11. Scale of Medium Term Port Development

11.1 Container Terminal

11.1.1 Design Vessel

Major shipping lines and Alliances are striving to remain competitive in the global market by building numbers of larger sized vessels, especially at the main routes such as Asia-North America (Trans Pacific) and Asia-Europe. Some container carriers operational in mid 2009 have already exceeded 14,500 TEU. However, when considering the geographical location of Lach Huyen Port, it is unlikely that mother vessels on Asia-Europe service routes with very tight schedules will call the Lach Huyen Port. However, it is very likely that mother vessels on Asia – North America routes will call the Lach Huyen Port by the following reasons:

(1) In accordance with the study report of the University of Mexico in 2001 regarding the economy of scale of container vessels, it is said that the shipping cost of container per TEU which is transported by 7,000TEU (90,000DWT) vessel will be 70% of that of by 4,000TEU (50,000DWT) vessels.

(2) In order to enjoy the economy of scale, the world container fleets are increasing its size year by year. In 2006, the maximum container vessel in the world was the Emma Maersk, 11,000TEU but at present, Dec. 2009, the maximum container vessels are 14,500TEU and number of container vessels more than 50,000DWT capacity owned by 20 main shipping lines only is more than 1,250.

(3) Super Post panamax ships with the capacity around 100,000DWT and length around 330 meters are considered to be the majority of the fleet on Trans-Pacific and Asia-Europe trade service by 2012.

(4) The enlargement of Panama Canal will be completed by 2014 after then Panamax ship now plying between Asia and East Coast of North America will be shifted to post Panamax ships and introduction of larger vessels will be accelerated in the Trans-Pacific shipping route.

(5) Traditionally, Northern Vietnamese export cargoes to USA are transshipped at Hong Kong or Kaohsiung and transported by mother vessels. Therefore, bearing the extra transshipment cost and the longer shipping time is inevitable, and the economy of scale can't be achieved.

(6) Based on the information of shipping lines, if more than 1,000TEU/week of lot of containers is obtainable constantly, it will be feasible to extend the service range of 100,000DWT mother vessels in Trans-Pacific trunk route from Hong Kong/ Kaohsiung up to the Haiphong /Lach Huyen International Gateway Port.

(7) If Lach Huyen port can accept 100,000DWT mother vessels directly, it is achieved to lower the shipping cost due to larger vessel size, in addition to save the transshipment cost, which will result to increase competitiveness of export good prices and contribute to decrease domestic market prices by lower import prices, and that will stimulate Vietnamese national economy.

(8) As explained above, it is necessary the container traffic demand of more than 1,000TEU/week constantly for USA to attract 100,000DWT mother vessels. The demands for USA are calculated as follow:

- Based on the TEDI's FS, it is known that the shares of export and import cargoes to USA are 18% and 30% respectively.
- The total container demand in Northern Vietnam at 2020 was forecasted as 1,719,000TEU for export and 1,719,000TEU for import.
- Therefore, the export container volume to USA is calculated as follows: 1,719,000 × 0.18 / 52 = **5,950 TEU/week** and the import container volume from USA is: 1,719,000 × 0.30 / 52

= 9,917 TEU/week.

As known from above calculation, there is enough container volume for plural 100,000DWT container mother vessels to call the Lach Huyen port every week.

On the other hand, when shipping lines make their shipping schedule, they will consider the Saturday/ Sunday/ Holyday of destination of USA and it will occur very often that plural vessels for Trans-Pacific route will start Lach Huyen Port at the same day. Therefore, if there are two (2) berths in one (1) terminal, it is preferable for both berths to be able to accommodate 100,000DWT vessels simultaneously.

However, 100,000DWT mother vessels from ports of Hong Kong, Kaohsiung will not call with its full-loaded condition, since Lach Huyen Port will be the terminal port of Asia - North America routes and many containers were loaded/unloaded at Hong Kong, Kaohsiung after/before calling at Lach Huyen Port. Therefore, the depth of access channel and berth will be designed for the partial loaded condition of 100,000DWT container vessel.

