and Mongla. These routes are mainly formed by the natural river system, apart from the route between the mouth of the Lower Meghna River and Chittagong Port in the Bay of Bengal. These routes have controlled depths of 3.7 meters (12 feet) below Chart Datum or average Lowest Low Water, being classified as Class I mentioned in Section 5.2.2. Maintenance dredging is conducted at such locations as the shallows described in the same section.

The basins of Dhaka and Narayanganj ports within the declared limits are also controlled in the same depth. Taking account of under-keel clearance and tidal fluctuation, the maximum permissible draft of a vessel is determined. The upstream rivers from Buriganga Bridge and Kachpur Bridge are not accessible for vessels with high masts due to the vertical clearance of 12.2 meters and 12.8 meters at High Water Level, respectively. On the navigational routes between the ports of Dhaka and Narayanganj and the seaports of Chittagong and Mongla, overhead power lines crossing rivers are installed with a minimum vertical clearance of 15.8 meters.

When considering suitable project sites within the limits of Dhaka and Narayanganj ports in view of accessibility for vessels, navigational hindrances due to bridges and overhead power lines should be taken account of.

11.5.7 Potential Project Sites

(1) Introduction

Considering the above conditions, the following potential sites for this project are considered:

- Dhaka Port

1. South Bank of Buriganga River

Owing to the construction of Buriganga Bridge, the south bank of the Buriganga River presents great development potential. The riverbank upstream from Buriganga Bridge, however, has already been developed by various kinds of factories, such as garment factories and shipyards. On the contrary, the riverbank downstream from Buriganga Bridge is still undeveloped. Except for the opposite side of Fatulla, most of the riverside is utilized as brick fields. Several villages are located partly on the riverside. Except for the village sites, brick fields and low-lying land behind them are considered as the suitable project site. At the brick fields between Hasnabad new Postogola village and Pangaon village, general cargo berths were proposed in the 1987 JICA Study. Thus, the downstream riverside of Pangaon village is proposed as a potential project site, which is the closest to the Mawa-Dhaka Road among the alternative sites.

2. North Bank of the Buriganga River

The riverbank upstream from Buriganga Bridge is densely built-up, and there is no room for land acquisition for this project. The riverbank downstream from Buriganga Bridge has been considerably developed, and therefore it is rather difficult to find suitable project sites in this area except for Pagla. At Pagla, three potential sites are considered.

- Narayanganj Port

1. West Bank of the Sitalakhya River

The west riverbank of the Sitalakhya River neighboring Narayanganj's urban area is densely built-up and it is difficult to find a potential site there. The riverbank downstream from the city area is made up of cultivated lands. Behind them is the local road leading to Gopchar ferry ghat diverting from the Dhaka-Narayanganj Road. The road, however, is only one lane and is therefore unusable for a local access road to the planned container terminal. On the other hand, the riverbank upstream from the city area has been considerably developed. Along the riverbank, many factories, mainly jute baling mills, food grain silos, etc., are located. Therefore, it is difficult to find spacious open land that is available for a project site. The BIWTA's open land available at Khanpur is good for a small project, but insufficient for a full-scale container terminal.

2. East Bank of the Sitalakhya River

Except for the vicinity of Kachpur Bridge, there are no road connections on the east riverbank of the Sitalakhya River. Moreover, many factories are located there. On the riverbank near Kachpur Bridge, several factories and Kachpur village are located, and there is no vacant land. Thus, there are no suitable sites for the project.

- Meghna River

In the vicinity of Meghna Bridge, which is now under construction and expected to be completed by July of 1990, a suitable project site is being examined. From Meghna Bridge to the confluence of the Dhaleswari River with the Meghna River, the water depth is over 6 meters below the average LLW, based on the 1988 sounding record, and it seems sufficient for inland water vessels. Except for the Dhaka-Chittagong Road and the ferry ghats, the low-lying land near the bridge is left vacant. The distance from the center of Dhaka (GPO) to the bridge is about 28 km, and from Kachpur Bridge, about 15 km. The Meghna River is much larger than the Buriganga and Sitalakhya rivers, and therefore erosion and siltation of the Meghna River seem to be much more serious than in the Buriganga and Sitalakhya rivers, which are comparatively stable. Upstream from Meghna Bridge, there is a sharply curved area and a sandbar at the inner curve stretches remarkably close to the bridge. On the contrary, there is continuous serious erosion at the outer curve, which once damaged the ferry ghat near the bridge. On the other hand, downstream from the bridge, the south riverside is becoming shallow due to remarkable siltation. The north riverbank seems to be temporarily stable. Judging from the above situation, however, no one can ensure the stability of the riverbank in the future. Thus, the vicinity of Meghna Bridge is not considered as a suitable project site.

(2) Comparison of the Potential Sites

The potential project sites listed above are compared in accordance with the principal factors described previously as follows (see Fig. 11.15):

1. Site A: Pangaon

a. Access traffic mode

-Inland water and road
-Distance from GPO: 10 km.

b. Land acquisition

Private open land

c. Stability of the river

The shoreline is straight and historically stable.

d. Navigational conditions

The river's breadth is around 350 meters and sufficient for a turning basin. A water depth of 3.7 m. (12 ft.) can be maintained near the shoreline.

2. Site B-1: Pagla

a. Access traffic mode

-Inland water, road and railway
-Distance from GPO: 9 km.

b. Land acquisition

-Private land
-The riverbank is used for unloading construction materials and buildings for the business are located. Behind the road, the land is vacant and low-lying.

c. Stability of the river

The shoreline is straight and historically stable.

d. Navigational conditions

The river's breadth is around 300 meters and somewhat insufficient for a turning basin for large vessels. A water depth of 3.7 m. can be maintained near the shoreline.

3. Site B-2: Pagla

a. Access traffic mode

-Inland water, road and railway
-Distance from GPO: 8 km.

b. Land acquisition

-Private land
-The riverbank is used for unloading construction materials. Behind the road, the land is vacant and low-lying. The planned container backyard could not be allocated just behind planned berths due to the pucka buildings, which are located behind the berths and would be difficult to remove.

c. Stability of the river

The shoreline is straight. However, a tendency toward siltation exists, judging from the riverbed contours. This seems seems likely to be partly due to drainage of the sewage hole located adjacent to the site.

d. Navigational conditions
The river's breadth is around 250 meters and insufficient for a turning basin for large vessels. Consequently, it might lead to high transportation costs. Capital dredging and maintenance dredging would be necessary along the berth line.

4. Site B-3: Pagla

a. Access traffic mode

-Inland water, road and railway

-Distance from GPO: 10 km.

b. Land acquisition

-Land owned by the PWD, partly private land

-The riverbank is used for unloading construction materials and coal by the PWD.

c. Stability of the river

The shoreline is straight and historically stable.

d. Navigational conditions

The river's breadth is around 350 meters and sufficient for a turning basin. A water depth of 3.7 m. can be maintained near the shoreline.

5. Site C: Khanpur

a. Access traffic mode

-Inland water, road and railway

-Distance from GPO: 16 km.

b. Land acquisition

-Land owned by the BIWTA

-The area is insufficient for a full-scale container terminal.

c. Stability of the river

The shoreline is straight and historically stable.

d. Navigational conditions

The river's breadth is around 300 meters and somewhat insufficient for a turning basin for large vessels. A water depth of 3.7 m. can be maintained near the shoreline.

By comparing the locational conditions and availability of lands mentioned above, the following two sites are chosen to be further assessed in detail:

1. Site A : Pangaon.

2. Site B-1: Pagla.

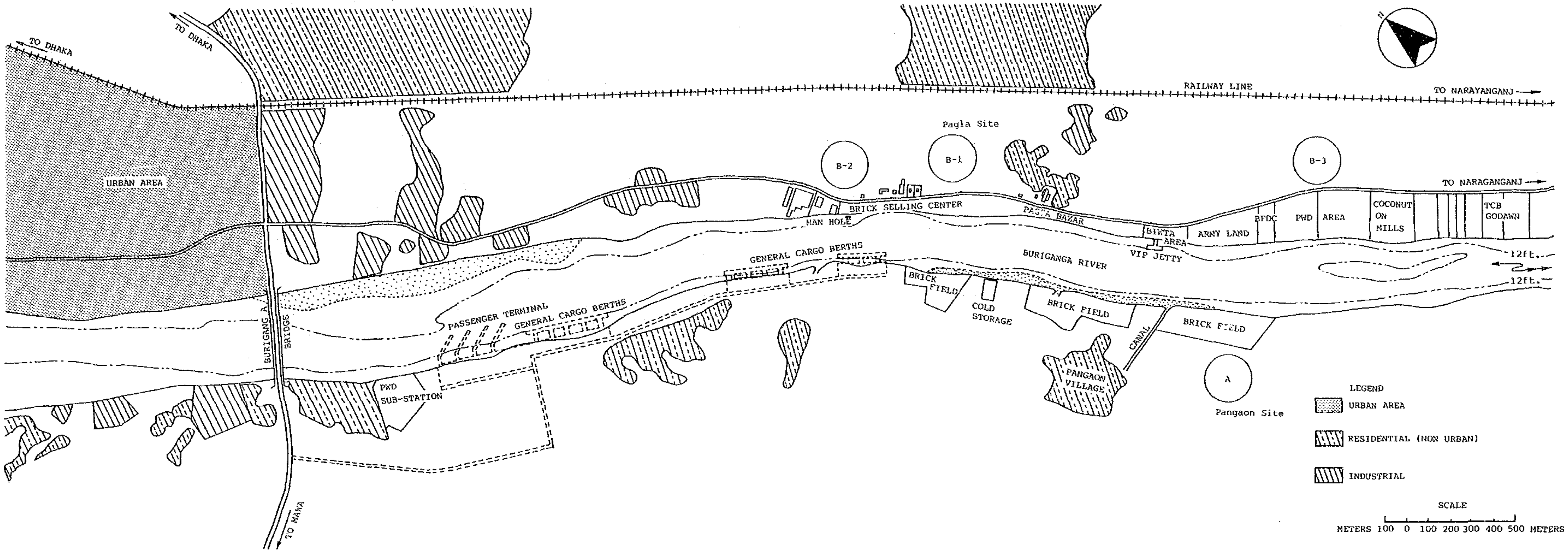


Fig. 11.15 Suitable Project Sites at Pangaon and Pagla

11.6 Alternative Development Plans of the Container Terminal

Considering the required scale of the container terminal and proposed suitable sites described in Section 11.3-Section 11.5, alternative development plans of the container terminal with a target year of 2005 are proposed as follows (see Fig. 11.16 - Fig 11.20):

	Project Site	Container No. Handled (TEUs per annum)	Remarks
- Case-1	Pangaon	154,000	
- Case-2	Pagla	154,000	
- Case-3	Pangaon	77,000	Simultaneous Development Plan
	Pagla	77,000	
		Total 154,000	
- Case-4	Pagla	69,000	The First Phase Plan
	Pangaon	85,000	The Second Phase Plan
		Total 154,000	

The alternative plans listed above are compared from the following points:

a. Land Acquisition

Considering the present land use described in Section 11.5.7, land acquisition in Case-1 at the Pangaon site seems likely to be easier than in Case-2 at the Pagla site that is functioning as a selling center for construction materials such as bricks, sand and gravels delivered to the Dhaka city area, and therefore is used rather densely.

b. Basins

A basin needs to be located in a place capable of securing safety maneuvering and anchorage for container ships. In other words, if there are no proper basins near a container terminal planned at riverside, the plan should not be justified. In Case-1 at Pangaon site, a necessary turning basin can be allocate just adjacent to the site. Several basins for ships

