12.6 The Master Plan for the Main Channel, Approach Channel and Basin

As it is mentioned that the optimum depths of the approach channel and the basin for the proposed container berths in Chapter 12.2.4, the optimum depths of the proposed open-sea container berths and the approach channel are considered -13.0 m and -10.5 m respectively. This combination as selected, which gives the optimum difference (2.5 m) of the depths between berth and channel minimizing the total costs. Therefore, the main channel is focused on in this Section.

The purpose of deepening the main channel is to serve larger tankers of crude oil visiting JD-4 and larger container vessels visiting JNP with less time constraints when entering/departing the ports as long as the project of deepening the main channel is feasible.

12.6.1 Preparing Alternative Depths of Deepening the Main Channel

Four alternative plans are prepared for deepening the main channel. The alternative plans are summarized shown in Table 12.6.1.

1) Alternative-1

Alternative-1 is a plan to remain the current depth of the main channel -10.8 m. It is assumed that oil tankers with the maximum draft of 12.2m calling at JD-4 is considered to be the maximum permissible limitation of the main channel without excessive waiting time due to high tide for computer simulation.

2) Alternative-2

Alternative-2 is a plan to deepen the main channel by 1.2 m up to -12.0 m. It is assumed that the maximum draft of oil tanker is 13.6m which is the maximum permissible limitation for berthing JD-4.

3) Alternative-3

Alternative-3 is a plan to deepen the main channel by 1.2 m up to -12.0 m. It is assumed that oil tankers with maximum draft of 13.6m calling JD-4 and container vessels of over-panamax type with a full-draft of approximately 13.6m visit JNP in 2017.

4) Alternative-4

Alternative-4 is a plan to deepen the main channel by 1.7 m up to -12.5 m. It is assumed that the vessels the same as Alternative-3 visit JNP in 2017.

Table 12.6.1 Alternative Plans for Deepening the Main Channel

Alternative Plan	Alternative Depth of the Main Channel	Depth of JD-4	Depth of Additional Container Berths at JNP	Arriving Max. Draft of Tankers at JD-4	Arriving Max. Draft of Container Vessels at JNP
Alternative-1	-10.8 m	-14.3 m	-13.5 m	-12.2 m (50,000DWT)	-12.8 m (3,000TEUs)
Alternative-2	-12.0 m	-14.3 m	-13.5 m	-13.6 m (75,000DWT)	-12.8 m (3,000TEUs)
Alternative-3	-12.0 m	-14.3 m	-14.5 m	-13.6 m (75,000DWT)	-13.6 m (4,500TEUs)
Alternative-4	-12.5 m	-14.3 m	-14.5 m	-13.6 m (75,000DWT)	-13.6 m (4,500TEUs)

Remarks) DWT in parentheses shows maximum DWT in fully-loaded condition.

Table 12.6.2 Number of Container Vessels to JNP and Tankers to MOT in 2017

	Annual Number of Container Vessels to JNP					Annual Number of Tankers to MOT			
	4,500 TEUsize	3,000 TEUsize	2,000 TEUsize	1,500 TEUsize	Total	Crude Oil	POL	Chemical	Total
	(container vessels/year)					(tankers/year)			
Alternative-1	---	1,036	1,019	194	2,249	310	530	39	879
Alternative-2	---	1,036	1,019	194	2,249	310	530	39	879
Alternative-3	586	596	1,019	194	2,395	310	530	39	879
Alternative-4	586	596	1,019	194	2,395	310	530	39	879

12.6.2 Evaluation of the Alternatives

(1) Method of Evaluation

Alternative plans are evaluated by comparing the total costs required to handle 18.9 million tons of crude oil at Marine Oil Terminal including JD-4 at MBP and a container volume of 4.9 million TEUs at JNP. The total costs consist of 1) ship-waiting and ship-staying costs at the port, 2) transportation cost, 3) capital dredging cost of deepening the main channel, the access channel

to JNP and an additional channel to the future container berths at JNP, and 4) maintenance dredging cost of those channels.

The ship-waiting and ship-staying costs are estimated using the computer simulation results of off-shore waiting time of tankers at JD-4 of MBP and container vessels at JNP.

The transportation cost is estimated by summing up the transportation costs for each route over the total volume of crude oil and containers respectively.

(2) Evaluation Flowchart

The optimum water depth of the main channel to JD-4 is identified according to the evaluation flowchart shown in Figure 12.6.1.

The optimum water depth of the main channel to the future container berths at JNP is also identified according to the evaluation flowchart shown in Figure 12.6.2.

(3) Total Costs

Total costs to receive oil tankers at JD-4 are estimated for each plan of the main channel to receive both oil tankers and container vessels including over-panamax type vessels and the results are shown in Table 12.6.3.

Furthermore, the total costs are also estimated for each plan of the main channel and the approach channel to the future container berths at JNP and the results are shown in Table 12.6.4.

Table 12.6.3 Total Costs for the Alternative Plans of Deepening the Main Channel to JD-4

(unit: million)

Alternative Plan	Alternative Depth of Main Channel	Depth of JD-4	Waiting Cost	Transportation Cost	Capital Dredging Cost	Maintenance Dredging Cost	Total Costs
			(Rs./yr.)	(Rs./yr.)	(Rs.)	(Rs./yr.)	(Rs.)
Alt.-1	-10.8 m	-14.3 m	267	1,396	0	157	17,057*
Alt.-2	-12.0 m	-14.3 m	264	1,324	2,955	494	22,468
Alt.-3	-12.0 m	-14.3 m	264	1,324	2,955	494	22,468
Alt.-4	-12.5 m	-14.3 m	239	1,340	4,180	595	24,554

Remarks) Discount rate of 10% and project life of 30 years are assumed. Number with asterisks indicates the minimum total costs.

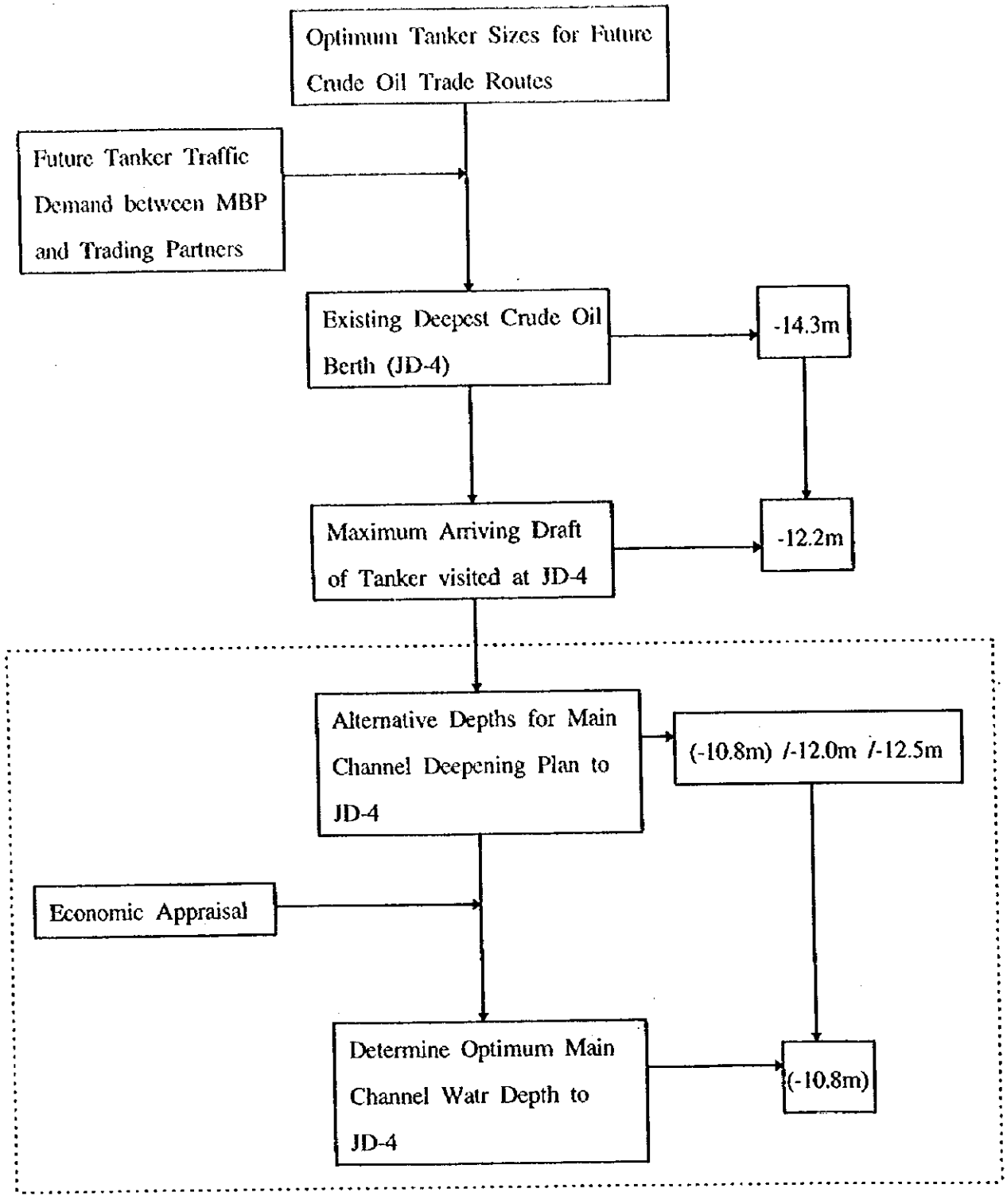


Figure 12.6.1 Flowchart of Determining Optimum Depth of Main Channel to JD-4

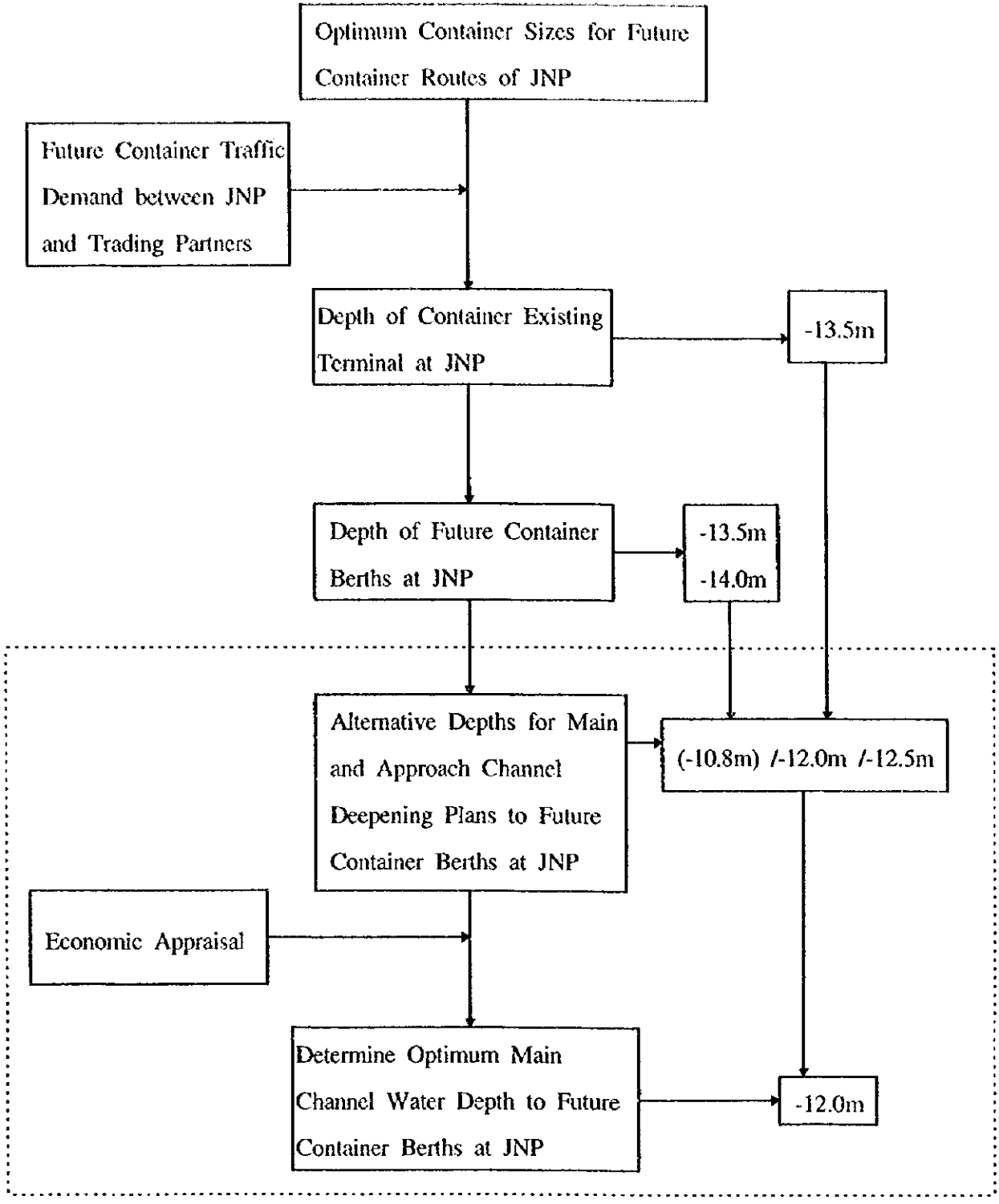


Figure 12.6.2 Flowchart of Determining Optimum Depth of Main and Approach Channel to JNP

Table 12.6.3 shows that the main channel depth of -10.8 m (Alternative-1) gives the minimum total costs.

Table 12.6.4 Total Costs for the Alternative Plan of Deepening the Main and Approach Channel to Future Container Berths at JNP (unit: million)

Alternative Plan	Alternative Depth of Main Channel	Depth of Future Container Berths at JNP	(JD-4) Waiting Cost + Transportation Cost	(JNP) Waiting Cost + Transportation Cost	Capital Dredging Cost	Maintenance Dredging Cost	Total Cost
			(Rs./yr.)	(Rs./yr.)	(Rs.)	(Rs./yr.)	(Rs.)
Alt.-1	-10.8 m	-13.5 m	1,663	54,809	0	178	530,792
Alt.-2	-12.0 m	-13.5 m	1,589	54,518	3,744	526	534,364
Alt.-3	-12.0 m	-14.5 m	1,589	53,661	4,428	526	527,320*
Alt.-4	-12.5 m	-14.5 m	1,580	53,589	6,531	669	529,706

Remarks) Discount rate of 10% and project life of 30 years are assumed. Number with asterisks indicates the minimum total costs.

Table 12.6.4 shows that the combination of -12.0 m of the main channel depth and -14.5 m of the future container berths' depth (Alternative-3) gives the minimum total costs.

12.6.3 Theoretically Desirable Channel Dimensions

Considering the extreme state of traffic congestion at Mumbai port which forces vessels to waste many days for mooring at the quays, one of the effectual solutions from nautical aspect would be deepening and partly widening the existing channels to enable free two-way transit regardless of tidal range, which in turn might minimize waiting time for berthing vessels.

However, in view of economic realities, practical measures based on the most effective cost performance analysis of channel deepening (see the preceding clause) should be adopted. Hence this chapter summarizes the theoretically desirable channel depth and width and includes a concrete proposal of the dimension of the new channel.

(1) Depth of the channels and maneuvering area of the port

The required under keel clearance (UKC) and safety margins are schematically shown in Figure 12.6.3.

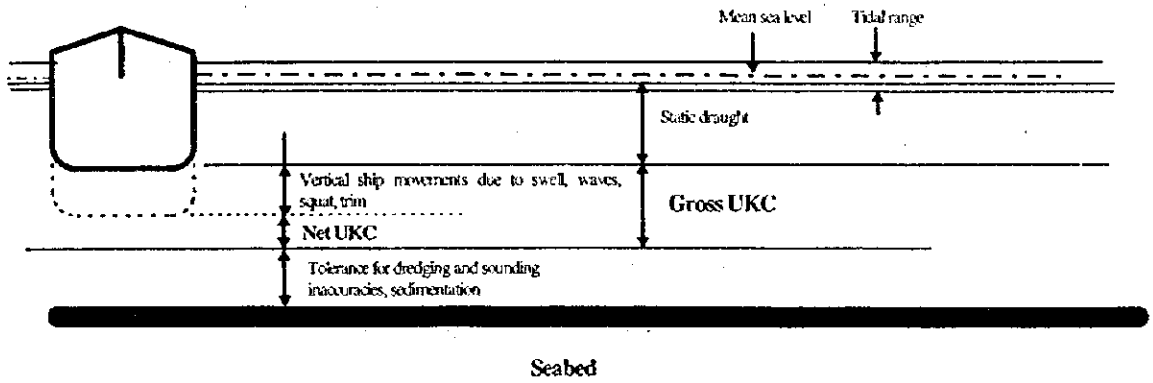


Figure 12.6.3 Definition of UKC

A necessary UKC by which contact with the seabed is prevented can be determined from the following factors:

1) resultant vertical movements of vessels due to swell and waves, i.e. pitching, rolling and heaving,

2) tendency of nearly parallel sinking with slight trim by the head known as squat, which appears under sailing shallow water,

3) accuracy of chart datum,

4) weather/sea conditions such as air pressure effect to the sea level (1cm/1hPa), a tidal level, a water density change, sedimentation/drift sand, and ground obstacles.

A proper quantity of UKC for safe sailing of a shallow channel is not obtained from a straightforward addition of the above factors. As regards to an open sea channel, the proper UKC shall not be less than the amount which enables the stable steering/maneuverability of the largest vessel expected preventing shallow water effect. At sheltered ports inside, however, vertical movements such as pitch/roll/squat would be negligibly small, thus the UKC shall be considered as the water between a quay and a vessel which allows the smooth flow of water when berthing.

Europe Maritime Pilot Association (EMPA) has made recommendations on the UKC of calling vessels at Rotterdam, Antwerp and Amsterdam as follows:

UKC at open sea passage	20 % or more of the draft
" off port fairway	15 % "
" at port inside	10 % "

However, the updated criteria at Europort are, reportedly, reduced five percent from the above to cope with the increasingly large vessels that are now calling i.e.,

UKC at open sea passage	15 % or more of the draft
" off port fairway	10 % "
" at port inside	5 % "

Also, UNCTAD's handbook, "Port Development Volume", lists three factors to be considered for planning channel depth i.e.,

1) The transit time of vessels along the channel both with and against the tidal direction, and the relationship of these times to the tidal cycle;
2) The nature of the sea or riverbed which, if of soft silt, for instance, might lead to a decision to reduce the designed UKC for vessel using the channel;
3) The vessel draught: upon entering an approach channel, the load-line draught of the vessel is modified by such factors as water density changes, which may occur along the length of the channel, the effect of squat and of wave action causing pitch and roll of the vessel, and, mentioned as an example; "a general cargo vessel drawing nine meters at sea would squat 50 cm in narrow channel; pitching would require about a half the wave height in additional draught, and rolling somewhat less".

Thus, allowing 50 cm for UKC if the channel bed is soft, it might be assumed, for preliminary planning purposes, that a vessel drawing nine meters might require some 10.5 m of dredged depth in an approaching channel. A greater depth would be necessary where the channel bed was hard. As suggested above, a minimum clearance of one to one and a half meters might be taken as appropriate for most vessels.

(2) Width of channel

A major consideration will be whether the channel should be wide enough to allow ships to pass in opposite directions. Unless there are severe economic restraints, a two-way channel should be made in order to offer unrestricted access to the port.

Channel widths depend on the size of vessel to be catered for and the physical conditions of the site. As a typical example, illustrated in Figure 12.6.4 in a well-marked channel, total

of full-depth channel on straight reaches, consists of maneuvering lanes of about twice the vessel beam for each direction, plus about one L between vessels and up to one-and-a-half times the beam for bank clearance each side.

For an expected case of Mumbai, a total width is deemed to be one L plus 7 B, practically equal to two L of expected vessel, and consequently, about 500 m of the total width of full-depth channel would be appropriate.

At bends in the channel, greater width is required than on straight stretches because of the tendency of vessels to drift on turning. An additional width, depending upon the radius of curvature of the bend but approximately equal to the beam of each vessel, will be required in order to allow for the projected width of vessels negotiating the bend. This feature of projected width will also occur on straight reaches of channel subject to the action of cross-winds and currents, which also cause vessels to drift.

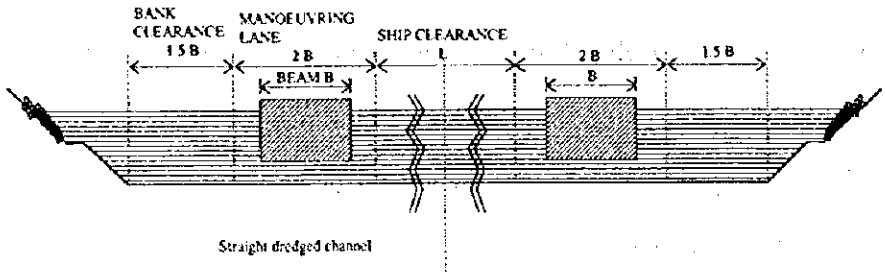


Figure 12.6.4 Typical Width Dimensions of Channel

12.6.4 Proposed Dimensions of the Channels

According to the accepted wisdom mentioned above and by combining cost performance analysis, the desired depths, UKCs widths and possible deepest draught of a vessel at each channel of Mumbai port are summed up in Table 12.6.5.

Table 12.6.5 Desired Channels' Depth, Width and Possible Deepest Draft of Vessels

Leg	Alignment <°>	Distance (km)	CD Depth(m)	UKC (m) Rise(250)	Width (m)	Max. draft
Main channel (Entrance - Oil Terminal)						
Entrance (18-50N,72-43.5E) - First bend (18-50N,72-46.5E)	<090>	5.0	12.0	1.5(12%)	500	13.0
First bend - Second bend (18-52N, 72-50.5E)	<063>	7.7	12.0	1.5(12%)	500	13.0
Second bend - Junction of Approach channel	<030>	6.8	12.0	1.5(12%)	500	13.0
Junction of Approach .Chan'l.- Junction of JNP Chan'l	<055>	4.6	12.0	1.5(12%)	500	13.0
Junction of JNP Chan'l - E of f Butcher Oil Terminal	<042>	2.4	10.8	1.5(13%)	750	11.8
Approach Channel (Main Channel - Ballard/Indira)						
Main channel junction - Ballard pier/ Indira dock/wall	<305>	3.1	10.5	0.6(5%)	360	11.4
Jawahar Lal Nehru Channel (Main Channel - JNP)						
Main channel Junction - S off Elephanta Is.	<085>	2.9	12.0	1.6(12%)	500	12.9
S off Elephanta Is. - JNP Container Terminal	<045>	2.3	12.0	1.6(12%)	450	12.9
North channel (Approach channel - Victoria/Prince's Dock)						
Approach channel Junction - <098>1.1 km off Dock-gate	<005>	2.8	4.3	0 (0%)	100	6.8
<098>1.1 km off Dock-gate - Dock-gate	<276>	1.1	4.3	0 (0%)	180	6.8
Trombay Channel						
E off No.1 Oil berth - New Pir Pau Berth	<022>	2	10.8	0.6 (5%)	230	12.7

12.7 The Master Plan for the Navigation Safety

12.7.1 Equipping the Channels with Navigational Aids

With the partial widening and deepening of the channels, a series of navigational aids should be provided at due positions of the new channels. It is desirable that these marks have:

1) a solar battery system within,
2) a radar reflector,
3) synchronizing lightening system of all buoys by transmitted signals from the entrance buoy,
4) a hybrid power system (solar & wave activating generator) for the entrance buoys, in particular, and
5) an interval of one sea mile between each buoy.

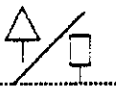
An arrangement of these marks is shown in Figure 12.7.1 and the details are given in Table 12.7.1.