Therefore, the design vessel sizes for the Lach Huyen Port are proposed as follow:

- Fully loaded 50,000DWT Container Vessel
  LOA= 274m, Width= 32.3m, Draft= 12.7m
- Partial loaded 100,000DWT Container Vessel
  LOA= 330m, Width= 45.5m, Draft= 11.7m (80%)

11.1.2 Berth

1) Required Number of Berth

As explained in Clause 5.9, the total container volume to be handled at Lach Huyen Port in 2020 is forecasted at 2,229,000 TEUs (Medium Growth Case). To handle these containers, required number of container berth is calculated as follows:

a) Prerequisite Conditions

Composition of calling vessels is 20,000DWT: 50,000DWT: 80,000DWT: 100,000DWT = 20%: 30%: 20%: 30% in throughput bases.

Where, typical dimensions of each vessel are as shown below.

Table 11.1.1 Dimensions of Container Vessels

Ship Type	DWT	L (m)	B (m)	D (m)	TEU
Container Ship	20,000	177	27.1	9.9	1,300 - 1,600
	50,000	274	32.3	12.7	3,500 – 3,900
	80,000	300	40.0	14.2	5,800 – 6,200
	100,000	330	45.5	14.7	7,300 – 7,700

Source: Actual Data and Japanese Design Standard

- Unloading plus loading cargo volume of each calling vessel will be 50% of its capacity in average.
- 20' box : 40' box = 1 : 1
- Productivity of a Quay Gantry Crane = 30 boxes / hour
- Number of QGC applied for 20,000DWT, 50,000DWT, 80,000DWT and 100,000DWT are 2,

3, 3.5 and 4 respectively.

- Consuming vessel time other than cargo handling time is 5 hours considering one way channel and 18km of cannel length, etc.
- Basic berth length is 400m based on 100,000DWT vessel and in case of mooring of 20,000DWT vessels two (2) vessels at once can be moored but other vessels can moor one / berth.
- Design BOR (Berth Occupancy Ratio) is targeted less than 70%.

b) Required Number of Berth

The required number of berths is calculated based on the prerequisites mentioned above as shown in Table 11.1.2

Table 11.1.2 Calculation of Number of Container Berth

	Item	Unit	Calculation	Container
20,000 DWT				
a	Number of Container	000 TEUs		460
b	Average Cargo Volume Handled	TEUs/Vessel		1,000
c	Number of Vessel Call	Call/year	a/b	460
d	Cargo Handling Productivity	TEUs/hour/vessel	45TEU/h × 2G × 0.7	63
e1	Total Berth Hour	Hour/year	(b/d+5) × c/2	4,799
50,000 DWT				
a	Number of Container	000 TEUs		690
b	Average Cargo Volume Handled	TEUs/Vessel		2,000
c	Number of Vessel Call	Call/year	a/b	345
d	Cargo Handling Productivity	TEUs/hour/vessel	45TEU/h × 3G× 0.7	95
e2	Total Berth Hour	Hour/year	(b/d+5) × c	9,023
80,000 DWT				
a	Number of Container	000 TEUs		460
b	Average Cargo Volume Handled	TEUs/Vessel		3,000
c	Number of Vessel Call	Call/year	a/b	153
d	Cargo Handling Productivity	TEUs/hour/vessel	45TEU/h × 3.5G×0.7	110
e3	Total Berth Hour	Hour/year	(b/d+5) × c	4,937
100,000 DWT				
a	Number of Container	000 TEUs		690
b	Average Cargo Volume Handled	TEUs/Vessel		4,000
c	Number of Vessel Call	Call/year	a/b	172
d	Cargo Handling Productivity	TEUs/hour/vessel	45TEU/h × 4G × 0.7	126
e4	Total Berth Hour	Hour/year	(b/d+5) × c	6,336
E	Grand Total Berth Hour	Hour/year	e1+e2+e3+e4	25,094
f	Available Hour for Using Berth	Hour/year	24 × 365 × 0.95	8,322
g	Berth Occupancy	%	E/(f × B)	60%
B	Number of Berth			5

Source: Study Team

Based on the above conditions, required number of berths is calculated for Medium Growth Case as 5 berths at target year of 2020. If calculate for High Growth Case of 3,012,000TEU/year in 2020, the required number of berths will be 6 berths (BOR 66%). Therefore, It is recommended that although number of berths to be developed by 2020 should be determined based on the actual trend of container volume, the port layout for target year 2020 should be prepared for 6 container berths.

2) Dimension of Berth

a) Berth Length

The berth length is governed by the maximum design vessel length, i.e., 100,000DWT container vessel length of 330m. If each berth is operated and managed by different operator, the berth length for 100,000DWT should be 400m each. However, if 2 berths are operated and managed by one operator that is very common since terminal facilities and equipment can be utilized more efficiently than the case of 1 berth operated by 1 operator, the required berth length can be reduced to 750m per 2 berths as illustrated in Figure 11.1.1.

