monoliths (4 pockets) founded at shallow depths. The width of the beam is 9.144m which can accommodate only lesser capacity of 5 to 10 tons ELL wharf cranes of gauge 5.79m. Recently for WQ 6 berth 10m gauge crane track was provided for accommodating the 20 t lifting capacity of ELL wharf cranes.

To cater the future demand of cargo handling there is a need to provide 100t capacity harbor mobile cranes at WQ-7 WQ-8 berths. The HM cranes have standard pad dimensions of 4 nos. 5.50mx1.80m and having standard supporting base of 12.00mx12.00m c/c and the type mounted base size of the crane is 19.50m x6.0m, hence the rear side of spuds of the HMC is falling behind the berth is on the back up area. The width of the berth available is less than the supporting base width of HMC and also the expected base pressure due to HMC is 17 t/sq.m. Hence there is a need to widen WQ-7 & WQ-8 berths by providing suitable sub structure and superstructure to cater to the 100 t capacity Harbour Mobile Cranes.

- Providing 2 rows of 750mm dia. Piles at 2.975 m c/c for WQ7 berth on land side.
- Providing 2 rows of 750 mm dia. Piles for WQ8 berth with first row of piles at 2.975m c/c on land side and a second row of piles at 5.95 m c/c on sea side.
- Piles are connected with 1000mm solid deck slab.
- Dismantling of 10m gauge track for WQ 7 berth

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- Providing service trench for WQ8 berth.

5.2 Construction & Strengthening of Berth

5.2.1 Sub-Structure

5.2.1.1 Site Information

- **The site**

The site is located in the State of Andhra Pradesh on the East coast of India and is within the boundaries of the Visakhapatnam Port Trust. The proposed locations of the berths are in the Inner Harbour of Visakhapatnam Port.

- **Datum**

The datum of soundings (Chart datum 0.00) is the Indian Naval Hydrographic chart datum which is 6.84 metre below bench mark GTS/SBM 1910 located 210 metres NE of the Chapel of the blessed virgin or Ross hill.

- **Tidal Information**

The following are particulars of certain tidal levels related to Chart Datum.

➢ Highest high water recorded .	(+) 2.38 m.
➢ Mean high water spring tide ..	(+) 1.49 m
➢ Mean high water neap tide ..	(+) 1.07 m
➢ Mean sea level ..	(+) 0.79 m
➢ Mean low water neap tide .	(+) 0.52 m
➢ Mean low water spring tide	(+) 0.09 m
➢ Chart datum ..	0.00 m
➢ Lowest low water recorded .	(-) 0.55 m

5.2.2 Method of Construction

- **Boring**

Boring shall generally be carried out by recommended procedure as set out in IS : 2911 by either rotary or percussion equipment, grabbing equipment or by reverse or direct mud circulation method. If the soil is found to be unstable, the boring tools should be such that suction effects are minimized. Walls of boreholes shall be stabilized by using casing / liners with or without drilling fluid depending upon the soil conditions. In soils liable to flow the bottom of the casing / liners should be kept ahead of the boring in all cases to prevent the entry of soil into the bore, so preventing the formation of cavities and settlements in the adjoining ground.

Continuous pumping shall not be used for excavating inside the bore holes. While below sub-soil water level, precaution shall be taken so that no boiling of the bottom of the hole occurs due to the difference in hydrostatic head. Where stabilization of the sides of the bore hole is effected by the use of drilling fluids, the fluid level shall be maintaining at a level not less than 1.50 m. above the level of the sub soil water or high water level as the case may be and the hole shall then always be kept almost full with it till the concreting is completed.

The specific gravity and composition of the fluid shall be such as to suit the requirements of the ground conditions and to maintain the fine materials from the boring in suspension. Boring of any pile must be

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completed in one continuous operation without interruption. In case such interruptions are unavoidable, steps shall be taken to prevent the collapse of sides of the borehole.

Boring in rock shall be carried out either by chiseling or by any other approved method. The bottom of the borehole shall be cleaned off by air lifting all the spills and sediments so that the bases of piles shall be free from loose materials. The pile shall be anchored into hard rock with about 1.0 m. socketing. Rock in which the rate of penetration of the chisel of weight 3 tonnes is less than 20 cms. P er hour of continuous chiseling will only be deemed to be hard rock. The drop of the chisel for this purpose shall not be less than 60 cm. In case of lesser weight of chisel the drop of the chisel shall be correspondingly increased proportionately to obtain the equal energy of fall and the number of blows on an average not less than 20 per minute. Bailer samples shall be collected invariably at rock touch level and founding level and at any other intermediate level.

Fig. 12

DMC Boring with Chisel and circulation of bentonite

- **Drilling Fluid**

Bentonite used in the works shall be of the best quality, sodium based bentonite shall be used in preparing bentonite slurry. The bentonite used in the work shall satisfy the following requirements.