12.7.2 Reinforcement of Tug Fleet

(1) Required number of tug boats

The ocean going vessel that reduces her speed under several knots in approaching a berth, normally loses almost all of her rudder function, consequently, the assistance of tug boat(s) is indispensable for turning/berthing the vessel. Furthermore, the geographical features at Mumbai Port should be taken in account, i.e., the location of some turning basins lies in close proximity to the channel and/or inroads into the channel, and most of the maneuvering circles are small (two L of expected vessel in diameter) which means that a mother vessel is unable to

Table 12.7.1 Description of Channel Buoys

No.	Body			Light					Power source			Top mark
	Function	Height	Color	Lantern	Character	Color	Intensity	Visible range	Type	Capacity	Battery life	
1	Entrance Light Buoy Starboard	8 - 9 m	Green	12 V 0.55 A	Fl. 4 s 0.5 s + 3.5 s	Green	30 cd	3.9 N.M	Hybrid Solar & Wag	12 v 65 Ah	30 days	
2	Entrance Light Buoy Port	8 - 9 m	Red	12 V 0.55 A	Fl. 4 s 0.5 s + 3.5 s	Red	34 cd	4.1 N.M	Hybrid Solar & Wag	12 v 65 Ah	30 days	
3 - 21	Lateral Light Buoy Starb'd / Port	7.2 m	Green / Red	12 V 0.25 A	Fl. 4 s 0.5 s + 3.5 s	Green / Red	14 - 15 cd	2.9 / 3 N.M	Solar	12 v 65 Ah	65 days	
22-27	Lateral Light Buoy Starb'd / Port	6.0 m	Green / Red	12 V 0.25 A	Fl. 4 s 0.5 s + 3.5 s	Green / Red	14 - 15 cd	2.9 / 3 N.M	Solar	12 v 65 Ah	65 days	
28-29	Light Buoy for Special Mark	6.0 m	Yellow	12 V 0.25 A	Fl. 5s 0.5 s + 4.5 s	Yellow	42 cd	4.4 N.M	Solar	12 v 65 Ah	75 days	
30	Light Buoy Preferred to Starb'd Cha'l	7.2 m	Red / Green	12 V 0.25 A	Gp.Fl.(2 + 1) 8 s	Red	15 cd	3 N.M	Solar	12 v 65 Ah	50 days	
31-34	Light Buoy for Special Mark	7.2 m	Yellow	12 V 0.25 A	Fl. 5s 0.5 s + 4.5 s	Yellow	42 cd	4.4 N.M	Solar	12 v 65 Ah	75 days	
35	Light Buoy Preferred to Starb'd Cha'l	7.2 m	Red / Green	12 V 0.25 A	Gp.Fl.(2 + 1) 8 s	Red	15 cd	3 N.M	Solar	12 v 65 Ah	50 days	
36-52	Lateral Light Buoy Starb'd / Port	6.0 m	Green / Red	12 V 0.25 A	Fl. 4 s 0.5 s + 3.5 s	Green / Red	14 - 15 cd	2.9 / 3 N.M	Solar	12 v 65 Ah	65 days	
53 - 54	Light Buoy for Special Mark	7.2 m	Yellow	12 V 0.25 A	Fl. 5s 0.5 s + 4.5 s	Yellow	42 cd	4.4 N.M	Solar	12 v 65 Ah	75 days	

maneuver without tug assistance.

A proper number of capable tug boats should thus be provided to secure sound and smooth flow of the calling vessels since the number of calling vessels is forecast to increase. In addition, most of the existing tugs will soon exceed their service lives.

Desired number of tug boats by stage is shown in Table 12.7.2.

(2) Required output of tug boats

The maximum thrust is required when moving a mother vessel athwart direction, and an empirical formula on the thrust based on vessels' deadweight and external force (mainly by wind force) is shown in Figure 12.7.2.

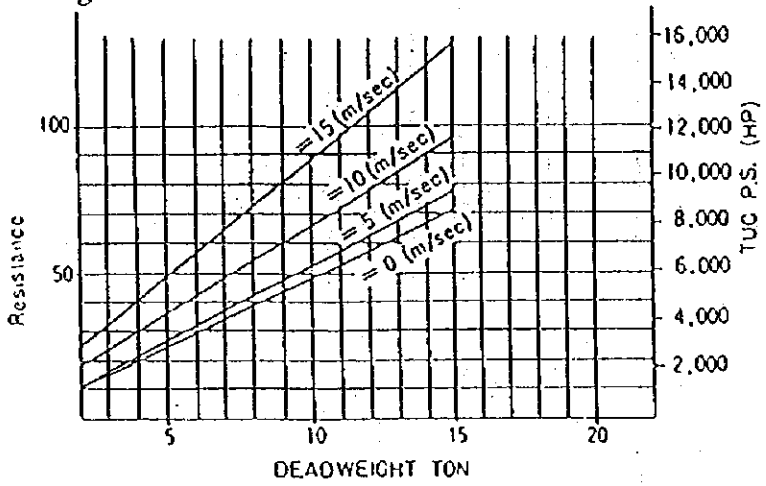


Figure 12.7.2 Necessary tug Boat(s) Thrust against Vessel's DWT and Winds

According to the above figure, as an example, the assisting maneuver for a 24,000 dwt mother vessel under against wind of 10 m/s requires a total of 2,400 ps tug power (2 tugs 1,200 ps each). Another effective formula which requires for tug power with eight to ten (8 - 10) % in ps of an objective vessel's dwt is in practical use.

The vessels which require tug assistance are not only large mother vessels but are inclusive of some medium or small vessels as 10,000 to 3,000 dwt, and hence powerful tugs are not needed at all times. With reference to this, an example of the tug fleet composition in major

Table 12.7.2 Desired Tug Fleet by Stage

Berth	1996			2007					2017				
	Calling Vessels A	Tug Boats B	Service Frequency A x 2 x 2	Calling Vessels A'	Service Frequency A' x 2 x 2	Desired Tugs C	Renewal of Aged Boats D	Required Tugs : E = C + D - B	Calling Vessels A"	Service Frequency A" x 2 x 2	Desired Tugs C'	Renewal of Aged Boats D'	Required Tugs E' = C' + D' - C
Ballard & Indira	1,277	11	5,108	1,275	5,100	11	11	11 (0)	1,449	5,796	13	0	2
Prince's & Victoria	401	6	1,604	198	792	3	4	3 (0)	198	792	2	0	0
Oil Terminal & Pir-Pau	586	5	2,344	621	2,484	6	5	6 (1)	877	3,508+ 326x2	9	0	3
Total	2,264	22	9,056	2,094	8,376	20	20	20 (1)	2,524	10,748	25	0	5

ports in Japan is shown in Table 12.7.3

Table 12.7.3 Distribution of Tug Boats by Power

PS	Number of Tugs	(%)
200 - 1,200	16	5.9
1,200 - 2,200	36	13.2
2,200 - 3,200	120	44.1
3,200 over	100	36.8
Total	272	100

Summing up, tug boats should thus be provided, 1 in 2007 and 5 in 2017, each fleet consisting of 500 to 1,000 ps for Indira dock, 1,000 to 1,500 ps for Ballard pier, 300 to 500 ps for Victoria/Prince's Docks, and 2,000 to 3,000 ps for Oil terminal. In addition, it is recommended to replace the existing propulsion devices with a rudder propeller system known as Z propeller[1)] which is widely employed for harbor tug boats for high maneuverability, reliability and powerful performance.

12.7.3 Additional Pilots

Assuming that the working conditions in terms of service frequency of each pilot will be the same as heretofore, the regular staff of pilots will have to be increased as shown in Table 12.7.4.

Table 12.7.4 Regular Number of Pilots and Piloting Services

Year	No. of Vessel	Frequency of Piloting	No. of Pilots	Frequency/Pilot
1996	2,264	4,528	44	103
2007	2,292	4,584	45	103
2017	2,748	5,496	54	103

[1)] Z Propeller is a kind of propulsion device.

For the Port Authority's information, piloting staffs at similar and representative ports in Japan are listed in Table 12.7.5.

Table 12.7.5 Piloting Staffs at Similar and Representative Ports in Japan

Port	No. of Vessel	Frequency of Piloting	No. of Pilots	Frequency/Pilot
Kushiro	-	900	3	300
Tomakomai	-	1,400	5	280
Muroran	-	1,000	3	333
Sendai	-	1,450	5	290
Onahama	-	1,000	3	333
Kashima	-	2,550	8	318
Tokyo	-	8,000	16	500
Niigata	-	1,200	6	200
Shimizu	-	3,000	6	500
Isewan	-	15,000	38	394
Wakayama	-	1,500	6	250
Hakata	-	2,000	5	400
Shimabara	-	1,250	4	313
Entire Japan ports		216,518	709	305

Source) Japan Pilot Association, 1991

The selection and training of a qualified candidate would require a certain period of time, and hence the authority should commence the necessary steps at an adequate time based on a pre-estimated need for the additional pilots, which could be concluded from the forecast whole service frequency divided by a proper unit of frequency/pilot.

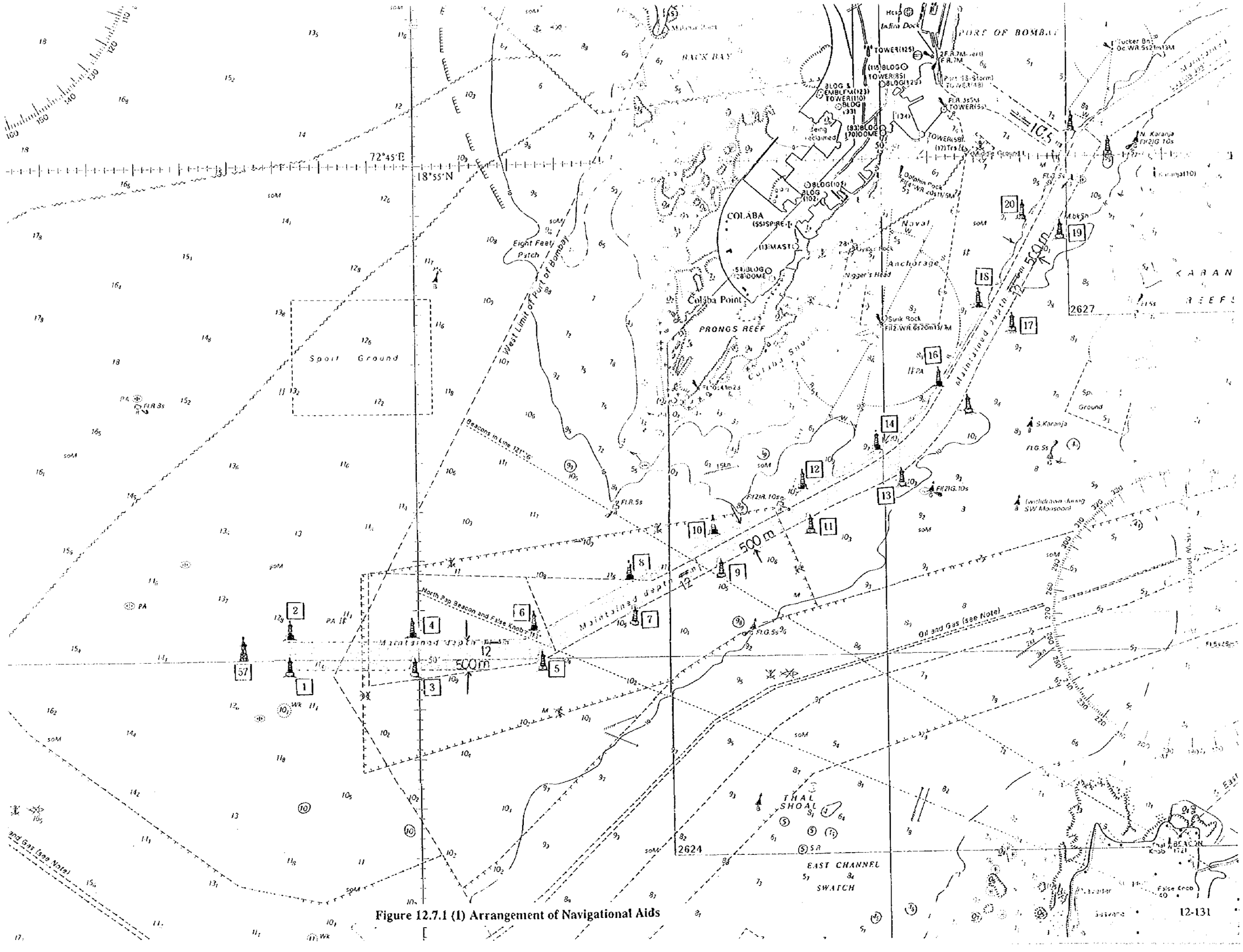


Figure 12.7.1 (1) Arrangement of Navigational Aids

Figure 12.7.1 (2) Arrangement of Navigational Aids

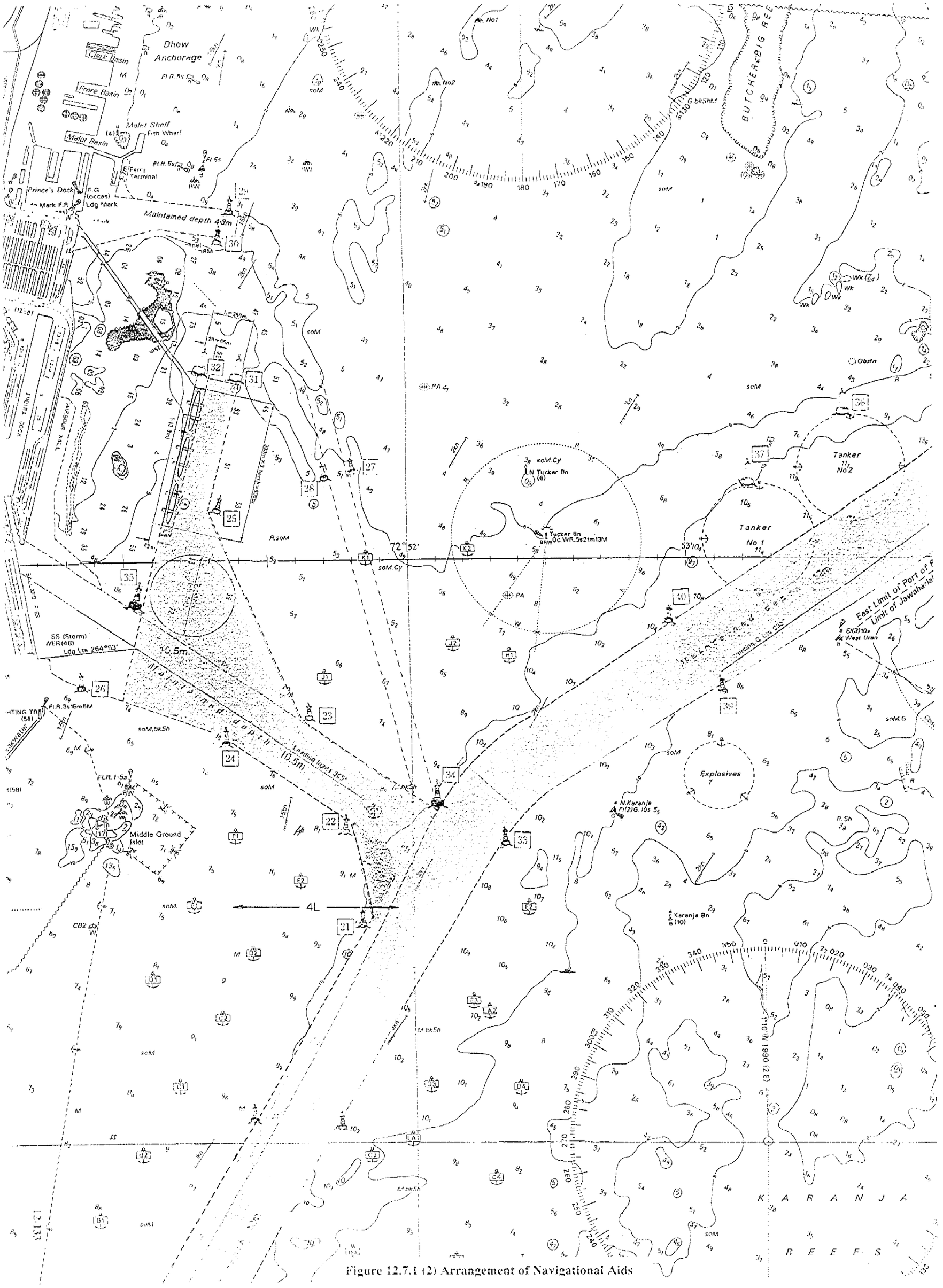


Figure 12.7.1 (2) Arrangement of Navigational Aids

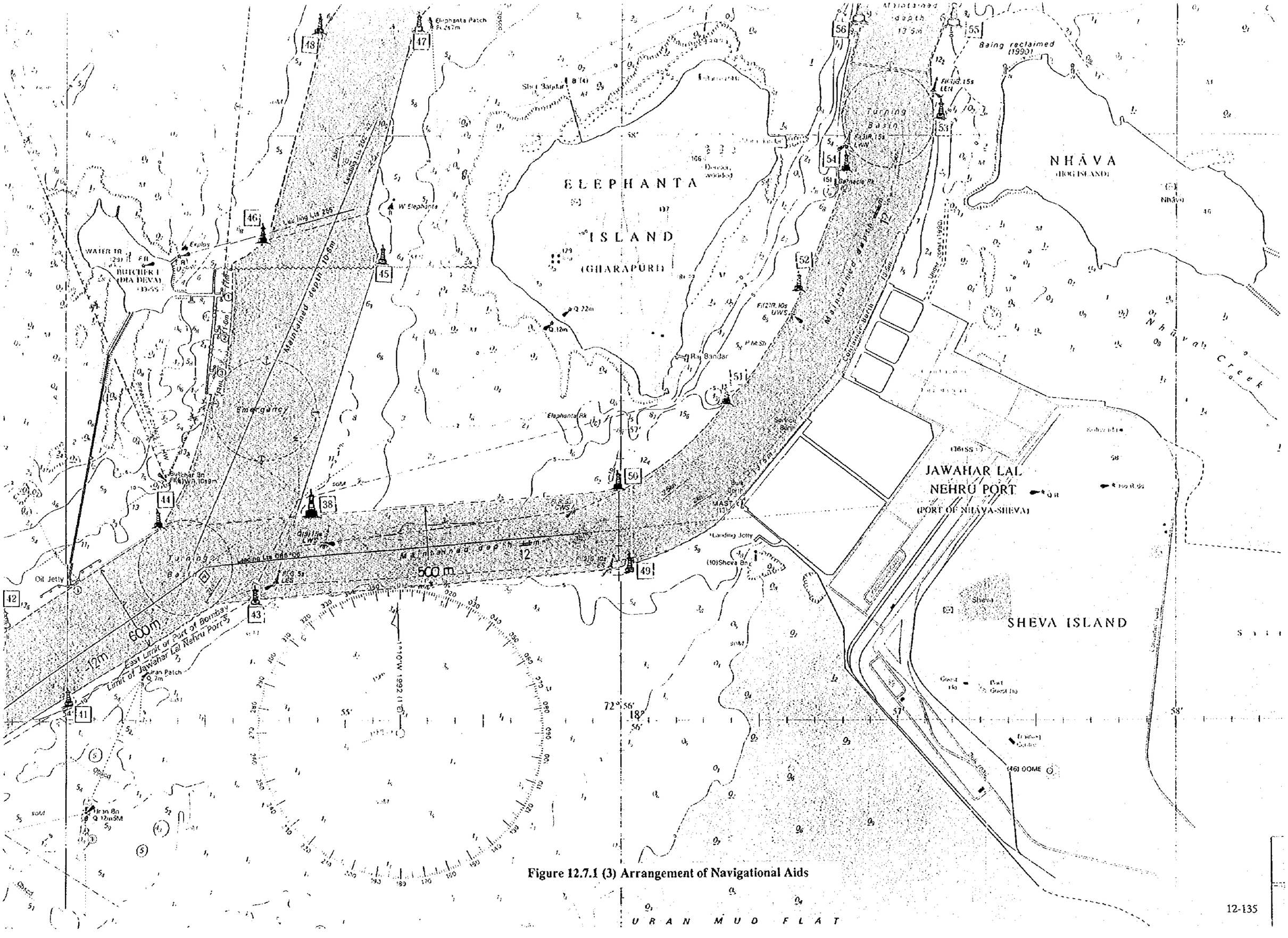


Figure 12.7.1 (3) Arrangement of Navigational Aids

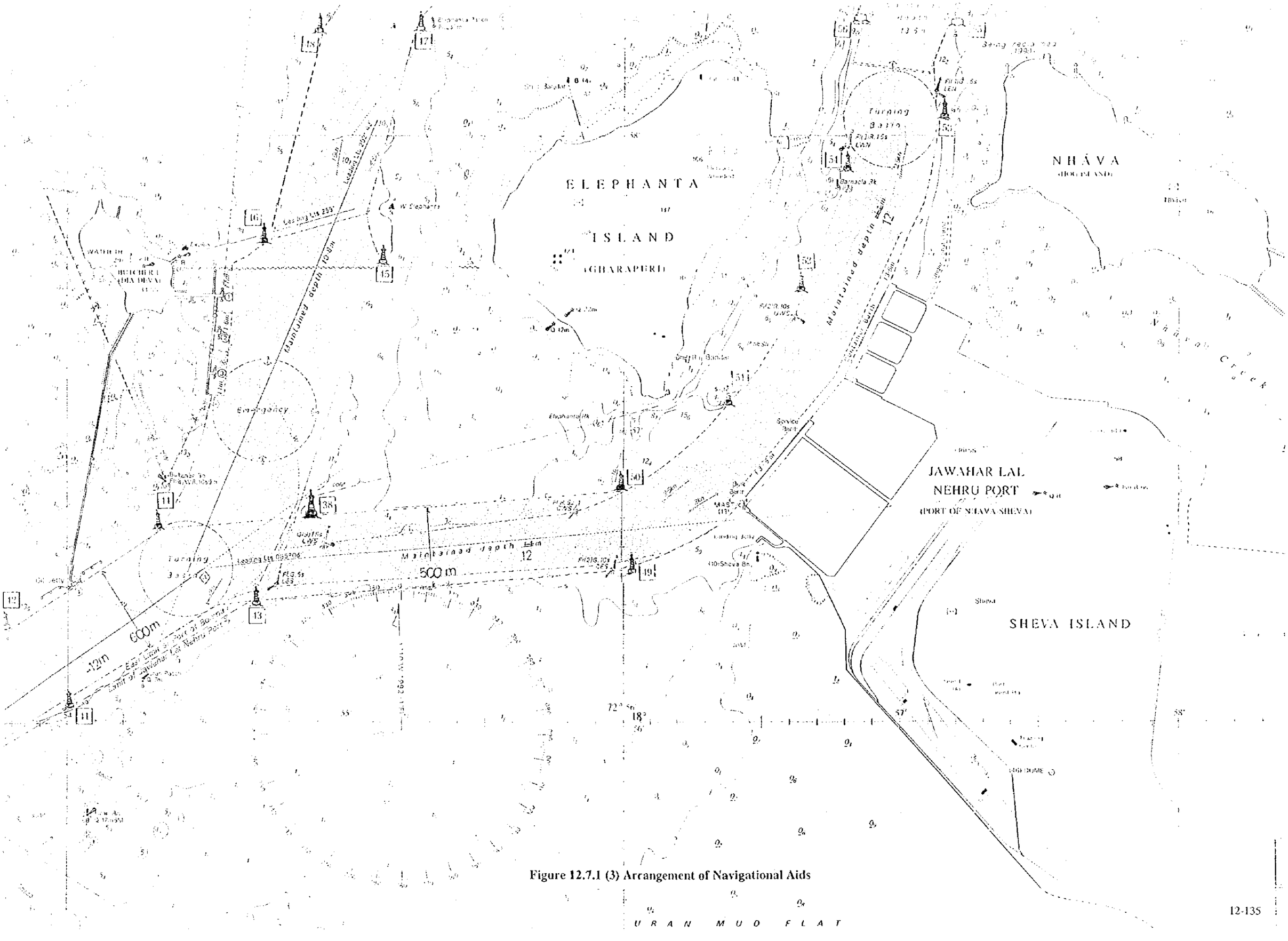


Figure 12.7.1 (3) Arrangement of Navigational Aids

12.8 The Master Plan for Passenger Traffic

12.8.1 Target Volume of Passenger Traffic to embark/disembark at MBP in 2017

Target volume of passenger traffic to embark/disembark at MBP in 2017 is estimated in Chapter 9. Summary of the target volume of passenger traffic consisting of 1) inter-harbour passengers, and 2) coastal and foreign passengers is shown in Table 12.8.1.