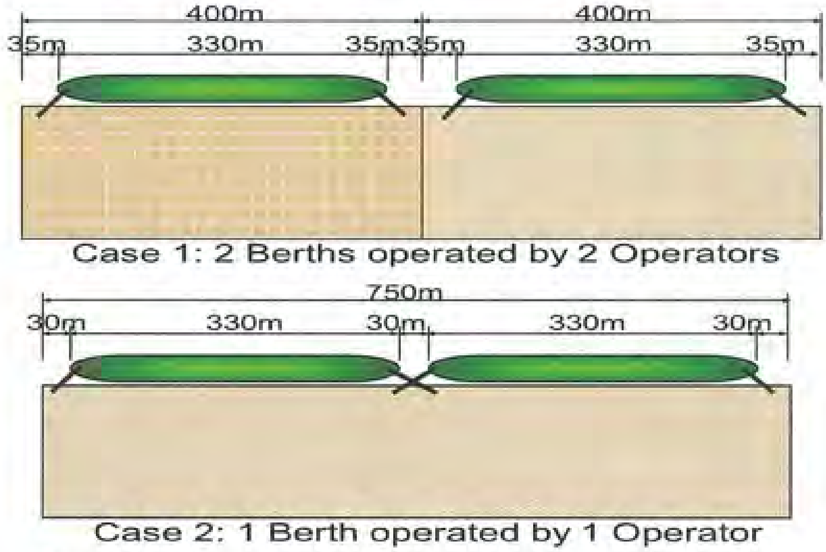


Figure 11.1.1 Berth Length of 100,000DWT Container Vessel

b) Height of Berth Structure

According to the following tide and frequency of water level in Lach Huyen port, the height of berth structure is determined.

- Water level per hour, frequency 1% : +3.55m
- Water level per hour, frequency 99% : +0.43m
- Water level per hour, frequency 50% : +1.95m
- Highest water level recorded : +4.21m

Based on the standard of Vietnam, it is calculated at between +3.95m to +4.55m. There are various standards in the world for determining the height of berth structure and TEDI FS checked some different standards such as Japanese, British, EAU standards and Carl A. Thoresen's Guideline, and obtained the heights between +3.45m and +5.66m. Based on these values, TEDI proposed to apply +5.5m.

SAPROF study considers +5.5m of height of berth structure is appropriate even if consider the sea level rise due to climate change of 75cm by year 2100, which is estimated by the Ministry of Natural Resources and Environment of Vietnam in August 2009.

c) Depth of Berth

The depth of berth is determined for design vessels by PIANC guideline which recommends to keep 10% of maximum draft as under keel clearance. Following depths are required:

- For 50,000DWT container vessel (full load): 12.7m x 1.1 = 14.0m
- For 100,000DWT container vessel (80% draft): 11.7m x 1.1 = 13.0m

Therefore, the depth of berth is governed by the fully loaded 50,000DWT vessel as -14.0m.

In TEDI FS the depth of berth is recommended also to be -14.0m and no modification is required. However, SAPROF study recommend that the design depth for berth structure should be -16.0m, because 100,000DWT container vessels with fully loaded condition will call at Lach Huyen Port in future when depth of berth should be deepened to -16m and the structure should be reinforced but the reinforcement at that time will be very difficult and costly.

d) Required Scale of Container Berth

As calculated above, number of berths required by 2020 is 5 for medium growth case and 6 for high growth case and it is recommended that 2 berths are operated and managed by one operator as much as possible from operational and economical viewpoints and the scale of container terminal of Lach Huyen port in 2020 will be as shown in Table 11.1.3.