(a) The liquid limit of bentonite shall be more than 300% and less than 450%.

(b) Sand content of the bentonite powder shall not be greater than 7%.

(c) The swelling index shall be at least 2 times its dry volume.

(d) The pH value of the bentonite suspension shall be less than 11.5.

(e) Bentonite solution should be made by mixing it with fresh water using pump for circulation. The density of the bentonite solutions should be about 1.12.

(f) The marsh viscosity when tested by marsh cone should be about 37 Sec. Bentonite shall be mixed thoroughly with clean fresh water to make a suspension, which will maintain the stability of the pile excavation for the period, necessary to place concrete and complete construction. The fluid used shall be such as to form a suspension, which remains stable under the saline conditions likely to be encountered at the site. Control tests shall be carried out on the bentonite suspension using suitable apparatus. The density of freshly mixed bentonite suspension shall be measured daily as a check on the quality of the suspension being formed.

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The measuring device shall be calibrated to read to within 0.005 g/ml. Tests to determine density, viscosity, shear strength and pH value shall be applied to bentonite supplied to the pile boring.

Fig. 13

Bentonite Circulation in tank with vertical pump

- **Sounding**

Sounding is to be done to check the depth of bore hole.

Fig. 14

Sound chain

5.3 Reinforcement

Reinforcement shall be mild steel bars conforming to IS:432, tor steel bars conforming to IS:1786.

Any reinforcement used shall be made up into stiff cages sufficiently well wired or welded to withstand handling without any distortion or damage. The bars shall be so placed as not to impede the placing of the concrete. They shall be placed correctly in position and be supported away from the sides of the pile shaft by means of spacer blocks to assume concentric alignment in the shaft. Steps shall be taken to ensure correct positioning during concreting of reinforcement in the piles without any distortion or displacement. Care shall be taken to preserve the correct cover and alignment of the reinforcement throughout the whole operation of placing the concrete.

Normal lap between reinforcement cages shall be as per I.S. specifications. The main reinforcing steel shall project for a length sufficient to develop bond above the cut off level of the pile. The clear concrete cover to main reinforcement shall be 75 mm. and suitable spacer blocks shall be provided at intervals not exceeding 2 M and wired to the main reinforcement.

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Fig. 15

Reinforcement cages for piles

5.3.1 Concrete Placing

Concrete is placed into the piles using tremie pipes through which concrete is placed below water level. The lower end of the tremie pipe is kept immersed in fresh concrete so that the raising concrete from the bottom displace the bentonite slurry without washing out the cement content. The concrete is poured into the pipes through a conical hopper named as funnel. As the concrete is poured the bentonite clay fluid raises up due to its low specific gravity compared to concrete.

The top 1 to 1.5 m of the piles are removed because it usually mixes with bentonite clay and therefore doesn't have required strength. The particular level is called cut off level.

Fig. 16

Placing concrete for piles through funnel

- **Tremie Pipe**

It is made with steel with dia. of 200 mm. The bottom tremie pipe is normally 3.0 m long and the remaining are 1.5 m to easy handling. It has threads at the both sides for fixing together.

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Fig. 17

Tremie pipes of 200 mm dia.

- **Funnel**

Funnel is a conical shape with 1000mm dia. At the top and 200 mm dia. At the bottom for pouring the concrete.

- **Design mix concrete**

Concrete mix is to be designed in general as per IS: 10262 to have a target mean strength specified. The water to cement ratio of various mixes shall be not to exceed the following :

Grade	***W/C Ratio***
M – 30	0.40 For Beams, slabs etc.
M – 30	0.40 For piles
M – 20	0.45

Approved super-plasticizers in required quantities as per manufacturer's specification shall be used to get the desired workability and strength. The super plasticizer to be incorporated in the work shall conform to relevant BIS code and shall be of sulphonate naphthalene formaldehyde condensate and shall be compatible with the Portland slag cement to be used in the work and shall produce workable concrete without loss of slump until placed in position thus helping in placing and compaction of concrete. The proportion of super plasticizer to be used in concrete shall be determined by the tests.

Fig. 18

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The concrete mix shall be designed for values of target mean strength not lower than those indicated in table below:

Table 5

Grade of concrete	Target mean strength (N/Sq.mm) after 28 days.
M-30	39.90 N / mm^2
M-20	27.60 N / mm^2

- **Earth Work**

After completion of piling earth work excavation is done.

Length of the berth is 280.00 m and width is 7.08m and depth is 1.30 m. and quantity of earth work is 2577.12 cu.m.

- **Plain cement concrete 1:4:8**:

PCC 1;4:8 nominal mix (using 170 Kgs. of cement per cum of finished concrete) Using 40mm graded metal of approved quality as coarse aggregate and river sand as fine aggregate

Fig. 19

BATCHING PLANT

Length of concreting is 280.00 m and breadth is 7.08m and the depth is 0.10m and quantity works out to 198.24 cum.