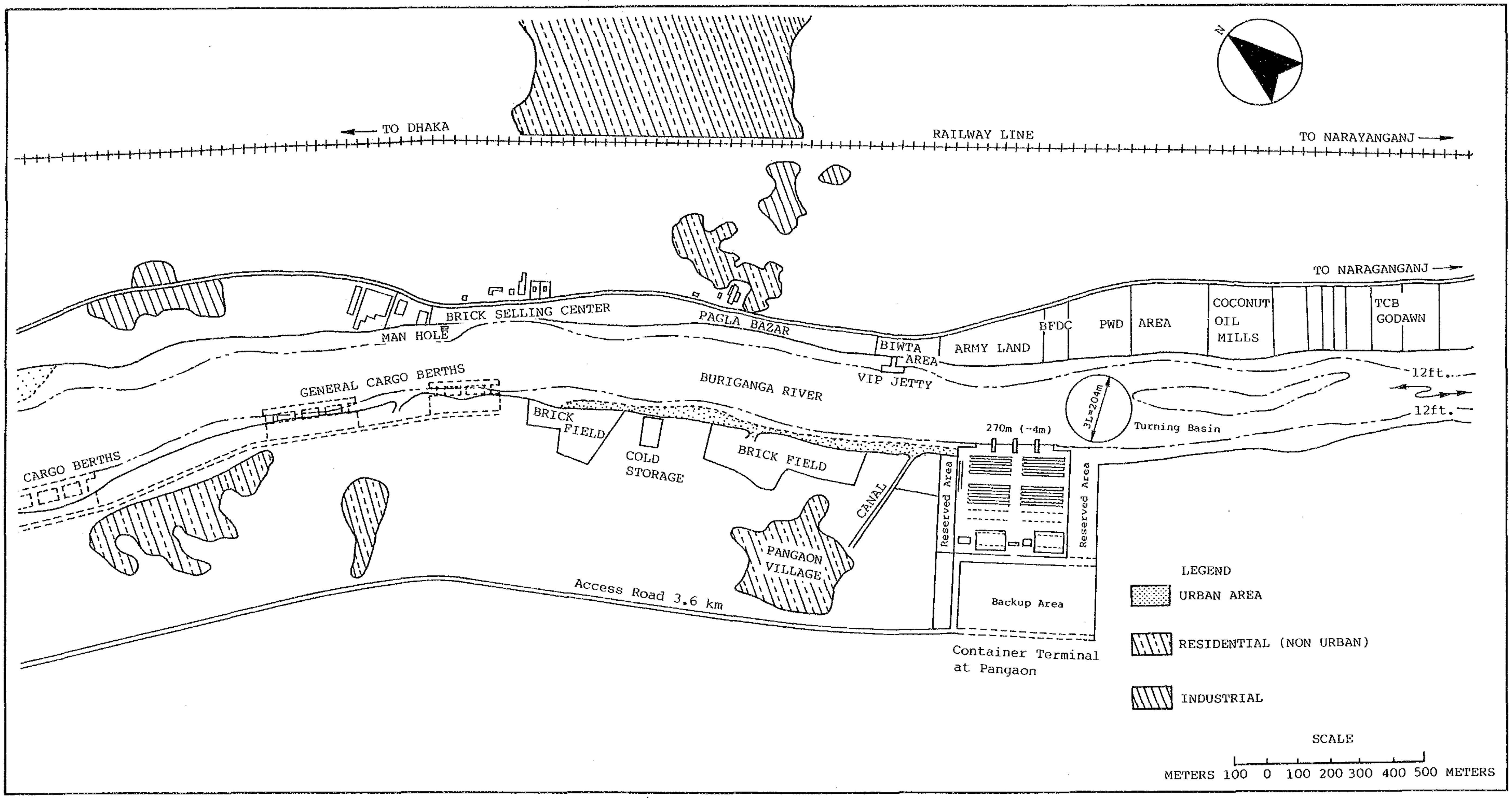


Fig. 11.16 Alternative Development Plan at Pangaon Site - Case 1

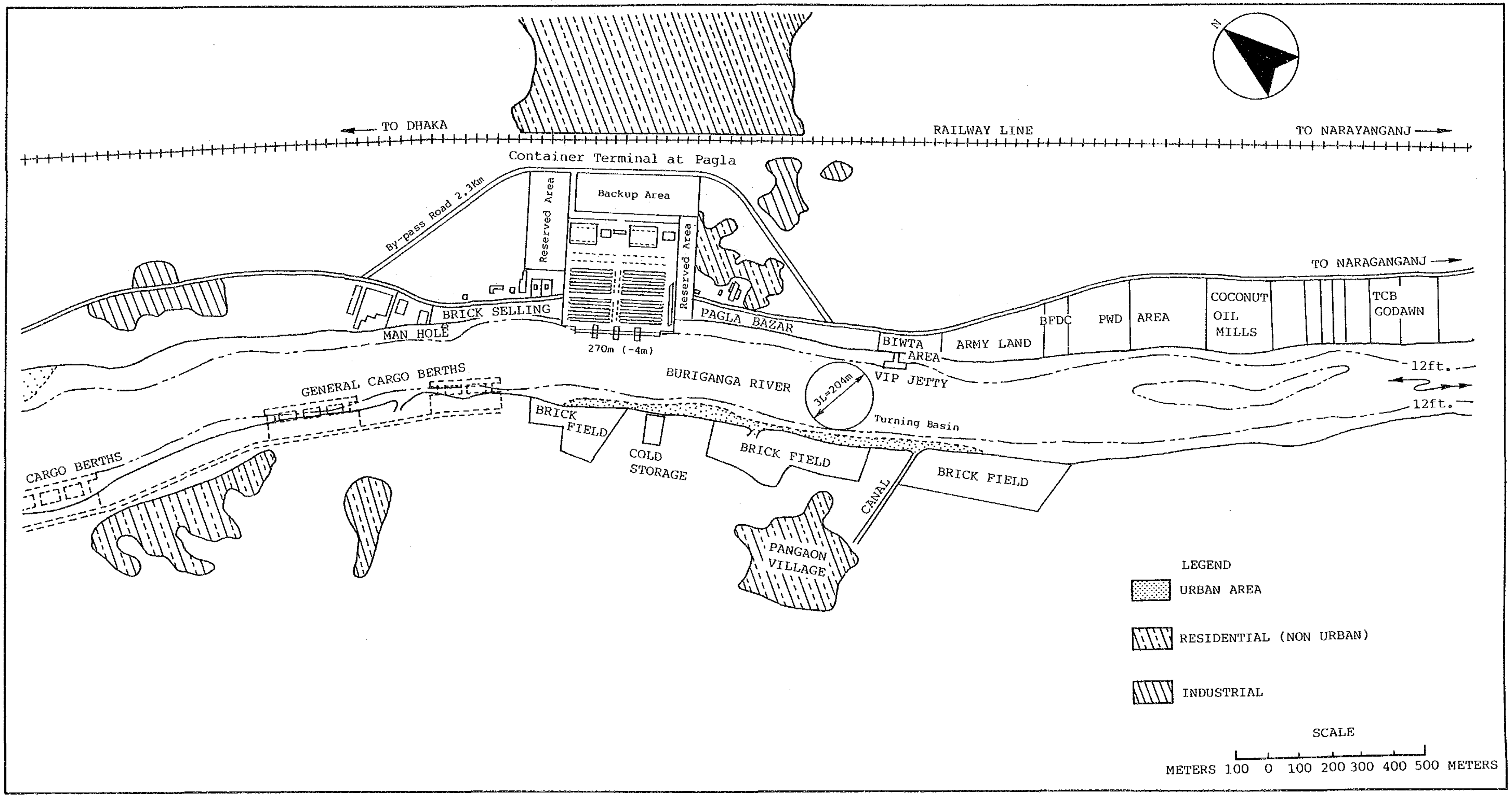


Fig. 11.17 Alternative Development plan at Pagla Site - Case 2

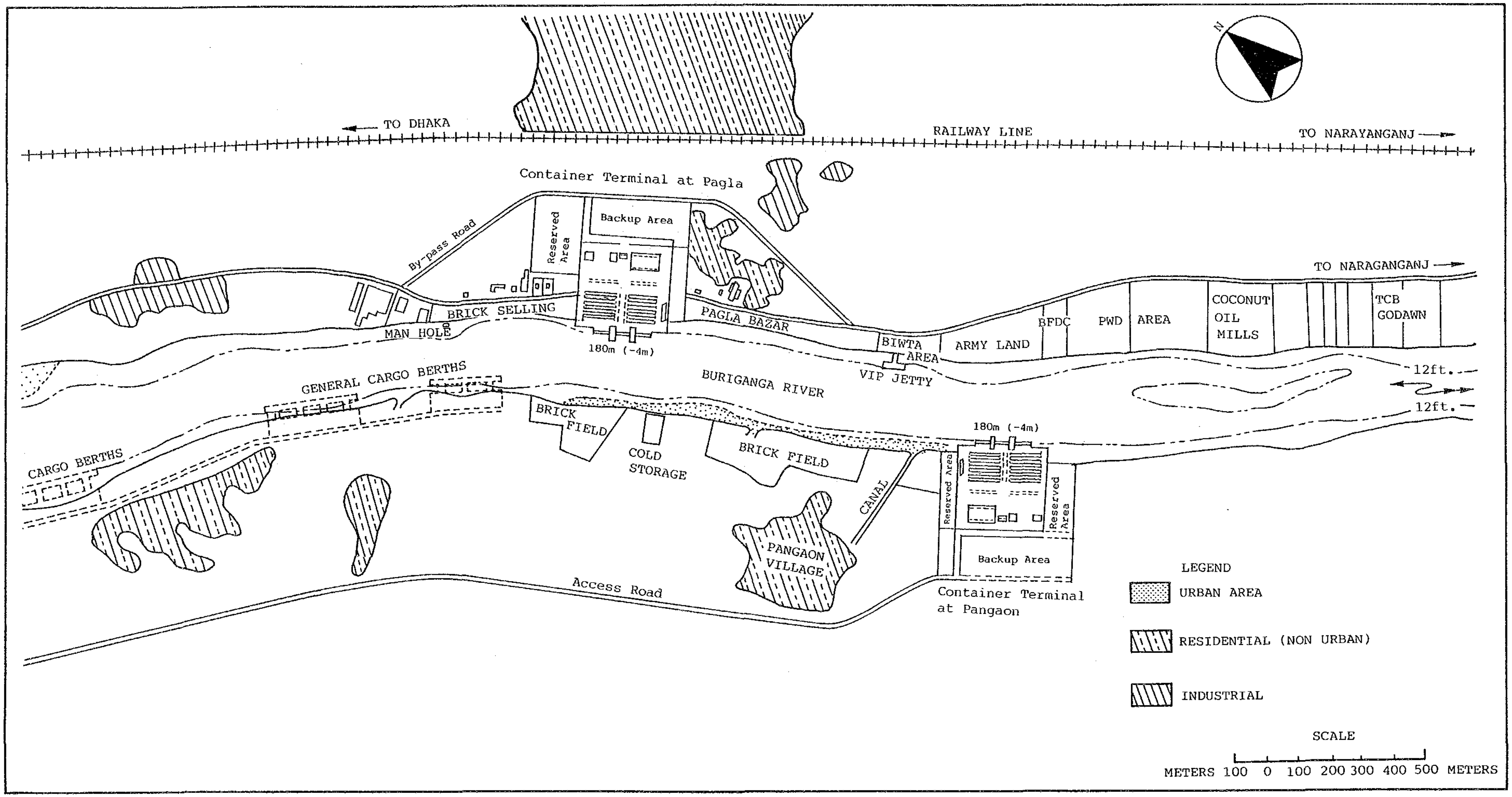


Fig. 11.18 Alternatie Development Plan at Pangaon and Pagla Site - Case 3

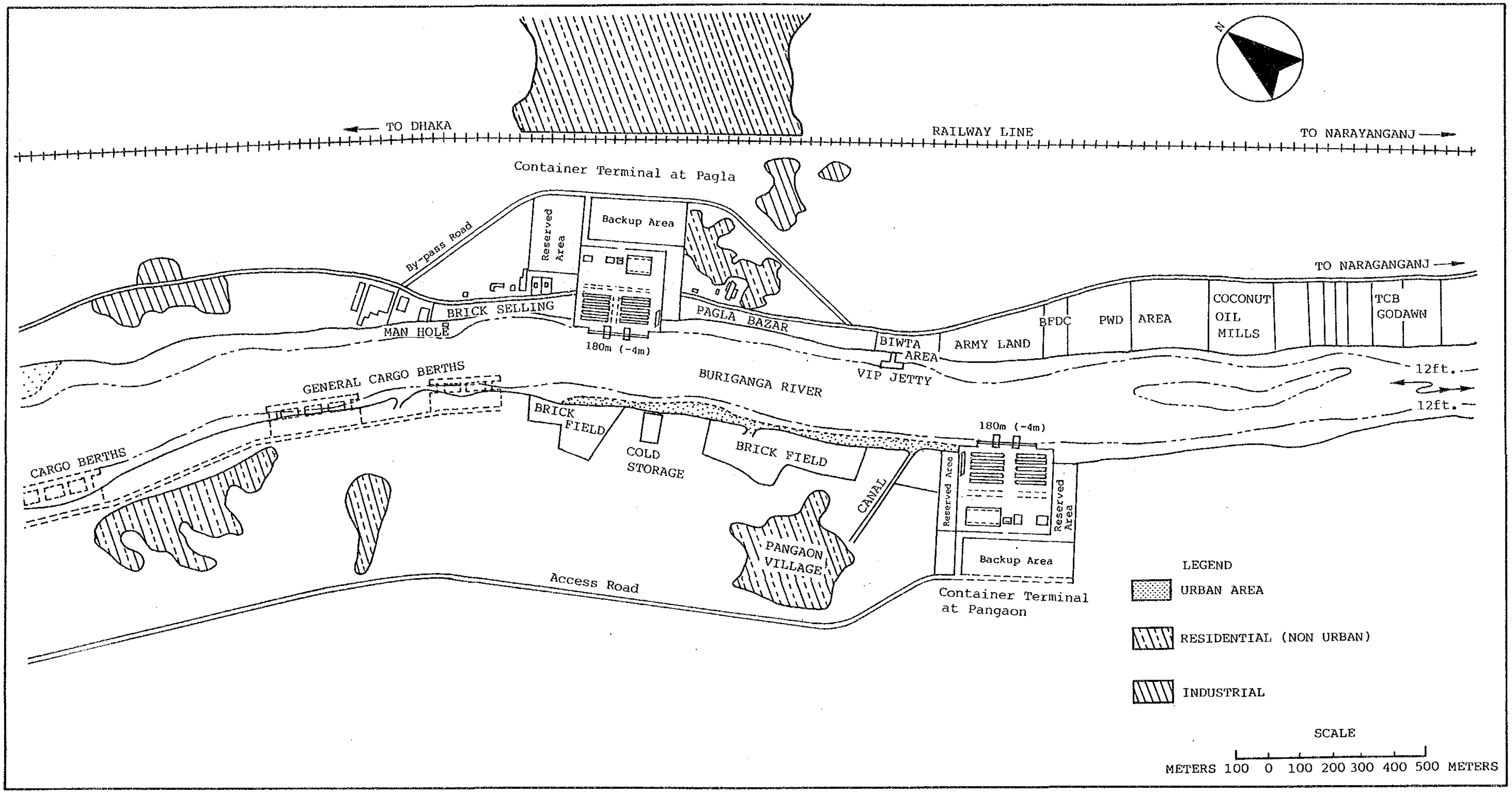


Fig. 11.19 Alternatie Development Plan at Pangaon and Pagla Site - Case 4

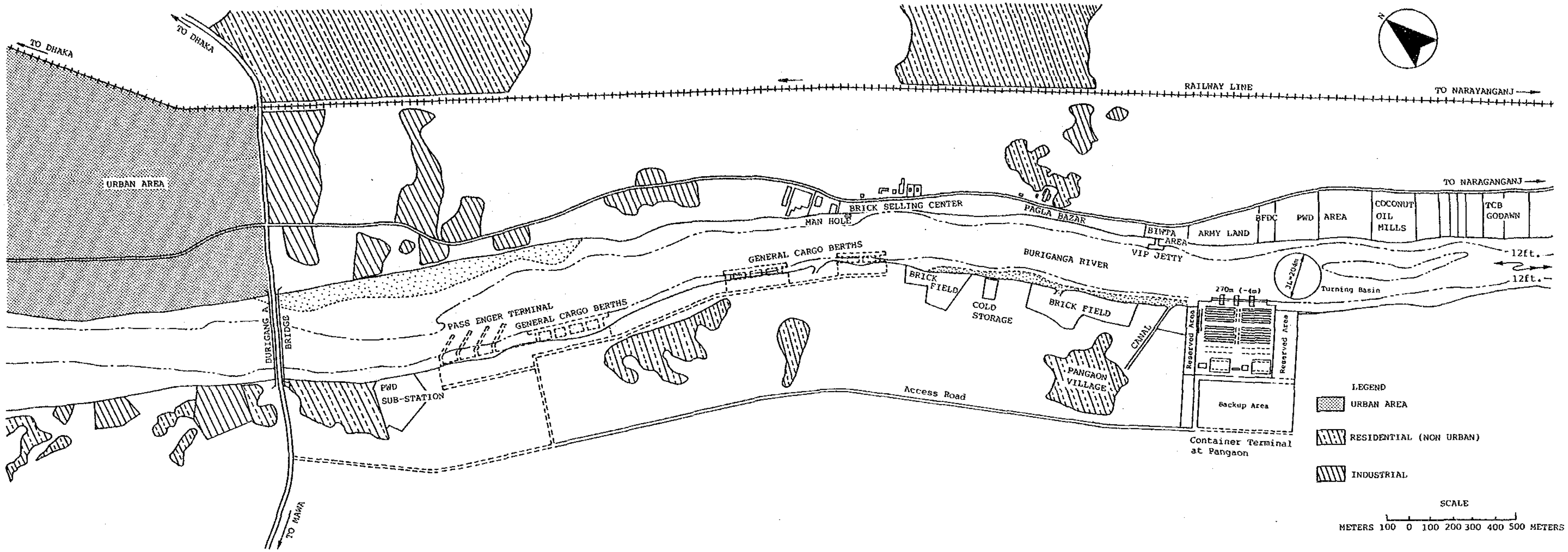


Fig. 11.20 Access Road Alignment of Case 1

waiting for mooring at a container terminal can be also located in the comparatively spacious water area neighboring the site.

On the other hand, water area neighboring the Pagla site of Case-2 is insufficient for maneuvering a container ship with long LOA. When turning her, she is forced to back astern to the water area near the BIWTA's VIP Jetty. In this point, the Pangaon site of Case-1 has advantage than Case-2.

c. Access Road

In Case-1 at the Pangaon site, a new two-lane access road needs to be connected with the Dhaka-Mawa Road near Buriganga Bridge. A part of cost of the access road is allocated to the general berth project proposed by the previous JICA study team. As a result of the allocation, the remaining access road of around 3.6 km long is allocated to this project.

On the other hand, in Case-2 at the Pagla site, the existing Dhaka-Narayanganj Road runs through the site. However, a by-pass road needs to be constructed considering not to hinder various activities generated from a container terminal to be established newly and its future expansion. Thus, the by-pass road of around 2.3 km long is planed to be aligned.

d. Efficient Operation

Case-3 and Case-4 are plans to establish two container terminals each at both the Pagla and Pangaon sites for the purpose of developing both areas from the standpoint of regional development. However, in view of efficient container-handling operation at the terminals to be newly established, such separation of the terminals will cause serious inefficiency. In a case where a container ship berths at one terminal and there are still no containers having finished export procedures and being ready to be loaded onto the ship and there are such containers at the other terminal, the containers must be transferred to the relevant terminal, and otherwise, she must wait cargos or depart with half-loaded condition, resulting costly and inefficient container transport. Percentages of loaded containers for export transferred from one terminal to the other terminal to the total loaded containers for export are estimated as 46% and 48 % in Case-3 and Case-4, respectively. On the contrary, in Case-1 and Case-2, the above transfer don't occur. Moreover, investment costs of Case-3 and Case-

4 are much higher than these of Case-1 and Case-2 due to their uneconomical separate plans (see Table 11.3). Thus, Case-3 and Case-4 should be avoided.

e. Phase Plan for Construction

As for Case-3, taking account of the first phase plan for this project to be implemented around 1995, required scale of a planned container terminal seems to be too small to divide into two terminals to be established simultaneously. In this stage, it is roughly estimated that only two berths as a total will be sufficient for the first phase plan. From the above, Case-3 should be avoided.

f. Construction Cost

The four cases, namely Cases 1, 2, 3 and 4, are further divided by four different container-handling systems as mentioned in Section 11.4. Thus, sixteen cases as a total are compared each other as alternatives (see Table 11.3). Thus, chassis and fork-lift systems are not advisable to be adopted for his project.

The comparison of the sixteen alternatives is summarized in Table 11.3.

Investment costs of chassis system is much higher than the other three cases, namely straddle carrier, transfer crane and forklift systems. there is no decisive difference in cost between the three cases. However, forklift system has fear to damage containers in cargo-handling operation as mentioned in Section 12.5 compared with straddle carrier and transfer crane systems.

Table 11.3 Comparison of the alternative Development Plans of the Container Terminal

Case No.	Container-handling System	Project Site	Terminal Area (sq.m)	Access Road (km)	Project Cost (Million TAKA): Infra- & Upper-Structures	ditto Taxes & Duties	Container Handling Equipment	ditto Taxes & Duties	Access Road	ditto Taxes & Duties	Sub-total: Project Cost	Sub-total: Taxes & Duties	Total	Cost Index	Remarks
1-1	Straddle Carrier	Pangaon	137,350	3.6	1,011	139	633	382	94	2	1,738	523	2,261	100	X
1-2	Transfer Crane	Pangaon	124,800	3.6	950	127	735	467	94	2	1,779	596	2,375	105	X
1-3	Forklift	Pangaon	190,600	3.6	1,217	176	582	262	94	2	1,893	440	2,333	103	
1-4	Chassis	Pangaon	247,100	3.6	1,334	179	2,039	151	94	2	3,467	332	3,799	168	
2-1	Straddle Carrier	Pagla	137,350	2.3	1,108	141	633	382	86	1	1,827	524	2,351	104	X
2-2	Transfer Crane	Pagla	124,800	2.3	1,039	129	735	467	86	1	1,860	597	2,457	109	X
2-3	Forklift	Pagla	190,600	2.3	1,345	178	582	262	86	1	2,013	441	2,454	109	
2-4	Chassis	Pagla	247,100	2.3	1,627	222	2,039	151	86	1	3,752	374	4,126	182	
3-1	Straddle Carrier	Total	171,800	5.9	1,335	165	806	472	179	3	2,320	640	2,960	131	
		(Pangaon)	85,900	3.6	637	82	403	236	94	2					
		(Pagla)	85,900	2.3	698	83	403	236	85	1					
3-2	Transfer Crane	Total	161,400	5.9	1,288	155	972	608	179	3	2,439	766	3,205	142	
		(Pangaon)	80,700	3.6	615	77	486	304	94	2					
		(Pagla)	80,700	2.3	673	78	486	304	85	1					
3-3	Forklift	Total	245,600	5.9	1,626	215	728	320	179	3	2,533	538	3,071	136	
		(Pangaon)	122,800	3.6	775	107	364	160	94	1					
		(Pagla)	122,800	2.3	851	108	364	160	85	2					
3-4	Chassis	Total	282,200	5.9	1,715	222	2,490	3,210	179	3	4,384	3,435	7,819	346	
		(Pangaon)	141,100	3.6	773	99	1,245	1,605	94	1					
		(Pagla)	141,100	2.3	942	123	1,245	1,605	85	2					
4-1	Straddle Carrier	Total	172,600	5.9	1,334	165	807	475	179	3	2,320	643	2,963	131	
		(Pagla)	80,000	2.3	678	80	378	213	94	1					
		(Pangaon)	92,600	3.6	656	85	429	262	85	2					
4-2	Transfer Crane	Total	157,600	5.9	1,272	154	916	567	179	3	2,367	724	3,091	137	
		(Pagla)	72,500	2.3	645	74	429	257	94	1					
		(Pangaon)	85,100	3.6	627	80	487	310	85	2					
4-3	Forklift	Total	252,800	5.9	1,648	220	747	333	179	3	2,574	556	3,130	138	
		(Pagla)	117,100	2.3	832	105	362	160	94	1					
		(Pangaon)	135,700	3.6	816	115	385	173	85	2					
4-4	Chassis	Total	293,900	5.9	1,742	227	2,491	3,211	179	3	4,412	3,441	7,853	347	
		(Pagla)	134,200	2.3	899	119	1,105	1,391	94	1					
		(Pangaon)	159,700	3.6	843	108	1,386	1,820	85	2					

According to the above comparison, the separate plans, namely Cases 3 and 4 are excluded. As for container-handling systems, chassis and forklift systems are also excluded. Thus, the following for cases are considered as suitable cases for this project and are further assessed form various points of views:

	Project Site	Container-handling System
1.	Case 1-1: Pangaon	Straddle Carrier
2.	Case 1-2: Pangaon	Transfer Crane
3.	Case 2-1: Pagla	Straddle Carrier
4.	Case 2-2: Pagla	Transfer Crane

As the alternative project sites, Pangaon and Pagla were compared in detail from various points of view (see Table 11.4). Land acquisition of the Pangaon site seems to be much easier than that of the Pagla site which has already been partly developed and built-up. As for basins essential to a riverside container terminal, a necessary turning basin can be allocated just adjacent to the Pangaon site in the comparatively spacious waters. On the contrary, turning basin cannot be allocated just adjacent to the Pagla site, and consequently container ships will be forced to back astern dangerously in the congested waterways to the broad waters away from the site. Furthermore, the Pangaon area left vacant has greater development potential than the Pagla area which has already been developed to a certain extent. Construction cost at the Pangaon site is estimated cheaper than that at the pagla site. Thus the pangaon site has advantages and is selected as the optimum project site.

As the alternative cargo-handling systems for the container terminal, straddle carrier system and transfer system were compared in detail from various points of views. The straddle carrier system has advantages over the transfer crane system in flexible operation owing to less number of container handling times. The straddle carrier system has already been adopted at the two seaports, therefore skill and technique of the system can be easily introduced to the planned new container terminal from the seaports. In this case, by applying similar procurement system adopted at the seaports, spare-parts of straddle carriers for the planned terminal may be procured conveniently. There is no decisive difference in cost between the two systems. Thus, the straddle carrier system has advantages over the transfer system, and is selected as the optimum cargo-handling system.

From the above comparison, Case 1-1 is selected as the optimum plan.

In order to support container-handling operation in the container terminal, backup area for warehouses, office space of shipping companies, shipping agencies and forwarders, etc. needs to be prepared adjacent to the container terminal. Though the areas is expected to be used mainly for private sectors, land acquisition should be included in this project in order to avoid disorderly development and control land use around the container terminal. Thus, the project areas for the Master plan are summarized as follows (see Fig. 11. 21):

- Terminal Area: 137,350 sq. m. (Van Pool: 12,600 sq. m.)
- Port Road: 8,695 sq. m.
- Backup Area: 37,280 sq. m.

- Total Area: 183,325 sq. m.

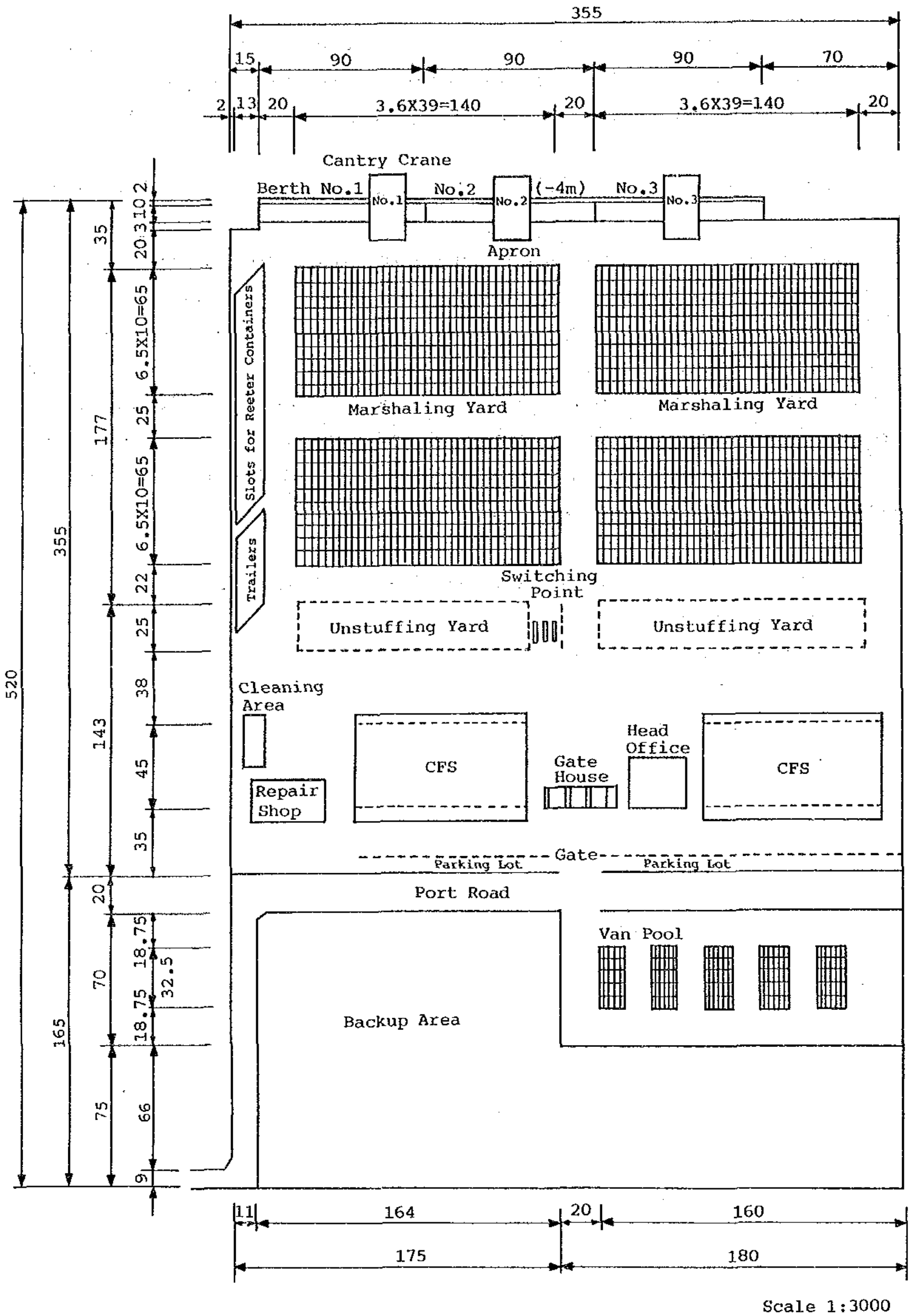


Fig.11.21 Layout Plan of the Facilities of the Container Terminal for the Master Plan with the target year of 2005

Table 11.4 Comparison of the Alternative Project Sites for the Container Terminal

Project Site	Pangaon	Pagla
Case No.	Case 1-1 & Case 1-2	Case 2-1 & Case 2-2
Land Aquisition	Most part of the site is low-lying vacant land and its aquisition seems to be easier than at Pagla.	Backward area from Dhaka-Narayanganj road is low-lying and vacant, and waterfront area is used rather densely for a selling center for construction materials.
Basins	A necessary turning basin can be allocated just adjacent to the site.	When turning a container ship, she is forced to back astern to the water area near the BIWTA's VIP Jetty.
Potential for Future Development around the Project Site	Owing to the construction of Buriganga Bridge, the south bank of the Buriganga River presents great development potential and by constructing a local access road, the area can be developed greately.	Pagla site has been considerably developed, especially in waterfront area. The Dhaka-Narayanganj Railway Line might hinder future development in backward area.
Environmental Impact on the Areas Adjacent to the Terminal	The project site is sparsely-populated area and environmental impact on the areas adjacent to the terminal seems to be small by this project.	There is built-up area comprising residences and the Pagla Bazar in the east of the Pagla site. When establishing a containerterminal, a buffer zone will need to be made.
Cost Index	Case 1-1 (Straddle Carrier System): 100 Case 1-2 (Transfer Crane System): 105	Case 2-1 (Straddle Carrier System): 104 Case 2-2 (Transfer Crane System): 109

11.7 Land Use Plan in and around the Container Terminal

After determination of the optimal project site, it is necessary to prepare a land use plan in and around the selected site as part of the Master Plan in order to harmonize land use for massive container-handling and activities related to the handling with other uses such as for industrial, agricultural and urban activities. When preparing the land use plan, the following points should be considered:

- Reservation of land for future expansion of the container terminal,

- Preparation of space for the activities related to container-handling such as for warehouses and offices of shipping agencies and forwarders,

- Preparation of space for new industries generated from the establishment of the container terminal,

- Harmonization with the other land uses such as for existing industries, agriculture, housing and urban activities,

- Environmental consideration.