Table 11.1.3 Required Scale of Container Berth (2020)

Type of Berth	Design Vessel Size	No. of Berth	Unit Length of Berth	Total Length of Berth	Design Depth of Berth	Dredging Depth of Berth
Container	50,000DWT (Full Load) 100,000DWT (Partial Load)	5 (6)	375m	1,875m (2,250m)	-16m	-14m

11.1.3 Container Yard

1) Required Ground Slot

The required storage number of containers is calculated by the following formula:

$$M_l = (M_y \times D_w / D_y) \times P$$

Where:

M_l	:	Required storage number of containers (TEUs)
M_y	:	Annual container throughput (TEUs)
D_w	:	Average dwelling days (=6 days)
D_y	:	Operation days (=365 days)
P	:	Peak Ratio (1.0)

Required number of ground slots

$$S_l = M_l / (L \times O)$$

Where:

S_l	:	Required number of ground slots (TEUs)
M_l	:	Required storage number of containers (TEUs)
L	:	Stacking height of containers (=4 layers)
O	:	Operation Factor (=0.75)

The number of container to be handled per one berth is as follow:

2,299,000 TEU / 5 berths = 459,800 TEU

Therefore, required storage capacity per berth is calculated as shown in Table 11.1.4.

Table 11.1.4 Required Storage Capacity / Berth in Container Yard

Item	Unit	Storage Capacity
Annual Container Throughput (M_y)	'000TEUs	460
$(M_y \times D_w / D_y) \times P$	TEUs	7,562
Stacking Height L $\times$ O	Layers	3.0
Required Number of Ground Slots	Slots	2,521

2) Reefer Storage

As to reefer yard, reefer ratio has been assumed as 10% of the total containers taking account of the historical trend of reefer ratio in Haiphong Port. The required ground slot number is calculated as follows:

7,562 TEUs $\times$ 10% / 1.5 (TEU unit ratio) / 3 (tiers) = 168 FEUs

Then, the required number of reefer plugs is calculated as follows:

168 FEUs in ground slots $\times$ 1 plug / FEU $\times$ 3 tiers = 504 plugs

To satisfy the above requirements, the following ground slots have been proposed by this study:

For dry containers: 50 (20') bays $\times$ 6 slots $\times$ 10 lanes

For reefer containers: 17 (40') bays $\times$ 6 slots $\times$ 2 lanes

3) Empty Container Stacking Yard

In addition to the above container-stacking yard to be equipped with RTGs, back storage yard has been proposed in this study. The back yard is planned mainly for empty container stacking to be equipped with empty handlers (side lifters & top lifters). The backyard (empty-container-stacking yard) is planned to cater for inventory movements of empty containers between the yard and outside importers/exporters rather than for movements from/to container ships. The ground slots of 250 TEUs have been planned, that is 10% of the total marshaling yard capacity.

11.1.4 Container Check Gate

Number of gates for one container berth is calculated as follow:

Number of container: 460,000TEU/1.5 = 306,667 box/year

306,667/365 $\times$ 1.0 (peak ratio) = 840 box/day

- Land transport : Inland Water transport = 95% : 5%

- Container through gate: 840 × 0.95 = 798 box/day, Say 800 box/day
- In Gate:
  400 tractor-trailer with loaded container
  40 tractor-trailer with empty container
  440 tractor-trailer without container
- Out Gate:
  400 tractor-trailer with loaded container
  40 tractor-trailer with empty container
  440 tractor-trailer without container
- Hourly peak ratio: 2.0
- Time for gate procedure: 3 minutes excluding tractor-trailer without containers at gate out
- Gate in: 880 vehicles / day / 24 × 2.0 / (60min / 3 min / lane) = 4 lanes
- Gate out: 440 vehicles / day/ 24 × 2.0 / (60 min / 3 min / lane) = 2 lanes

Actually the peak times of gate-in and gate-out traffic will not occur at the same time. So, 1 lane can be used alternatively for both purpose and total 5 numbers of lanes will be sufficient.

11.1.5 Other Facilities

Following buildings will be constructed in each container terminal. Total floor area will be approx. 8,855m^2 in case of one terminal consists of 1 berth and approx. 10,655 m^2 in case of one terminal consists of 2 berths.

Table 11.1.5 Proposed Scale of Terminal Buildings

Buildings		Story	Floor Area (m^2) 1 terminal 1 berth	Floor Area (m^2) 1 terminal 2 berths
1	Operation Office	4	4,800	4,800
2	Amenity block	2	750	1,500
3	Security office	1	75	75
4	Maintenance shop	2	1,500 + 500	1,500 + 500
5	Container repair shop	1	400	800
6	Substation	1	150	150
7	Fuel Station	1	30	30
8	Container Gate	1	650	1,300
	Total		8,855	10,655

11.1.6 Container Handling Equipment

Following cargo handling equipment will be required in each container berth.