Table 12.8.1 Target Volume of Passengers to Embark / Disembark at MBP in 2017

(Unit: thousand persons)

Year		1996/97	2007	2017
Inter-Harbour Traffic		3,724	4,125	5,186
	(to/from Ferry Wharf)	1,950	2,354	2,978
	1. Mumbai - Mora	1,090	1,265	1,472
	2. Mumbai - Rewas	860	1,089	1,506
	(to/from Gateway of India)	1,773	1798	2,208
	3. Mumbai - Mandwa	253	321	443
	4. Mumbai - Elephanta	746	866	1,008
	5. Mumbai - JNP	657	419	488
	6. Mumbai - Vashi	117	192	269
Coastal and Foreign Traffic		71	---	---
	7. Mumbai - Goa	59	---	---
	8. Mumbai - Middle East	12	---	---
Grand Total		3,845	---	---

12.8.2 Present Routes and Schedule of Inter-Harbour Passenger Services

As to passenger traffic, foreign and coastal passenger traffic being in service at BPX (international cruise) and Ferry Wharf connected to Prince's Dock (to/from Goa) accounts for only 3% of the total passengers in 1996/97. The service for the route of Mumbai-Goa has been provided by Frank Shipping Ltd. since November, 1994 at the Ferry Wharf.

Inter-harbour passenger traffic accounts for almost 97% of the total passenger traffic in 1996/97. New Mumbai and newly developed areas on the east and southeast side of Mumbai Harbour (i.e. Panve, Uran, Khopta, Pen and Alibag Regions) have generated increasing inter-harbour passenger traffic. The services for the routes of Mumbai-Mora and Mumbai-Rewas

(1,950 thousand passengers in 1996/97) are provided by eight private shipping companies at the Ferry Wharf. The services for the remaining routes of Mumbai-Mandwa, Mumbai-Elephanta Island and Mumbai-JNP (1,656 thousand passengers in 1996/97) are provided at Gateway of India. Hover craft services for Mumbai-Vashi route has been also provided since 1994 at the Gateway of India (Approximately 117 thousand persons in 1995/96).

Relatively small passenger boats of about 22 to 250 persons in capacity are presently used for the inter-harbour transport. The capacities and schedules of the present inter-harbour passenger services are shown in Table 12.8.2.

Table 12.8.2 Present Capacity and Schedule of the Present Inter-Harbour Passenger Services

Routes	Complement	Daily Services	Max. daily services
Inter-Harbour Traffic (to/from Ferry Wharf)			(One-direction) 40
1. Mumbai - Mora	40 - 222 persons	18 or 26 services (Every 45 or 30 minutes from 0600 to 1700, and 1800, 1900 and 2000) (Monsoon or Normal Season)	26
2. Mumbai - Rewas	40 - 222 persons	14 services (0600, 0630, 0700, 0730, 0815, 0930, 1030, 1130, 1300, 1345, 1430, 1530, 1630 and 1730)	14
Inter-Harbour Traffic (to/from Gateway of India)			(One-direction) 76
3. Mumbai - Mandwa	70, 78, and 250 persons	10 services	10
4. Mumbai - Elephanta	40-96 persons	Continuous services	36*
5. Mumbai - JNP	50-75	18 services (from 0500 to 2400)	18
6. Mumbai - Vashi[1]	22 persons (Hover-craft)	12 services (Mon.-Sat.), 5 services (Sun.)	12
Inter-Harbour Total			116
Coastal Traffic (to/from Ferry Wharf)			(One-direction) 1
7. Mumbai - Goa	approx. 200 persons	Everyday (peak), 5 services/week (off-peak)	1
Grand Total			117

Sources) Information as of 1997 is provided by MBPT and collected by the Study Team.

Remarks) Number with asterisks (*) is estimated by the Study Team.

[1] "Water Transport System between South Bombay and New Bombay" 1997, CIDCO

12.8.3 Present Navigational Routes of Inter-Harbour Passenger Services

(1) Navigational Routes of Services to/from Ferry Wharf (Figure 12.8.1)

1) Mumbai-Mora

From the Ferry Wharf at the NE end of the Prince's Dock, the route leads SSE-ward passing 700 m SW of Tucker Bn., hence crosses the Main Channel and heads ESE for Mora Jetty.

2) Mumbai - Rewas

From the Ferry Wharf at the NE end of the Prince's Dock, the route follows the same course as the above route until Tucker Bn, whence it curves S-ward crossing the Main Channel, passing in between two buoys (N.Karanja Light Buoy and the green buoy showing a sunken vessel), proceeds 8 km, hence curves ESE-ward heading off Rewas Bander Light.

(2) Navigational Routes of Services to/from Gateway of India (Figure 12.8.1)

3) Mumbai - Mandwa

From the Gateway of India, the route bears <130° > to the SE, crossing the Main Channel, until 1,000 m E of it's E'ly boundary, whence curves S-ward, passing Gull Is. Light 1,700 m to the E, and hence heads to Mandve berth.

4) Mumbai - Elephanta

From the same terminal as above, the route bears <113° > to the SE crosses the Main Channel, passing the Green Buoy and Karanja Bn. both on its port side, whence it curves NE-ward and proceeds along the Main Channel until the W-end jetty of Elephanta Is.

5) Mumbai - JNP

The route follows the same course as above until the junction of the Main Channel and the Jawahar Lar Nehru Channel, whence it heads to the S-end jetty of JNP.

6) Mumbai - Vashi

The route follows the same course as Mumbai - Elephanta until W-off Elephanta but passes Elephanta Is. on the W, hence it proceeds along the Trombay Channel heading to Vashi berth.

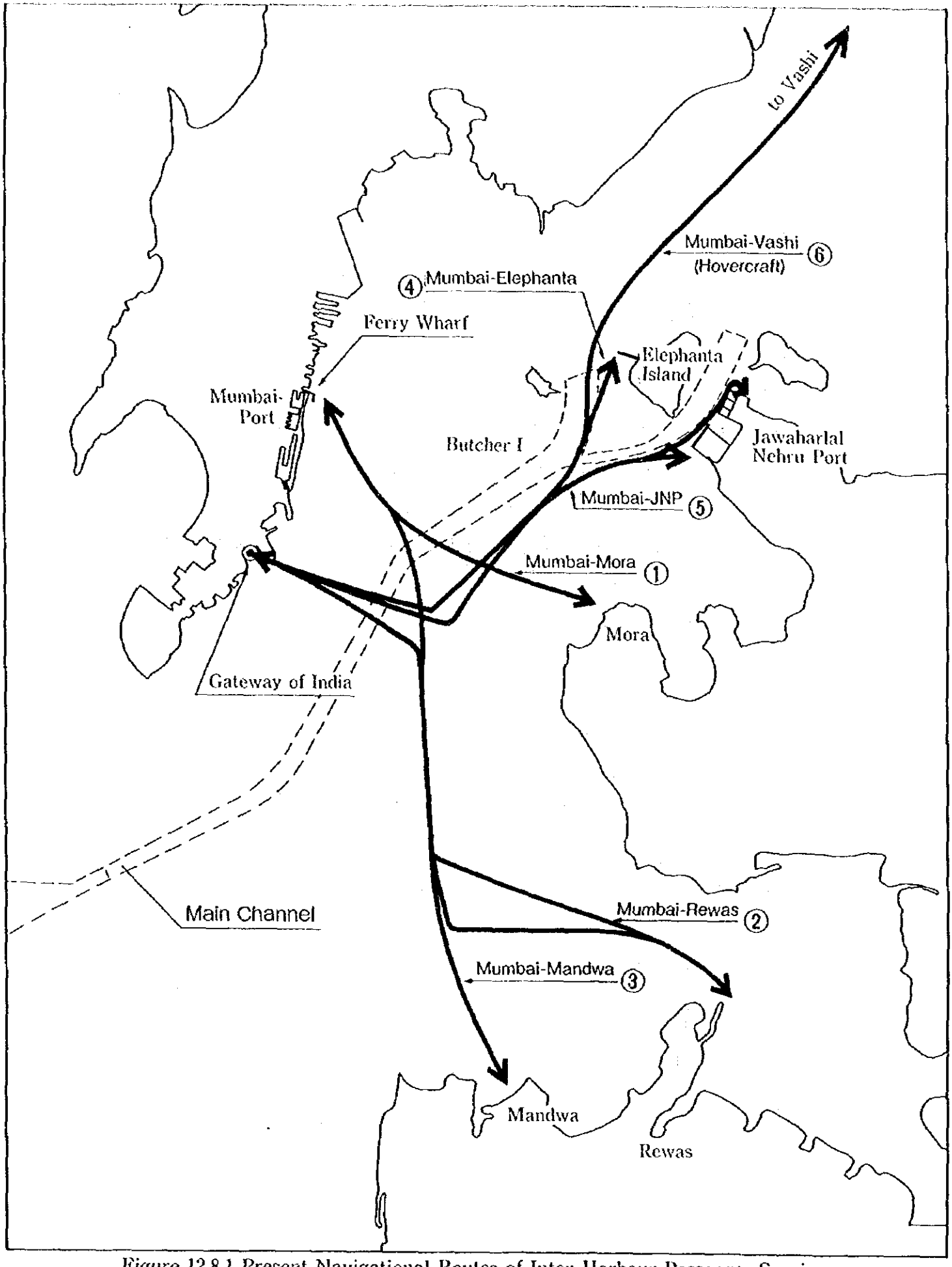


Figure 12.8.1 Present Navigational Routes of Inter-Harbour Passenger Services

12.8.4 Estimated Number of Inter-Harbour Passenger Boats and Other Vessels in 2017

(1) Estimated Number of Inter-Harbour Passenger Boats

Suppose that the target inter-harbour passenger volume (shown in Table12.8.1) and the future operational conditions of passenger boats (Table 12.8.3), the number of passenger boat services in 2017 is estimated and shown in Table12.8.3. Capacities of the future passenger boats are studied and assumed in the following Section. Capacities of passenger boats are assumed as 200 and 100 persons/boat for the routes of more than and less than 1 million passengers/year respectively in this study. Although the capacity of Hover-craft for the present services is 22 seats, some larger-sized Hover-craft (50 seats) is assumed in this study for handling the future traffic volume taking into account of the present frequency of services and doubled demand in 2017.

Table 12.8.3 Estimated Number of Passenger Boat Services for Inter-Harbour Traffic in 2017

Route	Target Volume in 2017	Capacity of Passenger boat	Load Factor	Peaking Factor to Average Daily Services	Peaking Daily Number of Services (One-direction)
	('000 passenger)	(persons/ boat)			(services/day)
1. Mumbai - Mora	1,472	200	0.6	1.26**	22
2. Mumbai - Rewas	1,506	200	0.6	1.26**	22
3. Mumbai - Mandwa	443	100	0.6	1.26**	13
5. Mumbai - Elephanta	1,008	100	0.6	2.0***	46
6. Mumbai - JNP	487	100	0.6	1.26**	14
7. Mumbai - Vashi*	269	50	0.6	1.26**	15
Grand Total		---	---		132

Remarks) * indicates hovercraft services are necessary due to inadequate water depth in Thane Creek to/from Vashi.
** is calculated with actual data between Mumbai and JNP for August, 1997.
*** is assumed taking into account of interview survey by the Study Team.

(2) Estimated Number of Other Vessels to Enter the Main Channel

The number of the major cargo vessels in 2017 to enter the Mumbai Harbour through the Main Channel is also estimated in Chapter 9 and the peaking daily number of vessels is also

shown in Table 12.8.4. The required number of supply vessels to serve those cargo vessels in 2017 is also estimated in Section 12.7 and the peaking daily number of vessels is also shown in Table 12.8.5.

Table 12.8.4 Estimated Number of Cargo Vessels to Enter Mumbai Bay in 2017

Vessel Type	Cargo Type	Annual Number of Vessels (vessels/year)	Average Daily Number of Vessels (vessels/day)	Peaking Daily Number of Vessels (vessels/day)
MBP		2,575	7.1	9.2
Conventional Cargo		1,167	3.2	4.2
Pulses	Bag	66		
Rice	Bag	55		
Sugar	Bag	7		
Oil Cakes	Bag	46		
Miscellaneous	Miscellaneous	478		
Iron and Steel	Break	198		
Phosphate Rock	Dry Bulk	50		
Scrap	Dry Bulk	8		
Sulfur	Dry Bulk	110		
Edible Oil	Liquid Bulk	149		
Container		529	1.5	2.0
Containers	Containers	529		
Liquid Bulk Cargo		879	2.4	3.1
Crude Oil Tanker	Liquid Bulk	310		
POL Tanker	Liquid Bulk	530		
Chemical Tanker	Liquid Bulk	39		
JNP		2,341	6.4	8.3
Bulk	Dry Bulk	92		
Containers	Containers	2,249		
Grand Total		4,916	13.5	17.5

Remarks) Peaking Factor to Average Daily Number of Vessels is assumed as 1.3.

Table 12.8.5 Estimated Number of Supply Vessels to move Mumbai Bay in 2017

Vessel Type	Annual Number of Vessel Movements	Peaking Factor to Average Daily Number of Vessels	Peaking Daily Number of Vessels
MBP	(vessels/year)		(vessels/day)
Pilots	19,664=4,916*4	1.3	70
Tugs	19,664=4,916*4	1.3	70
Dredgers	---	---	36
Grand Total			176

12.8.5 Salient Particulars of the Future Inter-Harbour Passenger Boats

The transport investment programme (concerned agency: CIDCO[2]) includes provision of ferry landing facilities with associated on shore terminal facilities, and navigation aids for proposed ferry services between Colaba and Belapur and Vashi[3]. The following ferry craft for foot passengers is proposed in the feasibility study[4]. Although this feasibility study is originally conducted for the ferry services between Colaba and Belapur and Vashi, the study pointed out a necessity to review the presently-used passenger boats catering at present between Mumbai and Mandwa, Alibag, Nhava Sheva and Mora as well.

Table 12.8.6 Salient Particulars of the Future Inter-Harbour Passenger Boats

Type of Craft	Max. Size (L×B)	Draft	Passenger Capacity	Max. Speed
	(m)	(m)	(persons)	(knots)
Catamaran	34×9.5	1.2	250	14
	20×6.0	0.8	100	20
	27.5×5.4	0.6	80	30
Hovercraft	24.5×11.0	---	50	50

Capacity of passenger boat is to be determined taking into consideration of the passenger demand. However, larger craft with less frequency of services does not attract passengers. The capacity of passenger boat for each route is to be assumed taking into consideration of the present frequency of services and the future demand for each route.

12.8.6 Possible Navigational Problems to be Resolved

A continuous increase of vessel traffic until 2018 within Mumbai port area is projected in this chapter (see Table 12.8.3, Table 12.8.4 and Table 12.8.5). In this connection, owing to the heavy vessel traffic in future, risky situations in which vessels meet or cross one another, at intersections

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[2] CIDCO: City and Industrial Development Corporation of Maharashtra Ltd.

[3] "Comprehensive Transport Plan for Bombay Metropolitan Region" 1994, BMRDA

[4] "Techno-Economic Feasibility Study for Passenger Water Transport Service" 1992, CIDCO

in particular, may arise.

Therefore, it is desirable to set up new standards on vessel traffic within the Port area by the Authority concerned to avoid possible sea accidents, i.e.:

(1) Relating to the sailing rules;

1) A vessel proceeding along the course of the designated channels(Main/Approach/JNP) shall keep as near to the outer limit of the channel which lies on her starboard side as is safe and practicable.
2) A vessel of less than 40 m in length shall not impede the passage of a vessel which can safely navigate only within the designated channels.
3) A vessel of less than 40 m in length shall not cross the specified area of the designated channels (for example; in close proximity of the joint of the Main and the Approach channel)
4) A vessel shall not cross the designated channels if such crossing impedes the passage of a vessel which can safely navigate only within such channels.
5) A vessel proceeding along the course of the designated channels shall not overtake any other vessel proceeding in the same direction.
6) A vessel proceeding along the course of the designated channels shall keep less than 6 knots so that she can take proper and effective action to avoid collision and be stopped within a distance appropriate to the prevailing circumstances and conditions such as visibility, traffic density, and vessel maneuverability.
7) Any vessel shall, if the circumstances admit, avoid anchoring in the designated channels.
8) A vessel of larger than 10,000DWT carrying dangerous cargo shall be escorted by a patrol boat.
9) A vessel proceeding along the course of the designated channels shall keep the minimum distance of eight times of her length to the vessel going ahead. If the vessel is larger than 10,000 DWT and carrying dangerous cargo, the minimum distance shall not be less than one sea mile regardless her length.
10) Vessels in the Port area shall comply at all times with the instructions of Harbor Master.

(2) Relating to the Maritime Administration:

11) Matters related to inter-harbor passenger liners such as the deployed boats, the life-saving /fire-fighting/communicating equipment, the license of Captain/Engineer, the service frequency/time tables, the regularly routes and other specified matters by the Authority shall be subject to the Authority's approval.

12) To carry into effect " Port State Control".

12.9 The Phase Plan for Developing and Modernizing MBP

In the framework of the proposed Master Plan to meet the port requirements on the stage of the short-term plan up to the target year 2007, the first phase projects to be completed by the target year 2007 are proposed (see Table 12.9.1) together with the following second phase project up to the target year 2017.

However, "Deepening Main Channel Project" may need a longer term than 20 years so as to gain a higher EIRR (see Chapter 14).

Table 12.9.1 Summary of Projects of the Phase Plan

Phase Plan	Project Name
First Phase Plan (up to 2007)	1. Container Terminal Project
	2. Deepening Approach Channel Project
Second Phase Plan (up to 2017)	3. Deepening Main Channel Project

Chapter XIII Design and Cost Estimation

13.1 General

The design procedure will begin with the preparation of a list for major civil engineering structures, cargo handling equipment, buildings, electrical installations and ancillary facilities which were studied in developing the Master Plan for the Port of Mumbai.

A preliminary design will be developed for those onshore and offshore civil engineering structures which are of primary importance. In the preliminary designs, a basic study will be prepared for several alternative types of each structure selected for inclusion in the Master Plan. The various alternative structural types will be compared and evaluated to select and propose an optimal type for each structure.

The comparative evaluations when we design the facilities will take full account of specific service conditions, cost effectiveness, durability, relative ease of construction and maintenance, construction time involved, compatibility with the future expansion / improvement plans, and other pertinent factors.

Based on the preliminary designs and the results of comparative evaluation, the Study Team will draw up an implementation program for the Short Term Plan. The implementation Program will include a detailed description of the technical characteristics of the various components of the port infrastructure proposed in the Short Term Plan, preliminary construction costs and scheduling of construction works.

Relevant Japanese technical standards and codes of practice in respect of ports and harbours, roads and bridges will be used in developing the basic studies for the various facilities, structures and equipment proposed in the Master Plan. At the detailed design stage, however, due consideration will be given to the application of Indian or British Standards where necessary.

13.2 Preliminary Structural Design

13.2.1 Matters to be Considered to Design of Facilities

(1) Natural Conditions

At the preliminary design stage, the natural condition of Mumbai Port and neighboring areas which should be applied in the engineering designs of the planned port facilities are as given in Table 13.2.1. The design conditions will be determined in a realistic way so as to meet the actual service and other pertinent conditions of the individual components of the port facilities and equipment planned when these become definable in more specific terms.

(2) Service Conditions

The service conditions to be considered in the engineering designs include the following:

(a) Design ship type and size;

(b) Cargo handling equipment required;

(c) Type and volume of cargo to be handled by proposed port facilities;

(d) Incoming and outgoing traffic volumes and vehicles; and

(e) Port buildings and electric power and water supply systems required.

(3) Operation Conditions during Construction

Provision of a work yard having a shoreline is indispensable for the construction of offshore structures. In Mumbai Port, however, it seems to be difficult to secure adequate spaces along the shoreline for such purpose. If wide space can not be obtained for the purpose along the shoreline of the port, it may well be a constraint in the basic designs of the port facilities required.

In Mumbai Port, road transport of construction materials may also prove to be a constraint in the construction in the port facilities needed, since the port is located close to the urban area of Mumbai City and the access roads to the port are heavily congested. For this reason, sea transport should be considered where selection is made of such structural types in the design process as will involve hauling large quantities of stones to the construction site in the port.

If construction activities have to take place in the port area where normal cargo handling operations are in progress, it is wise to choose structural types that will permit the adoption of such construction methods as will avoid interference with the cargo operations.

Reclamation and dredging works invariably require thoughtful environmental considerations in port projects. In Mumbai Port, reclamation works are banned as a means of construction. Dredging works, on the other hand, are supposed to be free from restrictions in the port, but dredge spoils must be dumped in a specified spoil ground.

In the harbour basin of Mumbai Port, where deeper areas than - 10 meters are limited, large construction plants and equipment, if needed for offshore works, should be used with utmost care.

(4) Remodeling of Existing Wharf

The JICA Study team is currently carring out soil borings in the area behind Berths No.18 and No.21 in Indira Dock to investigate the backfill material used for the wharf construction and the condition of the original ground and bearing stratum.

Soil data derived from the boring operations will be used in the study of remodeling plans for the Indira Dock wharf. The remodeling plans will consider a gravity type of structure and the study will involve an indepth analysis and evaluation of the structural safety of the existing wharf as a whole and its safety against internal stress.

13.2.2 Design Condition

Data and information collected in the field during the first stage of investigation in Mumbai during the period between February and June, 1997 and the requirements for Master Plan of the Project were taken into account, and the following elements were consolidated for consideration in designing civil engineering facilities

(1) Tide

High Water Level (HWL)	+4.40 m
Low Water Level (LWL)	+0.75 m

(2) Geology

Elevation	Soil classification (N : SPT Value)
-7.0 m	Existing seabed
-7.0 m ~ -9.0 m	Soft dark gray mud (N=0~5)
-9.0 m ~ -14.0 m	Clayey or sand stratum with stone (N>10)
-14.0 m ~ -16.0 m	Decomposed rock (N>50)
-16.0 m ~	Fresh rock

(3) Wave

Significant wave height	H = 1.5 m
Wave period	T = 10 sec.
Direction	South ~ Southwest

(4) Current

Velocity of Flows	0 ~ 3 knots
Direction	Northeast and Southwest

(5) Seismic Load

5% of dead load acting either in the longitudinal or transverse direction shall be considered.

(6) Ship to be accommodated

Tonnage	35,000 DWT (2,000TEU's class)
Overall Length	260 m
Molded Breadth	32.2 m
Full Load Draft	12.0 m
Berthing Speed	15 cm/sec

(7) Berth Elements

Water Depth in front	-13 m (design water depth of -13.5 m to be considered)
Length of Berth	300.0 m
Crown Height	+7.0 m

(8) Surcharge

- Weight of container crane (Panamax type, rail span of 20 m)
- Weight of lorry and weight of containers (surcharge of 1.5 ton/m^2 considered)

13.2.3 Design of Container Berth

(1) Offshore Berth

As pile foundation type of pier is generally adopted as the structure for container ship berthing facility to be constructed several hundred meters away from the shore, reinforced concrete pile foundation is to be selected for study of the berth. Also, concrete cellular block foundation type pier are taken up for study, because it is foreseen that seabed may consist of hard base rock.