Considering the above points, a land use plan in and around the project site is proposed in Fig. 11.22.

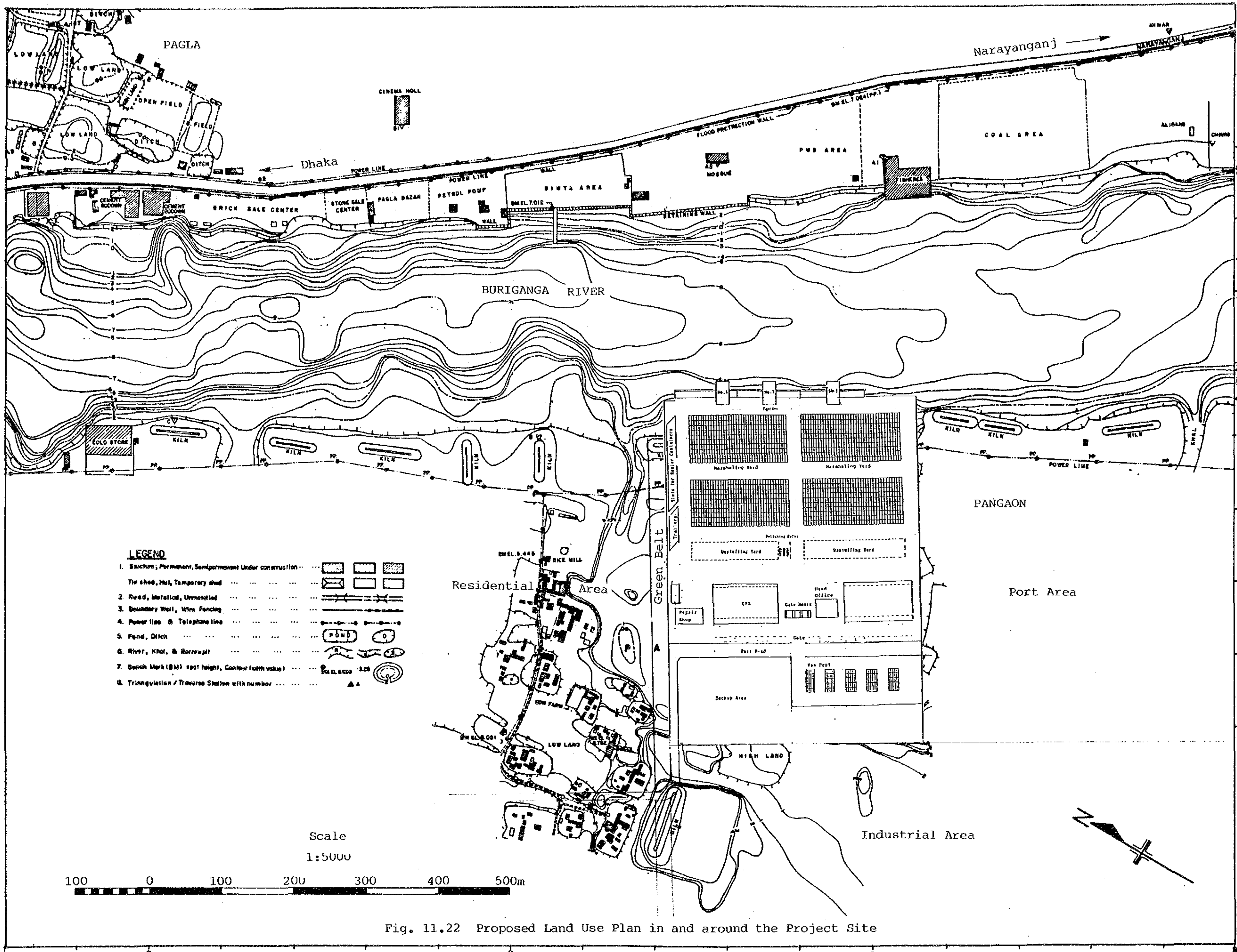


Fig. 11.22 Proposed Land Use Plan in and around the Project Site

Chapter 12 Design And Cost Estimate

12.1 Design Conditions

12.1.1 Basic principle of Design

In Bangladesh, there seems to be no established design criteria and methodology for port and harbor facilities.

For this reason, the Technical Standards and Commentaries for port and Harbor facilities, published by the Port and harbor Research Institute of the Ministry of Transport, Japan, have been adopted as the criteria for the present design.

The Technical Standards, completed in 1977, were compiled on the basis of years of research work under taken by the Institute.

With respect of seismic designs, in particular, the Technical Standards provide for sound and reliable design criteria and methods and procedures based on extensive experience and can, therefore, be applied appropriately to the present design.

12.1.2 Design Conditions for Berth

This project consists of a long-range plan targeted for the year 2005 and a short-range plan targeted for 1995.

Depending on the extent to which the proposed container terminal will be expected to perform distributive functions in water transportation, it is conceivable that the ship size considered in the present design will show an increasing tendency.

In view of the urgency of early completion of the proposed container terminal, however, the required berth length has been established as indicated below to primarily accommodate coasters, which are expected to use the new berth with a higher frequency than the other types of vessels.

Short-range plan : 2 berth of 180 m in length

Long-range plan : 3 berths with total length of 270 m

12.1.3 Design Parameters of Quay

(1) Principal Particulars of Design Ship

Based on analysis of the operation plan of ships considered in the present design, the major ship characteristics given in Table 12.1.1 have been selected for design purposes.

Table 12.1.1 Design Ship Characteristics

Vessel Type	Length (m)	Breadth (m)	Depth (m)	Draft (m)	Displacement Tonnage (ton)
Type A(coaster)	68.00	13.00	8.00	3.40(1.45)	2,200
Type B(ocean-going)	75.00	13.50	6.00	3.50(1.45)	2,550
Type C(ocean-going)	83.00	15.50	8.50	3.50(1.60)	3,800

Note : Figures in brackets indicate light-load drafts.

The design depth alongside the berth will be -3.60 m (P.W.D), the same value as the planned depth.

(2) Crown Level of Quay

During floods, it is important to prevent gantry crane wheels and power cables from being submerged, even for a short period of time. For this reasons, the highest river water level of P.W.D+7.58m (equivalent of return period of about 25 years) ever recorded in Dhaka Port and higher water levels were taken into consideration in determining the design crown level of the proposed quay structure. in accordance with technical standard for port facilities. In consequence, the crown level of P.W.D+7.80m has been taken for the design purpose. The crown level of P.W.D+8.00m is adopted for th marshalling yard considering 100 year return period of flood level.

(3) Berthing Speed

The speed of a ship immediately before it comes alongside the berth varies depending on the maneuvering technique used. In the case of 2,000 d.w.t. cargo vessels with an overall length of 70 m, however, the berthing speed is generally 15 cm/sec in most cases.

In the present design, it is presumed that the design ships, mostly of smaller drafts than ordinary cargo vessels, will tend to arrive at berths at a higher speed.

Another consideration taken into account in determining the design berthing speed is that although a ship normally sails against the river flow in approaching the berth, it encounters a counter current at flood tide during the dry period of the river.

With all these considerations taken into account, a design berthing speed of 20 cm/sec has been adopted.

12.1.4 Superimposed Load

The superimposed load of the quay consists of the dead load of the structure and live loads, such as containers, cranes and other cargo handling equipment and vehicles.

Loading conditions in the present design are as described below:

(1) Uniformly Distributed Load

1) Quay Apron

On the basis of analysis of pile spacings, required beam height and slab thickness, the following uniformly distributed loads have been considered in the design.

w = 2.3 tons/m^2 for that part of the apron carrying container cranes

w = 1.7 tons/m^2 for that part of the apron backing cranes

2) Marshalling Yard

For this area, w = 2.4 ton/m^2 is considered assuming 8' x 8' x 40' containers stacked three high.

(2) Live Loads

Live loads vary in magnitude depending on cargo handling equipment and vehicles used. Selecting cargo handling equipment (except cranes) whose concentrated loads attain the highest values, the following live loads were considered:

1) Crane Load

Rated load : 30.5 tons

Rail span : 10.0 m

Wheel base : 16.0 m

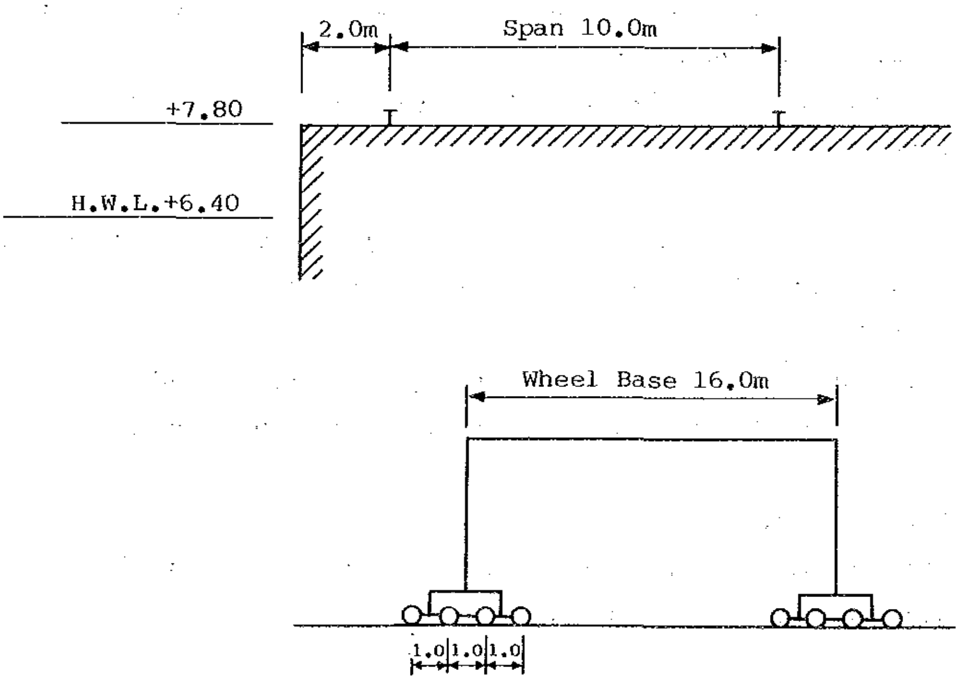
No. of wheels : River side 4 wheels x 2 = 8 wheels
Land side 4 wheels x 2 = 8 wheels

Wheel Load (per wheel)

During operation : River side 38 tons/wheel
Land side 26 tons/wheel

In abnormal situations : River side 42 tons/wheel
(wind = 50 m/sec) Land side 45 tons/wheel

Crane weight : 300 tons/unit



	River side	Land side
During operation	38t/wheel	26t/wheel
Inabonormal situation	42t/wheel	45t/wheel

Fig. 12.1.1 Container crane

2) Other Cargo Handling Equipment

The design considers tractors with 40 ft. trailers illustrated in Fig. 12.1.2 as live loads on the quay apron.

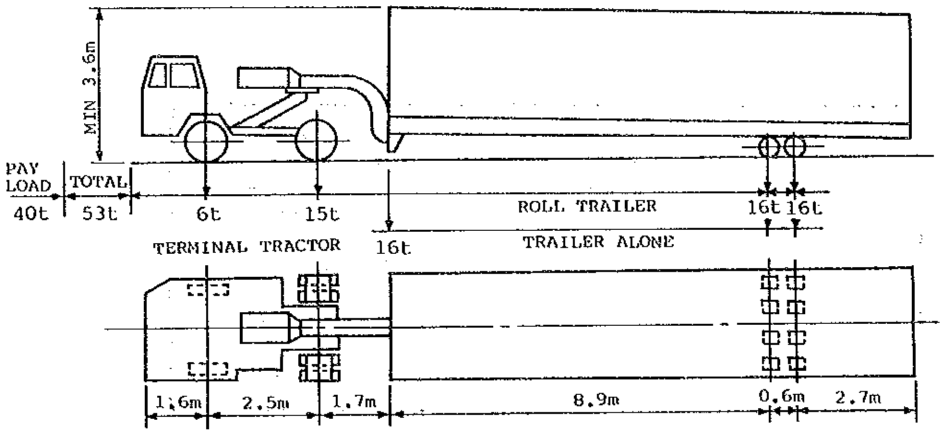


Fig. 12.1.2 Tractor with 40 ft. trailer

12.1.5 Natural Conditions

(1) Design Tide Level

The design tide level indicated in Table 12.1.2 was determined on the basis of analysis of existing water level observation records.

Table 12.1.2 Design Tide Level

Design high water level (HWL)	: + 6.40 m
Design low water level (LWL)	: + 0.40 m

The design HWL is the mean value for the flood observations made at 10-day intervals at Demra near Dhaka Port in September 1988. The design LHL is the mean value for the 1989-90 period in the same port.

(2) Probability of Occurrence of High Water Level in Dhaka Port

In the absence of long-term flood observation records covering Dhaka Port, an attempt was made to estimate high water levels with different return periods on the basis of a correlation between the field data from Station 179 at Demra and Station 42 at Mill Bark.

From the flood observation records spanning the 1966-1989 period derived from the observation station at Demra on the Lakhya River near Dhaka Port, the high water levels with return periods of 25, 50, 75 and 100 years were fore east as shown in Table 12.1.3.

Table 12.1.3 High Water Levels with Different Return periods Based on Field Data from Demra

Return paeriod (years)	High Water Level	Value of r
25	6.687 (m)	1.7941
50	6.879	1.9779
75	6.984	2.0779
100	7.055	2.1460

High Water Level = 10.437r + 48.150

$$r = [- \log (1 - p)]^{\frac{1}{k}} \qquad p = 1 - \frac{K}{NR_p}$$

Where N : Number of data

R_p : Return period

K : Period covered by analysis

k : Constant (200 adopted)

Table 12.1.4 gives the records of the observation stations at Demra and Mill Bark for September 1988 when the maximum high water levels in the past were observed.

Table 12.1.4 Maximum High Water Levels

(In meters)

Date Observed	Demra	Mill Bark
Sept. 4, 1988	-	7.580
Sept. 14, 1988	6.675	6.760

Thus the high water levels with return periods of 25, 50, 75 and 100 years at Mill Bark in Dhaka Port were estimated as indicated in Table 12.1.5.

Table 12.1.5 High Water Levels with Different Return Periods at Mill Bark in Dhaka Port

Return Period (year)	Estimated value	Equation for estimation
25	7.592	$6.867 \times \left(\frac{6.760}{6.675} \right) + \left(\frac{7.580 -}{6.760} \right)$
50	7.786	6.879 x " + "
75	7.893	6.984 x " + "
100	7.965	7.055 x " + "

From table 12.1.5, the high water level of +7.80 m, or the same as the planned fill level, is estimated to have a return period of 53 years.

(3) Assumption of Natural Ground

The soil conditions of the natural ground vary from site to site. Therefore, they are treated in the different sections dealing with the design of individual terminal facilities planned under the project.

(4) Waves

It is conceivable that waves will be generated by cyclones, etc. In this design, however, waves are left out of consideration because of negligible estimated wave height due primarily to the limited river width (about 300 m).

(5) Seismic Coefficient

From the results of analysis of the natural conditions, the following seismic coefficients have been established:

Horizontal seismic coefficient $K_h = 0.06$

Vertical seismic coefficient $K_v = 0.00$

(6) Design Characteristics of Stones and Fill Material

Table 12.1.6 gives the design characteristics of back filling stones, rubble stones for base and fill material to be used behind Fig. 12.2.9.(1) the Quay.

Table 12.1.6 Design Characteristics of Stones and Fill Material

Material	ϕ	Angle of friction with quay	Unit weight ton/m^3	Submerged unit weight ton/m^3
Back filling stone	40°	+15°	1.8	1.0
Rubble stone	40°	-	1.8	1.0
Fill material	30°	+15°	1.8	1.0

12.1.6 Allowable Stress and Unit Weight

(1) Table 12.1.7 gives the allowable stresses for major construction materials.

Table 12.1.7 Allowable Stresses for Major Construction Materials

Material	Design strength Kg/cm^2	Bending & Compressive Kg/cm^2	Tensile stress Kg/cm^2
Concrete	210	80	
Reinforcing bar (SR 24)			1,400
" (SR 30)			1,800
Steel sheet pile		1,800	1,800
Steel pipe pile		1,400	1,400

The allowable stresses during earthquakes shall be equivalent to 1.5 times the above values.

(2) Unit Weight of Concrete and Steel

The unit weights of concrete and steel considered in the design are as follows:

Plain concrete : 2.3 tons/m^3

Reinforced concrete : 2.45 tons/m^3

Steel : 7.85 tons/m^3

12.1.7 Safety Factors and Coefficient of Friction

(1) Safety Factor

The principal safety factors for the design of the quay structure are given in Table 12.1.8.

Table 12.1.8 Design Safety Factors

Item	Normal situation	In times of earthquake
Overturning of structure	1.2	1.1
Sliding of structure	1.2	1.0
Circular failure	1.3	-
Straight line failure	1.2	-
Bearing capacity of shallow foundation	2.5	-
Bearing capacity of deep foundation	2.5	1.5
Allowable toe pressure at rubble base	50 tons/m^2	50tons/m^2

(2) Coefficient of Friction

The coefficients of friction for concrete and rubble stones taken for the design purpose are as follows:

For friction between concrete and rubble stone : 0.6

For friction between concrete : 0.55

For friction between rubble stones : 0.8

(3) Corrosion Rate of Steel Pipe Piles

Steel materials incorporated in harbor structures may undergo corrosion due to oxidization depending on the environment in which they are placed.

Generally, the corrosion rate of steel tends to be highest in locations with a large tidal range or where repeated contacts take place between water surface and the atmosphere as a result of water level fluctuations. Corrosion progresses at a higher rate in locations exposed to sea water.

The river water of the project site may contain a certain amount of salinity when sea water flows into the river at flood tide during its dry period, when the river flow slows down. However the river water can be considered to be fresh water throughout the year.

For the design purpose, the total amount of corrosion for steel incorporated in the quay is 2 mm based on the assumption that the corrosion rate with fresh water averaged 0.018 to 0.025 mm per year and that the service life of the quay structure is 50 to 80 years.

12.2 Design of Main Pier

12.2.1 Assumption of Natural Ground

Two alternative sites are considered for the construction of the proposed container quay : PAGLA in Dhaka and PANGAON about 500 m downstream on the opposite riverbank. Soil boring data derived from both sites indicates that the stratification of the two locations is substantially the same, that the bearing stratum increases in depth in the upstream direction and that soft subsoil layers tend to increase in thickness in that direction. However, the soft layer is less thick and the bearing stratum lies at a shallower depth at the PANGAON site than at the PAGLA site.

For this reason, PANGAON can be considered to be more favorable in terms of subsoil conditions.