Table 11.1.6 Required Main Cargo Handling Equipment

Cargo Handling Equipment		Unit 1 terminal 1 berth	Unit 1 terminal 2 berths	Basic Specification
1	Quay Gantry Crane	4	8	Capacit:60 tons, Outreach 56.6m, Rail gauge 30m, Lift Height 40.m, Twin 20' type,
2	RTG	12	24	Rail spun 23.47 m , Stacking Height 15.24m (1 over 4), 16 wheeler
3	Top Lifter	3	5	Lifting Capacity 35 tons, with Telescopic Spreader
4	Yard Chassis	30	55	Convertible 40' & 20' with strong steel beam type
5	Yard Tractor-Head	25	50	More than 350 HP
6	Multipurpose Forklift	2	4	Lifting Capacity 3tons, Mast height less than 2.2m
7	Hoist	1	2	Lifting capacity 5 tons with 24m outreach
8	Mobile Crane (for barge)	1	2	Lifting Capacity 40 tons with Outreach 4th row from Quay line available type

11.1.7 Summary of Land Requirement for Port Facilities

Table 11.1.7 summarizes the land requirements for the port facilities on the container terminal in the Lach Huyen Port.

Table 11.1.7 Land Requirement/Berth for Container Port Facilities

Description	Area	Dimensions
1. Storage Area inc. Road, Drainage etc.	375,000m^2	750m × 500m
- Dry Container	160,000m^2	-
- Reefer Container	32,000m^2	-
2. Building Area inc. Road, Parking, etc.	75,000m^2	750m × 100m
Total	450,000m^2	750m × 600m

Source: Study Team

11.2 Multi-Purpose Terminal

11.2.1 Design Vessel

In TEDI FS, the general cargo vessels were divided into general cargo vessel and bulker but in SAPROF study both type of vessels are not divided and regarded as a general cargo vessel and terminal is designed as Multi-Purpose Berth since reviewed demand forecast showed that the bulk cargo volume is not big amount.

The design vessel size is 50,000DWT, same as that of TEDI FS. The dimensions of general cargo vessels for Lach Huyen port are shown in table below.

Table 11.2.1 Dimensions of General Cargo Vessels

Ship Type	DWT	L (m)	B (m)	D (m)
General Cargo Ship	20,000	160	25	10.0
	30,000	185	27	11.0
	50,000	225	31	12.0

Source: Actual Data and Japanese Design Standard

11.2.2 Berth

1) Required Number of Berth

As explained in Chapter 5.9, the total general cargo and bulk cargo volume to be handled at Lach Huyen Port in 2020 is forecasted at 2,834,000 Tons. To handle these cargoes, required number of Multi-purpose berth is calculated as follows:

a) Prerequisite Conditions

- Composition of calling vessels is 20,000DWT: 30,000DWT: 50,000DWT = 40%: 40%: 20% in throughput bases.
- Unloading plus loading cargo volume of each calling vessel will be 50% of its capacity in average.
- Productivity of a Quay Gantry Crane = 60 ton / hour
- Number of gangs applied for 20,000DWT, 30,000DWT, and 50,000DWT are 4, 5 and 5 respectively.
- Consuming vessel time other than cargo handling time is 5 hours considering one way channel and 18km of cannel length, etc.
- Basic berth length is 250m based on 50,000DWT bulker.
- Design BOR (Berth Occupancy Ratio) is targeted at 60%.

b) Required Number of Berth

The required number of berths is calculated based on the prerequisites mentioned above as shown in Table 11.2.2.

Table 11.2.2 Calculation of Number of Multipurpose Berth

Item		Unit	Calculation	G.C.& Bulk
20,000 DWT				
a	Cargo Volume Handled	000 tons		1,134
b	Average Cargo Volume Handled	Tons/Vessel		15,400
c	Number of Vessel Call	Call/year	a/b	74
d	Cargo Handling Productivity	Tons/hour/vessel	60Ton/h × 4G × 0.7	168
e1	Total Berth Hour	Hour/year	(b/d+5) × c/2	7,042
30,000 DWT				
a	Cargo Volume Handled	000 tons		1,134
b	Average Cargo Volume Handled	Tons/Vessel		23,100
c	Number of Vessel Call	Call/year	a/b	49
d	Cargo Handling Productivity	Tons/hour/vessel	60Ton/h × 5G × 0.7	210
e2	Total Berth Hour	Hour/year	(b/d+5) × c/2	5,594
50,000 DWT				
a	Cargo Volume Handled	000 tons		567
b	Average Cargo Volume Handled	Tons/Vessel		38,500
c	Number of Vessel Call	Call/year	a/b	15
d	Cargo Handling Productivity	Tons/hour/vessel	60Ton/h ×5G × 0.7	210
e3	Total Berth Hour	Hour/year	(b/d+5) × c/2	2,758
E	Grand Total Berth Hour	Hour/year	e1+e2+e3	15,394
f	Available Hour for Using Berth	Hour/year	24 x 365 × 0.95	8,322
g	Berth Occupancy	%	E/(f × B)	62%
B	Number of Berth			3