Prudent care should be taken in selection of structure to preclude such structural type as affects natural tidal currents as it may accelerate the shoaling with siltation over the fairway due to flow of tidal currents through the Port of Mumbai. Furthermore, as land reclamation is strictly controlled in view of environmental protection, an island type structure consisting of retaining wall, which is impermeable, is excluded from an object of study. Two (2) different cases of standard profiles of structure are shown in Figure 13.2.1 to 13.2.4. Characteristics of each type of structure are described below.

a) Concrete pile foundation type berth

- A liner pipe is to be driven to the weathered rock layer and pre boring is to be carried out through the solid rock layer, then reinforced concrete in-situ is placed to form a concrete pile.
- Rock anchor acts to resist against extraction
- No cathodic protection work is needed
- The method of construction is popular in India.
- A period of works at sea is longer than other methods of work.
- A manufacturing yard for PC beams for deck slab is necessary.
- No large sized floating crane or pile driving barge are necessary.

b) Concrete cellular block foundation type berth

- Concrete cellular blocks are to be tiered in water, and their interior are to filled with stone.
- Underwater concrete is to be placed about the bottom part to secure even bearing capacity.
- Original ground is to be excavated to expose a very hard stratum, and rubble stones are

placed and spread over the exposed surface to form an even horizontal bearing stratum.

- A large sized floating crane capable of 500 tons is needed.
- Block manufacturing yard is necessary.
- A period of works at sea is rather short.
- A manufacturing yard for PC beams for deck slab is necessary.

(2) Harbour Wall Berth Expansion

Structure of wharf was examined in preparation for the proposed -13.0 m container wharf immediately outside of the existing Harbour Wall Berth. Two different types of structure, namely, concrete pile foundation type berth and concrete cellular block foundation type one, were studied. Standard profile of each type is shown in Figure 13.2.5.

Features of each method of construction are as same as in the case of the foregoing chapter "Offshore Berth", provided that, in these cases, construction works from the existing wharf is possible by either one of the methods of construction, and no large, special type of working vessel is necessary.

(3) Indira Dock Berth Expansion

Plans of improvement of Indira Dock Berth, from No. 2 to No. 5 and installation of container cranes were examined.

Two different types of structure, namely, concrete pile foundation type pier and concrete cellular block foundation type pier, were considered. Standard profile of each type of structure is shown in Figure 13.2.6. Features of each method of construction are as same as in the foregoing chapter "Offshore Berth", provided that, by either one of the methods, construction works are possible from the existing wharf, and no large, special type of crane is necessary.

13.2.4 Design of Other Facilities

(1) Access Bridge

Standard profile of bridges that connect the proposed offshore berth and the container yard on the land side is shown in Figure 13.2.7.

The 24 meter width of the bridge with two-lane dual carriageway are provided. Type of

structure is of 10 m span on pile foundation pier structure, and PC Slab superstructure is provided. It is envisaged that cost may be reduced by making structural type of the bridge uniform with that to be adopted for the offshore berth structure.

Construction of causeway type access that permits movement of sea water under the road is proposed where the water depth is shallower than -2 meter.

(2) Container Yard

Though asphalt concrete pavement is adopted for the container yard, PC slab track shall be adopted for the passage of transfer cranes to gain a smooth travel. Adequate lighting facility will be provided in consideration of night work at the wharf. Figure 13.2.8 shows the typical cross section of container yard paving.

(3) Elevated Container Road in Port Premises

With regard to the container road planned to connect the container yard in the Dock Area with the container yard immediately behind the port premises, an elevated road will be constructed for that section of the container road which will run through traffic congested area, in order to reduce interference from general cargo traffic on the dock road.

The elevated road will have two lanes in both ways with a total width of 20 m , but will have no sidewalk. The elevated road bridge structure will consist of a slab system constructed of concrete beams and a bridge pier of concrete pile foundation. Typical cross section of elevated road bridge is shown on Fig. 13.2.9.

13.2.5 Berthing Facilities for Accommodation of Larger Sizes of Container Vessel

The container berth consistent with the container handling capacity of 2,000 TEU's class container vessel is designed and its synopsis is given in the previous section. In this section, further study is carried out to meet the requirements for accommodating 2,500 ~ 3,000 TEU's class container vessel based on the layout of Alternative-6 case.

The study on the preliminary design is made taking into consideration the following data and its typical cross section of -13.5 m berth is illustrated in Figure 13.2.10 and the plan of offshore berth is shown in Figure 13.2.11.

Design conditions

1) Ship to be accommodated ;

   50,000DWT - 3,000TEU's class of Container Vessel

   (Ship data are given in the Table 12.2.5)

2) Water depth in front of berth ;

   Alternative-6A : -13.5 meter, and Alternative-6B : -14.0 meter

3) Water depth of Approach Channel and Basin

   Alternative-6A : -11.0 meter, and Alternative-6B : -11.5 meter

4) Other conditions are as same as the basic case of Alternative-6.

The landward side of offshore berth 500 meter in length from south end is so designed as a mooring quay for tugboats, pilot boats, dredgers and other harbor craft. The typical cross section of this berth structure is shown in Figure 13.2.12.

13.3 Cost Estimation

13.3.1 Basis of Cost Estimation

The project cost is computed in Indian Rupees Currency on the basis of 1997 fiscal year price and no escalation in prices will be allowed for.

The construction cost, procurement of equipment, engineering service, contingency and taxation are the main component of the capital project cost and the operation cost and maintenance cost are also the part of the project cost.

The above mentioned prices will be calculated based on different methods. These are broadly classified into three categories depending on the feature of the work. This classification is given in Table 13.3.1.

Table 13.3.1 Basis of Project Cost Estimation

Category	Description
Category I	The estimated costs are prepared by applying the unit rates of materials and construction equipment etc. with quantities.
Category II	The costs are provided based on updated rates of individual items from works of similar nature completed in the recent past.
category III	Certain percentage of the related construction cost will be considered.

The breakdown of project costs are presented as schematized below with the classification of categorized methods of cost estimation.

(1) Construction cost (CC) = DC + IC

DC : Direct Construction Cost

Civil work for major facilities	Category I
Civil work for miscellaneous facilities	Category II
Building work	Category II
Utilities	Category II
Mobilization and Demobilization (from abroad)	Category I

IC : Indirect Construction Cost

Site expense — Category III

Overhead and profit — Category III

(2) Procurement of Equipment (PE) = EC + IS

EC : Equipment cost on CIF basis — Category II

IS : Installation cost at site — Category III

(3) Engineering Service (ES) = BD + DD + SV

BD : Basic design and site investigation — Category III

DD : Detailed design and tender assistance — Category III

SV : Construction supervision — Category III

(4) Contingency (CG) = PC + PE

PC : Physical contingency — Category III

PE : Price escalation - No price escalation will be considered

(5) Tax and Duty (TD) :

Central tax, State tax, Works contract tax, Customs duty, etc. — Category III

13.3.2 Cost Estimation of Master Plan

(1) Unit Rates and Sources Obtained

The related unit rates of materials, equipment available in the country and labour wages, which will be used for calculation of the construction cost under category I, are obtained from such various sources as published wage data, published rates of construction equipment, several bid documents, information from construction companies and markets as listed below. The results of investigation are tabulated in Tables 13.3.2, 13.3.3, and 13.3.4.

a) Schedule of Rates April 1995 and updated slip

Bombay Port Trust (Chief Engineer's Department)

b) Summary of Rates 1995

Industrial Development Corporation (Maharashtra)

c) New Pir Pau Berth Contract -I 1991

Bombay Port Trust

d) Maintenance Dredging in Navigation Channel for two years from 1996

Bombay Port Trust

e) Other information obtained during the first and second phases of JICA Team Study in India

(2) Tax and Duty

The applicable taxes imposed on the construction work of project and customs duties in connection with the procurement of container handling equipment are taken as shown in Table 13.3.5.

Table 13.3.5 Component of Taxes and Duties

Description	Percentage
Central sales tax	10 % of direct cost
Maharashtra state turnover tax	4 % of direct cost
Works contract tax	4 % of direct cost
Import duty of container handling equipment	37.86 % of CIF price

Although the main import items required for the project are assumed some type of equipment for special construction purpose, selected materials and the equipment for container handling operation, only the customs duty for the container handling equipment is considered to the cost estimation, while the import duties on construction equipment and materials from abroad are not included in the estimation.

(3) Depreciation Period of Facilities and Equipment

The facilities and equipment of the project are assumed to be depreciated for a certain

period as given in the Table 13.3.6 on condition that appropriate maintenance should be continually performed.

Table 13.3.6 Life Span of Port Related Facilities and Equipment

Facilities	Life Span
Dredging	100 years
Jetties and berths	75 years
Building and others	40 years
Equipment and plant	25 years

(4) Construction Cost of Berthing Facilities

As the results of rough cost estimate of construction, there are not much difference between the concrete pile foundation type and the concrete cellular type pier of construction in respect of cost. Accordingly, further investigations will be carried out to select the suitable structure type during the detailed design stage of the development scheme to the Port.

The costs of construction by either case of these methods are as shown in Table 13.3.7.

Table 13.3.7 Construction Cost of Container Berth

Item	Water Depth	Net Cost of Construction (per meter)
Offshore Container Berth	- 13.5 meter	Rs. 7,327,000
Offshore Container Berth	- 13.0 meter	Rs. 5,785,000
Harbour Wall Berth Expansion	- 13.0 meter	Rs. 1,248,000
Indira Dock Berth Expansion	- 10.0 meter	Rs. 940,000

(5) Cost Estimate of Master Plan

Preliminary cost estimates have been worked out in respect to the Master Plan targeted for the year 2017. The cost estimates are primarily based on the basic prices and rates in Mumbai derived from a construction material and equipment price survey conducted by the Study Team in early 1997, and they are adjusted on the basis of market prices in Southeast Asian countries in recent years.

The cost estimates have been arrived at on a quantification basis for major types of work with due consideration given to local conditions and expected construction restraints.

The preliminary project cost estimates with respect to the Master Plan 2017 under the condition of eight (8) alternatives including the navigational improvement scheme of approach channel to Indira Dock and the construction of offdock container yard with dedicated road system in the port are summarized in Table 13.3.8.

The detailed Construction Costs are calculated in Tables as listed below.

Alternative -1	Indira Dock Expansion Plan	Table 13.3.9
Alternative -2	Harbour Wall Expansion Plan	Table 13.3.10
Alternative -3	Offshore Berth Plan (1) with Harbour Wall Container Yard	Table 13.3.11
Alternative -4	Offshore Berth Plan (2) with Harbour Wall Container Yard	Table 13.3.12
Alternative -5	Offshore Berth Plan (1) with Indira Dock Container Yard	Table 13.3.13
Alternative -6	Offshore Berth Plan (1) with Victoria Container Yard (Water depth of container berth : -13.0 meter)	Table 13.3.14
Alternative -6A	Offshore Berth Plan (1) with Victoria Container Yard (Water depth of container berth : -13.5 meter)	Table 13.3.15
Alternative -6B	Offshore Berth Plan (1) with Victoria Container Yard (Water depth of container berth : -14.0 meter)	Table 13.3.16
Navigation Improvement Scheme for Main Channel		Table 13.3.17
Information about Present Main Channel and Proposed Main Channel		Table 13.3.18

13.3.3 Cost Estimation of Maintenance Dredging

(1) Main Channel

The maintenance Dredging cost is estimated depending on the combination of different maintenance depths and the relevant siltation rates which are examined through our study provided under Chapter X of this report. The detail calculation of cost estimate is shown in Table 13.3.19.

(2) Indira Dock Container Terminal

The calculation of estimated maintenance cost for the Approach Channel and Basin of Indira Dock Container Terminal is also indicated in Table 13.3.20

Table 13.2.1
General Information on Natural Conditions at Mumbai Port

No.	Item	Design Condition	Operation Condition	Remarks
1	Meteorological Conditions			
1-1	Wind speed	150 km per hour	70 km per hour	Source -1
1-2	Rainfall intensity	50 mm/hr.		Reference to Chapter II
1-3	Temperature	min.20 deg., max.40 deg.		Reference to Chapter II
1-4	Humidity	min.50 %, max.100%		Reference to Chapter II
2	Sea Conditions			Reference to Chapter II
2-1	Wave (max.)	H=3.0m, T=10sec, South		Source -1
2-2	Wave (significant)	H=1.5m, T=10sec, South		Reference to Chapter II
2-3	Current	4 knots	3 knots	Source -1
3	Tied level			Source -2
3-1	HW (Highest Record)	+5.38 m		June 1924
3-2	MHWS	+4.42 m		
3-3	MHWN	+3.30 m		
3-4	Highest LW	+2.74 m		
3-5	Local mean sea level	+2.51 m		Survey of India Datum
3-6	Lowest HW	+2.48 m		
3-7	MLWN	+1.85 m		
3-8	MLWS	+0.76 m		
3-9	Chart Datum	±0.00 m		
3-10	LW (Lowest Recorded)	-0.44 m		October 1879
4	Soil Condition	(Composition of typical soil strata and properties are given below.)		
4-1	Surface Layer	Soft dark gray mud		
4-2	Upper Layer	Clayey or sandy stratum with stones and boulders		
4-3	Decomposed Rock	Basalt and Tuff		
4-4	Base Rock	Basalt and Tuff		
5	Seismic load	6% of dead load acting either in the longitudinal or transverse direction shall be considered.		

Source - Replacement of Submarine Pipelines and Modernization of MOT Berths
Detail Project Report Part II Modernization of MOT Berths, Bombay Port Trust, Oct.1994

- Bombay Port Trust Master Plan Volume I Main Report Bertlin and Pertners(India)1970

Note : These information will be used for the purpose of preliminary design of structure and data are subject to change through further investigation.

Table 13.3.2 Unit Rates of Construction Materials

Unit : Rupees

No.	Description	Specifications	Unit	Unit Rates at MBPT		Remarks
				1.995	1.997	
01	Cement	Ordinary Portland	ton	2,900	3,835	
02	Fine Aggregate	River sand	cu.m	395	522	
03	Coarse Aggregate	3/4 inch	cu.m	390	516	
04	Rubble rock	200-500kg/each	cu.m	200	265	
05	Rubble rock	1,000-2,000kg/each	cu.m		633	
06	Filling Material	Laterite	cu.m		173	
07	Re-bars	10-20mm	ton	15,850	20,962	Mild steel
08	Plywood	thickness 3/8"	sq.m		633	
09	Shaped steel	Angle, Channel, H-steel	ton	20,470	27,072	
10	Steel plate	6mm, 9mm thickness	ton		-	
	Rail	FF52kg section	ton	20,654	27,315	
11	Asphalt		ton	5,200	6,877	
12	Gasoline		litter		26	
13	Diesel Oil		litter		12	
14	Concrete	250kg/cm2	cu.m		4,830	
15	Concrete Products	Precast concrete block	unit	29	38	39*20*19 cm
16		RCC 450 mm dia pipe	m	445	589	NP2, L=2.5m
17		RCC 300 mm dia pipe	m	240	317	NP2, L=2.5m
18		RCC 450 mm dia pipe	m	659	872	NP3, L=2.5m
19		RCC 300 mm dia pipe	m	580	767	NP3, L=2.5m
20		Crossing sleeper	unit	1,925	2,546	2750*280*150
21		Crossing sleeper	unit	4,120	5,449	4850*280*150
24						
25						
26						
27						

Table 13.3.3 Wages and Salary

Unit : Rupees

No.	Description	Unit	Wage/Salary				Remarks
			1991	1995	1996	1997	
1	Technical personal and labour						
1-1	Supervisor	day		100.0		115	
1-2	Skilled Labor	day	44.7	80.0	84.0	92	
	Semi Skilled Labour	day	42.7	75.0	82.1	86	
1-3	Unskilled Labor	day	39.7	65.0	79.1	83	
1-4	H.E. Operator	day		100.0		115	
1-5	Driver	day		75.0		86	
	Engineering Personnel						
06	Engineer (A)	day				2,000	30years experience
07	Engineer (B)	day				1,100	15years experience
08	Surveyor	day				800	qualified
09	Draftsman	day				300	experienced
	Administrative Personnel						
10	Clerk	day				400	experienced
11	Typist	day				300	experienced
12	Secretary	day				600	experienced
13							

Not 1) The rates in this table are net value and it does not include taxes, contractor's overhead and profit.

2) The rates are applicable to the normal onshore work.

Table 13.3.4 Unit Rate of Construction Equipment

Unit ; Rupees

No.	Description	Specifications	Unit	Unit Rate		Remarks
				1995	1997	
01	Dump truck	11 ton	day		6,599	
02	Truck (flat bed)	12 ton	day	500	575	
03	Truck	7.5 ton	day	500	575	
04	Back-hoe	0.6 cu m	day		6,041	
05	Truck-mounted crane	20 ton	day		11,473	
06	Truck-mounted crane	40 ton	day		14,510	
07	Crawler crane	12.5 ton	day	400	460	
08	Crawler crane	50 ton	day		18,943	
09	Payloader, Tyre loader	1.0 cu m	day		6,996	
10	Bulldozer	15 ton (D7)	day		5,062	
11	Asphalt plant	40ton/hr	hour	1,042	1,198	
12	Road Roller	8-10 ton	hour	190	219	
13	Morter Grader		hour	540	621	
14	Paving Finisher		hour	444	511	
15	Water Tanker	7.5 ton	day	955	1,098	
16	Water Pump	15 Hp	day	400	460	
17	Engine Generator	125 KVA	day		3,053	
18	Engine Generator	30 KVA	day	400	460	
19	Compressor	7m3/min	hour	180	207	
20	Diesel Welding Machine		hour	80	92	
21	welding Machine		day	75	86	
22	Gas Cutting Machine		day	75	86	

Table 13.3.8 Comparison Table of Summarized Project Cost among Alternatives

No.	Main Facility	Construction Cost (Million Rs.)					
		Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Alternative 6
1	Dock Container Terminal	3,674	13,495	13,118	13,611	13,023	14,502
1-1	Container Berth	662	9,722	9,112	9,572	9,104	9,705
1-2	Container Yard	463	1,004	1,004	1,004	884	1,762
1-3	Container Handling Equipment	2,549	2,769	3,002	3,035	3,035	3,035
2	Approach Channel	0	784	611	611	611	611
3	Road Improvement	2,125	2,371	2,371	2,371	3,317	809
4	Cotton Depot Container Yard	782	782	782	782	782	782
5	Timber Pond South Container Depot	186	186	186	186	186	186
6	Total	6,767	17,618	17,068	17,561	17,919	16,890
Remarks							
	1 Container Berth	Indira 2 to 5	Harbour Wall	Offshore-1	Offshore-2	Offshore-1	Offshore-1
	2 Depth of Berth	-10.0 m	-13.0 m	-13.0 m	-13.0 m	-13.0 m	-13.0 m
	3 Depth of Basin and Channel	-7.6 m	-10.5 m	-10.5 m	-10.5 m	-10.5 m	-10.5 m
	4 Dock Container Yard	Indira 2 to 5	Harbour Wall	Harbour Wall	Harbour Wall	Indira 2 to 6	Victoria
	5 Length of Elevated Container Road	2,000 m	2,200 m	2,200 m	2,200 m	3,100 m	700 m

No.	Main Facility	Construction Cost	
		Alternative 6A	Alternative 6B
1	Dock Container Terminal	16,338	18,535
1-1	Container Berth	3,041	3,049
1-2	Container Yard	11,530	13,716
1-3	Container Handling Equipment	1,767	1,770
2	Approach Channel	750	936
3	Road Improvement	808	808
4	Cotton Depot Container Yard	782	782
5	Timber Pond South Container Depot	186	186
6	Total	18,865	21,247
Remarks			
	1 Container Berth	Offshore-1	Offshore-1
	2 Depth of Berth	-13.5 m	-14.0 m
	3 Depth of Basin and Channel	-11.0 m	-11.5 m
	4 Dock Container Yard	Victoria	Victoria
	5 Length of Elevated Container Road	700 m	700 m

Table 13.3.9
PROJECT COST FOR DEVELOPMENT OF CONTAINER TERMINAL
Alternative-1

No.	Description		Unit	Quantity	Rate	Amount	Remarks
					(Rs.)	('000Rs)	
I	Indira Dock Container Terminal						
	1 Container Berth No.2 to No.5 of Indira Dock					592,076	
	a Container Berth	-10 m depth	m	630	939,803	592,076	Improvement of existing berth
	2 Indira Dock Yard					415,225	
	a Paving Work	Include I/C lane & utilities	m2	86,000	3,122	268,492	
	b Building Work	office, gate, work shop, facilities	sum	1	34,198,866	34,199	
	c Electric and Water Supply		sum	1	112,533,642	112,534	illumination, reefer, sump, tank
	3 Container Handling Equipment					2,282,580	
	a Container Crane		nos	6	183,200,000	1,099,200	
	b Transfer Crane		nos	18	40,200,000	723,600	
	c Yard Tractor and Chassis		nos	42	4,740,000	199,080	
	d Road Tractor and Chassis		nos	55	4,740,000	260,700	
	4 Sub Total					3,289,881	
	5 Engineering Service		sum	1		214,859	10% of Civil and 5% of Equip.
	6 Physical Contingency		sum	1		169,208	10% of Civil and 5% of Equip.
	7 Import Duty of Container Handling Equipment		sum	1		864,185	37.86% of Equip
	8 Total					4,538,133	
II	Road Improvement in Dock Area						
	1 Site Clearance work		sum	1	20,300,000	20,300	
	2 Container Road 1	Ground road (1200m * 20m)	m2	24,000	1,877	45,048	20 m wide of 4 lane road
	3 Container Road 2	Elevated road section	m	2,000	838,000	1,676,000	20 m wide of 4 lane road
	4 Miscellaneous	Boundary wall, gate, illumination	sum	1	29,300,000	29,300	
	5 Sub Total					1,770,648	
	6 Engineering Service		sum	1		177,065	10% of Sub Total
	7 Physical Contingency		sum	1		177,065	10% of Sub Total
	8 Total					2,124,778	
III	Cotton Depot Container Yard						
	1 Civil and Building Work					613,602	
	a Container Yard		m2	95,000	1,877	178,315	Boundary wall, Drainage
	b Container Freight Station		m2	19,200	18,850	361,920	
	c Building Work (office, gate, work shop)		sum	1	17,100,000	17,100	
	d Electric and Water Supply		sum	1	56,266,823	56,267	Electric Sub Station
	2 Container Handling Equipment					42,400	
	a Reach Stacker		nos	2	21,200,000	42,400	
	3 Sub Total					656,002	
	4 Engineering Service		sum	1		63,450	10% of Civil and 5% of Equip.
	5 Physical Contingency		sum	1		62,632	10% of Civil and 5% of Equip.
	6 Import Duty of Container Handling Equipment		sum	1		16,053	37.86% of Equip.
	7 Total					798,167	
IV	Timber Pond South Container Depot						
	1 Civil and Building Work					117,143	
	a Container Yard		m2	60,000	1,877	112,620	Boundary wall, Drainage
	b Building Work (office, gate, work shop)		sum	1	1,710,000	1,710	
	c Electric and Water Supply		sum	1	2,813,341	2,813	Electric Sub Station
	2 Container Handling Equipment					42,400	
	a Reach Stacker		nos	2	21,200,000	42,400	
	3 Sub Total					159,543	
	4 Engineering Service		sum	1		13,831	10% of Civil and 5% of Equip.
	5 Physical Contingency		sum	1		12,986	10% of Civil and 5% of Equip.
	6 Import Duty of Container Handling Equipment		sum	1		16,053	37.86% of Equip.
	7 Total					202,416	
VI	1 Total of Construction Cost					6,767,203	
	2 Import Duty of Container Handling Equipment					896,290	
	3 Grand Total					7,663,493	