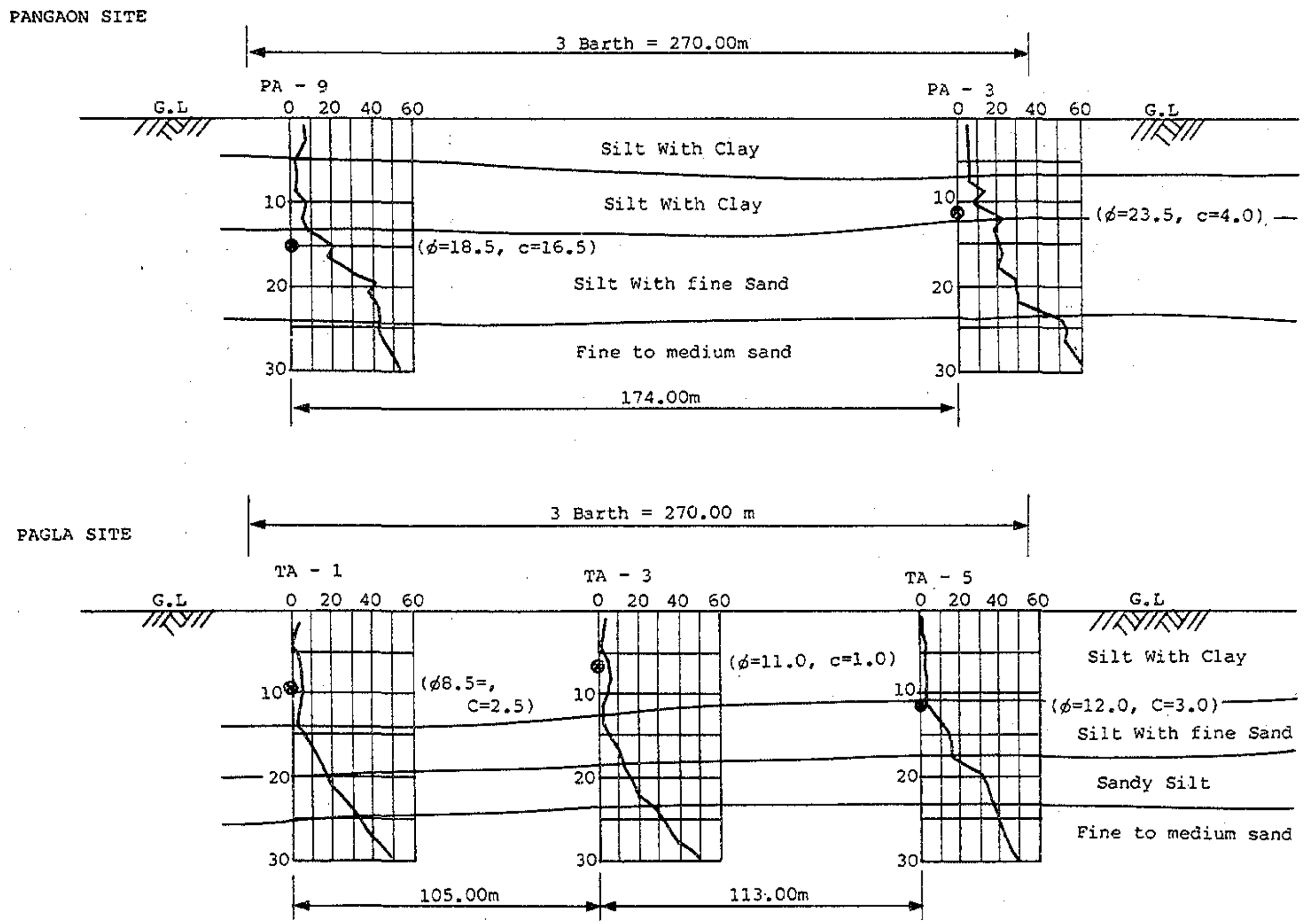


Fig. 12.2.1 Soil Profile of Quay Line

12.2.2 Selection of Structural Type

Selection of the structural type for the proposed pier took into account general conditions of construction, relative ease of obtaining construction materials, accumulated construction experience and reliability of construction. Another important factor considered in the choice of the structural type was that the pier construction should not affect the river flow.

Basically, various distinct structural types are conceivable for the proposed pier:gravity type, steel sheet pile wall type, steel pipe pile type Cast-in-Site R.C Pipe Pile type and pontoon type, etc. However in view of the substantial water level fluctuation (about 3m) of the river and the necessity of avoiding influencing the river flow, the selection was narrowed down to the pontoon type and the Cast-in-Site R.C Pipe Pile type.

The pontoon type has a cost advantage but would involve the pier structure projecting toward midstream with and adequate depth to permit berthing of vessels during the dry period of the river. This could make it difficult to secure a sufficient turning basing area for vessels berthing and deberthing.

Other problems with the pontoon type include substantial reduction in cargo handling operations of gantry cranes installed on the pontoon as a result of its pitching. In consequence, the container terminal would be unable to for perform one of its key functions as a physical distribution facility rapid cargo handling.

Thus, various structural designs of the piers for the container vessel are considered as follows;

Type A	Gravity Caisson	(Fig 12.2.2)
Type B	Steel Sheet Pile	(Fig 12.2.3)
Type C	Steel Pile Pile	(Fig 12.2.4)
Type D	Cast-in Site R.C Pipe Pile	(Fig 12.2.5)
Type E	Pontoon	(Fig 12.2.6)

For Types A and B, the sub-ground must be improved using the sand compaction pile method in order to maximize stability to prevent sliding.

For Type C, D and E, no soil improvement work need to be performed, as stability is ensured by the gentle slope of the structures.

As shown in Table 12.2, the Gravity caisson type and the Steel sheet pile wall type are not economical due to their high construction cost. the pontoon type has not only physical problems such as stability conditions of a floating body and the inclination of the deck for handling equipment but also will be affected by waves and river's current.

Consequently, it was decided that the Cast-in-Site R.C pipe pile type is a potential type for design and construction.

Alternative types for Pier are shown in Figure 12.2.2 - 12.2.

Table 12.2.1 Technical Comparison of Alternative Piers

No	Pier Type / Items	Gravity Caisson	Steel Sheet Pile Wall	Steel Pipe Pile	Cast-in-Site R.C Pipe Pile	Floating Pon-toon
1	Experience in local	+	+	+	++	++
2	Location in the river	+++	+++	+++	+++	+
3	Loading efficiency for handling equipment	+++	+++	+++	+++	+
4	Influence against river flow	+	+	+++	+++	++
5	Necessity of measures for adjacent river wall	+	+	+++	+++	++
6	Difficulty of Material procurement	++	+	+	++	++
7	Difficulty of Procurement of construction equipment	+	+	+	++	++
8	Construction control	+	+	+	++	++
9	Construction period	+	+	++	+	++
10	Care after completion of construction	+++	++	++	++	+
11	Necessity of corrosion protection	+++	+	+	++	+
12	Construction Cost (Thousand Taka/meter)	+(1.7) 1,835	+(2.2) 2,459	+++(1.5) 1,696	+++(1.0) 1,109	++(--) -----
	Evaluation	+	+	++	+++	++

Note:Ranking of evaluation +++:Excellent ++:Ordinary +:Some Problems

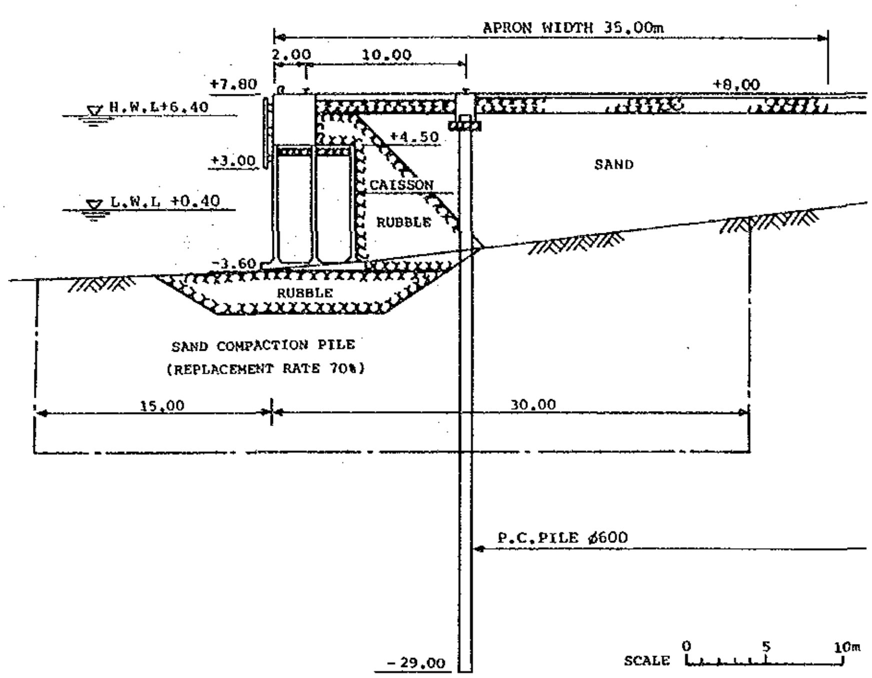


Fig. 12.2.2 GRAVITY CAISSON

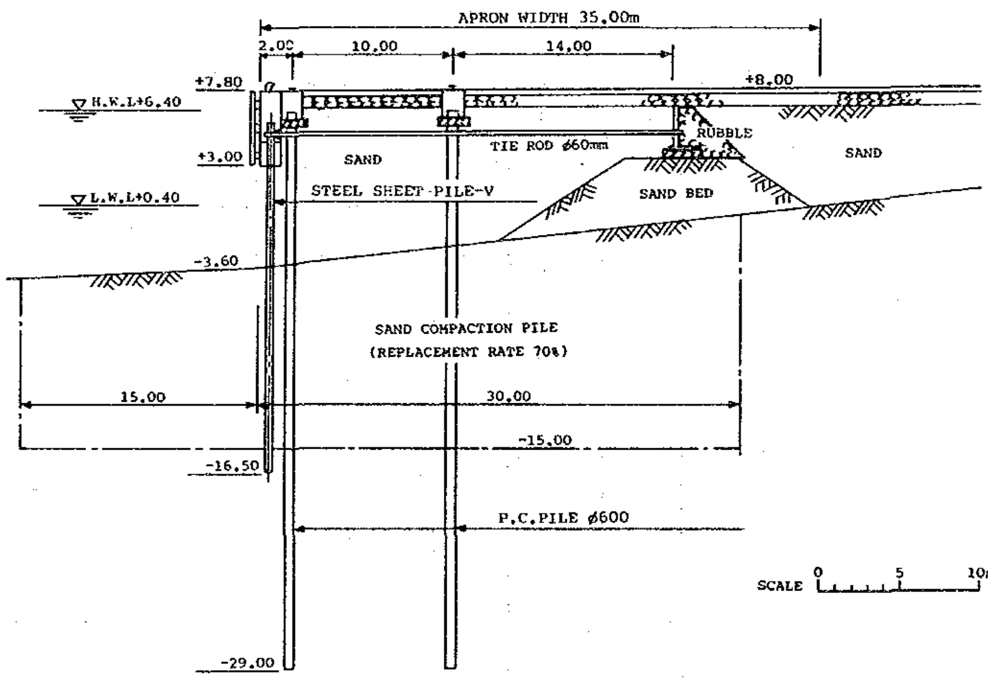


Fig. 12.2.3 STEEL SHEET PILE

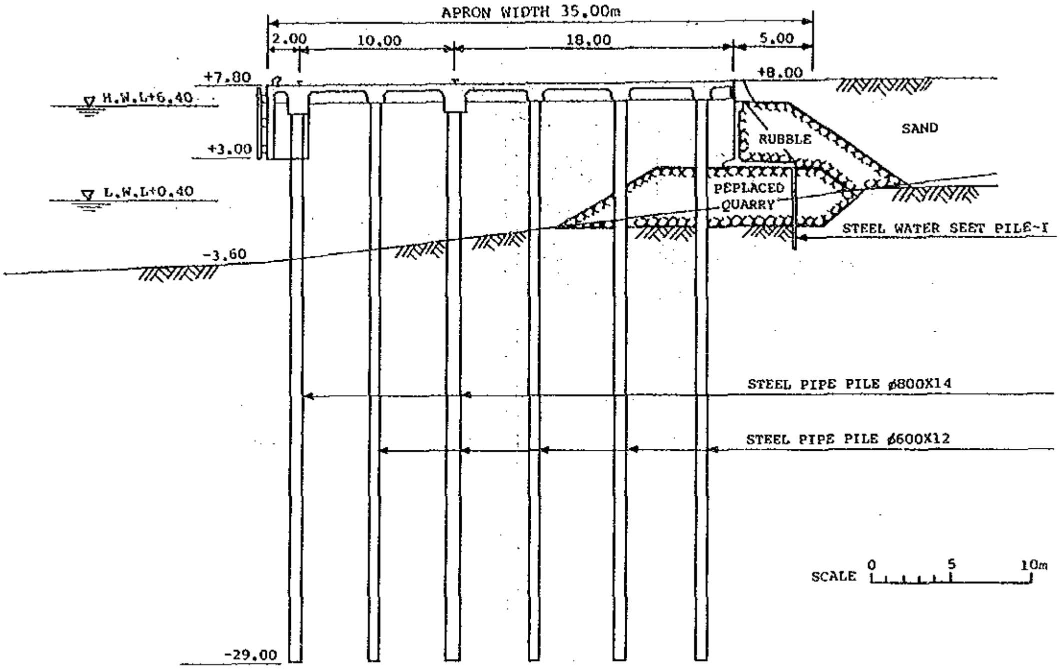


Fig. 12.2.4 STEEL PIPE PILE

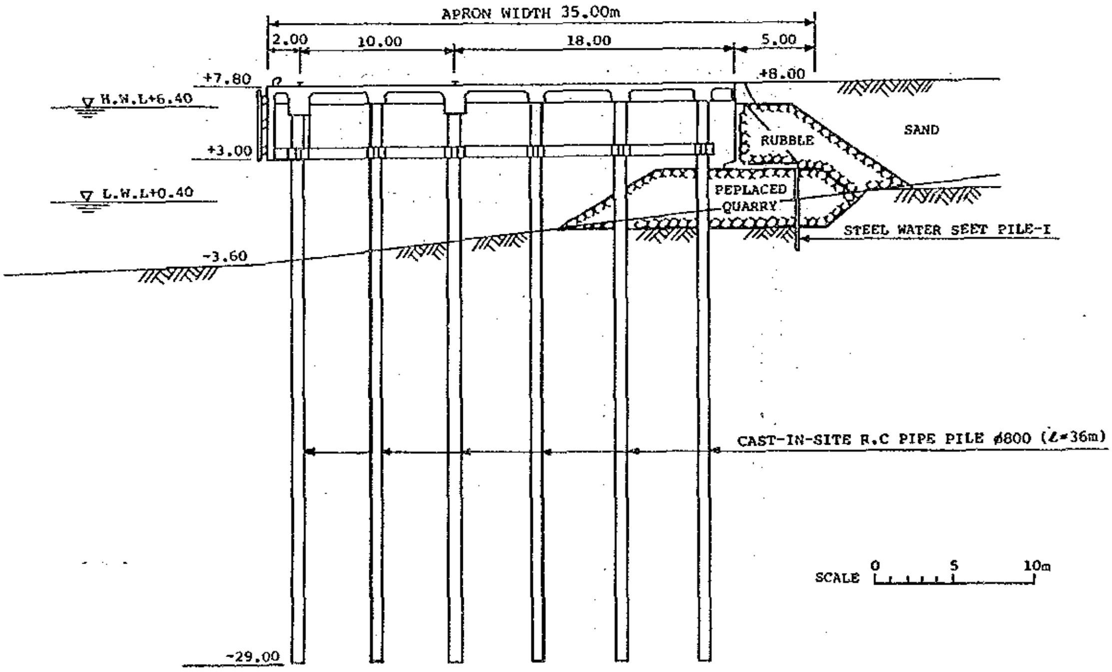


Fig. 12.2.5 CAST-IN-SITE R.C PIPE PILE

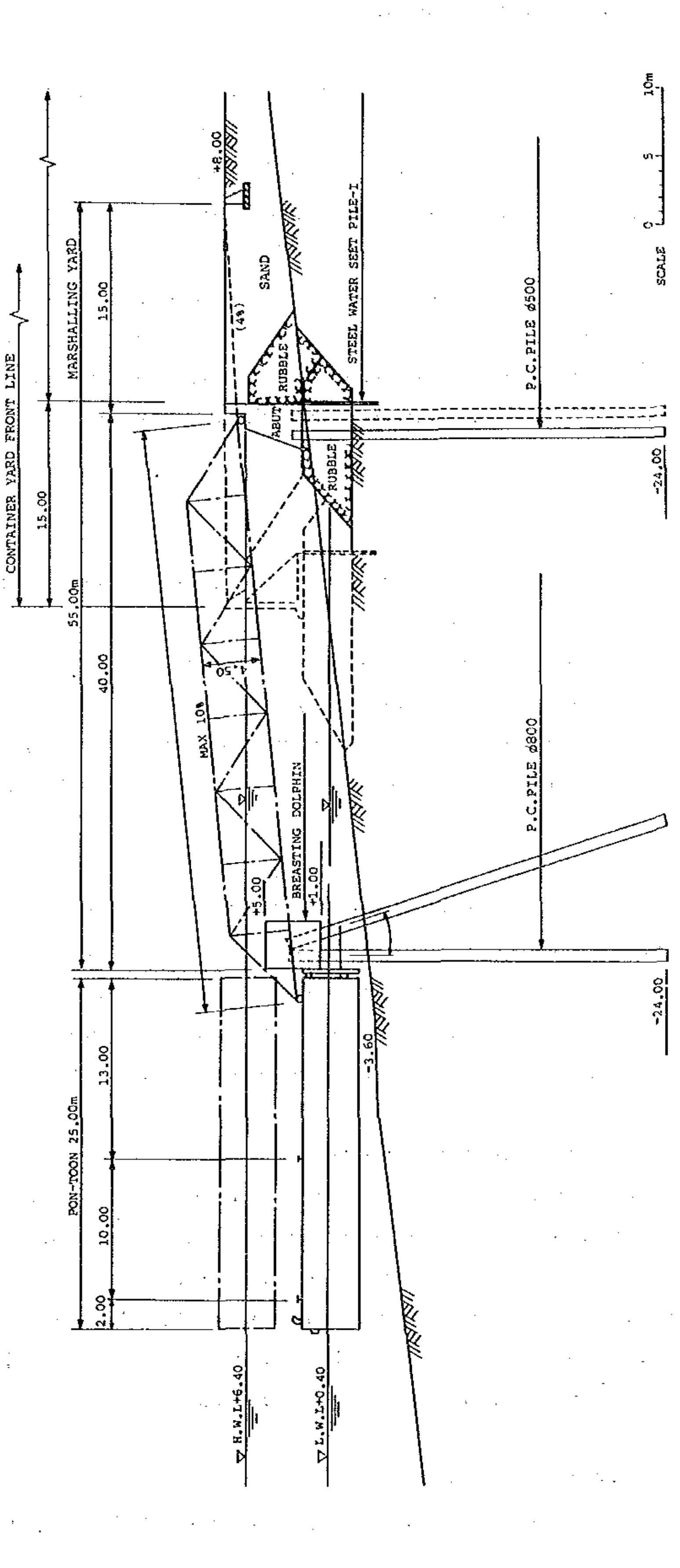


Fig. 12.2.6 PONTOON

12.2.3 Typical Cross Section of Pier Structure

The pier type is a more economical structure at a site where a relatively soft subsoil layer lies at a shallower depth. It is also advantageous in terms of structural mechanics in that it enables piles to absorb impact forces of berthing vessels or horizontal forces generated by an earthquake.

For selection of appropriate cross sectional form of the pier type in terms of economy and mechanical characteristics, it is of vital importance to undertake an in-depth study of the fender system and pile arrangement.

Given below are the results of the analysis of the fender system and pile arrangement.

(1) Fender System

A basic consideration in the choice of an optimum fender system is the type and shape of fenders with adequate capacity to absorb berthing energy of the design ship and their appropriate arrangement.

In the present design, the type and capacity of fenders have been evaluated in terms of coping with the maximum design ship size 3,800 tons which can eventually be expected to be accommodated by the new container berth.

1) Structure of Fenders

A common fender type used at quays where the design water level fluctuates by as much as about 6 m is the pile type using rubber fenders as cushions. This fender type is very useful when vessels come alongside the berth at right angles, but is often structurally difficult to absorb the berthing energy of vessels in case of their approach to the quay at an angle.

For the purpose of the present design, the fender type incorporating a steel protector has been selected instead of the pile type as a result of careful analysis of draft changes and water level fluctuation during loading and unloading of ships alongside the quay.

The design makes provision for installing fenders vertically over a range of +3.0 to +7.0 m as a result of in-depth analysis of the possibility of collision of the ship board with the quay.

2) Assumption of Berthing Energy of Vessels

The berthing energy of vessels increases in proportion to the square of their berthing speed.

Fig.12.2.7 illustrates the relationships between the berthing speed and berthing energy with respect to the three types of design vessel: type A (2,200 displacement tons), type B (2,550 displacement tons) and type C (3,800 displacement tons). The effective berthing energy indicated in Fig. 12.2.7 is the energy at a tangent point equivalent to a quarter of the ship length as calculated on the assumption that ships considered in the design will often perform berthing and unberthing under their own power instead of being aided by harbor tugboats.