Source: Study Team

c) Required Scale of Multi-purpose Berth

As calculated above, number of berths required by 2020 is 3 for medium growth case and the scale of multi-purpose berth of Lach Huyen port in 2020 will be as shown in Table 11.2.3.

Table 11.2.3 Required Scale of Multipurpose Berth (2020)

Type of Berth	Design Vessel Size	No. of Berth	Unit Length of Berth	Total Length of Berth	Design Depth of Berth	Dredging Depth of Berth
Multipurpose	50,000DWT	3	250m	750m	-13m	-13m

11.2.3 Storage Facility

Transit sheds for the Multi-purpose terminal will be provided along the berth apron. Open yards will be available behind transit sheds. Truck waiting areas will be built at both sides of the transit sheds to make the marshalling yard clear and minimize idle time.

The size of cargo handling and storage facilities including transit sheds and open yards have to be decided in consideration of the types, quantities of cargoes and the conditions of handling.

1) Transit Sheds

Based on the assumption that 20 % of annual volume of cargoes is stocked in the transit sheds, the required area for the transit sheds is calculated by the following formula:

$$A = (N \times p) / (R \times a \times W) / B$$

Where:

A	:	Required area of warehouses/transit sheds (m2)
N	:	Annual volume of cargoes handled (tons)
R	:	Turnover of transit shed (Average dwelling days = 7 days)
a	:	Utilization rate (=0.5)
W	:	Volume of cargoes per unit area (tons/m2)
P	:	Peak ratio (=1.3)
B	:	Efficiency storage rate (=0.75)

Therefore, the required area of the warehouses/transit sheds is as follows:

A = 7,000 m^2 for 50,000 DWT Berth

2) Open Storage Yards

Based on the assumption that 60 % of annual volume of cargoes is stocked in the open storage yards and another 20% of annual volume is delivered directly without keeping in the port, the required area for the open storage yards is calculated by the following formula:

$$A = (N \times p) / (R \times a \times W) / B$$

Where:

A	:	Required area of open storage yards (m2)
N	:	Annual volume of cargoes handled (tons)
R	:	Turnover of open storage (Average dwelling days = 14 days)
a	:	Utilization rate (=0.7)
W	:	Volume of cargoes per unit area (6 tons/m^2)
P	:	Peak ratio (=1.3)
B	:	Efficiency storage rate (=0.75)

Therefore, the required area of the open storage yards is as follows:

A = 30,000 m^2 for 50,000 DWT Berth

3) Other Facilities

Following building facilities are provided for the multipurpose terminal:

Table 11.2.4 proposes the recommended building facilities in the Multipurpose terminal.

Table 11.2.4 Building Facilities in a Multipurpose Terminal

Building Name	Ground Space (m^2)	Remarks
Administration Office and Amenity Block	2,500	2 to 3 floors
Maintenance Shop	500	Ceiling crane, Spare parts shelves, Office
Power/Fuel Station	500	
Main and Sub Gate	500	Gate house to be required
Others	1,000	
Total	5,000	

Source: Study Team

4) Cargo Handling Equipment

Equipment	Type	Nos. in demand	Remarks
Quay Crane	Jib type, Rail mounted	40 tons : 1 20 tons : 1	Outreach : 38m Outreach : 20m
Forklift	Finger Type	20 tons : 5 10 tons : 5	 With long mast type
Reach Stacker	Multipurpose, but mainly containers	4	For stuffed & empty Container handling.
Container Trailer	Yard type	10	
Hopper	For light weight cargo		For grain, fertilizer
Belt Conveyor	-"-	(40m × 2) 2 sets	-"-
Hopper	For heavy cargo		For ore loading
Belt Conveyor	-"-	Total 150m, 2 sets	-"-
Dump truck		20	Haulage quay/open yard
Reclaimer		2	For ore loading
Shovel loader		4	For ore loading
Excavator		2	For ore loading

Source: Study Team

5) Summary of Land Requirement for Port Facilities

Table 11.2.5 summarizes the land requirements for the port facilities on the Multipurpose terminal in the Lach Huyen Port.