Table 13.3.10
PROJECT COST FOR DEVELOPMENT OF CONTAINER TERMINAL
Alternative-2

No.	Description		Unit	Quantity	Rate (Rs)	Amount ('000Rs)	Remarks
I	**Indira Dock Container Terminal**						
	1 Container Berth					8,271,536	
	a Dredging of Basin	Maintained at -10.5 m depth	m3	5,246,000	1,363	7,148,480	
	b Container Berth	-13.0 m depth	m	900	1,247,840	1,123,056	Improvement of existing berth
	2 Harbour Wall Container Yard					853,897	
	a Site Clearance		sum	1	9,400,000	9,400	
	b Paving Work	Include T/C lane & utilities	m2	153,000	3,122	477,666	
	c Building Work	office, gate, work shop, facilities	sum	1	85,497,165	85,497	
	d Electric and Water Supply		sum	1	281,334,105	281,334	illumination, reefer, sump, tank
	3 Container Handling Equipment					2,355,960	
	a Container Crane		nos	6	183,200,000	1,099,200	
	b Transfer Crane		nos	19	40,200,000	763,800	
	c Yard Tractor and Chassis		nos	49	4,740,000	232,260	
	d Road Tractor and Chassis		nos	55	4,740,000	260,700	
	4 Sub Total					11,481,393	
	5 Engineering Service		sum	1		1,030,341	10% of Civil and 5% of Equip.
	6 Physical Contingency		sum	1		983,222	10% of Civil and 5% of Equip.
	7 Import Duty of Container Handling Equipment		sum	1		891,966	37.86% of Equip.
	8 Total					14,386,922	
II	**Approach Channel**						
	1 Dredging Work	Maintained at -10.5 m depth	m3	2,964,000	220	652,080	360 m width
	2 Navigation Buoy		nos	9	3,335,000	30,015	
	3 Sub Total					682,095	
	4 Engineering Service		sum	1		34,105	5% of Sub Total
	5 Physical Contingency		sum	1		68,210	10% of Sub Total
	6 Total					784,410	
III	**Road Improvement in Dock Area**						
	1 Site Clearance work		sum	1	20,300,000	20,300	600+1600 = 2200 m
	2 Container Road 1	Ground road (2200m*20m)	m2	44,000	1,877	82,588	20 m wide of 4 lane road
	3 Container Road 2	Elevated road section	m	2,200	838,000	1,843,600	20 m wide of 4 lane road
	4 Miscellaneous	Boundary wall, gate, illumination	sum	1	29,300,000	29,300	
	5 Sub Total					1,975,788	
	6 Engineering Service		sum	1		197,579	10% of Sub Total
	7 Physical Contingency		sum	1		197,579	10% of Sub Total
	8 Total					2,370,946	
IV	**Cotton Depot Container Yard**						
	1 Civil and Building Work					613,602	
	a Container Yard		m2	95,000	1,877	178,315	Boundary wall, Drainage
	b Container Freight Station		m2	19,200	18,850	361,920	
	c Building Work (office, gate, work shop)		sum	1	17,100,000	17,100	
	d Electric and Water Supply		sum	1	56,266,821	56,267	Electric Sub Station
	2 Container Handling Equipment					42,400	
	a Reach Stacker		nos	2	21,200,000	42,400	
	3 Sub Total					656,002	
	4 Engineering Service		sum	1		63,480	10% of Civil and 5% of Equip.
	5 Physical Contingency		sum	1		62,632	10% of Civil and 3% of Equip.
	6 Import Duty of Container Handling Equipment		sum	1		16,053	37.86% of Equip.
	7 Total					798,167	
V	**Timber Pond South Container Depot**						
	1 Civil and Building Work					117,143	
	a Container Yard		m2	60,000	1,877	112,620	Boundary wall, Drainage
	b Building Work (office, gate, work shop)		sum	1	1,710,000	1,710	
	c Electric and Water Supply		sum	1	2,813,341	2,813	Electric Sub Station
	2 Container Handling Equipment					42,400	
	a Reach Stacker		nos	2	21,200,000	42,400	
	3 Sub Total					159,543	
	4 Engineering Service		sum	1		13,834	10% of Civil and 5% of Equip.
	5 Physical Contingency		sum	1		12,986	10% of Civil and 3% of Equip.
	6 Import Duty of Container Handling Equipment		sum	1		16,053	37.86% of Equip.
	7 Total					202,416	
VI	**1 Total of Construction Cost**					17,618,789	
	2 Import Duty of Container Handling Equipment					924,072	
	3 Grand Total					18,542,861	

Table 13.3.11
PROJECT COST FOR DEVELOPMENT OF CONTAINER TERMINAL
Alternative-3

No.	Description		Unit	Quantity	Rate (Rs.)	Amount ('000Rs.)	Remarks
I	**Indira Dock Container Terminal**						
	1 Offshore Container Berth					7,773,670	
	a Dredging of Basin	Maintained at -10.5 m depth	m3	5,713,000	300	1,713,900	
	b Container Berth	-13.0 m depth & 65m wide Jetty	m	900	5,784,900	5,206,410	with berth facility of Tug Launch
	c Access Bridge 1	Pile foundation section	m	460	1,146,000	527,160	24 m wide of 4 lane road
	d Access Bridge 2	Causeway section	m	300	900,000	270,000	24 m wide of 4 lane road
	e Electric and water facilities		sum	1	56,200,000	56,200	
	2 Harbour Wall Container Yard					853,893	
	a Site Clearance		sum	1	9,400,000	9,400	
	b Paving Work	Include T/C lane & utilities	m2	153,000	3,122	477,666	
	c Building Work	office, gate, work shop, facilities	sum	1	85,497,165	85,497	
	d Electric and Water Supply		sum	1	281,334,105	281,334	Illumination, reefer, sump, tank
	3 Container Handling Equipment					2,559,780	
	a Container Crane		nos	6	183,200,000	1,099,200	
	b Transfer Crane		nos	19	40,200,000	763,800	
	c Yard Tractor and Chassis		nos	92	4,740,000	436,080	
	d Road Tractor and Chassis		nos	55	4,740,000	260,700	
	4 Sub Total					11,187,343	
	5 Engineering Service		sum	1		990,746	10% of Civil and 5% of Equip.
	6 Physical Contingency		sum	1		939,550	10% of Civil and 5% of Equip.
	7 Import Duty of Container Handling Equipment		sum	1		969,133	37.86% of Equip.
	8 Total					14,086,776	
II	**Approach Channel**						
	1 Dredging Work	Maintained at -10.5 m depth	m3	2,280,000	220	501,600	300 m width
	2 Navigation Buoy		nos	9	3,335,000	30,015	
	3 Sub Total					531,615	
	4 Engineering Service		sum	1		26,581	5% of Sub Total
	5 Physical Contingency		sum	1		53,162	10% of Sub Total
	6 Total					611,358	
III	**Road Improvement in Dock Area**						
	1 Site Clearance work		sum	1	20,300,000	20,300	600+1600 = 2200 m
	2 Container Road 1	Ground road (2,200m*20m)	m2	44,000	1,877	82,588	20 m wide of 4 lane road
	3 Container Road 2	Elevated road section	m	2,200	838,000	1,843,600	20 m wide of 4 lane road
	4 Miscellaneous	Boundary wall, gate, illumination	sum	1	29,300,000	29,300	
	5 Sub Total					1,975,788	
	6 Engineering Service		sum	1		197,579	10% of Sub Total
	7 Physical Contingency		sum	1		197,579	10% of Sub Total
	8 Total					2,370,946	
IV	**Cotton Depot Container Yard**						
	1 Civil and Building Work					613,602	
	a Container Yard		m2	95,000	1,877	178,315	Boundary wall, Drainage
	b Container Freight Station		m2	19,200	18,850	361,920	
	c Building Work (office, gate, work shop)		sum	1	17,100,000	17,100	
	d Electric and Water Supply		sum	1	56,266,821	56,267	Electric Sub Station
	2 Container Handling Equipment					42,400	
	a Reach Stacker		nos	2	21,200,000	42,400	
	3 Sub Total					656,002	
	4 Engineering Service		sum	1		63,480	10% of Civil and 5% of Equip.
	5 Physical Contingency		sum	1		62,632	10% of Civil and 5% of Equip.
	6 Import Duty of Container Handling Equipment		sum	1		16,053	37.86% of Equip.
	7 Total					798,167	
V	**Timber Pond South Container Depot**						
	1 Civil and Building Work					117,143	
	a Container Yard		m2	60,000	1,877	112,620	Boundary wall, Drainage
	b Building Work (office, gate, work shop)		sum	1	1,710,000	1,710	
	c Electric and Water Supply		sum	1	2,813,341	2,813	Electric Sub Station
	2 Container Handling Equipment					42,400	
	a Reach Stacker		nos	2	21,200,000	42,400	
	3 Sub Total					159,543	
	4 Engineering Service		sum	1		13,834	10% of Civil and 5% of Equip.
	5 Physical Contingency		sum	1		12,986	10% of Civil and 5% of Equip.
	6 Import Duty of Container Handling Equipment		sum	1		16,053	37.86% of Equip.
	7 Total					202,416	
VI	**1 Total of Construction Cost**					17,068,424	
	2 Import Duty of Container Handling Equipment					1,001,238	
	3 Grand Total					18,069,662	

Table 13.3.12
PROJECT COST FOR DEVELOPMENT OF CONTAINER TERMINAL
Alternative-4

No.	Description		Unit	Quantity	Rate (Rs)	Amount (000Rs)	Remarks
I	**Indira Dock Container Terminal**						
	1 Offshore Container Berth					8,163,310	
	a Dredging of Bassin	Maintained at -10.5 m depth	m3	5,713,000	300	1,713,900	
	b Container Berth	-13.0 m depth & 63m wide Jetty	m	900	5,784,900	5,206,410	with berth facility of Tug/Launch
	c Access Bridge 1	Pile foundation section	m	800	1,146,000	916,800	24 m wide of 4 lane road
	d Access Bridge 2	Causeway section	m	300	900,000	270,000	24 m wide of 4 lane road
	e Electric and water facilities		sum	1	56,200,000	56,200	
	2 Harbour Wall Container Yard					853,897	
	a Site Clearance		sum	1	9,400,000	9,400	
	b Paving Work	Include T.C lane & utilities	m2	153,000	3,122	477,666	
	c Building Work	office, gate, work shop, facilities	sum	1	85,497,165	85,497	
	d Electric and Water Supply		sum	1	281,331,105	281,334	Illumination, reefer, sump, tank
	3 Container Handling Equipment					2,583,480	
	a Container Crane		nos	6	183,200,000	1,099,200	
	b Transfer Crane		nos	19	40,200,000	763,800	
	c Yard Tractor and Chassis		nos	97	4,740,000	459,780	
	d Road Tractor and Chassis		nos	55	4,740,000	260,700	
	4 Sub Total					11,600,657	
	5 Engineering Service		sum	1		1,030,895	10% of Civil and 5% of Equip.
	6 Physical Contingency		sum	1		979,225	10% of Civil and 3% of Equip.
	7 Import Duty of Container Handling Equipment		sum	1		978,106	37.86% of Equip.
	8 Total					14,588,913	
II	**Approach Channel**						
	1 Dredging Work	Maintained at -10.5 m depth	m3	2,280,000	220	501,600	300 m width
	2 Navigation Buoy		nos	9	3,335,000	30,015	
	3 Sub Total					531,615	
	4 Engineering Service		sum	1		26,581	5% of Sub Total
	5 Physical Contingency		sum	1		53,162	10% of Sub Total
	6 Total					611,358	
III	**Road Improvement in Dock Area**						
	1 Site Clearance work		sum	1	20,300,000	20,300	600+1600=2200m
	2 Container Road 1	Ground road (2200m * 20m)	m2	44,000	1,877	82,588	20 m wide of 4 lane road
	3 Container Road 2	Elevated road section	m	2,200	838,000	1,843,600	20 m wide of 4 lane road
	4 Miscellaneous	Boundary wall, gate, illumination	sum	1	29,300,000	29,300	
	5 Sub Total					1,975,788	
	6 Engineering Service		sum	1		197,579	10% of Sub Total
	7 Physical Contingency		sum	1		197,579	10% of Sub Total
	8 Total					2,370,946	
IV	**Cotton Depot Container Yard**						
	1 Civil and Building Work					613,602	
	a Container Yard		m2	95,000	1,877	178,315	Boundary wall, Drainage
	b Container Freight Station		m2	19,200	18,850	361,920	
	c Building Work (office, gate, work shop)		sum	1	17,100,000	17,100	
	d Electric and Water Supply		sum	1	56,266,821	56,267	Electric Sub Station
	2 Container Handling Equipment					42,400	
	a Reach Stacker		nos	2	21,200,000	42,400	
	3 Sub Total					656,002	
	4 Engineering Service		sum	1		63,480	10% of Civil and 5% of Equip.
	5 Physical Contingency		sum	1		62,632	10% of Civil and 3% of Equip.
	6 Import Duty of Container Handling Equipment		sum	1		16,053	37.86% of Equip.
	7 Total					798,167	
V	**Timber Pond South Container Depot**						
	1 Civil and Building Work					117,143	
	a Container Yard		m2	60,000	1,877	112,620	Boundary wall, Drainage
	b Building Work (office, gate, work shop)		sum	1	1,710,000	1,710	
	c Electric and Water Supply		sum	1	2,813,341	2,813	Electric Sub Station
	2 Container Handling Equipment					42,400	
	a Reach Stacker		nos	2	21,200,000	42,400	
	3 Sub Total					159,543	
	4 Engineering Service		sum	1		13,834	10% of Civil and 5% of Equip.
	5 Physical Contingency		sum	1		12,986	10% of Civil and 3% of Equip.
	6 Import Duty of Container Handling Equipment		sum	1		16,053	37.86% of Equip.
	7 Total					202,416	
VI	**1 Total of Construction Cost**					17,561,558	
	2 Import Duty of Container Handling Equipment					1,010,211	
	3 Grand Total					18,571,799	

Table 13.3.13
PROJECT COST FOR DEVELOPMENT OF CONTAINER TERMINAL
Alternative-5

No.	Description		Unit	Quantity	Rate (Rs)	Amount ('000Rs)	Remarks
I	Indira Dock Container Terminal						
	1 Offshore Container Berth					7,713,670	
	a Dredging of Basin	Maintained at -10.5 m depth	m3	5,713,000	300	1,713,900	
	b Container Berth	-13.0 m depth & 63m wide Jetty	m	909	5,784,900	5,206,410	with berth facility of Tug Launch
	c Access Bridge 1	Pile foundation section	m	460	1,146,000	527,160	24 m wide of 4 lane road
	d Access Bridge 2	Causeway section	m	300	900,000	270,000	24 m wide of 4 lane road
	e Electric and water facilities		sum	1	56,200,000	56,200	
	2 Indira Dock Container Yard					753,783	
	a Site Clearance		sum	1	9,400,000	9,400	
	b Paving Work	Include T/C lane & utilities	m2	116,000	3,122	362,152	
	c Building Work	office, gate, work shop, facilities	sum	1	85,497,165	85,497	
	d Electric and Water Supply		sum	1	281,334,105	281,334	Illumination, reefer, sump, tank
	e Miscellaneous	Fence, Drainage	sum	1	15,400,000	15,400	
	3 Container Handling Equipment					2,583,486	
	a Container Crane		nos	6	183,200,000	1,099,200	
	b Transfer Crane		nos	19	40,200,000	763,800	
	c Yard Tractor and Chassis		nos	97	4,740,000	459,780	
	d Road Tractor and Chassis		nos	55	4,740,000	260,700	
	4 Sub Total					11,110,933	
	5 Engineering Service		sum	1		931,919	10% of Civil and 5% of Equip.
	6 Physical Contingency		sum	1		930,250	10% of Civil and 5% of Equip
	7 Import Duty of Container Handling Equipment		sum	1		978,106	37.86% of Equip.
	8 Total					14,001,208	
II	Approach Channel						
	1 Dredging Work	Maintained at -10.5 m depth	m3	2,280,000	220	501,600	360m width
	2 Navigation Buoy		nos	9	3,335,000	30,015	
	3 Sub Total					531,615	
	4 Engineering Service		sum	1		26,581	5% of Sub Total
	5 Physical Contingency		sum	1		53,162	10% of Sub Total
	6 Total					611,358	
III	Road Improvement in Dock Area						
	1 Site Clearance work		sum	1	20,300,000	20,300	600+500+2000=3100m
	2 Container Road 1	Ground road (3100m*20m)	m2	62,000	1,877	116,374	20 m wide of 4 lane road
	3 Container Road 2	Elevated road section	m	3,100	838,000	2,597,800	20 m wide of 4 lane road
	4 Miscellaneous	Boundary wall, gate, illumination	sum	1	29,300,000	29,300	
	5 Sub Total					2,763,774	
	6 Engineering Service		sum	1		276,377	10% of Sub Total
	7 Physical Contingency		sum	1		276,377	10% of Sub Total
	8 Total					3,316,528	
IV	Cotton Depot Container Yard						
	1 Civil and Building Work					613,602	
	a Container Yard		m2	95,000	1,877	178,315	Boundary wall, Drainage
	b Container Freight Station		m2	19,200	18,850	361,920	
	c Building Work (office, gate, work shop)		sum	1	17,100,000	17,100	
	d Electric and Water Supply		sum	1	56,266,821	56,267	Electric Sub Station
	2 Container Handling Equipment					42,400	
	a Reach Stacker		nos	2	21,200,000	42,400	
	3 Sub Total					656,002	
	4 Engineering Service		sum	1		63,480	10% of Civil and 5% of Equip.
	5 Physical Contingency		sum	1		62,632	10% of Civil and 5% of Equip.
	6 Import Duty of Container Handling Equipment		sum	1		16,053	37.86% of Equip.
	7 Total					798,167	
V	Timber Pond South Container Depot						
	1 Civil and Building Work					117,143	
	a Container Yard		m2	60,000	1,877	112,620	Boundary wall, Drainage
	b Building Work (office, gate, work shop)		sum	1	1,710,000	1,710	
	c Electric and Water Supply		sum	1	2,813,341	2,813	Electric Sub Station
	2 Container Handling Equipment					42,400	
	a Reach Stacker		nos	2	21,200,000	42,400	
	3 Sub Total					159,543	
	4 Engineering Service		sum	1		13,834	10% of Civil and 5% of Equip.
	5 Physical Contingency		sum	1		12,986	10% of Civil and 5% of Equip.
	6 Import Duty of Container Handling Equipment		sum	1		16,053	37.86% of Equip.
	7 Total					202,416	
VI	1 Total of Construction Cost					17,919,465	
	2 Import Duty of Container Handling Equipment					1,010,211	
	3 Grand Total					18,929,676	

Table 13.3.14
PROJECT COST FOR DEVELOPMENT OF CONTAINER TERMINAL
Alternative-6

No.	Description		Unit	Quantity	Rate (Rs)	Amount (000Rs)	Remarks
I	Indira Dock Container Terminal						
	1 Offshore Container Berth					8,260,610	
	a Dredging of Basin	Maintained at -10.5 m depth	m3	5,713,000	300	1,713,900	
	b Container Berth	-13.0 m depth & 63m wide Jetty	m	900	5,784,900	5,206,410	with berth facility of Tug/Launch
	c Access Bridge 1	Pile foundation section	m	880	1,146,000	1,008,480	24 m wide of 4 lane road
	d Access Bridge 2	Causeway section	m	300	900,000	270,000	24 m wide of 4 lane road
	e Electric and water facilities		sum	1	61,820,000	61,820	
	2 Victoria Container Yard					1,499,643	
	a Site Clearance		sum	1	9,400,000	9,400	
	b Revetment		m	55	463,000	25,465	Concrete block structure
	c Reclamation work		m3	1,300,000	320	416,000	
	d Paving Work	Include T/C lane & utilities	m2	190,000	3,122	593,180	500m by 380m
	e Building Work	office, gate, work shop, facilities	sum	1	102,596,598	102,597	
	f Electric and Water Supply		sum	1	337,600,926	337,601	Illumination, reefer, sump, tank
	g Miscellaneous	Fence, Drainage	sum	1	15,400,000	15,400	
	3 Container Handling Equipment					2,583,480	
	a Container Crane		nos	6	183,200,000	1,099,200	
	b Transfer Crane		nos	19	40,200,000	763,800	
	c Yard Tractor and Chassis		nos	97	4,740,000	459,780	
	d Road Tractor and Chassis		nos	55	4,740,000	260,700	
	4 Sub Total					12,343,733	
	5 Engineering Service		sum	1		1,105,199	10% of Civil and 5% of Equip.
	6 Physical Contingency		sum	1		1,053,530	10% of Civil and 5% of Equip.
	7 Import Duty of Container Handling Equipment		sum	1		978,106	37.86% of Equip.
	8 Total					15,480,568	
II	Approach Channel						
	1 Dredging Work	Maintained at -10.5 m depth	m3	2,280,000	220	501,600	360 m width
	2 Navigation Buoy		nos	9	3,335,000	30,015	
	3 Sub Total					531,615	
	4 Engineering Service		sum	1		26,581	5% of Sub Total
	5 Physical Contingency		sum	1		53,162	10% of Sub Total
	6 Total					611,358	
III	Road Improvement in Dock Area						
	1 Site Clearance work		sum	1	20,300,000	20,300	
	2 Container Road 1	Ground road (1000m*20m)	m2	20,000	1,877	37,540	20 m wide of 4 lane road
	3 Container Road 2	Elevated road section	m	700	838,000	586,600	20 m wide of 4 lane road
	4 Miscellaneous	Boundary wall, gate, Illumination	sum	1	29,300,000	29,300	
	5 Sub Total					673,740	
	6 Engineering Service		sum	1		67,374	10% of Sub Total
	7 Physical Contingency		sum	1		67,374	10% of Sub Total
	8 Total					808,488	
IV	Cotton Depot Container Yard						
	1 Civil and Building Work					613,602	
	a Container Yard		m2	95,000	1,877	178,315	Boundary wall, Drainage
	b Container Freight Station		m2	19,200	18,850	361,920	
	c Building Work (office, gate, work shop)		sum	1	17,100,000	17,100	
	d Electric and Water Supply		sum	1	56,266,871	56,267	Electric Sub Station
	2 Container Handling Equipment					42,400	
	a Reach Stacker		nos	2	21,200,000	42,400	
	3 Sub Total					656,002	
	4 Engineering Service		sum	1		63,480	10% of Civil and 5% of Equip.
	5 Physical Contingency		sum	1		62,632	10% of Civil and 3% of Equip.
	6 Import Duty of Container Handling Equipment		sum	1		16,053	37.86% of Equip.
	7 Total					798,167	
V	Timber Pond South Container Depot						
	1 Civil and Building Work					117,143	
	a Container Yard		m2	60,000	1,877	112,620	Boundary wall, Drainage
	b Building Work (office, gate, work shop)		sum	1	1,710,000	1,710	
	c Electric and Water Supply		sum	1	2,813,341	2,813	Electric Sub Station
	2 Container Handling Equipment					42,400	
	a Reach Stacker		nos	2	21,200,000	42,400	
	3 Sub Total					159,543	
	4 Engineering Service		sum	1		13,834	10% of Civil and 5% of Equip.
	5 Physical Contingency		sum	1		12,985	10% of Civil and 3% of Equip.
	6 Import Duty of Container Handling Equipment		sum	1		16,053	37.86% of Equip.
	7 Total					202,415	
VI	1 Total of Construction Cost					16,890,784	
	2 Import Duty of Container Handling Equipment					1,010,212	
	3 Grand Total					17,900,996	

Table 13.3.15
PROJECT COST FOR DEVELOPMENT OF CONTAINER TERMINAL
Alternative-6A (-13.5 m)