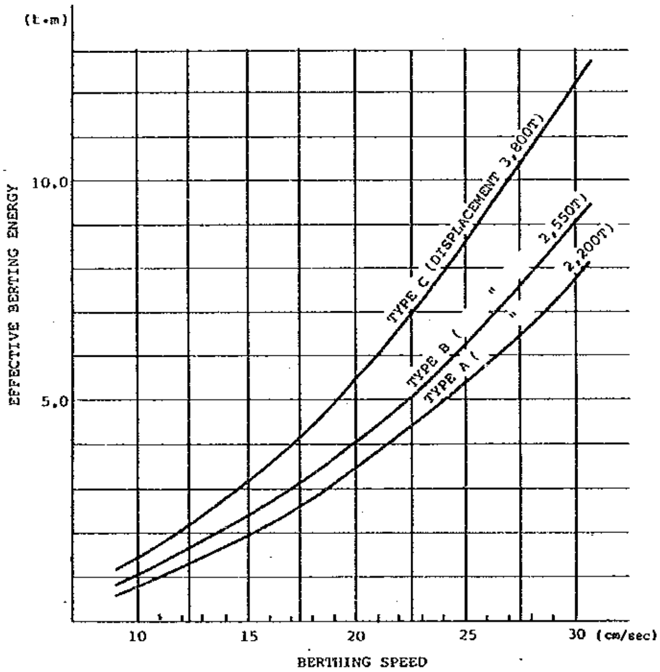


Fig. 12.2.7 Correlation between Berthing Speed and Berthing Energy

Berthing of the maximum design ship size of 3,800 displacement tons was taken into full consideration in determining the design berthing energy a Key factor in structural stability calculations. In consequence, a design berthing energy of 6.0 tm was taken.

3) Type of Fenders

There are a wide variety of fender types available for absorption of berthing energy: Circular, H-shaped, V-shaped, etc. Theses have their respective characteristics curves.

For our design purposes, however, the V-shaped fender has been chosen because of its higher energy absorption efficiency. On the basis of the size of protectors to be fitted vertically to the fenders and the fender characteristics curve, the design makes provision for the arrangement of three V-400H fenders in each location along the quay structure to be protected against the impact force generated by berthing.

The design reaction of 45 tons per point is obtained on the basis of the maximum reaction of the V-400H fender in relation to the design berthing energy of 6.0 tm.

(2) Size of Pier Blocks and Pile Arrangement

The rigidity of each pier block in relation to design external forces tends to increase with increasing block size. However, the block length should be moderate in terms of available concreting capacity, prevention of cracks due to uneven settlement of foundations or temperature differences, and other factors. For large quay structures, the standard block length is generally 20 to 30 m.

With respect to spacing of piles and pile rows, it is normal practice to determine the spacing with the sectional form of piles, loading conditions, and economic factors taken into full consideration.

Generally, pile spacings are often restricted by rail gauges of cargo handling equipment. However, the preferable pile spacing is said to be 4 to 6 m in terms of the ease of concrete placement.

In this project, it is considered desirable from the standpoint of structural mechanics and more specifically in terms of distribution of horizontal forces to divide the quay structure into two blocks. thus a pile spacing of 5.0 m is considered appropriate as can be seen from Fig. 12.2.8.

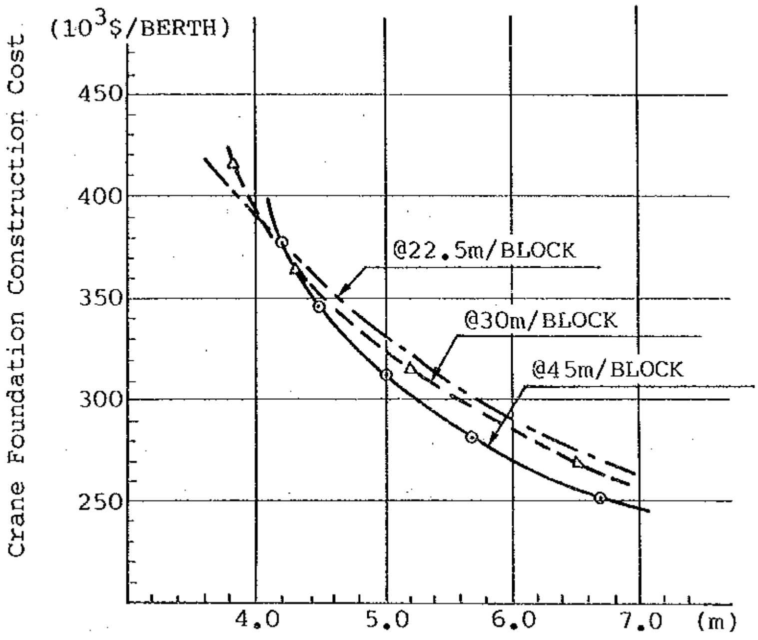


Fig. 12.2.8 Relationship between crane foundation pile spacings and construction cost with the number of blocks per berth taken as a parameter.

Note : Calculations were made assuming the block spacings to be equal and the use of steel pipe piles ϕ 800 x 14.

Fig. 12.2.8 illustrates the relationship between the pile spacings and construction cost with the pier length assumed to be 90 m.
In the figure, the downward trend of the cost tends to be accelerated when the pile spacing exceeds 5.5 m.
In the case of the 90 m pier divided into two blocks each block measures 45 m long, and no major problem is expected in working out approximate estimates of the construction cost. At the stage of detailed design, however, it is desirable to re-examine the division of the quay structure into blocks in terms of fender arrangement.

(3) Stress at Pile Section

Analysis of stresses at pile section was undertaken with respect to two cases : Case 1 where the crane foundation and the apron area behind are considered to be separate blocks perpendicular to the quay structure; and Case 2 where the two separate blocks are considered a continuous structure. Fig. 12.2.9 illustrates the results of the stress analysis.

In Case 1 of Fig. 12.2.9, stresses generated at the foundation piles of ϕ 700 x 12 and ϕ 500 x 12 combined are in excess of the allowable values both in normal situations and in times of earthquake. In Case 2, on the other hand. the stress analysis demonstrates the soundness of the pile section in terms of structural mechanics. however, the pile out displacement of 45 mm or over takes place during earthquakes and this definitely is a negative factor.

Thus the combination of foundation piles of ϕ 800 x 14 and ϕ 600 x 12 has been chosen for the proposed pier structure.

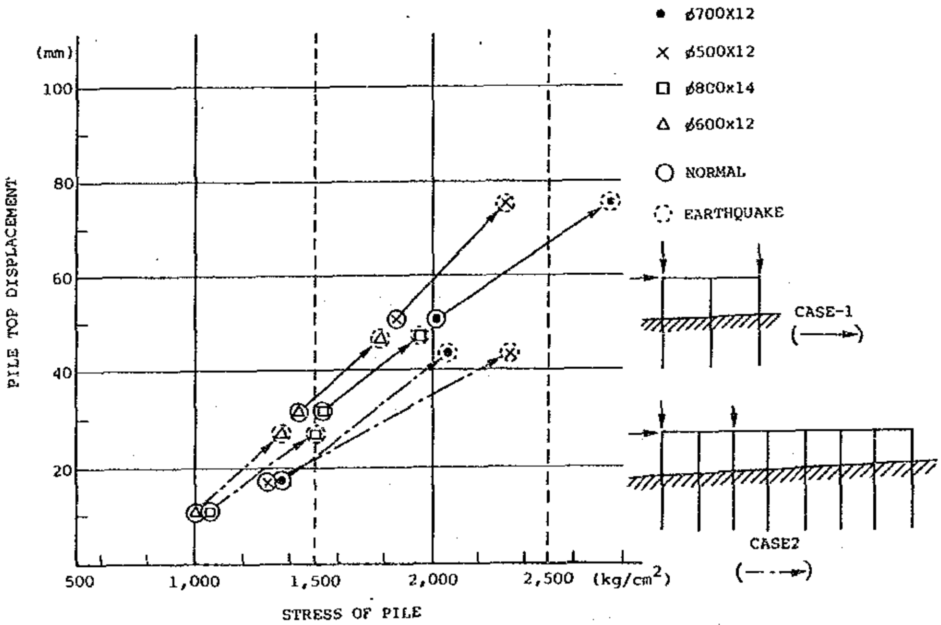


Fig. 12.2.9 Pile top displacement and stress due to variations in pier structure

(4) Typical Cross Section of Pier Structure

Figs 12.2.10(1) to 12.2.10(3) illustrate the typical cross section of the pier structure as the principal quay of the new container terminal.

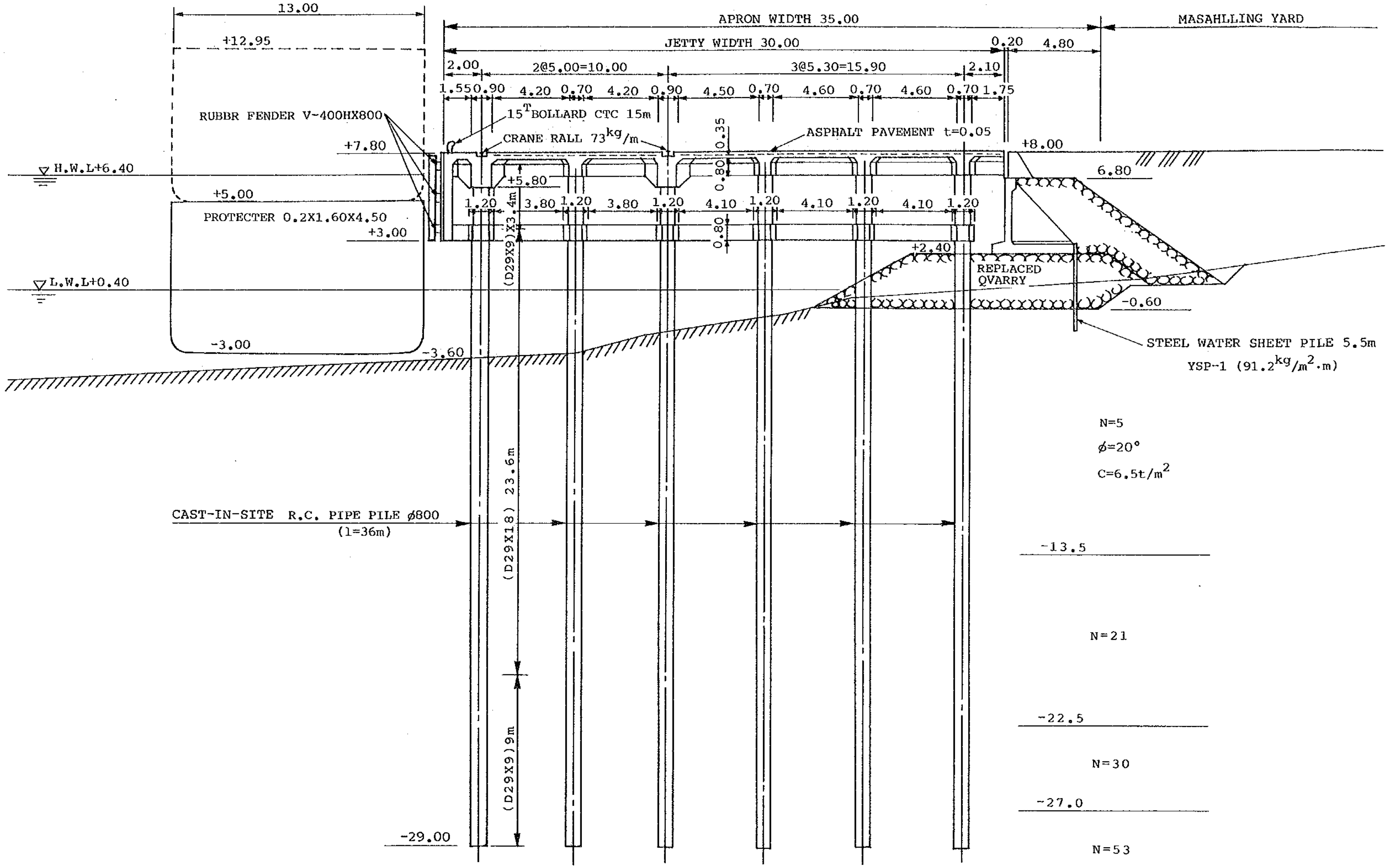


Fig. 12.2.10(1) Typical Cross Section of Open Type Wharf with Vertical Piles

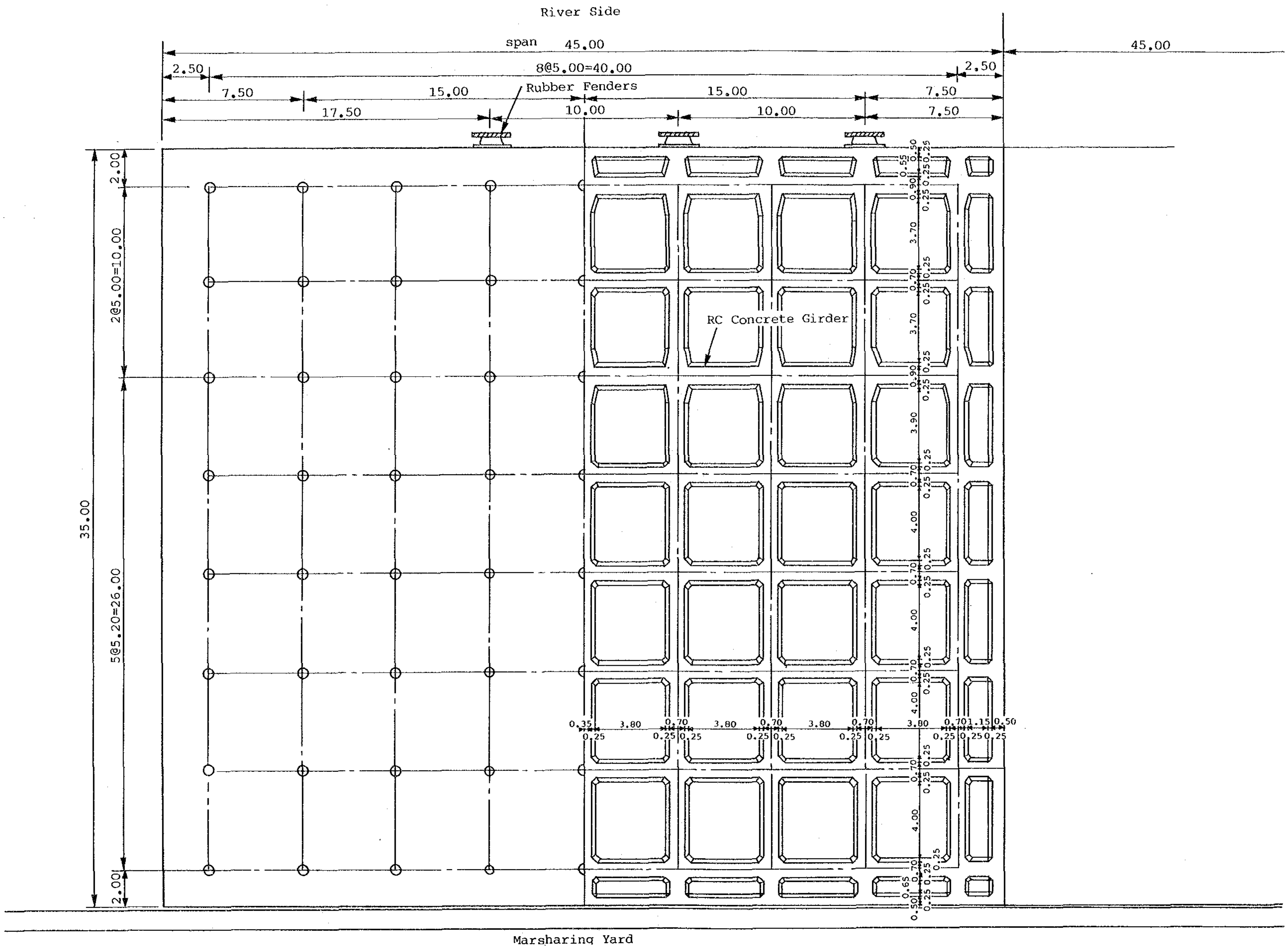


Fig. 12.2.10(2) Layout of Open-Type Wharf

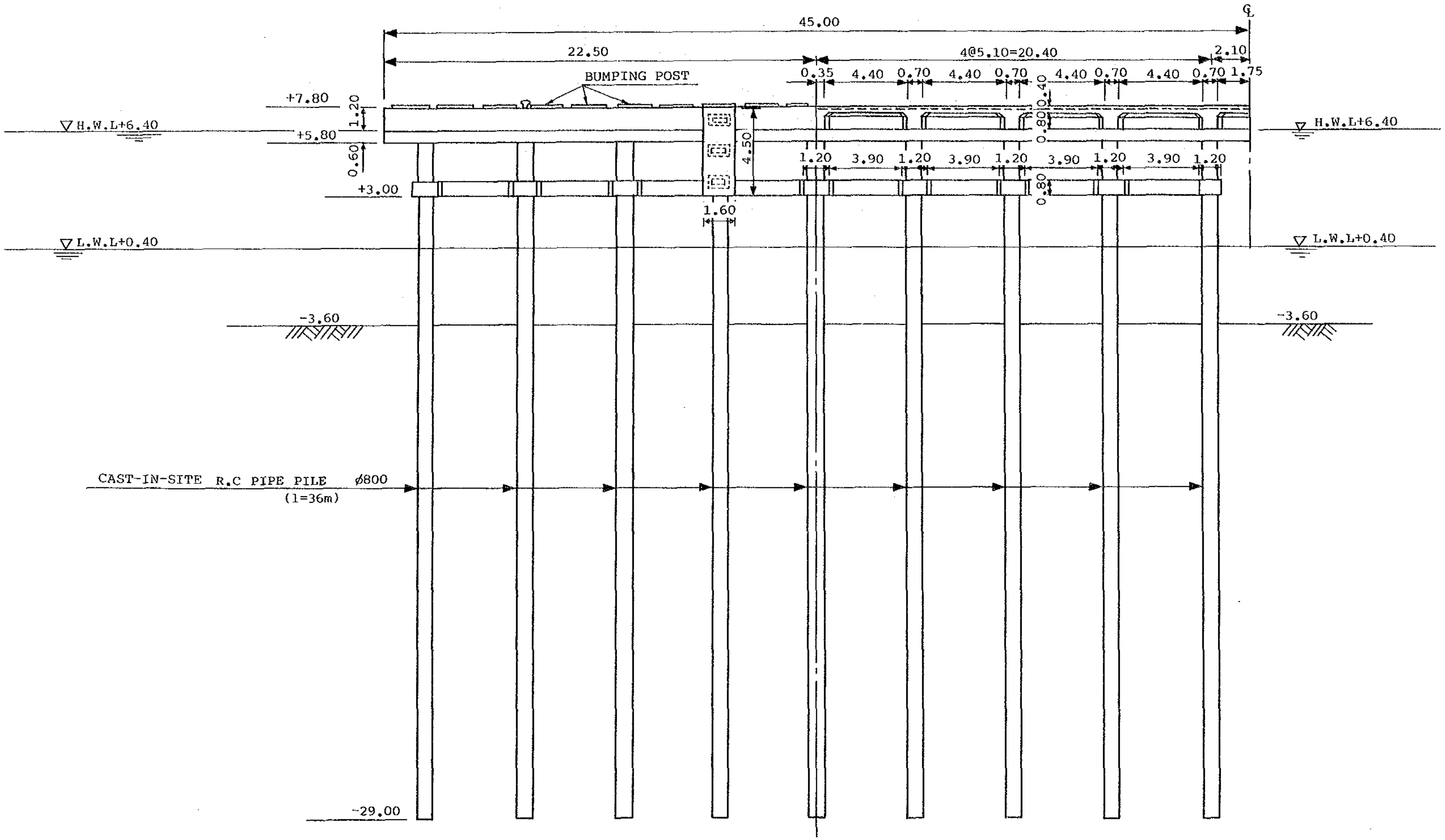


Fig. 12.2.10(3) Typical Front View of Open Type Wharf

12.3 Design of Other Terminal Facilities

12.3.1 Pavement of Marshalling Yard

There are four major systems of container handling at the marshalling yard: Straddle carrier, transfer crane, forklift, and chassis systems.

the superimposed loads at the yard vary depending on the container handling equipment used and the number of tiers in which containers are stacked.

It is normal practice to proceed to the design of marshalling yard pavement after the selection of container handing equipment to be employed. For our design purposes, however, a structural type easy to maintain has been selected for the yard pavement with particular attention paid to the possibility of uneven settlement of the foundation subsoils. Fig. 12.3.1 shows the typical cross section of the selected structural type of the pavement.