Table 11.2.5 Land Requirement/Berth for Multipurpose Port Facilities

Description	Area	Dimensions
1. Storage Area inc. Road, Drainage etc.	85,000m^2	250m × 340m
- Transit Sheds	7,000m^2	-
- Open Yards	30,000m^2	-
2. Building Area inc. Road, Parking, etc.	15,000m^2	250m × 60m
Total	100,000m^2	250m × 400m

Source: Study Team

11.3 Access Channel

11.3.1 Required Number of Lane

In TEDI FS, it was planned that the design vessel of 50,000DWT should enter the port at high tide. However, it is not acceptable for international gateway port to ask container mother vessels of 100,000DWT class enter into the port only during high tide. Therefore, SAPROF study recommends that the access channel shall be acceptable the design vessel at any tidal conditions with its operation draft but not with its maximum draft.

TEDI FS adopted the one way channel to save capital and maintenance dredging costs, however, it didn't show the sufficiency of one way for all calling vessels to Haiphong ports and Lach Huyen port. Therefore, SAPROF study tried to confirm the sufficiency of one way channel as follow.

At first, SAPROF team studied the trend of ship call of Haiphong ports and it was clarified that after new Lach Huyen channel was developed in 2005 by the Haiphong Port Rehabilitation Phase II Project, number of vessels more than 7,000DWT, especially more than 10,000DWT were increased drastically as shown in table below.

This data suggested that if deep water channel is provided, the shipping lines will introduce bigger vessels.

Table 11.3.1 Trend of Ship Call of Haiphong Port

Capacity (DWT)	Ship length	1990		2000		2001		2002		2004		2006		2007	
		Q'ty	(%)	Q'ty	(%)	Q'ty	(%)	Q'ty	(%)	Q'ty	(%)	Q'ty	(%)	Q'ty	(%)
<3000	<85	155	31	289	18	261	16	482	23	271	13	601	21	794	22
3001-5000	85 -125	96	19	1,043	65	1,123	67	342	17	431	20	550	19	542	15
5001-7000	125 - 140	97	19	158	10	135	8	555	27	827	39	489	17	488	14
7001-10000	140 - 160	141	28	81	5	110	7	427	21	440	21	758	26	1,109	31
>10000	160 - 185	10	2	40	2	49	3	254	12	141	7	473	16	596	17
Total		**499**	**100**	**1,611**	**100**	**1,678**	**100**	**2,060**	**100**	**2,110**	**100**	**2,871**	**100**	**3,529**	**100**

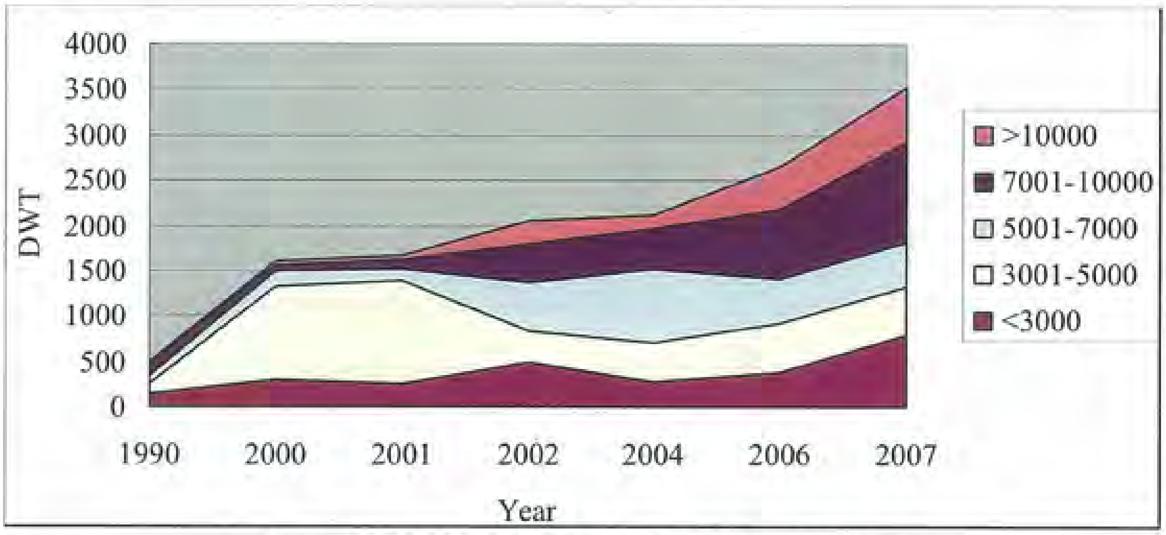


Figure 11.3.1 Ship Size Distribution of Haiphong Port

Based on the above data, future ship call was estimated as shown table below.