No.	Description		Unit	Quantity	Rate (Rs)	Amount ('000Rs.)	Remarks
I	Indira Dock Container Terminal						
	1 Offshore Container Berth					9,790,100	
	a Dredging of Basin	Maintained at -11.0 m depth	m3	6,185,000	300	1,855,500	
	b Container Berth	-13.5 m depth & 63m wide Jetty	m	900	7,327,000	6,594,300	with berth facility of Tug/Launch
	c Access Bridge 1	Pile foundation section	m	680	1,146,000	1,008,480	24 m wide of 4 lane road
	d Access Bridge 2	Causeway section	m	300	900,000	270,000	24 m wide of 4 lane road
	e Electric and water facilities		sum	1	61,820,000	61,820	
	2 Victoria Container Yard					1,499,643	
	a Site Clearance		sum	1	9,400,000	9,400	
	b Revetment		m	55	463,000	25,465	Concrete block structure
	c Reclamation work		m3	1,300,000	320	416,000	
	d Paving Work	Include T.C lane & utilities	m2	190,000	3,122	593,180	500m by 380m
	e Building Work	office, gate, work shop, facilities	sum	1	102,596,598	102,597	
	f Electric and Water Supply		sum	1	337,600,926	337,601	Illumination, reefer, sump, tank
	g Miscellaneous	Fence, Drainage	sum	1	15,400,000	15,400	
	3 Container Handling Equipment					2,583,480	
	a Container Crane		nos	6	183,200,000	1,099,200	
	b Transfer Crane		nos	19	40,200,000	763,800	
	c Yard Tractor and Chassis		nos	97	4,740,000	459,780	
	d Road Tractor and Chassis		nos	55	4,740,000	260,700	
	4 Sub Total					13,873,223	
	5 Engineering Service		sum	1		1,258,148	10% of Civil and 5% of Equip.
	6 Physical Contingency		sum	1		1,206,479	10% of Civil and 3% of Equip.
	7 Import Duty of Container Handling Equipment		sum	1		978,106	37.86% of Equip.
	8 Total					17,315,956	
II	Approach Channel						
	1 Dredging Work	Maintained at -11.0 m depth	m3	2,451,000	254	622,554	360 m width
	2 Navigation Buoy		nos	9	3,335,000	30,015	
	3 Sub Total					652,569	
	4 Engineering Service		sum	1		32,628	5% of Sub Total
	5 Physical Contingency		sum	1		65,257	10% of Sub Total
	6 Total					750,454	
III	Road Improvement in Dock Area						
	1 Site Clearance work		sum	1	20,300,000	20,300	
	2 Container Road 1	Ground road (1000m*20m)	m2	20,000	1,877	37,540	20 m wide of 4 lane road
	3 Container Road 2	Elevated road section	m	700	838,000	586,600	20 m wide of 4 lane road
	4 Miscellaneous	Boundary wall, gate, illumination	sum	1	29,300,000	29,300	
	5 Sub Total					673,740	
	6 Engineering Service		sum	1		67,374	10% of Sub Total
	7 Physical Contingency		sum	1		67,374	10% of Sub Total
	8 Total					808,488	
IV	Cotton Depot Container Yard						
	1 Civil and Building Work					613,602	
	a Container Yard		m2	95,000	1,877	178,315	Boundary wall, Drainage
	b Container Freight Station		m2	19,200	18,850	361,920	
	c Building Work (office, gate, work shop)		sum	1	17,100,000	17,100	
	d Electric and Water Supply		sum	1	56,266,821	56,267	Electric Sub Station
	2 Container Handling Equipment					42,400	
	a Reach Stacker		nos	2	21,200,000	42,400	
	3 Sub Total					656,002	
	4 Engineering Service		sum	1		63,480	10% of Civil and 5% of Equip.
	5 Physical Contingency		sum	1		62,632	10% of Civil and 3% of Equip.
	6 Import Duty of Container Handling Equipment		sum	1		16,053	37.86% of Equip.
	7 Total					798,167	
V	Timber Pond South Container Depot						
	1 Civil and Building Work					117,143	
	a Container Yard		m2	60,000	1,877	112,620	Boundary wall, Drainage
	b Building Work (office, gate, work shop)		sum	1	1,710,000	1,710	
	c Electric and Water Supply		sum	1	2,813,341	2,813	Electric Sub Station
	2 Container Handling Equipment					42,400	
	a Reach Stacker		nos	2	21,200,000	42,400	
	3 Sub Total					159,543	
	4 Engineering Service		sum	1		13,834	10% of Civil and 5% of Equip.
	5 Physical Contingency		sum	1		12,985	10% of Civil and 3% of Equip.
	6 Import Duty of Container Handling Equipment		sum	1		16,053	37.86% of Equip.
	7 Total					202,415	
VI	1 Total of Construction Cost					18,865,269	
	2 Import Duty of Container Handling Equipment					1,010,211	
	3 Grand Total					19,875,480	

Table 13.3.16
PROJECT COST FOR DEVELOPMENT OF CONTAINER TERMINAL
Alternative-6B (-14.0 m)

No.	Description		Unit	Quantity	Rate (Rs)	Amount (000Rs)	Remarks
I	Indira Dock Container Terminal						
	1 Offshore Container Berth					11,621,240	
	a Dredging of Basin	Maintained at -11.5 m depth	m3	6,580,000	393	2,585,940	
	b Container Berth	-14.0 m depth & 63m wide jetty	m	900	8,550,000	7,695,000	with berth facility of Tug Launch
	c Access Bridge 1	Pile foundation section	m	880	1,146,000	1,008,480	24 m wide of 4 lane road
	d Access Bridge 2	Causeway section	m	300	900,000	270,000	24 m wide of 4 lane road
	e Electric and water facilities		sum	1	61,820,000	61,820	
	2 Victoria Container Yard					1,499,643	
	a Site Clearance		sum	1	9,400,000	9,400	
	b Revetment		m	55	463,000	25,465	Concrete block structure
	c Reclamation work		m3	1,300,000	320	416,000	
	d Paving Work	Include T/C lane & utilities	m2	190,000	3,122	593,180	500m by 380m
	e Building Work	office, gate, work shop, facilities	sum	1	102,596,598	102,597	
	f Electric and Water Supply		sum	1	337,600,926	337,601	Illumination, reefer, sump, tank
	g Miscellaneous	Fence, Drainage	sum	1	15,400,000	15,400	
	3 Container Handling Equipment					2,583,480	
	a Container Crane		nos	6	183,200,000	1,099,200	
	b Transfer Crane		nos	19	40,200,000	763,800	
	c Yard Tractor and Chassis		nos	97	4,740,000	459,780	
	d Road Tractor and Chassis		nos	55	4,740,000	260,700	
	4 Sub Total					15,704,363	
	5 Engineering Service		sum	1		1,441,262	10% of Civil and 5% of Equip.
	6 Physical Contingency		sum	1		1,389,593	10% of Civil and 3% of Equip.
	7 Import Duty of Container Handling Equipment		sum	1		978,106	37.86% of Equip.
	8 Total					19,513,324	
II	Approach Channel						
	1 Dredging Work	Maintained at -11.5 m depth	m3	3,085,000	254	783,590	360 m width
	2 Navigation Buoy		nos	9	3,335,000	30,015	
	3 Sub Total					813,605	
	4 Engineering Service		sum	1		40,680	5% of Sub Total
	5 Physical Contingency		sum	1		81,361	10% of Sub Total
	6 Total					935,646	
III	Road Improvement in Dock Area						
	1 Site Clearance work		sum	1	20,300,000	20,300	
	2 Container Road 1	Ground road (1000m*20m)	m2	20,000	1,877	37,540	20 m wide of 4 lane road
	3 Container Road 2	Elevated road section	m	700	838,000	586,600	20 m wide of 4 lane road
	4 Miscellaneous	Boundary wall, gate, Illumination	sum	1	29,300,000	29,300	
	5 Sub Total					673,740	
	6 Engineering Service		sum	1		67,374	10% of Sub Total
	7 Physical Contingency		sum	1		67,374	10% of Sub Total
	8 Total					808,488	
IV	Cotton Depot Container Yard						
	1 Civil and Building Work					613,602	
	a Container Yard		m2	95,000	1,877	178,315	Boundary wall, Drainage
	b Container Freight Station		m2	19,200	18,850	361,920	
	c Building Work (office, gate, work shop)		sum	1	17,100,000	17,100	
	d Electric and Water Supply		sum	1	56,266,821	56,267	Electric Sub Station
	2 Container Handling Equipment					42,400	
	a Reach Stacker		nos	2	21,200,000	42,400	
	3 Sub Total					656,002	
	4 Engineering Service		sum	1		63,480	10% of Civil and 5% of Equip.
	5 Physical Contingency		sum	1		62,632	10% of Civil and 3% of Equip.
	6 Import Duty of Container Handling Equipment		sum	1		16,053	37.86% of Equip.
	7 Total					798,167	
V	Timber Pond South Container Depot						
	1 Civil and Building Work					117,143	
	a Container Yard		m2	60,000	1,877	112,620	Boundary wall, Drainage
	b Building Work (office, gate, work shop)		sum	1	1,710,000	1,710	
	c Electric and Water Supply		sum	1	2,813,341	2,813	Electric Sub Station
	2 Container Handling Equipment					42,400	
	a Reach Stacker		nos	2	21,200,000	42,400	
	3 Sub Total					159,543	
	4 Engineering Service		sum	1		13,834	10% of Civil and 5% of Equip.
	5 Physical Contingency		sum	1		12,985	10% of Civil and 3% of Equip.
	6 Import Duty of Container Handling Equipment		sum	1		16,053	37.86% of Equip.
	7 Total					202,415	
VI	1 Total of Construction Cost					21,247,829	
	2 Import Duty of Container Handling Equipment					1,010,211	
	3 Grand Total					22,258,040	

Table 13.3.17
Navigation Improvement Scheme for Main Channel - Capital Dredging

No.	Description	Unit	Alternatives			
			Alt-1	Alt-2	Alt-3	Alt-4
I	**Capital Dredging**					
1	Proposed Depth					
	1) Main Channel	m	-10.8	-12.0	-12.0	-12.5
	2) JNPT Channel	m	-10.8	-12.0	-12.0	-12.5
	3) JNPT Berth	m	-13.5	-13.5	-14.5	-14.5
2	Dredging of Main Channel					
	(1)Dredging Volume					
	1) Present Area	m3	0	14,471,000	14,471,000	20,616,000
	2) Widening Area	m3	0	2,106,000	2,106,000	2,834,000
	3) Total Volume	m3	0	16,577,000	16,577,000	23,450,000
	(3)Dredging Cost					
	1) Unit Rate	Rs./m3	155	155	155	155
	2) Amount	Rs.	0	2,569,435,000	2,569,435,000	3,631,750,000
	3) Engineering Servic (5%)	Rs.	0	128,471,750	128,471,750	181,737,500
	4) Contingency (10%)	Rs.	0	256,943,500	256,943,500	363,475,000
	5) Total Cost	Rs.	0	2,954,850,250	2,954,850,250	4,179,962,500
3	Dredging of JNPT Channel					
	(1) Dredging Volume					
	1) Present Area	m3	0	2,552,000	2,552,000	3,900,000
	2) Widening Area	m3	0	566,000	566,000	885,000
	3) Sub Total Volume-A [1)+2)]	m3	0	3,118,000	3,118,000	4,785,000
	4) Sub Total Volume-B [-14.5m area]	m3	0	0	289,000	210,000
	(2) Dredging Cost					
	1) Unit Rate-A [for volume -A]	Rs./m3	220	220	220	254
	2) Amount-A	Rs.	0	685,960,000	685,960,000	1,215,390,000
	3) Unit Rate-B [for volume -B]	Rs.	393	393	393	393
	4) Amount-B	Rs.	0	0	113,577,000	82,530,000
	5) Sub Total Amount [A+B]	Rs.	0	685,960,000	799,537,000	1,297,920,000
	6) Engineering Servic (5%)	Rs.	0	34,298,000	39,976,850	64,896,000
	7) Contingency (10%)	Rs.	0	68,596,000	79,953,700	129,792,000
	8) Total Cost	Rs.	0	788,854,000	919,467,550	1,492,608,000
4	**Total Dredging Cost**		0	3,743,704,250	3,874,317,800	5,672,570,500

No.	Description	Unit	Quantity	Rate (Rs.)	Amount ('000Rs.)	Remarks
II	**Navigation System**					
1	Tug Boat	No.	8	143,910,000	1,151,280	
2	Navigation Buoy	No.	54	400,000	21,600	
3	Sub Total				1,172,880	
4	Engineering Service	sum	1		58,644	5%
5	Contingency	sum	1		35,186	3%
6	Total				1,266,710	

Table 13.3.18
Information about Present Main Channel and Proposed Main Channel

(1) PRESENT CHANNEL

MAIN CHANNEL upto MARINE OIL TERMINAL

Section Number		1	2	3	4A	4B	4C	5I	5II	JWD	Total
Length	meter	4,500	2,700	3,631	2,500	2,360	2,920	2,440	2,136	2,150	25,337
Width (West)	meter	500	440	440	325	400	420	500	500	550	
Width (East)	meter	440	440	325	400	420	500	500	550	700	
Present Depth	meter	11.5	11.2	11.0	10.8	10.8	11.0	11.0	11.5	11.3	

JNPT CHANNEL

Section Number		1	2	3	Total
Length	meter	2,900	2,300	600	5,800
Width (West)	meter	230	430	500	
Width (East)	meter	330	500	500	
Present Depth	meter	11.5	11.5	11.5	

Note : Present Depth indicated in the bottome line are the average depth of sounding records prepared by MBPT in the last few years

(2) PROPOSED CHANNEL FOR STUDY

MAIN CHANNEL upto MARINE OIL TERMINAL

Section Number		1	2	3	4A	4B	4C	5I	5II	JWD	Total
Length	meter	4,500	2,700	3,631	2,500	2,360	2,920	2,440	2,136	2,150	25,337
Width (West)	meter	500	500	500	500	500	500	500	500	550	
Width (East)	meter	500	500	500	500	500	500	500	550	700	

JNPT CHANNEL

Section Number		1	2	3	Total
Length	meter	2,900	2,300	600	5,800
Width (West)	meter	500	500	500	
Width (East)	meter	500	500	500	

(3) SCHEMATIC DRAWING OF CHANNELS

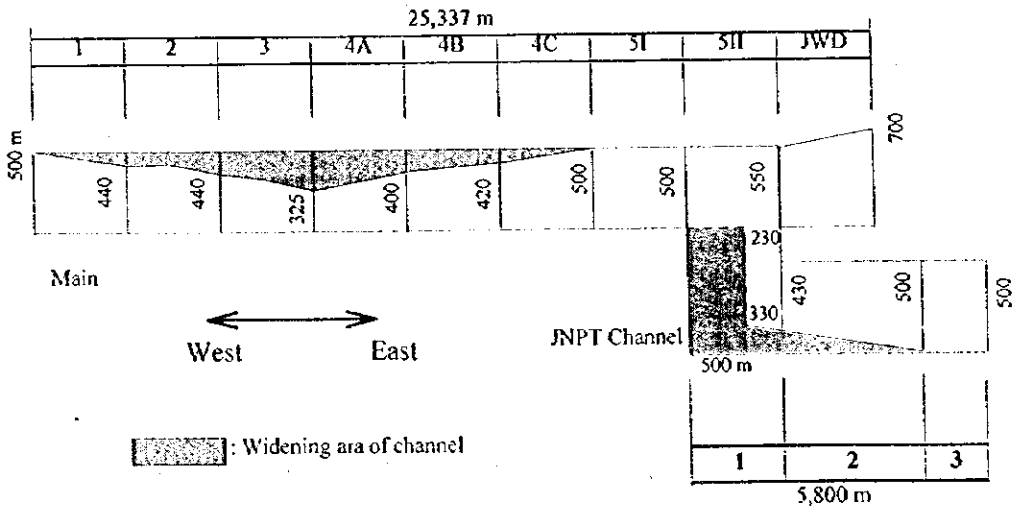


Table 13.3.19 Cost Estimation of Annual Maintenance Dredging for Main Channel

No.	Description	Unit	Alternatives			
			Alt-1	Alt-2	Alt-3	Alt-4
1	Proposed Depth					
	1) Main Channel	m	-10.8	-12.0	-12.0	-12.5
	2) JNPT Channel	m	-10.8	-12.0	-12.0	-12.5
	3) JNPT Berth	m	-13.5	-13.5	-14.5	-14.5
2	Main Channel					
	1) Dredging Volume	m3	1,947,000	6,132,000	6,132,000	7,391,000
	2) Unit Rate	Rs./m3	70	70	70	70
	3) Dredging Cost	Rs.	136,290,000	429,240,000	429,240,000	517,370,000
	4) Contingency (15%)	Rs.	20,443,500	64,386,000	64,386,000	77,605,500
	5) Total Cost	Rs.	156,733,500	493,626,000	493,626,000	594,975,500
3	JNPT Channel					
	1) Dredging Volume	m3	305,000	459,000	459,000	522,000
	2) Unit Rate	Rs./m3	70	70	70	70
	3) Dredging Cost	Rs.	21,350,000	32,130,000	32,130,000	36,540,000
	4) Contingency (15%)	Rs.	3,202,500	4,819,500	4,819,500	5,481,000
	5) Total Cost	Rs.	24,552,500	36,949,500	36,949,500	42,021,000
4	**Total Cost**	Rs.	**181,286,000**	**530,575,500**	**530,575,500**	**636,996,500**

Table 13.3.20
Maintenance Dredging of Indira Dock Container Terminal (Annually)

No.	Description	Unit	Basin	Approach	Total
1	Case 1 (Estimated maintenance dredging volume under present Depth)				
	Maintenance Depth	m	-	-7.6	
	Dredging Volume	m3	-	433,000	
	Silt Rate	m	-	0.43	
2	Case 2				
	Maintenance Depth of Basin and Channel	m	-10.0	-10.0	
	Maintenance Depth of Berth	m	-13.0	-13.0	
	Dredging Area	m2	891,000		
	Silt Rate	m	0.47	1.27	
	Maintenance Volume	m3	418,770	1,274,000	
	Unit Rate	Rs./m3	70	70	
	Dredging Cost	Rs.	29,313,900	89,180,000	
	Contingency (15%)	Rs.	4,397,085	13,377,000	
	Total	Rs.	33,710,985	102,557,000	136,267,985
3	Case 3				
	Maintenance Depth of Basin and Channel	m	-10.5	-10.5	
	Maintenance Depth of Berth	m	-13.0	-13.0	
	Dredging Area	m2	900,400		
	Silt Rate	m	0.52	1.40	
	Maintenance Volume	m3	468,208	1,418,000	
	Unit Rate	Rs./m3	70	70	
	Dredging Cost	Rs.	32,774,560	99,260,000	
	Contingency (15%)	Rs.	4,916,184	14,889,000	
	Total	Rs.	37,690,744	114,149,000	151,839,744
4	Case 4				
	Maintenance Depth of Basin and Channel	m	-11.0	-11.0	
	Maintenance Depth of Berth	m	-13.5	-13.5	
	Dredging Area	m2	909,000		
	Silt Rate	m	0.55	1.51	
	Maintenance Volume	m3	499,950	1,542,000	
	Unit Rate	Rs./m3	70	70	
	Dredging Cost	Rs.	34,996,500	107,940,000	
	Contingency (15%)	Rs.	5,249,475	16,191,000	
	Total	Rs.	40,245,975	124,131,000	164,376,975
5	Case 5				
	Maintenance Depth of Basin and Channel	m	-11.5	-11.5	
	Maintenance Depth of Berth	m	-14.0	-14.0	
	Dredging Area	m2	918,000		
	Silt Rate	m	0.60	1.62	
	Maintenance Volume	m3	550,800	1,668,000	
	Unit Rate	Rs./m3	70	70	
	Dredging Cost	Rs.	38,556,000	116,760,000	
	Contingency (15%)	Rs.	5,783,400	17,514,000	
	Total	Rs.	44,339,400	134,274,000	178,613,400
6	Case 6				
	Maintenance Depth of Basin and Channel	m	-13.0	-13.0	
	Maintenance Depth of Berth	m	-13.0	-13.0	
	Dredging Area	m2	990,000		
	Silt Rate	m	0.72	2.00	
	Maintenance Volume	m3	712,800	2,116,000	
	Unit Rate	Rs./m3	70	70	
	Dredging Cost	Rs.	49,896,000	148,120,000	
	Contingency (15%)	Rs.	7,484,400	22,218,000	
	Total	Rs.	57,380,400	170,338,000	227,718,400

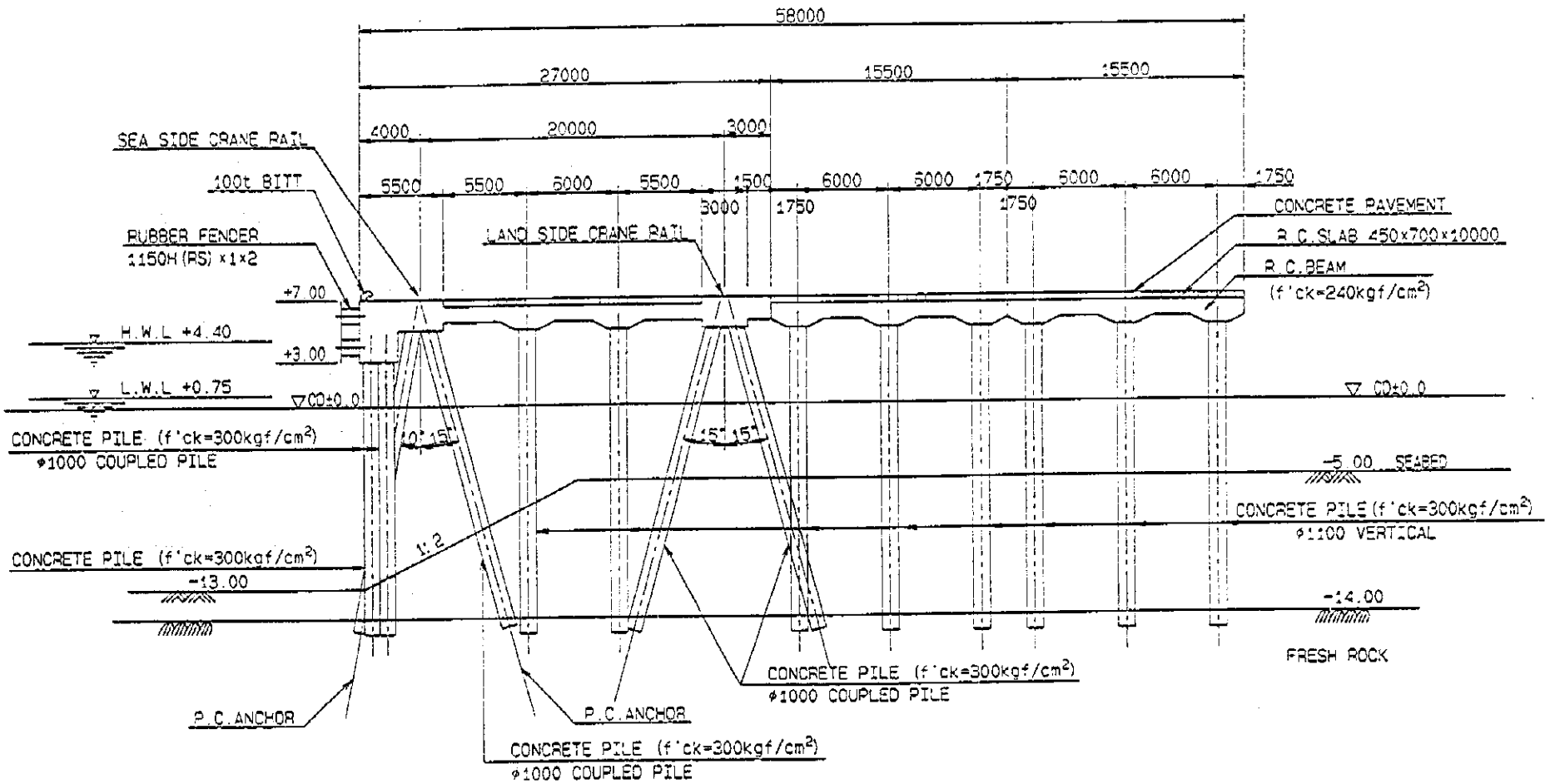


Figure 13.2.1(1) -13m Offshore Container Berth
Cross Section of Concrete Pile Foundation Type Deck Slab Pier
(Scale 1:400, Unit millimeter)