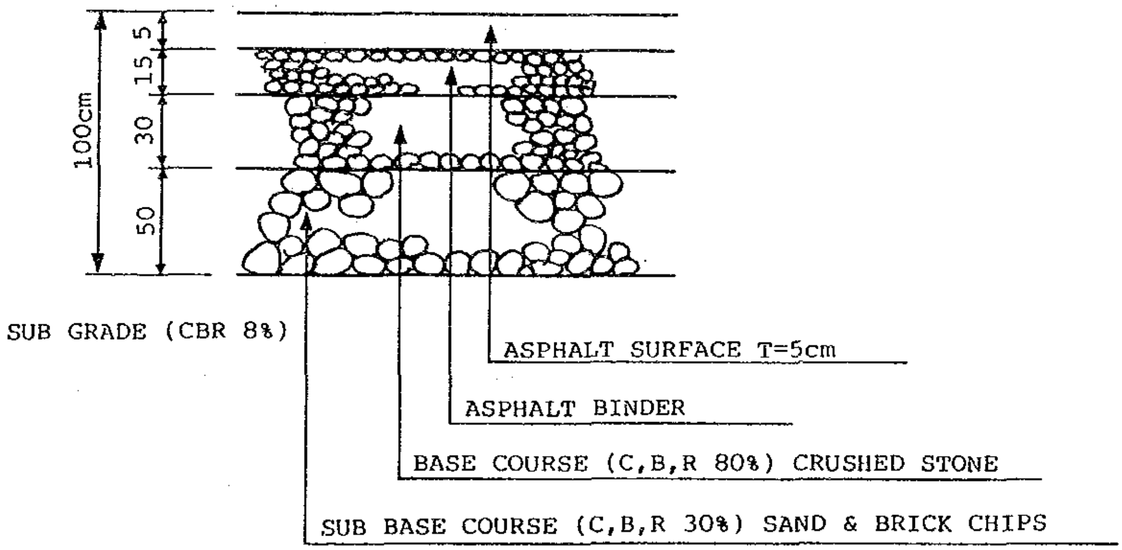


Fig. 12.3.1 Cross section of Yard Pavement

12.3.2 Container Freight Station

It is planned that two container freight stations with a total floor space of 8,300 m^2 will be built in the new terminal.

There are a wide variety of structural types available for CFS. From the standpoint of actual utilization of CFS, the shell structure and truss structure are in wide use because these structural types permit provision of wide internal spaces.

The present design provides for a truss structure because of its relative ease of construction. Fig. 12.3.2 illustrates a typical cross section of truss structure selected for the two planned container freight stations.

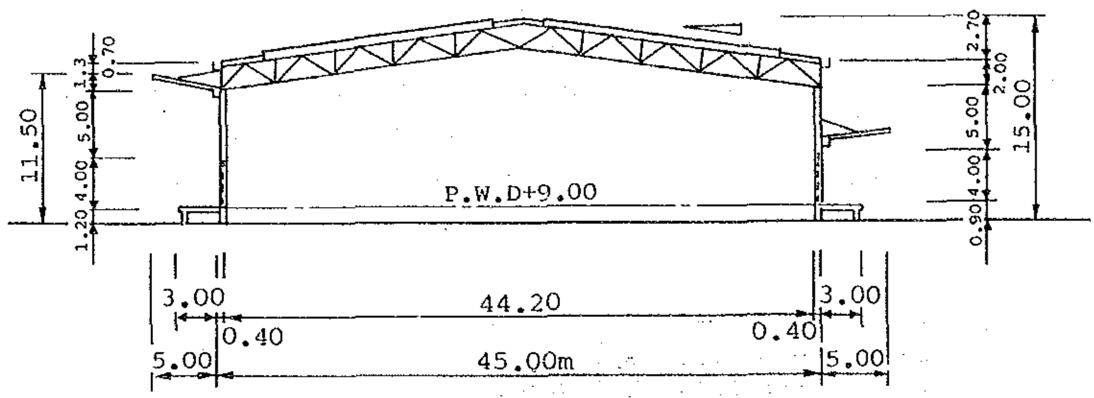


Fig. 12.3.2 Typical Cross Section of CFS

12.3.3 Functional Facilities

The proposed container terminal will require functional facilities for its efficient operation. These include an administration office building, repair and maintenance shop for containers and handling equipment, container gates with weigh bridges, drainage system, internal and access roads, oil and water supply installation, power supply facilities and lighting installations.

The structural designs of the functional facilities are outlined below:

(1) Administration Building

The administration building will house the nerve center of the container terminal which will perform such centralized functions as planning of container loading unloading, stacking and storage, planning of CFS operations and control of container handling equipment.

A control tower will be built on the top floor of the building to make sure that loading and unloading of container ships and operations in the container stacking area are performed as planned.

The building will be a three-story reinforced concrete structure with external walls built largely of bricks.

(2) Maintenance Workshop

The workshop will be dedicated to repairs, servicing and maintenance of gantry cranes transfer cranes, straddle carriers, forklifts, chassis, trailers, trucks and other similar vehicles as well as containers.

The workshop will be a steel-framed building with a floor area of 1,000 m^2 and incorporating large quantities of corrugated sheets in the external walls and roofs.

(3) Container Gate

The container gate will perform important functions, including checking incoming and outgoing containers, weighing arriving containers, receiving and giving necessary documents and assigning slots for container parking.

The gate will be provided with gate houses, inspection catwalks and two weigh bridges, each capable of measuring up to 50 tons.

(4) Fences

The container terminal will be fenced off to keep off trespassers and prevent loss of goods in storage due to theft. The fences will be 2.5 high and made of bricks.

(5) Drainage

In the container stacking area, reinforced concrete collecting conduits 0.6 m wide and 0.8 m deep, will be arranged perpendicular to the quay line at 50 m spacings and provided with a ϕ 600 mm inlet spaced 50 m apart. The conduits will incorporate bricks in large quantities.

(6) Internal and Access Roads

Pavements for the internal roads of the container terminal (except the stacking area and back yard) and the access road linking the terminal with nearby national highways will have the same structural cross section and thickness of 675 mm as the national highways.

(7) Oil, Water and Electric Power Supply Facilities and Lighting Installation and Fire Fighting Measures

These functional facilities will be provided in such a way as to meet the actual conditions of the alternative sites at PAGLA and PANGAON, whichever will be finally selected for the container terminal construction.

12.4 Reclaimed Land Plan (Urgent Plan)

The alternative land use plan of the reclaimed land under the Urgent Development Plan up to 1995 is shown in Fig 12-4-1.

Accordingly to the soil investigation at the site, the dredged material from the riverbed of the Briganga River can be used for the reclamation project, but only certain granular soils are suitable for this purpose. Silt and clays are generally much more difficult to use.

For the purpose of reclamation, great advantages in dredging works have been made in recent years in Bangladesh ,as well as neighbouring countries and various type and capacity of dredgers currently are used.

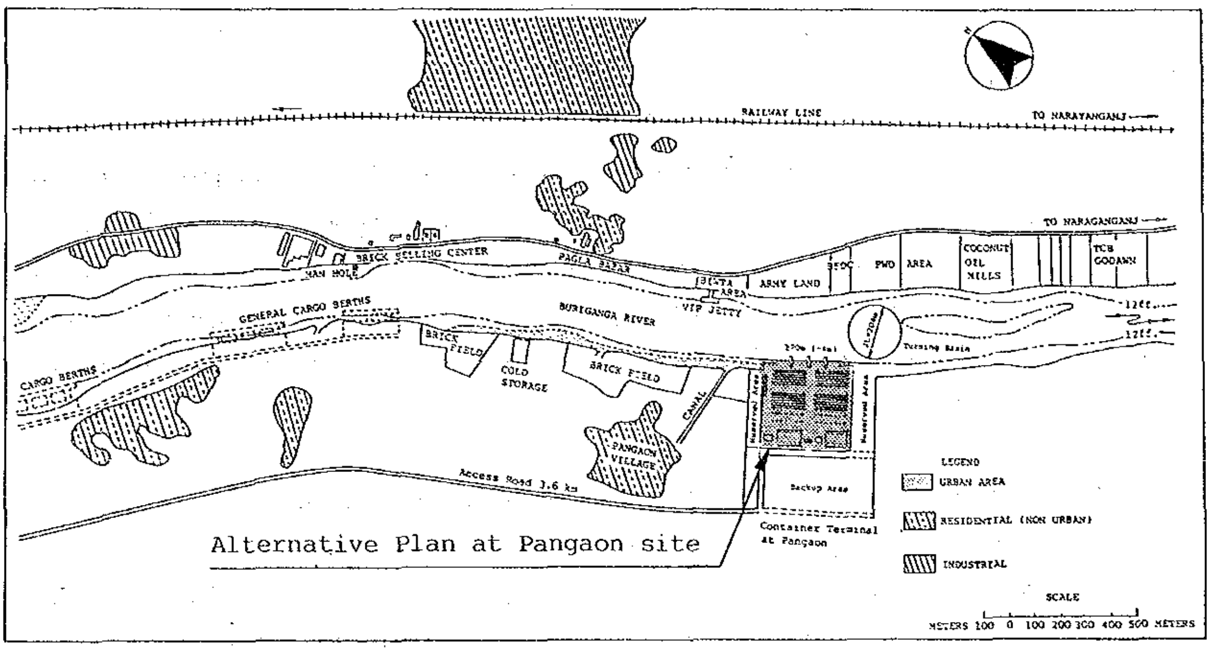
The settlement behavior of the fill materials by suction pump dredger should be carefully analysed and monitored before structure constructions permitted.

A pre-loading and sand compaction method may be needed to achieve settlement within a reasonable period buildings and roads are constructed. Consolidation or compaction of a hydraulic fill is an essential step in the transformation of the soil from a slurry, or water/soil heterogeneous mixture, to a competent load-bearing structure suitable for its intended use.

Compaction is the process whereby the soil particles are constrained, by rolling or other means, to pack more closely together, thus increasing the dry density of the soil.

On the other hand, consolidation is the process whereby soil particles are packed more closely together by the application of continued pressure over a period of time. Both processes help to reduce settlement of the soil under load, if they have occurred before the application of load to the soil.

Sand hydraulic fill with a small silt fraction will compact naturally in a few hours as drainage occurs.



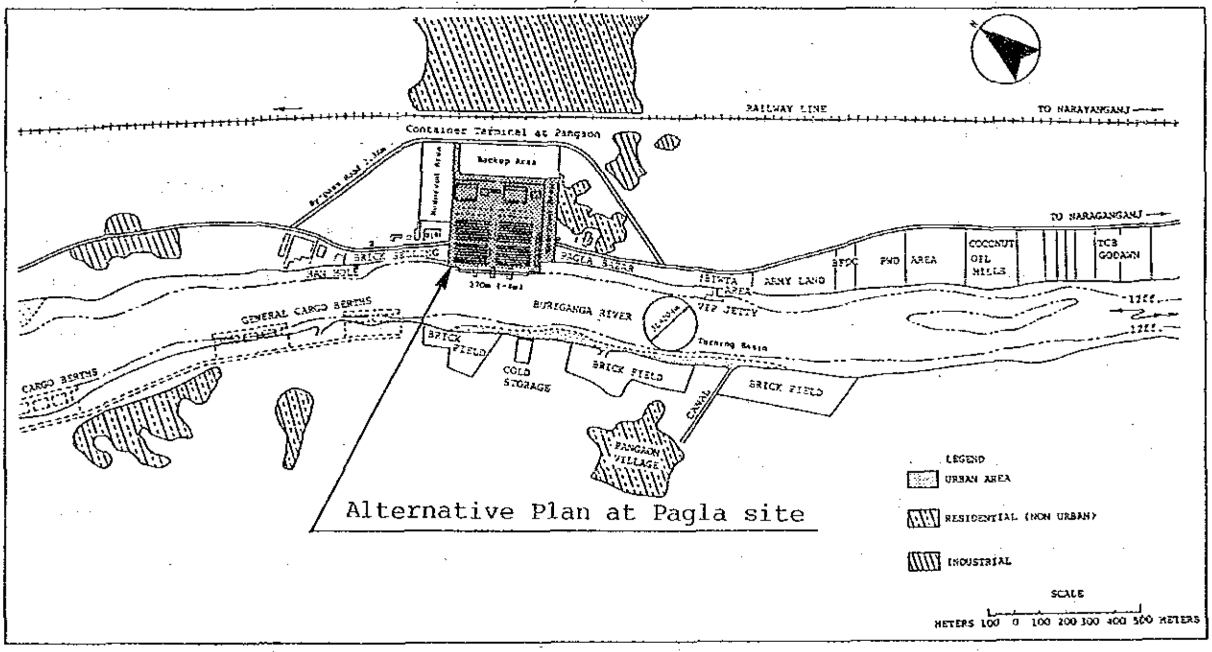


Fig. 12-4-1 Reclaimed Land Plan (Urgent Plan)

12.5 Container Handling Equipment

12.5.1 General

The container handling system and capability of the equipment are to be planned as a total system based on the assumed number of containers to be handled, considering seasonal variations. It is essential that each piece of equipment can perform at the capacity specified without interferring with each other and that the system deliver the overall designed throughput capacity.

The system is divided into the following three categories:

1) Movement of containers between the vessel and the apron.
2) Movement of containers between the apron and the marshalling yard.
3) vanning or de-vanning cargoes in container in the container freight station (CFS)

12.5.2 Equipment between the Vessel and the Apron

The equipment is the most important element in the container terminal, because the berth occupancy time of the vessel has a direct relation to the capacity of loading and unloading of containers with this equipment.

In the study, container vessels are designed as lift on/lift off system in order to accommodate as many containers as possible within the limits of the ships' dimensions. The following cranes are considered for this purpose:

(1) Gantry crane mounted on rails

All major container terminals in the world are equipped with gantry cranes at their berths. Each gantry crane may handle containers of 20 units or more per hour.

The spreader, which is remotely operated from the operator's cabin, is equipped with four vertical handling wires through guide rollers provided at each corner. The container is grasped with the spreader and can be lifted or lowered along the cell guides in the hold. The container can be handled safely and smoothly without swinging.

Principal particulars of the gantry crane are ss follows.

Type of crane	semi-rope trolley, hinged boom type		
Type of container	ISO 1A (40'), 1SO 1C (20')		
Type of spreader	20'/40' quick changeable telescopic spreader		
Dimensions	span of rails		10m
	outreach from the river side rail		16m
	approach		3m
	wheel base		16m
	lift above the top rail		13m
	below the top of rail		8m
	total		21m
Speed	main hoist		20 m/min
	trolly traverse		47 m/min
	gantry travel		26 m/min
	highed boom derricking		7 min/one way

(2) Mobile crane mounted on caterpillar tread

The manual operated spreader is hanged with four oblique wires caught by one hook. Consequently, a container can be easily inclined or turned while being lifted or lowered. There is a possibility that the container may stick in the cell guides while it is being handled. Adjustment work of the spreader to the container, and catch on/off work to the container are done manually, which is very dangerous for the workers.

The movement of containers between the vessel and the apron consists of three motions, that is, lifting, turning and lowering. Due to the turning motion of the crane, a swinging motion of the container is unavoidable.

Due to the reasons mentioned above, the mobile crane is used for container handling works for vessels having no cell guides in the hold, and several workers are allocated to carry out manual work. The number of containers that can be handled with the crane is about 10 units or more per hour.

In this study, the new feeder vessels are designed with cell guide in their holds to reduce the need to lash the containers and to reduce cargo handling time, so study of this crane is excluded from the project.

12.5.3 Equipment between the Apron and Marshalling Yard

The following system are considered.

1) Straddle carrier system
2) Transfer crane system
3) Forklift system
4) Chassis system

(1) Straddle carrier system

A straddle carrier system (S.C) is a self powered machine which extending over the container.

In this system, the containers unloaded from the vessel are directly left on the apron. After that, they are lifted with S.C. and are transferred up to the prescribed slot in the yard, where they are stacked up into three tiers. On the occasion of handling over of the containers, they are transferred with the S.C. up to the switching point where the tractor for inland transportation is waiting, and at that point they are loaded on the tractor.

The handling procedure is reversed in the case of exportation.

This system has the following advantages.

1) Since the S.C. has a high mobility, its disposition can be freely changed in order to cope with the daily fluctuation - peaks and bottoms of the cargo volume - at the terminal.
2) Compared with other system, the initial cost required by this system is relatively small.
3) Efficiency of the gantry crane can be kept high when the containers are unloaded from the vessel.

On the other hand, this system has the following disadvantages.

1) Although a wide range of improvement on the straddle carrier has been made compared with the initial phase one, considerable cost and time in addition to the need for skilled mechanics are required for the maintenance.
2) It is necessary to provide a heavy pavement over the entire yard surface because of the weight of the straddle carrier and load which must move around on it.

3) There are inconvenience regarding the range of vision from the driver's cabin, and the operator is required to be very skilled.

(2) Transfer crane system

A transfer crane (T.C.) is a large portal-shaped crane which stacks containers in multiple tiers, by extending over various rows containers.

There are two type of T.C. in respect of wheels, that is those which travel on rails and those which travel on rubber type wheels. The T.C. travelling on rails are large sized extended over nine or more rows of container and are able to stack container up to five tiers or more but they need an extremely large investment at the initial stage. Accordingly, in this study, the rubbler tire mounted T.C. is deemed suitable for this terminal.

This type of T.C. normally conprises 6 rows of containers inside the portal, in addition to one lane for tractor travelling.

The T.C. is able to move back and forth while handling the containers, the conveyance of the containers between the apron and the marshalling yard is carried out by the yard tractor head and chassis.

The T.C. system has the following advantages:

1) In the T.C. system, spaces among the rows of container can be reduced and the containers can be stacked in a large number of layers compared with othe system. Consequently, the availability of land area is high.
2) Since the T.C. moves only in an indicated place in a given direction, the safety of workers is good and application of automatic control is easy.
   Also, the area needing heavy pavement for the travelling of the T.C. is limited and the rest of the area needs only a light pavement.
3) Cost of maintenance is low and repair time is short compared with other system.

On the other hand, the T.C. system has the following disadvantages:

1) The T.C. is suited to work continuously in the same place, but it is difficult to increase the capacity to cope with occasional fluctuations in the pace of work.

2) The T.C. system does not present sufficient adaptability and flexibility with regard to the future working spaces, because only the travelling routes of the crane have heavy pavement.
3) The substitution of equipment is difficult in case of trouble.

(3) Forklift system

A forklift system consists of a forklift and chassis, that is, the conveyance of the containers between the apron and the marshalling yard is carried out by the yard tractor head and chassis, and stacking containers at the prescribed slot to three tiers is done by the forklift.

Since the containers are lifted up or down by means by the four forks inserted into bottom of the container, the ratio of damaged container is high. Consequently, the forklifts are used only for handling empty containers in the major terminals, at present.

Recently, a forklift with top spreader in lieu of two forks at the lower edge, has been developed and so the damage ratio of containers has improved.

This system has the following advantages:

1) Since the forklift has a high mobility and flexibility of movement, its ability to cope with daily fluctuations in term of peaks and bottoms of the cargo volume, is high.
2) The level of investment needed by this system is relatively small compared with other systems.

On the other hand, this system has the following disadvantages.

1) The availability of land area is low compared with S.C. or T.C. system, because wide spaces should be kept between every two or four rows of container in the yard for operation of the forklift.
2) The damage ratio of containers is high as mentioned before.
3) The driver is required to be skilled, but the safety of workers in the yard is low.
4) Heavy pavement over the entire yard surface is needed because the print pressure of the wheels is extremely high.
5) The cost maintenance is high.

(4) Chassis system

A chassis is a type of trailer which containers can be loaded onto. When the chassis is not coupled with the tractor it is parked by lowering the landing gear located at its front side. When the chassis is coupled with the tractor, it travels by retracting up the landing gear.

In this system the containers are arranged in the yard loaded on the chassis, instead of placing them directly on the container yard.

The chassis system advantages are as follows:

1) Auxiliary cargo handling equipment is not required, and this is the best system for door-to-door transportation of containers.
2) The risk of damage to containers is low because of the simple movements of containers.
3) The containers are always stored in one tier on the chassis, and so their movement in the yard can be carried out promptly.
4) A relatively light pavement in the yard is sufficient.

On the other hand, the chassis system has the following disadvantages.

1) All chassis are arranged in such a way to be accessible by the tractor and the container is loaded in one tiers on the chassis. The area efficiency of the yard is extremely low compared with other systems, therefore a huge land area is needed.
2) As many chassis as the number of containers to be handled in the yard are required, which means the cost of investments is very high.
3) There is no problem if one terminal is used by one shipping company, but when it is used by several shipping companies, the chassis provided by them will be mixed, and this could result in trouble.

(5) Comparison of each system

Each system has its own advantages and disadvantages as mentioned above. To select the system, the following items should be taken into consideration an essential element.

o The volume of containers throughput the yard
o The condition of the site, such as the available area and natural conditions.

o The size of container feeder vessel

o The cost of investment

A comparison of each system regarding each element is shown in Table 12.5.1.

Table 12.5.1 Comparison of Each System

	S.C.	T.C.	Forklift	Chassis
Required marshalling yard area	medium	small	rather large	huge
Do. Index on the project	38	31	64	100
Cost of investment	low	medium	low	high
Balance to the capacity of gantry crane	excellent	good	good	good
Efficiency of works	medium	medium	low	high
Flexibility of works	high	low	medium	high
Damage ratio of containers	low	low	high	very low
Maintenance fee & repair time	high	medium	high	low
Application of automation	medium	easy	medium	medium

12.5.4 Equipment in the CFS

1 - 3 ton forklifts are used for vanning or de-vanning work of the cargoes in the container.

The number of forklifts is decided depending on the volume of cargo handled there.

12.6 Construction Plan

12.6.1 Condition for Construction Work

The proposed sites for the container terminal construction project are located at Pangaon and Pagla villages on either side of Buriganga River. It seems that wave height is less than 0.4 metre, generated by strong winds only. Precipitation between November and March is very small (100m/month). Rainfall from June to August exceeds 300m per month. Accordingly, during the rainy season, it will be difficult to work smoothly at the site. On the other hand, during the dry season, from November to March, conditions favoring construction works at the site prevail.