5.3.2 Super Structure

5.3.2.1 Deck Slab

The super structure consists of M-30 design mix RCC slab, beams connecting piles.

The main reinforcement of piles are to be anchored into beams. The substructure reinforcement shall be anchored in the superstructure element.

Length of the berth is 280.00m, width of the berth is 6.94m and depth of the slab is 1.00m and quantity is 1943.20cum.

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Fig. 20

- **Wearing Coat**

Wearing coat of M-30 design mix is provided over the deck slab to protect the structural member will be laid in panels of 20 cm thick for the easy maintenance purpose.

Length of the wearing coat is 280.00m and breadth is 6.94 m and the thickness is 0.20m. Quantity of the wearing is 388.64 cum

- **Direct Circulation Method**

This method is used with rotary or percussion type rigs where drilling fluid (bentonite slurry) is pumped through the drilling rods. Simple trenching rigs for excavation may be used. Special cutters (for cutting and jointing) and elliptical concreting tremie pipes for backfilling the trench panel may be used.

- **Reverse Circulation Method**

The reverse circulation method within percussion shall be used to make trench panel in the ground. Forward and backward movement of the rig from one end of the panel to the other end shall increase the depth of the panel in a zig - zag manner.

Fig. 21

5.3.2.2 Placement of C.C Bricks

- **Salient Features**

1) Sub-grade preparation
2) Sub-base coarse (Wet Mix Macadam)
3) Base coarse (Dry lean concrete (1:3:6)

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4) Metal bed

5) Casting and supply of PCC blocks

6) Paving of C.C.blocks

7) Edge strip concreting (P.C.C M 30)

- **Design mix for Wet Mix Macadam**

The gradations is suggested for the aggregate mixture obtained by mixing 15% of 40mm,18% of 20mm,22% of 10mm,22% of 6mm and 23% of stone dust.

Fig. 22

Table 6

Sr.No.	I.S Sieve Size	Suggested gradation (%finer than)	Recommended Gradation as per MORT&H specifications
1.	53.0	100	100
2.	45.0	96	95-100
3.	22.4	76	60-80
4.	11.2	54	40-60
5.	4.75	34	25-40
6.	2.36	25	15-30
7.	600 microns	16	8-22

- **C.C.BLOCKS DESIGN MIX (adopted)**

PCC M 30 grade C.C.blocks.

Size of blocks = 30 x 15 x 20cm.

Design mix ratio (1:1.413:3.368)

Water cement ratio (0.326) =16.3 lit.

Super plasticizer: Fosroc conplast SP: 430 (250ml for a cement bag)

Cement: 400kg / cu.m.

Bulk density 1530gm/c.c (fine aggregate)

Bulk density 1480gm/c.c (coarse aggregate)

1) Cement for 1load -1bag (50kgs)

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2) Sand 50 x 1.413 =70.65kg =70.65/1530 =0.0461cu.m

3) Metal 50X3.368 =168.4kg

20mm (60%) =168.4X60/100

= 101.04 kg =101.04 / 1480=0.06851cu.m

10mm (40%) =168.4 x 40 / 100

= 67.36 kg = 67.36 / 1480 = 0.04551cu.m

4) Water = 0.326X50

=16.3 lit

- **PAVING OF C.C.BLOCKS**

1. The base should be prepared as per the specifications with straight edge, spirit level, camber etc.,
2. The area to be paved shall be divided in to a number of panels of about 15 m. Length /breadth using two rows of pavement blocks to required lines and levels at the periphery of the panel.
3. Laying of the block should commence from one edge following an approved bond. Blocks of half the size are to be used for achieving bond.
4. Placement of the blocks to the line and level should be verified with either 2.0m. Long mason rule or 3.0m.long straight edge. The camber shall be verified either with a camber template or straight edge, spirit level.
5. The blocks shall be laid with a gap of 10mm between two blocks. No deductions for the gaps while recording the measurements of paved areas.
6. The gaps shall be grouted with sand or crusher dust as per the specification.
7. Non standard gaps at junctions of panel and cads or panels shall be filled with concrete of PCC (M30) as specified properly compacted, finished and cured.
8. Tolerance for the surface from specified finish of the completed pavement shall not vary +6mm. in both longitudinal and transverse directions when checked with straighten edge/template.
9. Concrete blocks having cracks/honey combed surface/loss of materials shall be rejected.
10. C.C. Blocks will be properly stacked at required place.

Fig. 23

Paving of C.C. Blocks

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Fig. 24

Sand grouting in the Joints.

VI CONCLUSION

The maintenance of port is required on a regular basis. Due to cheaper transportation cost and increase in harbour activity, the extension and enlargement of port area is today's necessity. Hence, this kind of maintenance and construction practice is generally used every-where in the construction of ports in the world.

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