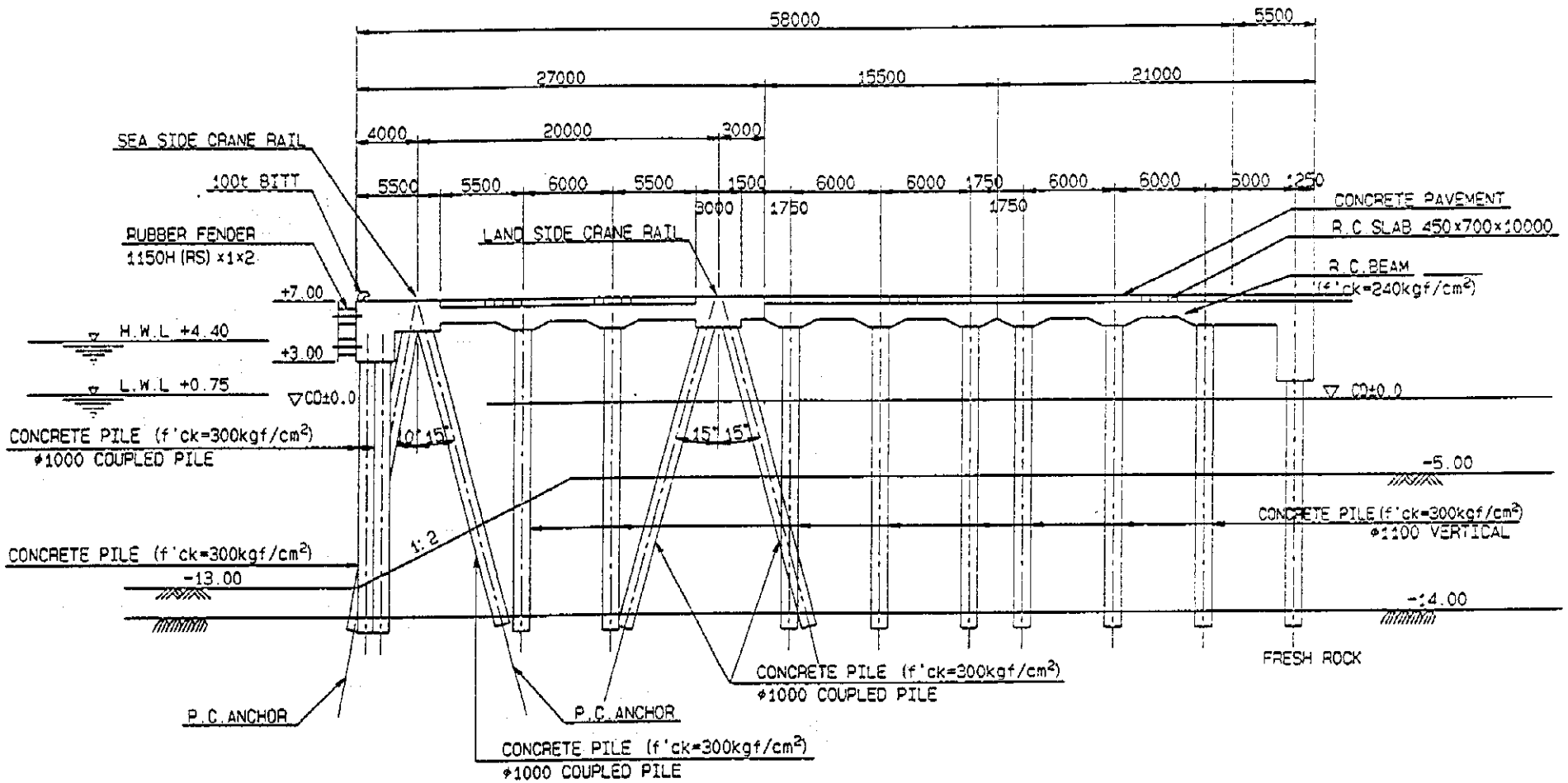


Figure 13.2.1(2) -13m Offshore Container Berth
Cross Section of Concrete Pile Foundation Type Deck Slab Pier
Harbour Craft Berthing Block (Scale 1:400, Unit millimeter)

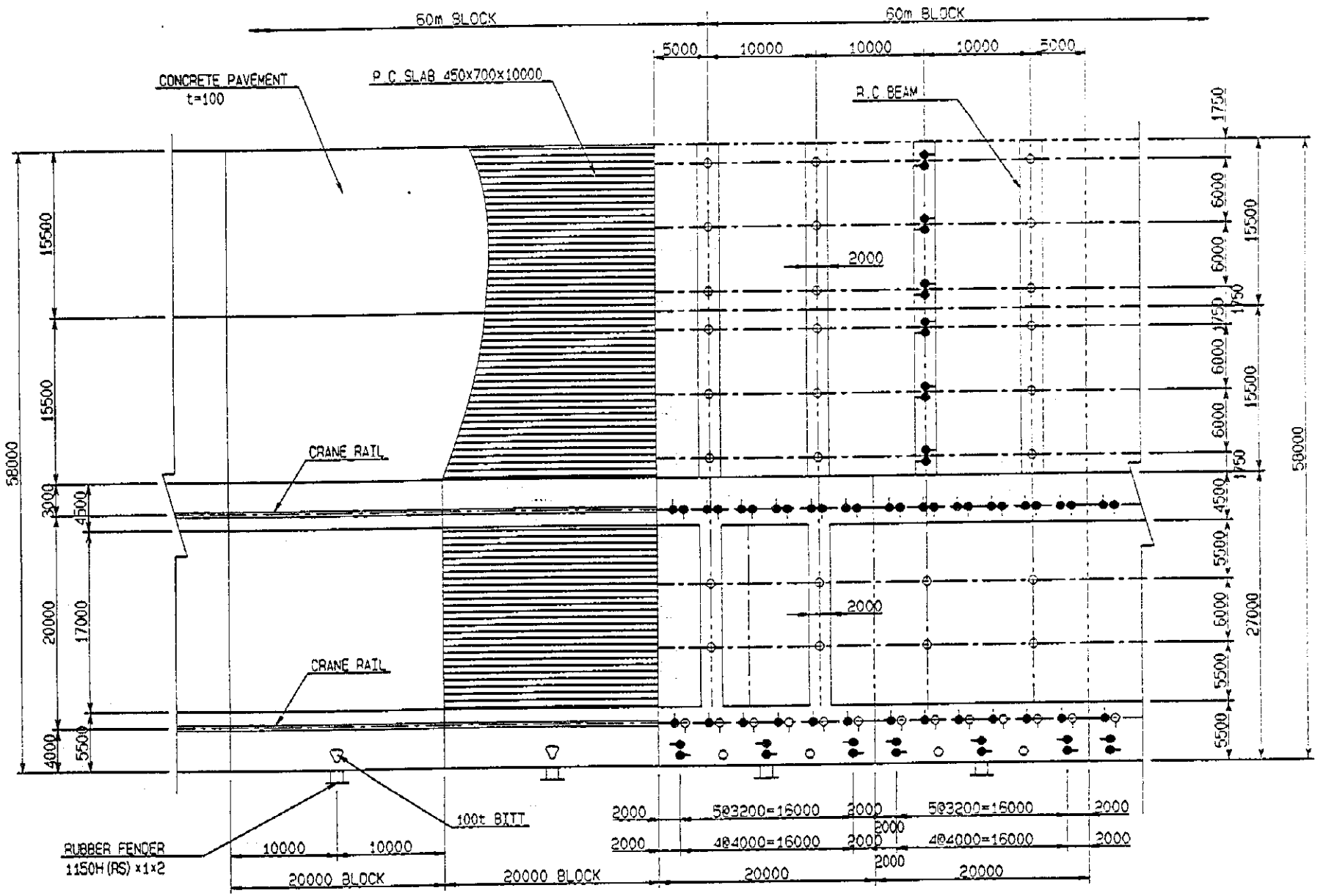


Figure 13.2.2 -13m Offshore Container Berth
Plan of Concrete Pile Foundation Type Deck Slab Pier
(Scale 1:500, Unit millimeter)

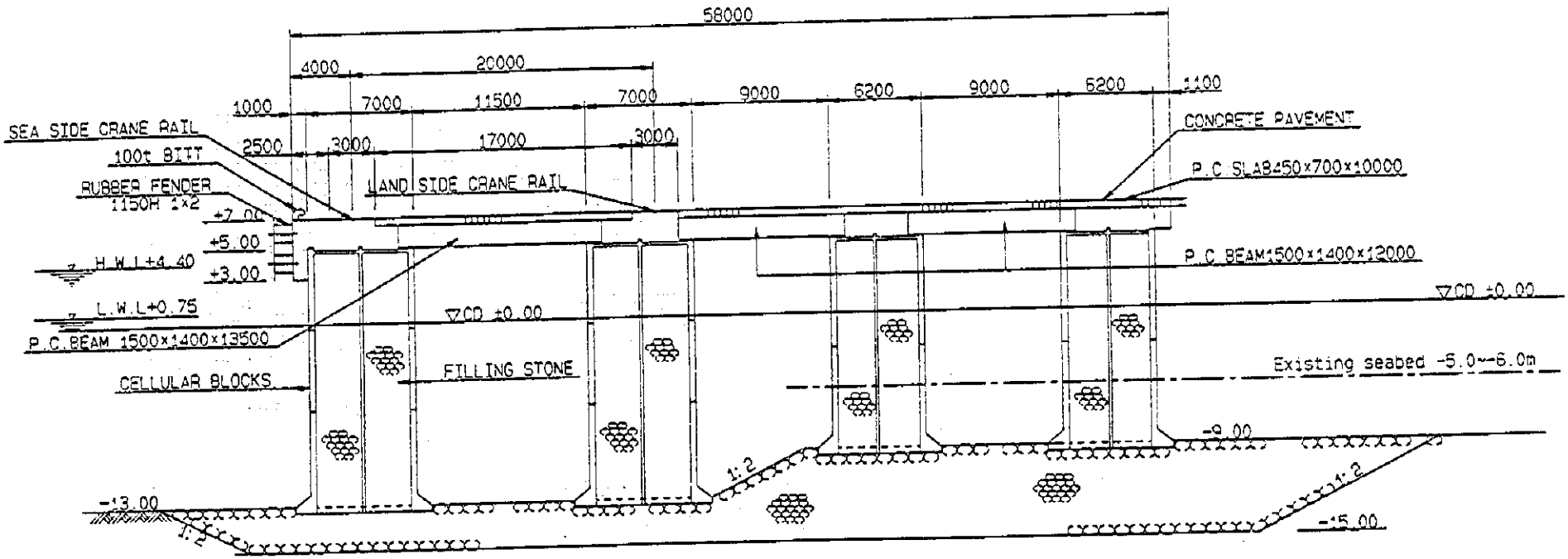


Figure 13.2.3 -13m Offshore Container Berth
Cross Section of Concrete Cellular Block Foundation Type Deck Slab Pier
(Scale 1:400, Unit millimeter)

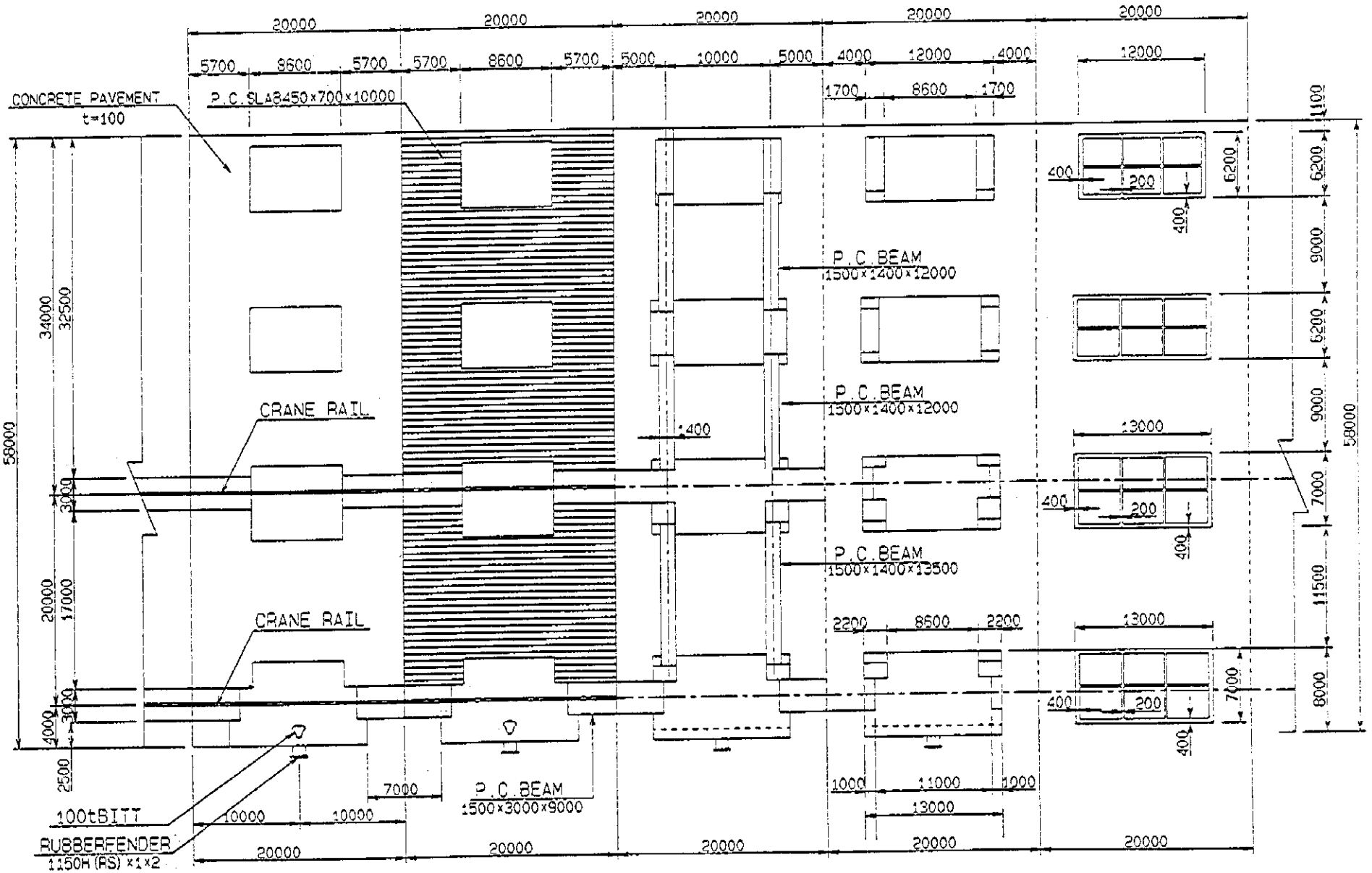
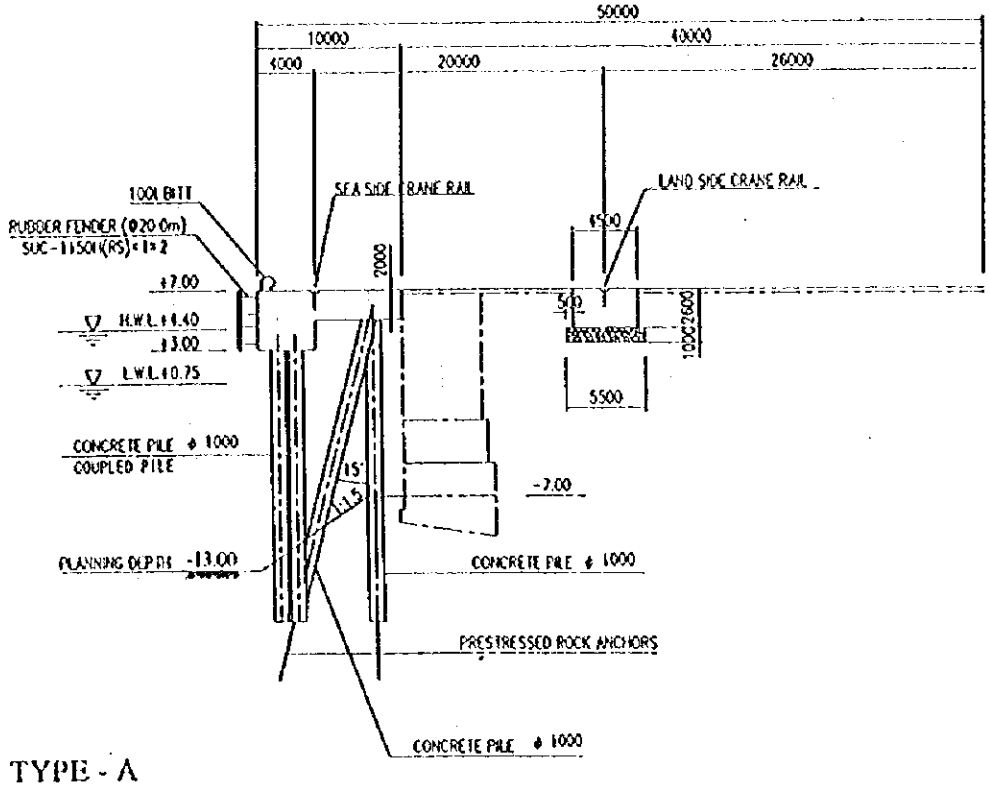
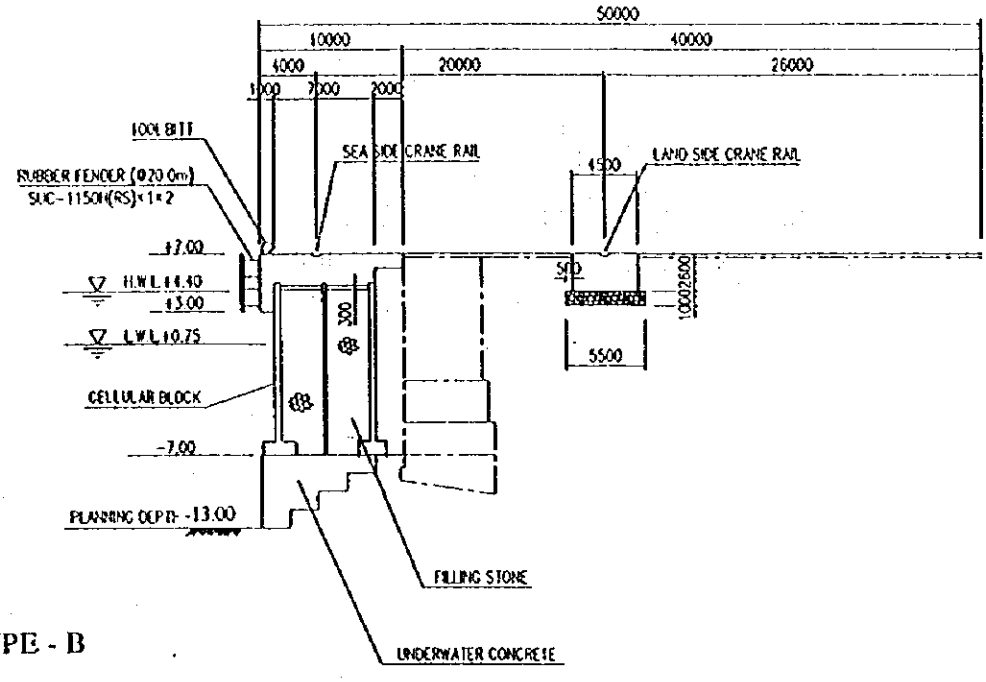


Figure 13.2.4 -13m Offshore Container Berth
Plan of Concrete Cellular Block Foundation Type Deck Slab Pier
(Scale 1:500, Unit millimeter)



TYPE - A

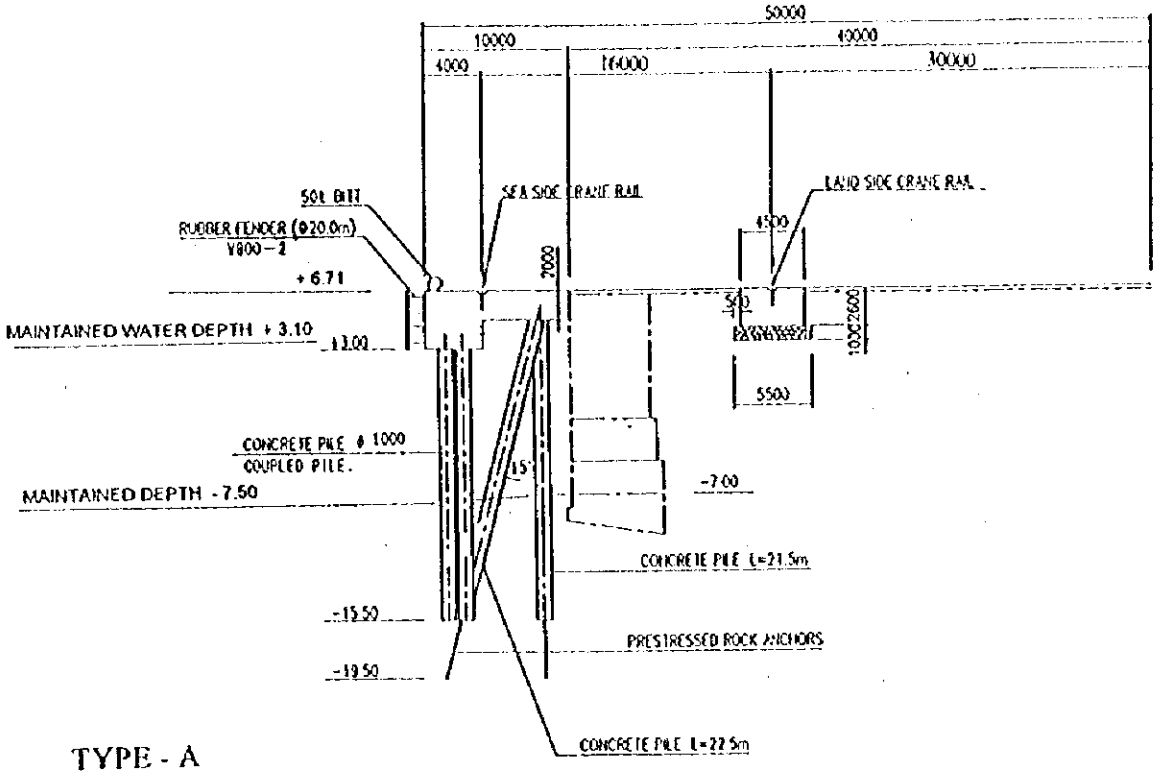
CROSS SECTION OF CONCRETE PILE FOUNDATION TYPE DECK SLAB BERTH



TYPE - B

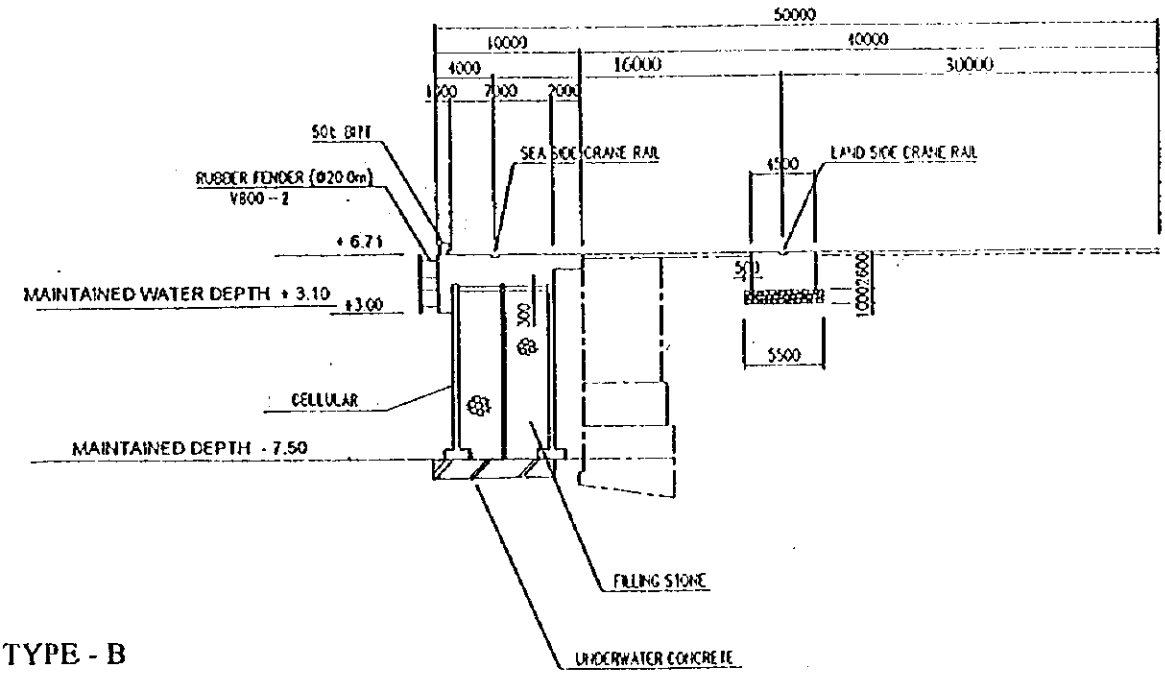
CROSS SECTION OF CONCRETE CAISSON FOUNDATION TYPE DECK SLAB BERTH

Figure 13.2.5 Cross Section for Expansion of Existing Harbour Wall
(Scale 1: 500, Unit millimeter)