The riverbed soil around the proposed site is grey loose siltly fine sand and will be useful material for land reclamation.

As for the procurement of materials and machinery in Bangladesh, locally available materials include sand crushed stoned, brick, cement, reinforced bars and L-shaped steel.

Common construction machinery such as bulldozers, dump trucks, motor graders and concrete mixing plants may be available. However this machinery will be not in good condition for the operation, and major construction equipment such as a pile driving barge for the batter pile and a large floating crane will be brought from neighboring countries. A list of heavy equipment & vehicles that may be available in Dhaka is shown in Table 12-6-1. A list of the B.I.W.T.A. Dredgers is shown in Table 12-6-2.

12-6-2 Construction Method

(1) Preparation and temporary facilities

The preparation and temporary facilities will include procurement of construction materials and construction equipment, survey of construction of temporary pier, road and buildings as well as setting up electricity and water supplies.

Preliminary preparation shall be done at the start of construction. It will include securing materials, equipment and manpower, supply routes for materials and equipment and transporting these items.

A temporary road will be used for transportation between the existing road and the storage yard for materials and machinery to the actual construction site.

Table 12-6-1 List of Heavy Equipment and Vehicles

as of Feb, 1990

Name of Equi't		Type & Capacity	Quantity
1	Bulldozer	CAT-D5B (Japan) 105 h.p	9
2	Tyre Dozer	CAT-814 (U.S.A) 210 h.p	2
3	Scraper	CAT-613 (U.S.A) 150 h.p	2
4	Compactor	CAT-815 (U.S.A) 210 h.p	2
5	Tyre Compactor	(U.S.S.R) 35 ton	1
6	Excavator	CAT-215 (Belgium) 1.25 Cu.yd	2
7	Pay-Loader	CAT 1.25 Cu.yd	4
8	Hydraulic Ladder Carrier	Mitsubishi (Japan) 28 ft	8
9	Mobile Generator	(Japan) 5.0 KVA	1
10	Mobile Generator	(U.S.A) 3.3 KVA	1
11	Power Trailer	(U.S.S.R) 30 ton	1
12	Tyre Finishing	(Japan) 8 wheel	2
13	Diesel Dump Truck	Mitsubishi Tilting Type 5 ton	4
14	Petrol Dump Truck	(U.S.S.R) 5 ton	6
15	Paver Machine	(U.S.S.R/U.K) 30 ton	2
16	Tractor	240 Massy Fargoson (Japan) 45 h.p	1
17	Mini Asphalt Plant	(Japan) 1.5 ton	1
18	Asphalt Plant	(U.S.S.R) 30 ton	1
19	Asphalt Plant	(Poland) 20 ton	1
20	Mixture Machine	3.3 cu.yd	6
21	Road Roller	(Denmark/U.S.S.R/Japan) 3-10 ton	28
22	Light Transport	Car, Jeep, Toyota, Mazda, etc.	33
23	Diesel Trucks	Mitsubishi (Japan) 5 ton	58
24	Ditto	Bedford (U.K) 5 ton	10
25	Ditto	Mitsubishi (Japan) 3 ton	48
26	Ditto	Isuzu (Japan) 3 ton	20
27	Diesel Mini Truck	Mitsubishi (Japan) 1.5 ton	25
28	Others		

Table 12-6-2 List of BIWTA Dredgers

as of Feb, 1990

Name of Vessels	Type	Capacity of Engine (hp)	Max-Dredging Depth (m)	Max-Dredging Width (m)
1 KHANAK	Diesel	850	11.0	32.0
2 DELT-I	Diesel	1165	14.0	35.0
3 DELT-II	Diesel	1165	14.0	30.0
4 D-135	Diesel	1100	9.0	30.0
5 D-136	Diesel	1200	9.0	30.0
6 D-137	Diesel	1200	13.0	35.0
7 D-138	Diesel	1200	13.0	35.0
8 D-139	Diesel	1200	13.0	35.0

c.f) Ancillary crafts of the BIWTA are shown in Appendix 12.

The temporary buildings will include a storage building for housing material of CFS and machinery, site offices for the engineer and worker's quarters and any other facilities required for the smooth execution of the construction.

Construction activities concerning machinery, electricity and water include the erection of a Concrete Plant and an Asphalt Plant as well as facilities for bringing electricity form a power substation in the vicinity of the construction site. These shall include all necessary preparation for commencement of construction works such as mobilization of construction equipment & machinery, procurement of materials & labour, installation of offices, camps, warehouses, storage space and workshops and investigation of quarries and borrow areas., etc.

(2) Land Reclamation

Almost all of the proposed sites will be submerged in the water during the rainy season. Land reclamation, therefore, shall be carried out in the entire proposed container yard including temporary facilities such as dikes and embankments for construction up to the designed level by the cutter suction dredger or similar equipment.

Regarding the land reclamation work, it should be done prior to commencement of mooring facilities, or before driving the steel pipe piles. Enough time shall be allowed for further study.

(3) Construction of Mooring Facilities

Mooring facilities consist of a pier and an apron. The steel materials needed for these facilities will be shipped from abroad and the facilities will be fabricated locally.

The foundation piles such as steel pipe piles will be designed as bearing piles for the pier. Therefore, the penetration length shall be kept to a designed length. The steel pipe piles must be as long as possible. Peir construction work such as connecting girders and steel pipe piles, fixing of steel-bars and placing of concrete, etc., shall be performed according to normal procedures.

(4) Construction of Container Stacking Area

After the site has been leveled and graded, the stacking yard and marshalling yard within the premises will be paved. The base course of the yards may be prepared using crushed stones and bricks produced locally.

(5) Container Freight Station (CFS)

The floor of the CFS will be approximately 1.2 meters above ground level to allow easy transfer of commodities to and from containers. The steel materials needed for the steel frames will be imported, worked on locally and assembled to create a roof truss. These trusses will be installed with truck cranes after completion of the concrete pillars. The concrete pillars and the truss will be secured with bolts.

(6) Other Construction

Other construction will include building, control office, gates, truck counter, lighting, fences, water supply, drainage and sewerage, etc. These works will be executed according to normal procedures on the basis of technical regulations and specifications.

12.6.3 Project Implementation Schedule

(1) Construction Schedule of Facilities for Container Terminal

The project schedule is as follows:

1) Completion of feasibility study on the project .... March 1991
2) Period of detailed design & documentation for tender ...... 9 months
   Completion of tender .... Dec 1992
3) Period of financial settlement for construction .... 4 months
   Completion of financial settlement .... Dec 1992
4) Commencement of construction for the short term plan ...... Jan 1993
5) Survey, soil investigation at the site .... 3 months
6) Removal of existing obstacles & inhabitants ....by the end of 1992
7) Construction period of land reclamation, wharf & pier ..... 12 months
8) Completion of the container terminal project .... Dec 1995

Based on the above project schedule, the study team estimates the construction schedule of the project as follows:

Commencement of the short term plan .... Jan 1993
Construction period .... 36 months
Completion of construction .... Dec 1995

(2) Installation of Gantry Crane

1) Transportation of Gantry Crane from Japan
   i) Selection of Transportation route
   ii) Suitable seasons for transportation of Gantry Crane
   iii) Type and capacity of equipment for transportation
   iv) Required time for transportation from Japan
2) Installation for Gantry Crane
   i) Suitable timing for installation of Gantry Crane
   ii) Type and capacity of equipment for installation
   iii) Installation Method
3) Import of handling equipment such as Transfer Crane, Transtainer, Straddle Carrier, Chassis, Fork-lift trucks, Trailer, etc.

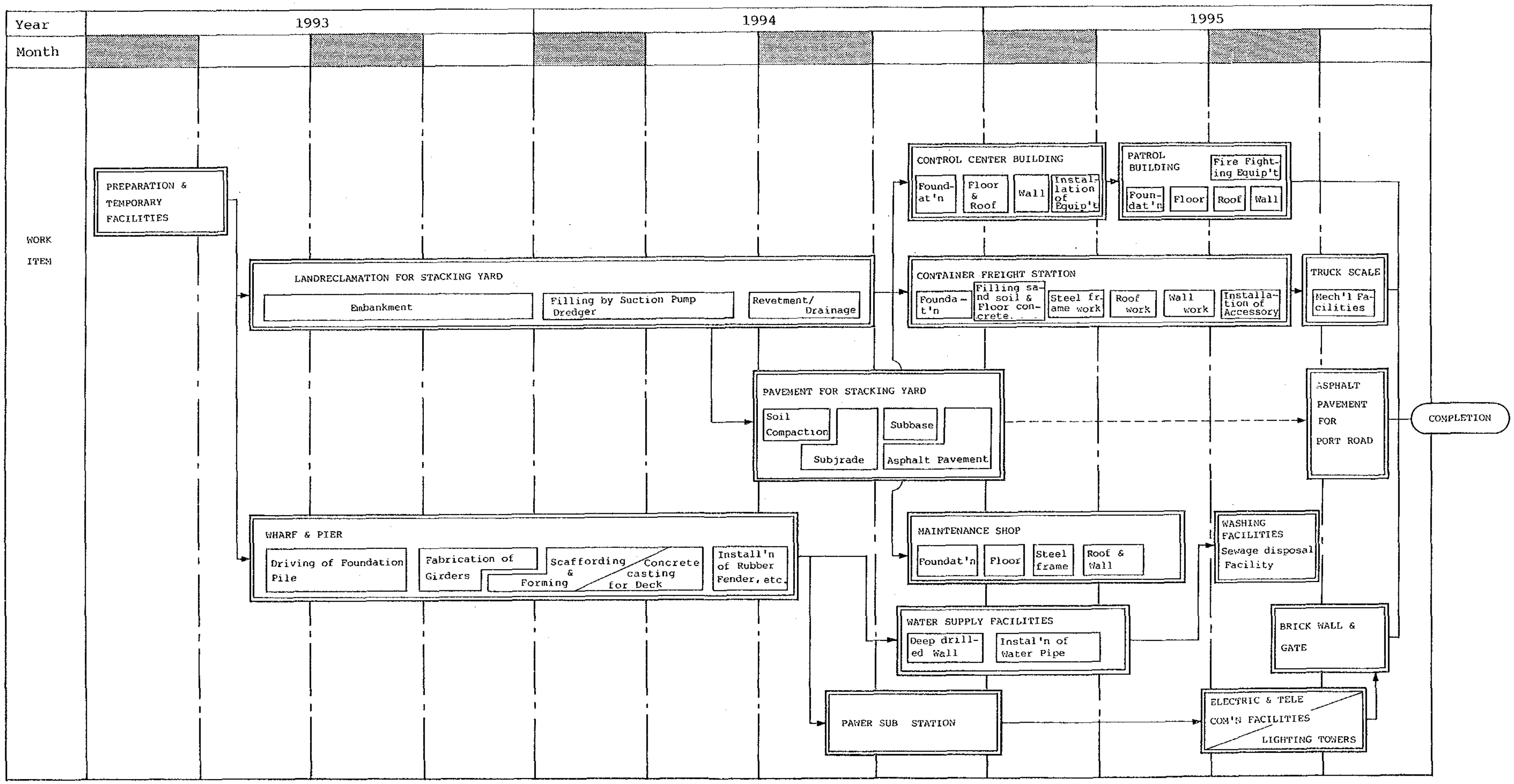


Fig. 12.6.1 Construction Flow of Container Terminal Facilities

12.7 Cost Estimate

12.7.1 Condition of Cost Estimate

(1) Natural Condition for Construction

The annual rainfall of Bangladesh ranges between 1,040mm to 4,840mm. The average rainfall is 2,240mm per year at Dhaka. Wind velocity is generally less than 10m/sec and wave height is almost negligible at the sites.

(2) Construction Materials

Cement will be available from the local Chattack Cement Factory, located Chattack Sylhet, and the Chittagong Kilinker Cement Factory, located at Patenga of Chittagong, these produce portland cement in 50kg-bags. Both factories are operated by the government of Bangladesh.

Steel Materials are supplied from a local steel company, Chittagong Steel Mill (Owned by the Bangladesh Government) located at Hali Shahar Chittagong. It produces M.S. rods, plain sheets, C.I. sheets, flat bars, angles, Z bars, deformed bars., etc. The Dhaka Steel Mill, located at Tongi, Gazipur, produces M.S. rods, flat bars, deformed bars., etc.

Boulders can be obtained from the Sylhet district; Bholagong Stone Boulders and Shingle from Bholagong; Shingle from Sunamgonj; and Peagravel from Fazilpur.

Distance from Dhaka to Resources of Boulders is approximately 340 miles on the waterways.

Sand and filling soil are available in the Dhaka and Comilla districts.

The laboratory test center is located at Mohakhali, Dhaka.

(3) Construction Equipment & Machinery

Standard-sized construction equipment such as road equipments as well as suction pump dredgers (see Appendix) are available at the site.

A list of locally procured construction equipment and vehicles is shown in Table 12-6-2 and 12-6-2.

Special construction equipment such as a pile driving barge with accessories will be procured abroad.

(4) Labour Force for Construction Works

Common Labourers are available at any time, but slingers, high-gradesailors, divers and special technicians will be brought in from aboard.

(5) Social Conditions

The number of normal working days per year is 298 days.

The normal working hours of every day for business men is as follows;

Saturday to Wednesday

Beginning time : 09:00 hrs

Rest time : 13:00 hrs to 14:00 hrs

Finishing time : 17:00 hrs

Thursday

Beginning time : 09:00 hrs

Finishing time : 14:00 hrs (without Rest)

Friday

Rest

12.7.2 Cost Estimate Factors

Construction costs estimated carefully on the basis of preliminary design, construction methods and work schedule of the project, and after a comprehensive study of site conditions such as land utilization, conditions of construction equipment and machinery, materials that must be taken to the site and the appropriate method of construction, etc.

The cost estimate is further affected by the following conditions;

(1) The cost is estimated on the condition that the work of construction will be carried out in accordance with international tender regulations.

(2) The unit prices of labor, materials, equipment and machinery, etc., are calculated on the basis of market prices in local and CIF prices at Dhaka Port of imported goods in August 1990.
Basic labor cost per day is shown in Table 12-7-1, unit costs of materials are shown in Table 12-7-2 and hire charges of road construction machines & equipments are shown in Table 12-7-3.

Table 12-7-1 Basic Labour Cost per Day

Unit Cost of Local Labour Unit: Taka/8 hour per day

Kind of Work		Direct Cost (Taka)	Indirect Cost (Taka)	Total (Taka)
1	Foreman	300.00	75.00	375.00
2	Carpenter	200.00	50.00	250.00
3	Concrete Finisher	200.00	50.00	250.00
4	Steel Fixer	200.00	50.00	250.00
5	Labour	80.00	20.00	100.00
6	Plant Operator	300.00	75.00	375.00
7	Driver	250.00	62.50	312.50
8	Plaumber	200.00	50.00	250.00
9	Scaffolder	200.00	50.00	250.00
10	Piling Crew	200.00	50.00	250.00
11	Banksman	200.00	50.00	250.00
12	Captain	200.00	75.00	375.00
12	Sailor	200.00	50.00	250.00

Source : BIWTA

Unit Cost of Foreign Labour Unit: ¥/8 hour per day

Kind of Work		Direct Cost (¥)	Remarks
1	Special Labour	36,000	Overseas Allowance included
2	Slinger	36,700	ditto
3	Electrician	36,100	ditto
4	High Grade Sailor	40,400	ditto
5	Diver	58,000	ditto

Source : Kensetsu Bukka, June 1990

Table 12-7-2 Unit cost of main materials

NO	Name / Type	Unit	Foreign (¥)	Local(Taka)	Country
1	H-Shaped Steel	T	74,000		Japan
2	Small Steel Bar@16-25mm	T	57,000	22,000	J/L
3	Deformed Bar D19-25mm	T	57,000		Local
4	Thick Steel Plate	T	67,000		Local
5	Angle iron with same frang	T	61,000		Local
6	Crane rail 73kg/m	T	100,000		Japan
7	Timber sheet pile	C.M	34,000		Japan
8	Timber(Ceder, Pine)	C.M	53,000		Japan
9	Cement(Portland)	T		4,300.0	Local
10	Imported Cement	T		4,400.0	Indonesia
11	Imported Cement	T	12,000		Japan
12	Sand 2.5FM	C.M		900.	Local
13	Stone chips	C.M		1,350.0	Local
14	Boulder or Cobble	C.M		2,000.0	Local
15	Brick	thou			Local
16	Brick chips	C.M		950.0	Local
17	Heavy oil(Diesel)	L		9.20	Local
18	Light oil(Diesel)	L		9.20	Local
19	Petrol	L		9.20	Local
20	Straight Asphalt p-60-100	T	34,000	12,000.00	Singapore
21	Electric power	KW			Local
22	Aneal Steel Bar #8	T	91,000		Japan
23	Concrete admixture	ℓ	360		Japan
24	Rubber Fender (400H x 800L)	No	390,000		Japan
25	Mooring post	No		10,000	Local
26	Rerolled steel	T		20,000	Local
27	Paint for protection	kg	250		Japan
28	Galvanized steel pipe for water supply	nos	2,024		Japan
29	Hard vinyl chloride pipe	nos	1,200		Japan
30	Electrical copper plate	kg	470		Japan
31	Lead pipe for water supply	kg	280		Japan
32	Fill materials	C.M		50.0	Local

*Duties/Taxes and Transportation cost of foreign portions are excluded.

Table 12-7-3 Hire Charges of Municipal Road Construction Machines & Equipment

Unit : Taka

No	Name of Machine	Type & Capacity	Hire Charge Rates
1	Pay Loader	CAT-920 (Japan) 80 h.p	3,147*1.2
2	Bulldozer	CAT-D-5B 105 h.p (Japan)	3,139*1.2
3	Compactor	CAT-815 (U.S.A) 210 h.p	6,132*1.2
4	Excavator	CAT-215 (Belgium) 90 h.p	7,774*1.2
5	Scrapar	CAT-613 (U.S.A) 150 h.p	7,774*1.2
6	Wheel Dozer	CAT-814 (U.S.A) 210 h.p	3,123*1.2
7	Paver Machine	(U.S.S.R/U.K)	4,868:1.2
8	Dumper (Patrol)	(U.S.S.R) 5 ton	2,349*1.2
9	Dumper (Diesel)	(Japan) 5 ton	1,344*1.2
10	Bitumen Distributor	(U.S.S.R) 5 ton	1,320*1.2
11	Water Tank (Diesel)		2,063*1.2
12	Tyre Finisher	(Japan)	1,510*1.2
13	Road Roller		1,390*1.2
14	Power Trailer	(U.S.S.R) 30 ton	1,514*1.2
15	Mixture Machine	3.3 cu.yd	575*1.2
16	Portable Generator	(U.S.A) 3.3KVA	347*1.2
17	Mobile Generator	(Japan)	806*1.2
18	Tractor	Massy Fargoson	1,000*1.2

Source : Dhaka Municipal Corp'n

cf) Hire Charges are without fuel, full day (8 hours) and including Allowance for Preliminary Cost Estimate

(3) The exchange rate of foreign currency is assumed as an average value in September 1990.

US$ 1.00 = Taka 34.06 = ¥ 140.50

(4) Construction costs are divided into foreign portion (indicated as ¥) and a local portion (indicated as Taka).

The foreign and local currency portions of the unit prices of construction are considered basically in accordance with the following categories:

<Breakdown of foreign portion>

* Imported construction equipment, imported materials, supplied goods
* Handling equipment and machinery
* Imported goods procured in the local market
* Salary allowance and indirect cost for foreign staff members

<Breakdown of local portion>

* Construction equipment and machinery procured locally
* Construction materials and Supplied goods procured locally
* Salary allowance and indirect cost for local labor
* Taxes/Duties

(5) The unit price of each aspect of the construction work consists of the cost of labor, materials and charges for construction machinery.

(6) Major materials are steel, cement, timber, stone for structures, aggregate for concrete, sand for fill, etc.,

(7) Taxes/Duties on the imported material and machinery are excluded from the cost estimate.

(8) The cost of land acquisition is estimated on the unit price indicated by the BIWTA in 1990.

(9) The rate of miscelleneous allowances including preparation costs like survey, stake, cleaning and servicing at sites separate from the direct work of construction, transportation for materials and equipment from abroad and bringing ships from abroad, management and

operation, safety and quality control are assumed as described in Table 12-7-4.

Table 12-7-4 Rate of Miscellaneous Allowance

Name of Facility	Mis-Allowance
1. Port & Harbour Facility	
1) Wharf, Revetment & Breakwater	24%
2) Dredging, Reclamation	22%
3) Road, Railway	20%
2. Building	40%
3. Navigation Aids	15%
4. Handling Equipments	15%

(10) The contingency is considered to be 10% of the combination of the total amount of direct construction costs and technical assistance fees. This excludes the inflation value of the market price for the materials during the period, considering only allowable errors by the physical aspects such as the accuracy of measurements.

(11) The cost of technical assistance is estimated at a rate of 10% against the direct construction cost and it is composed engineering cost for the detailed design and construction supervision of the project, including training cost abroad that engineers of the Government of Bangladesh will receive concerning engineering and technology of ports and harbors.

Cost of Detailed Design : 4%

Cost of Construction Supervision: 6%

(12) The factor of cost inflation and deflation during the construction period is excepted from the cost estimate.

CHAPTER 13 MANAGEMENT AND OPERATING SYSTEM OF THE CONTAINER TERMINAL

13.1 Basic Ideas Required for Management and Operations of Ports

There are common basic ideas required for management and operations of ports throughout the world. The basic ideas are as follows:

(1) Speed

In order to not only establish efficient utilization of port facilities and services but also minimize the cost of transportation through ports, speed in the operations of cargo and vessels is required. Quickly making changes in response to new circumstances and users' needs in ports is also required.

(2) Affordability

Port facilities and services must be supplied to port users as inexpensively as possible with efficient management and operations of ports.

(3) Reliability

Delivery/receiving or unloading/loading of cargo and arrival/departure of vessels must be carried out on time and correctly.

(4) Safety

Operations of cargo and vessels must be carried out in a safe manner.

Even if the above factors are given differing priorities, it is impossible to attract users to ports without all of them. They are especially important for container terminals, compared with other cargo terminals.

13.2 The Problems in Existing Management and Operations

In this section, we analyze the gaps between the existing management and operating system of the ports in Bangladesh and the four basic ideas mentioned above in order to establish the optimum management and operating system for the projected container terminal.

13.2.1 Common Problems to Inland River Ports, Seaports and ICD

(1) Lack of an Incentive for Employees to Work Hard in the Pay System

The pay systems of the BIWTA and the Port Authorities managing and operating these ports are prescribed in common by the Services Pay and Allowances Order, which decides the payment policy of public bodies and nationalized enterprises. This system is based mainly on the seniority system. Consequently, the will to work is not so high as that of private companies' staff and it is difficult to make the management and operations efficient and attractive for users compared with private companies.

(2) Employment System for the Laborers Unsuitable for Technical Innovation

The laborers working at the terminals, except the operators of the cargo handling equipment in the seaports and the ICD, are recruited on a day-labor basis. This system has the advantage of varying the number of laborers according to the cargo volume and is an economical system in this sense.

Under this system, however, it is difficult to improve laborers' skills. Consequently, this system is unsuitable for container operations requiring cooperative, technical, efficient and programmed operations. This system has another demerit in that neither the stevedoring companies nor the authorities can sufficiently direct and supervise the laborers since there is no direct status relationship between them.

(3) Small-Scale Private Stevedoring Companies Unsuitable for Container Operations

There are no private stevedoring companies handling containers with their own equipment, such as forklifts and straddle carriers, in the ports of Bangladesh. One of the reasons is that the Port Authorities prohibit them from operating such equipment in the ports. But it should also be taken into account that the scales of their finance are too small to allow them to introduce this equipment into their operations and that technical skills are too low to operate and maintain the equipment.

On the other hand, the Port Authorities allow private shipping companies to introduce and operate their own equipment in the ports when the Port Authorities cannot supply them with enough equipment to handle cargo.

(4) Insufficient Training System for Container Operations

There are no training courses or institutions for the staff managing and operating the ports at the organizations, except the CPA. Even in the CPA, there are no training courses for container operations or maintenance of the equipment requiring a high technical level and broad experience.

(5) Complicated Procedures and Documentation

We can find many inefficiencies in the procedures and documentation for cargo operations and vessels' arrival/departure in river ports, seaports and ICD. For example, the agents or owners of vessels and the consignees and shippers of cargo or their representatives are required to submit many documents to many different offices of the concerned organizations. Their formats and sizes are different and the proceedings are sometimes divided, depending on the staff in charge. These situations cause not only the users additional cost and time; the organizations in charge of management and operations of the ports also waste money and time in cargo operations and vessel control. Since container operations require swift and economical planning and practice of cargo handling and vessel control based on reliable and swift transfer of information, these problems are big obstacles to the smooth development of containerization in Bangladesh.

13.2.2 The Problems of the Inland River Ports

(1) Lack of an Incentive for Efficiency in the Financial System of the BIWTA

The BIWTA receives subsidies and loans from the government for management and operations as well as development and construction of the ports. The main reason for this situation is that the BIWTA does not have any commercial function. However, it should be noted that the system is inclined to prevent the organization from making any effort to streamline its management and operations or to develop new demand by improving the levels and contents of its services.

(2) System of Engaging Handling Contractors Unsuitable for Improvement of the Services

In the river ports, cargo handling is performed by a single stevedore contractor on each ghat. Cargo handling contracts for one year are given to them following an annual auction held by the BIWTA. The highest bidder is awarded the contract. In a sense, this system represents an advantage in terms of the finances of the BIWTA. However, this has also a demerit that this system prevents the contractors from making an effort to improve their services for the users since the port users cannot choose the contractors as they like. Consequently, this may reduce the attraction of the ports as a whole for the users.

(3) Inadequate Planning System of Berth Assignment and Cargo Operations

Since the procedures for berth assignment and cargo handling are sometimes inadequate for planning efficient utilization of port facilities and services in advance for the inland river ports, this system will be unsuitable for container operations in future.

(4) Inefficient Direct Delivery/Loading of Cargo

In the inland river ports, much cargo is directly delivered to consignees without being stored at storage facilities, such as warehouses and open yards, after being unloaded from vessels, and loaded to vessels without storage after being received from the shippers. In this system, when the consignees' trucks which are to receive the cargo unloaded from the vessels or the vessels which are to load the cargo received from the shippers do not arrive in time, the vessels transporting the cargo to be delivered to the consignees or the shippers' trucks transporting the cargo to be loaded to the vessels must wait for the arrival of the consignees' trucks or the loading vessels, respectively. This system makes cargo operations and vessel navigation not only inefficient but also costly, is not suitable for containers requiring efficient and economical operations.

(5) Dangerous and Unreasonable Working Areas

Since the inland river ports, with a few exceptions, do not have fences enclosing the port areas, people or vehicles can go freely in and out of the port areas. It should be noted that such a situation can make cargo operations dangerous or result in theft. This system will not be suitable for container operations carried out with huge cargo handling equipment.

(6) Inefficient System of Toll Collection

Most charges and tolls in the inland river ports are collected by toll collectors of the BIWTA each time facilities are used, in the ports in cash. This system can prevent missing the charges and toll from the port users, but needs many staff members and costs a lot.

13.2.3 The Problems of the Seaports

(1) Long Dwelling Time of Imported Containerized Cargo

The dwelling time of imported FCLs and LCLs stored at the storage facilities in the seaports, which exceeds 25 days, is very long compared with that of the main ports in the world. This situation not only causes the consignees additional cost and time for cargo transportation but also prevents efficient utilization of the facilities of the ports. There are many reasons for this, such as the long procedures required by Customs and the Port Authorities, and the lack of reliable and speedy communication of the relevant information, as mentioned above.

(2) Complicated Arrangement of Cargo Operations

In the seaports, the stevedoring companies in charge of handling cargo between vessels and wharves and at storage facilities are arranged by the agents/owners of the vessels and the Port Authorities or the owners of the cargo, respectively. The stowage plans and the stacking plans are prepared by the agents/owners of the vessels and the Port Authorities, respectively. This system, in which the arrangement and planning of cargo operations are carried out by various organizations, prevents the establishment of efficient and integrated operations. This also causes traffic accidents and robbery, loss or non-delivery of cargo.

(3) Inefficient Management of Container Stacking Yards

In the container stacking yards of Chittagong Port, there are some areas in which clear slot and row markings are not indicated. So it takes a long time for forklift operators to find containers in yards.

(4) Dangerous Stuffing/Stripping Operations at Container Stacking Yards

Stuffing/stripping cargo to and from containers is carried out in the container stacking yards in the seaports, partly due to a shortage of space in the CFS. These operations at the yards in which huge cargo handling vehicles, such as forklifts and straddle carriers, run around, are very dangerous.

13.2.4 The Problems of the ICD

Inadequate Number of Pieces Equipment and Shunting Engines

There is only one forklift handling containers and shunting engine marshaling wagons transporting containers, each in the ICD. This system offers no problems unless the cargo volume is so big that they do not have enough time to maintain and repair the equipment and engine. However, when the cargo volume increases and they do not have enough time to maintain and repair them, the functions of the ICD will stop.

13.3 The Basic Concept of the Management and Operating System of the Terminal

Table 13.1 Management and Operating Systems of the Main Container Terminals in Asia

Kind of Functions	Singapore	Colombo Culcatta	Yokohama (Public)	Kaoshun	Yokohama (Exclusive)	Hong Kong
Planning and Development	Port Authority	Port Authority Port Trust	Port Authority (Local Government) Private Stevedoring Companies (Cargo Handling Equipment except Gantry Cranes)	Port Authority (Central Government) Private Stevedoring Companies (Cargo Handling Equipment except Gantry Cranes)	Port Corporation Private Stevedoring Companies (Cargo Handling Equipment except Gantry Cranes)	Private Companies
Funds of Construction	Port Authority	Port Authority Port Trust Loans from the Central Government	Port Authority Loans & Subsidies from the Central Government Private Stevedoring Companies (Equipment)	Port Authority Loans & Subsidies from the Central Government Private Stevedoring Companies (Equipment)	Loans from the Local & Central Government Treasury Investment & Loans Loans from the Lessee	Private Funds
Public or Exclusive Use	Public Use (Preferential)	Public Use (Preferential)	Public Use (Preferential)	Berth Public Use (Preferential) CY/CFS Exclusive Use	Exclusive Use (Lease)	Exclusive Use (Lease)
Navigation Control	Port Authority	Port Authority Port Trust	Harbour Master	Port Authority	Harbour Master	Port Authority
Pilot & Tug Service	Port Autority	Port Authority Port Trust	Private Companies	Private Companies	Private Companies	Private Companies
Berth Assignment	Port Authority	Port Authority Port Trust	Port Authority	Port Authority	Lessees	Lessees
Cargo Handling	Port Authority	Port Authority Port Trust	Terminal Operators (Private Stevedoring Companies)	Terminal Operators (Private Stevedoring Companies)	Terminal Operators (Private Stevedoring Companies)	Terminal Operators (Private Stevedoring Companies)

The services of container waterway transport through this container terminal must confront severe competition from trucks and railways. Consequently, in order to obtain adequate cargo and to gain a position as one of the main modes of inland container transport, the establishment of the four basic ideas required for management and operations of ports is strongly urged to upgrade the management and operating system of the container terminal. The study of the basic concept has been carried out based on the analysis of the basic ideas and existing problems of the management and operations, and based on a comparative study of the management and operating system of the container terminals of the main ports in Asia.

13.3.1 The Management and Operating Systems of the Main Ports in Asia

There are various systems in terms of management and operation of container terminals in Asia, as shown in Table 13.1. The systems depend on many factors, such as the economic, labor and social policies, the scales of the ports, the national character, etc. No system is best for all the ports in the world.

The port that most strongly promotes privatization of management and operations of container terminals is Hong Kong. In Hong Kong Port, private companies develop, construct, manage and operate the port using their own funds and loans from private companies. On the other hand, in Singapore, Colombo and Culcatta Ports, the Port Authorities or the Port Trust, autonomous public organizations, develop, construct, manage and operate the ports using their funds and loans from the government or private companies.

13.3.2 The Study of the Possibility of Privatization

(1) The Advantages and Disadvantages of Privatization

The advantages of privatization are that the system requires complete efficiency, promptitude and originality under the absolute criterion of profit. On the other hand, the disadvantages of the public sector are that the system lacks an incentive to efficiency, promptitude and originality, due to the excessive interference of the government and subsidies or low-interest loans from the government.

The disadvantages of privatization are that the system may not be coordinated with the public interest and the economic policy of the government if individual interests are pursued too strongly. Private companies cannot receive subsidies and loans from the government and it is not expected that private companies operate their business in a non-commercial field.

(2) The Study of Possibility of Privatization by Field

1) Planning, Development and Construction of the Port

Since the development and construction of ports requires a large amount of funds and cooperation with the economic and transport policies of the government, the public sector (the government or the port authorities) plans, develops and constructs ports, except in the case of Hong Kong. As far as cargo handling equipment, except gantry cranes, is concerned, private stevedoring companies purchase them by themselves in the ports, except for Singapore, Colombo and Culcatta.

Taking into account the small financial resources of private companies and the necessity for cooperation with the development of ports and the government policies in Bangladesh, it is recommended that the public sector (for example the BIWTA) carry out these functions, including the purchase of cargo handling equipment, in the projected terminal.

If the BIWTA carries out these functions, it should be considered that the accounts of the container terminal will be separated from those of the BIWTA's other businesses in order to gain adequate funds for maintenance and re-investment of the facilities.

2) Management of Vessels' Navigation

Management of vessels' navigation in ports is carried out by the public sector (port authorities or harbour masters) in every port. This is why users of this service must receive equal treatment and this service is not expected to make a profit like a commercial business.

Pilot and tug services are supplied by private companies, except in Singapore, Colombo and Culcatta. The reason is that these require efficient operations and are expected to gain a big profit. These two services are carried out by the public sector, the BIWTA and the BIWTC, respectively, in Bangladesh. Since there are no big problems in the present system, it is acknowledged the services in the projected container port will be supplied by the present system.

3) Berth Assignment

The system of berth assignment depends mainly on whether the berth is managed according to a public-use or exclusive-use system. Which system is the best in the projected container terminal is analyzed in another section, 13.3.5.

4) Cargo Handling, Tallying and Related Documentation

These tasks are carried out by private stevedore and tally companies in all ports, except in Singapore, Colombo and Culcatta. The reason is that these tasks require the greatest efficiency and speed out of all the tasks performed at the ports. It is desirable that more than one private company should take part in the operations of the terminal, especially entire cargo operations including planning and related documentation work, taking into account the inefficiency of the public sector in Bangladesh.

However, there are no private companies handling cargo using their own equipment in the ports in Bangladesh. It may be difficult for the private sector to fulfill the work in the early stage of container operations at the projected terminal. When the private sector carries out these operations, financial support from the government and introduction of foreign advanced technology should be strongly urged for them.

13.3.3 Introduction of Competition System

As mentioned above, waterway transport through the projected container terminal must face severe competition from trucks and railways. In order to improve waterway transport's competitive position still more, it should be considered that a system in which a number of private companies compete with each other be introduced in the operations, such as cargo handling, at the port. It is necessary for port users to choose their favorite operators among those operating at the port in order to make the operators improve their services. No improvement of service for the users can be expected without competition.

When this system is adopted at the projected terminal, careful consideration must be given to efficient arrangement of companies in charge of the operations of the port to maintain efficient and safe operations by preventing cross-transportation of containers at the terminal.

13.3.4 Establishment of Combined-Responsibility System for the Port Users

All container operations in the port, such as planning, arrangement and practice of cargo handling and delivery/receiving, should be supplied on a combined-responsibility basis for the users, even if the operations are carried out by plural organizations in practice. All charges and dues of the port, such as berth occupancy, loading/unloading, demurrage and wharf rent, etc., should also be collected from the users by one organization. This is why the unification of the responsibility for the operations and collection of the charges and dues of the port is strongly required in order to promote efficiency and convenience of operations, not only for the operators themselves but also for the port users, such as the owners or their agents of vessels and cargo. Consequently, when all or a part of the operations in the port are carried out by private companies, an organization that takes on all responsibilities for operations and charges in the port, we will call it "a terminal operator", should be set up. The terminal operators will be incorporated by the organizations concerned, such as shipping and stevedoring companies and their agents, etc.

The terminal operators should be assigned berths in order to prevent congestion through cross-transportation of containers in the terminal. They should also consist of staff members and laborers hired on a long-term basis in order to establish the high-skilled and cooperative operations in the port.

13.3.5 Choosing Between Public and Exclusive Use of the Port Facilities

In the main ports of Asia, berths are mainly managed on a public-use system, "first comes, first served". On the other hand, container stacking yards and container freight stations operate mainly on an exclusive-use system. The reason seems to be that the management of berths and storage facilities are executed based on the principles of maximum utilization of port facilities and efficient and safe cargo handling, respectively.

The public-use system may contribute to equality of berth use among users and a high occupancy ratio of the facilities. However, under this system there will be congestion through cross-transportation of containers inside the port. This is caused by the difficulty in predicting the assigned berth beforehand and the necessity of assigning stacking space at least several days before vessels arrive in order to accept containers from shippers.

Preventing this disadvantage, a preferential system has been adopted by almost all public container terminals in Asia. In this system, some constant users are assigned a certain berth and a near-by yard before vessels come to the port and consequently the terminal operator may stack this vessels' containers at a convenient place in advance and ensure steady loading/unloading of containers. Another advantage of this system for shipping companies is less waiting time for berthing. The terminal operator would gain some privilege, such as a guarantee of substantial throughput from shipping companies.

On the other hand, in an exclusive-use system, the same berth and the same yard will always be assigned to shipping companies for convenience of operations. The advantages are less waiting time for berthing and efficient and safe operations in the terminal, while the disadvantage will be low occupancy ratio of the berths. However, one way of counteracting this disadvantage is for users, when their berths are vacant, to mutually lease their berths to others in order to decrease waiting time for berthing at exclusive-use container terminals in Asia.

Consequently, there are no big differences between the public and exclusive use systems in terms of utilization of the facilities and cargo operations. However, there are two differences between them in terms of management of facilities and charges and dues. Most of the world's exclusive-use terminals are leased to lessees, shipping companies or terminal operators, on a long-term basis, such as for five to ten years. The charges and dues of exclusive-use terminals are collected on a throughput basis from the users by the lessees. Almost all charges and dues, such as berth occupancy, loading/unloading charges and wharf rent, except demurrage, are joined together in a charge, that is a throughput charge. These systems are effective not only in securing the lessors' business but also in saving costs and time required for collecting and paying the charges. The outline of lease system is shown in Fig. 13.3.1.

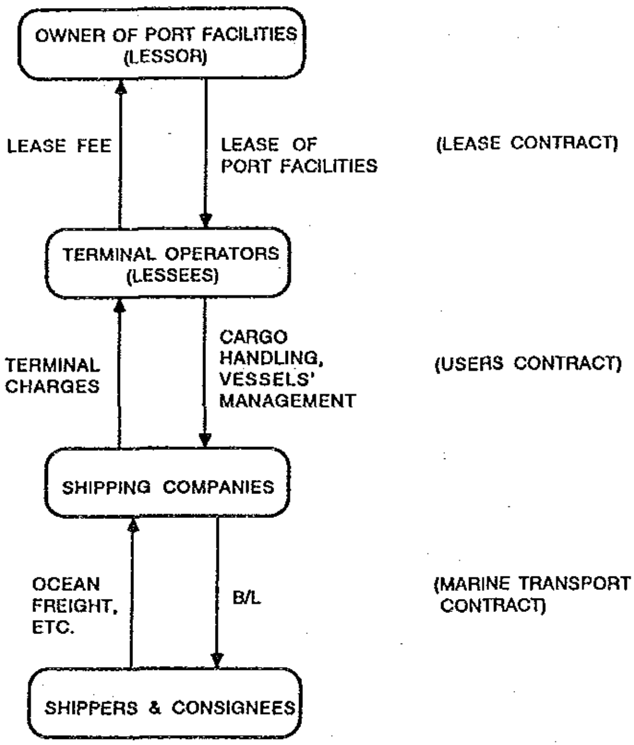


Fig. 13.3.1 LEASE SYSTEM

It is difficult to choose between a public and an exclusive-use system for the management of the berths and other facilities of the projected port. Taking into account the projected cargo volume and the number of berts, however, an exclusive-use and lease system can be seen as saving costs and time for the management of the port for both the lessors and lessees. In the early stage, the term of lease should be short until the business of the lessee becomes stable.

13.3.6 The Border of the Responsibility for Maintenance and Repairs

In a public-use system, maintenance and repair of facilities in the port is carried out by the supplier, except for when the responsibilities clearly lie with others. In an exclusive-use and lease system, daily maintenance and small repairs should be carried out by the lessee to give them a sense of responsibility for use of the facilities.

13.3.7 Simplification and Efficiency of the Procedures and Documentation

In order to prevent not only long demurrage of cargo but also inefficient management and operations in the port, it should be recommended that the procedures for vessels' arrival/departure and cargo operations be simplified and the formats and sizes of the documents be common among the concerned organizations as much as possible. Manuals for documentation should be prepared in order to prevent confusion.

After giving careful consideration to simplification and efficiency of the procedures and documentation, introduction of computers into the management and operations of the terminal will be studied.

From the historical view of the degree and extent of computerization, when annual throughput of containers at a terminal exceeds approximately 60 thousand TEUs, a part of terminal office operations, such as accounting and statistics, is computerized with a small system. When the throughput exceeds approximately 120 thousand TEUs, almost all terminal office operations, including gate control, various planning of cargo handling, etc., are computerized. Since this system consists of an on-line processing series dealing with a large volume of information, an investment of more than a million dollars is necessary.

13.3.8 Training System and Foreign Experts

In order to make up for the lack of expertise in management, operations, maintenance and repairs of the port, it will be necessary to establish a training system for the staff and laborers and to employ foreign experts, especially during the early stages.

13.3.9 Tariff System

The tariff system of the port should be decided taking into account the competition from the other modes(trucks and railways), the costs required for the construction/maintenance and the management/operations of the port and the users' ability to bear costs. Careful consideration should also be given to simplification of the structure and collection methods of the charges and dues in order to save the costs and time required for their calculation and collection.

JICA