TYPE - A

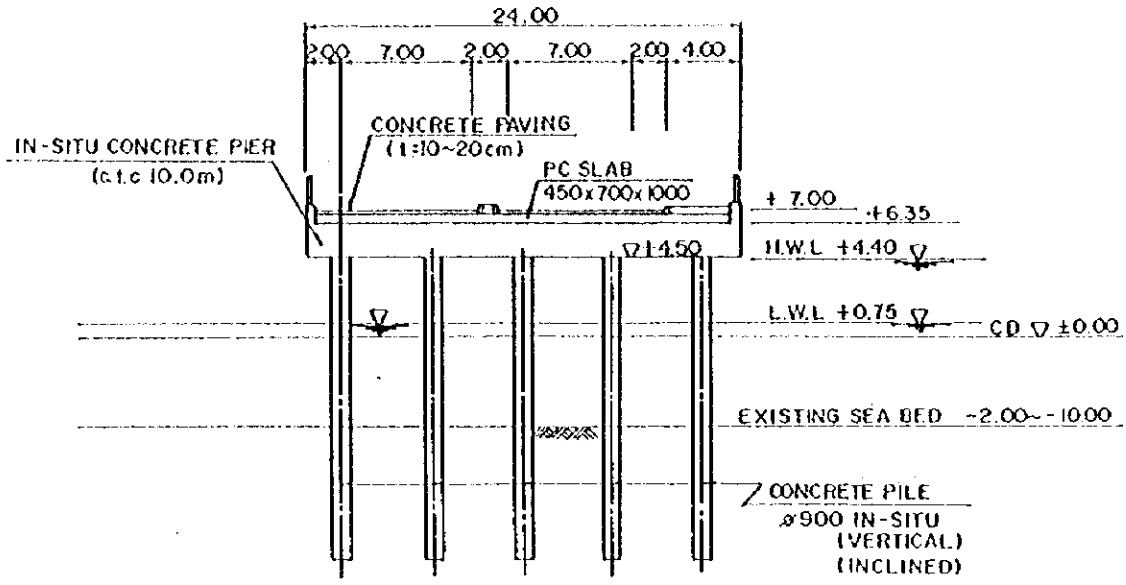
CROSS SECTION OF CONCRETE PILE FOUNDATION TYPE DECK SLAB BERTH



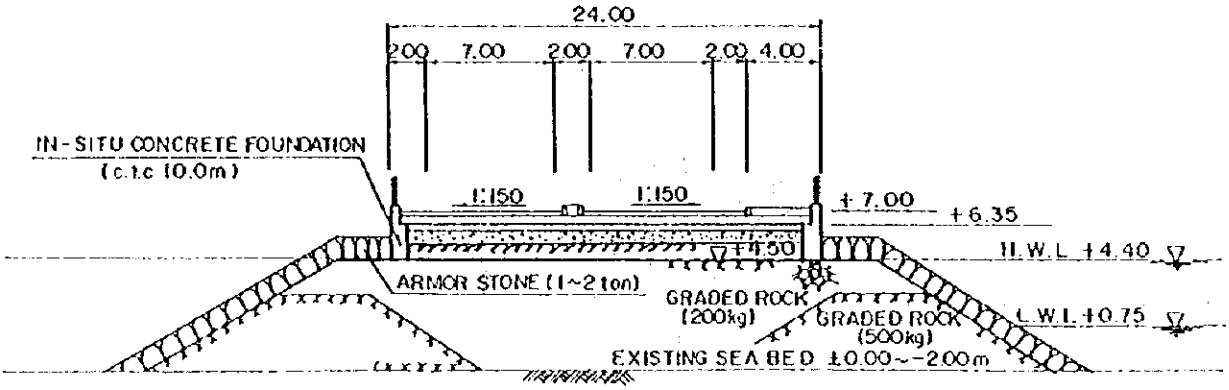
TYPE - B

CROSS SECTION OF CONCRETE CAISSON FOUNDATION TYPE DECK SLAB BERTH

Figure 13.2.6 Cross Section for Expansion of Existing Indira Dock Berth No.2 to No.5
(Scale 1: 500, Unit millimeter)

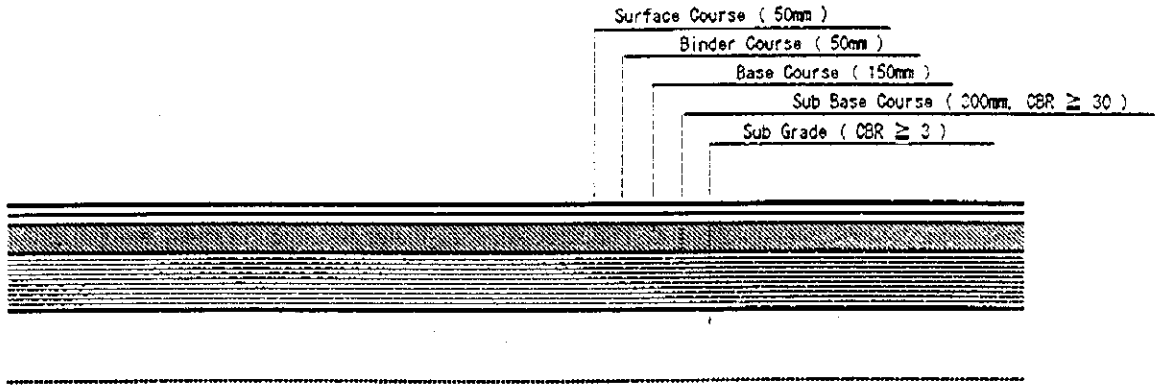


TYPICAL CROSS SECTION OF BRIDGE SECTION

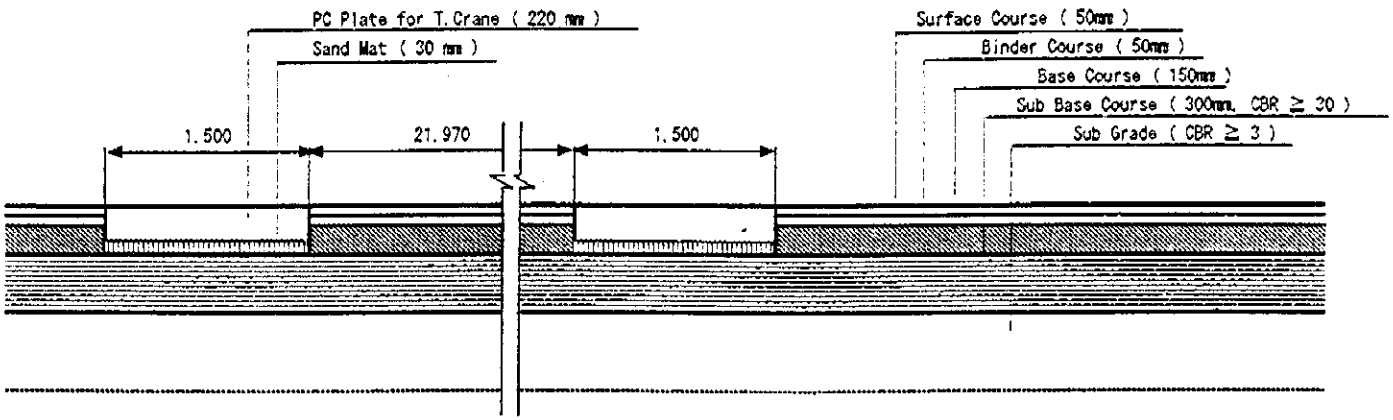


ISLAND SECTION

Figure 13.2.7 Cross Section of Access Bridge to Offshore Berth
(Scale 1: 400, Unit meter)



TYPICAL CROSS SECTION OF YARD PAVING
(OFF DOCK CONTAINER YARD)



TYPICAL CROSS SECTION OF YARD PAVING
(TRANSFER CRANE YARD - DOCK AREA)

Figure 13.2.8 Typical Cross Section of Container Yard Paving

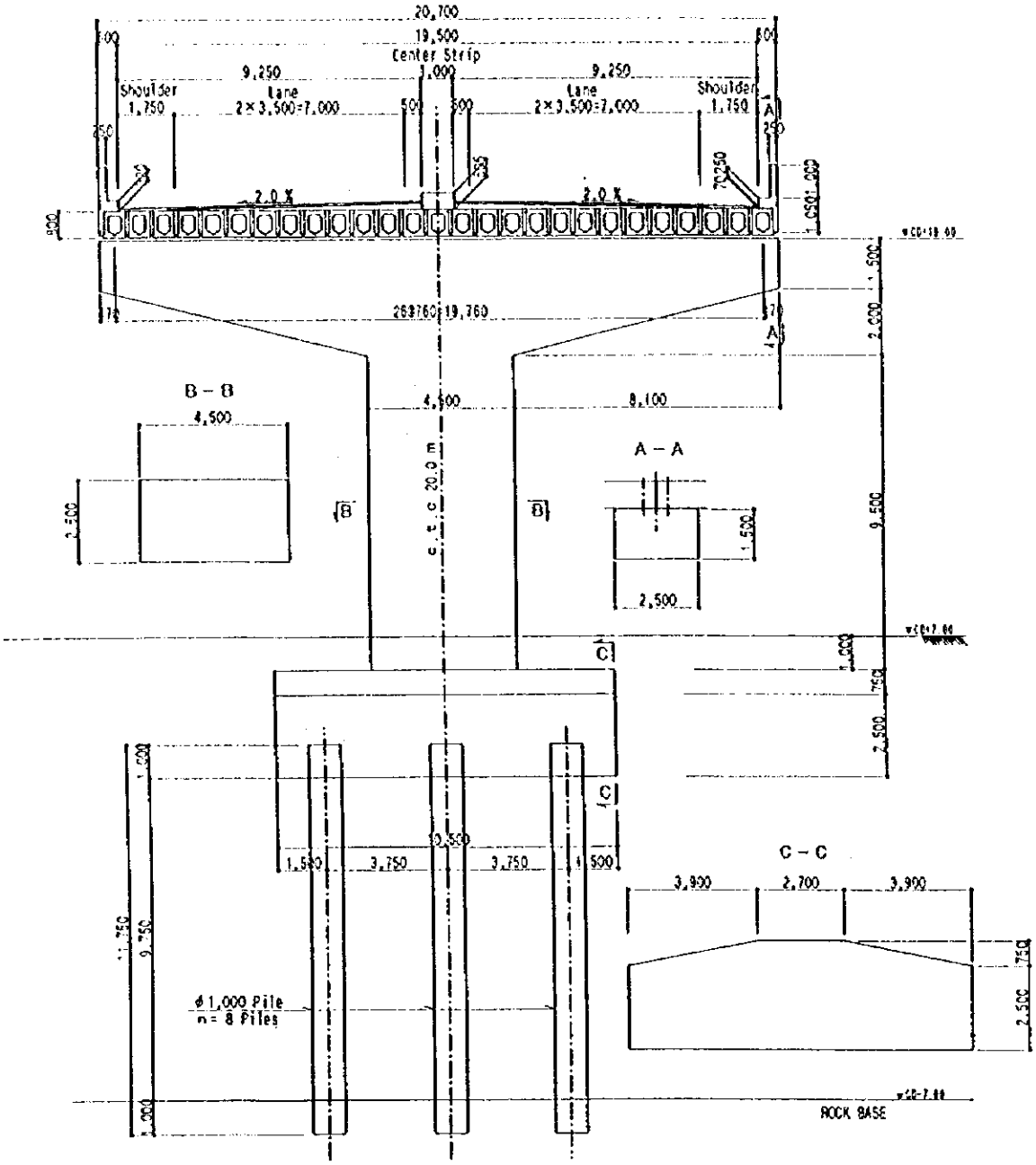


Figure 13.2.9 Cross Section of Elevated Container Road in Port Premises

(Scale 1:200, Unit : millimeter)

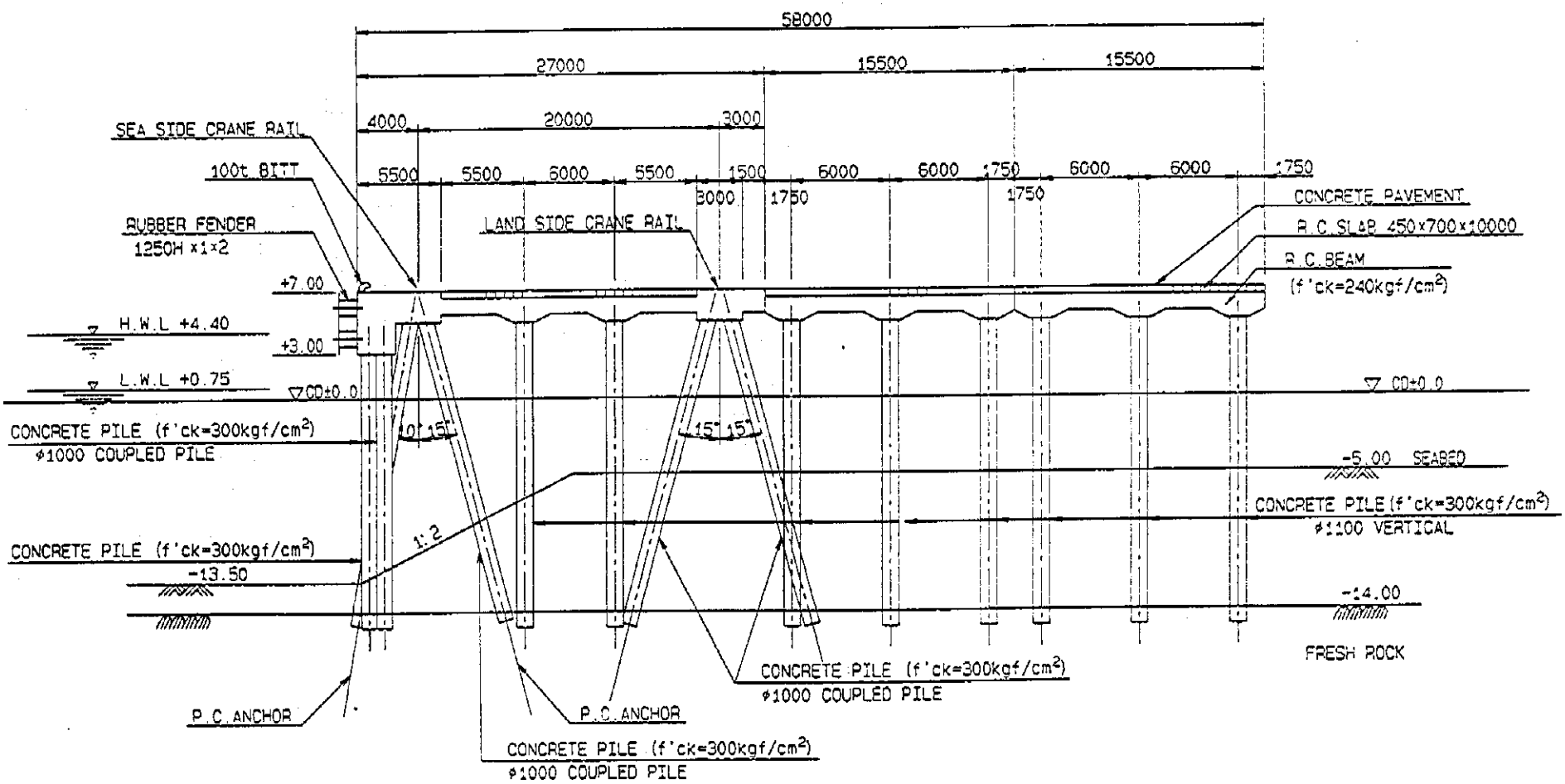


Figure 13.2.10 -13.5 m Offshore Container Berth

Cross Section of Concrete Pile Foundation Type Deck Slab Pier

(Scale 1: 400, Unit : millimeter)

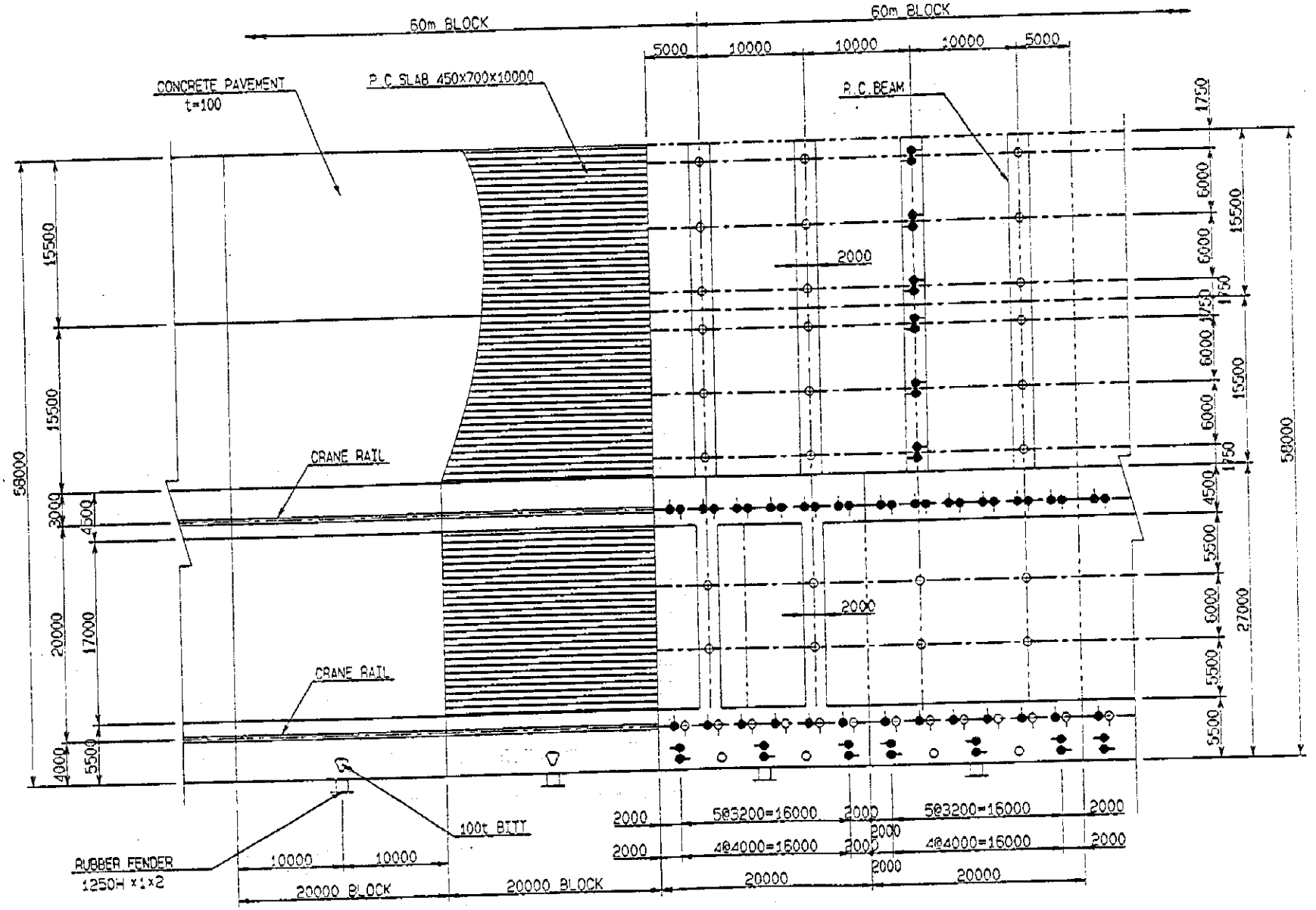


Figure 13.2.11 -13.5 m Offshore Container Berth

Plan of Concrete Pile Foundation Type Deck Slab Pier

(Scale 1: 500、 Unit : millimeter)

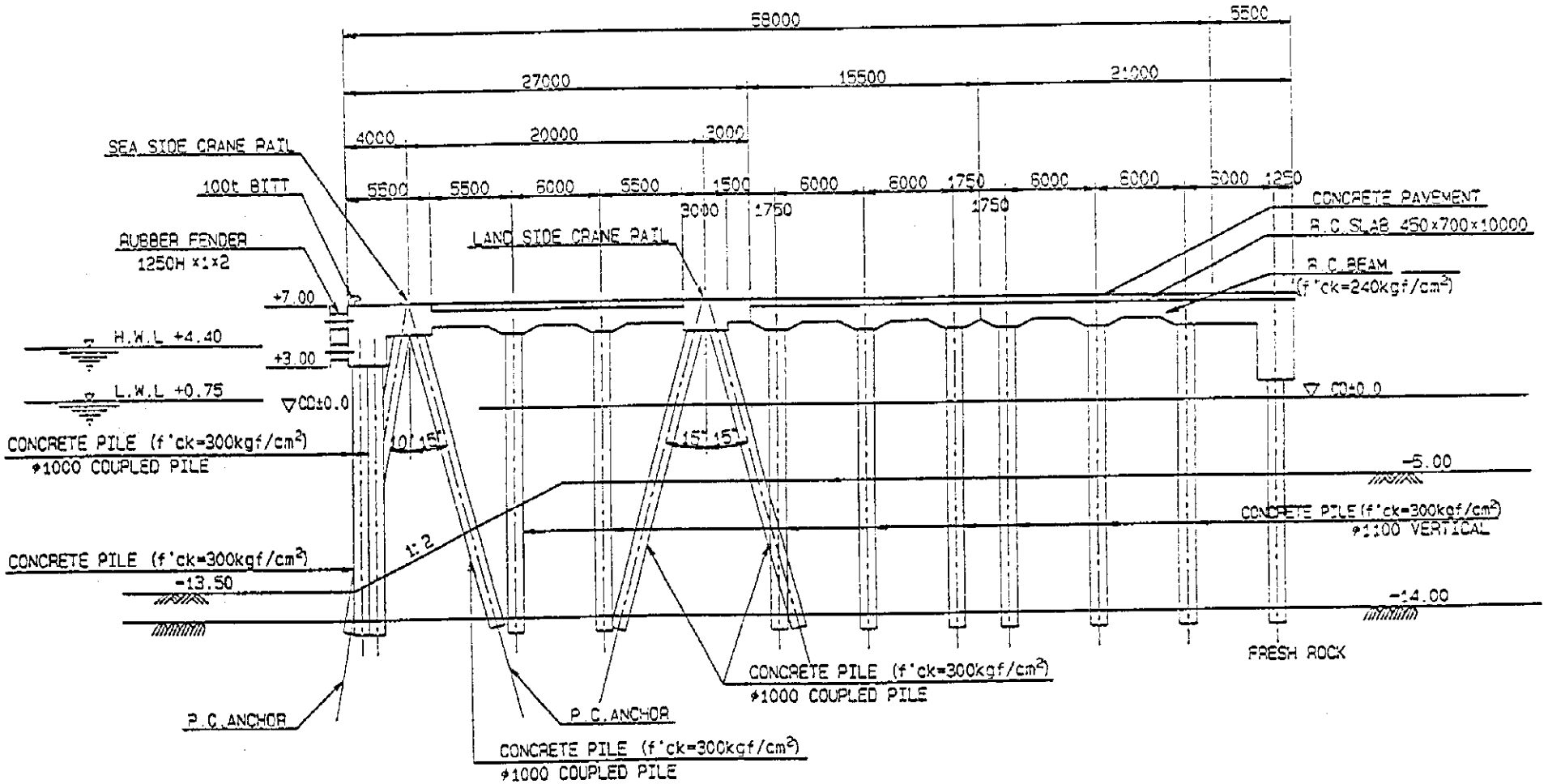


Figure 13.2.12 -13.5 m Offshore Container Berth

Cross Section of Concrete Pile Foundation Type Deck Slab Pier

Harbor Craft Mooring Block (Scale 1: 400, Unit : millimeter)