Table 11.3.2 Estimated Calling Vessels to Haiphong Ports (2020)

Type of Cargo	Vessel Size (DWT)	% of Vessel	Throughput (%)	Throughput (mil. ton) 2020	(a) No. of Call	(b) L average (m)	(a)x(b)	L average (m)
General Cargo + Bulk Cargo	< 3,000	23	4.4	1.62	1,406	75	105,585	
	3,001-5,000	15	7.7	2.84	924	100	92,387	
	5,001-7,000	14	10.7	3.95	856	112	95,859	
	7,001-10,000	31	33.7	12.44	1,903	125	237,850	
	>10,000	17	43.5	16.07	1,044	162	169,105	
Total		100	100	36.92	**6,134**		700,786	**114**

On the other hand, the calling vessels to Lach Huyen port were estimated based on the distribution of ship size used for calculation of required number of berth as follows.

Table 11.3.3 Estimated Calling Vessels to Lach Huyen Port (2020)

Type of Cargo	Size of Vessel (DWT)	Exchange of Cargo (/ship)	Throughput (%)	Throughput m.ton/m.TEU 2020	(a) No. of Call	(b) L average (m)	(a)x(b)	L average (m)
G Cargo + Bulk	20,000	15,400ton	40	1.13 m.ton	74	160	11,840	
	30,000	23,100ton	40	1.13 m.ton	49	185	9,065	
	50,000	38,500ton	20	0.57 m.ton	15	225	3,375	
Container	30,000	1,000TEU	20	0.46 m.TEU	460	203	81,420	
	50,000	2,000TEU	30	0.69 m.TEU	345	274	94,530	
	80,000	3,000TEU	20	0.46 m.TEU	153	300	45,900	
	100,000	4,000TEU	30	0.69 m.TEU	172	330	56,760	
Total					**1,268**		303,310	**239**

From above 2 tables, total number of call and average length of passing vessels through the Lach Huyen channel is obtained as follow.

- Total Ship Call : 7,402
- Average Ship Length : 136m

The capacity of Lach Huyen channel is calculated based on the following prerequisites.

- Navigation speeds in channel are 8 kt in daytime and 4 kt at night.
- Minimum intervals of ships are 8L in daytime and 16L at night.
- According the number of calling vessels to Lach Huyen port, the number of turning of vessel is 4 times/day and stop navigation of other vessels 0.5 hours/turning.
- The restriction of channel navigation due to one way operation is necessary 4 times a day and 1 time need 1.2 hours = 18km / (8kt × 1.852km/hr), however, this restriction is not a restriction for that vessel itself and 2.4 (= 2 × 1.2) hours/day is considered.
- Weather restriction factor : 1.5
- Safety factor : 1.5

Based on the above conditions, number of navigable vessels in a year is calculated as follows.

Day Time: 365d × (12h-2h-2.4h) / ((8 × 136m / (8 × 1,852m))=37,775 ship

Night Time: 365d × 12h / ((16 × 136m/ (4 × 1,852m))=14,911 ships

(37,775+14,911) / 1.5(Weather) / 1.5(Safety)=23,416 ships

Total: 23,416 Ships/year = 11,708 Call/year > 7,402 call/year

Therefore, if all ship can call the port at any tidal conditions, one (1) way navigation channel is enough for ship calls at 2020.

11.3.2 Width of Channel

This channel is anticipated to be suffered considerable volume of sedimentation and the initial dimensions of this channel should be small as much as possible and after confirmed actual maintenance dredging volume this channel will be expanded. Therefore, since it was confirmed in above section that one way channel can accommodate required number of calling vessels, the width of access channel is planned as one (1) way channel.

For this access channel, a sand protection dyke will be provided along the channel and it will simultaneously function as a breakwater. Therefore, this access channel can be designed as so called in PIANC definition an "Inner Channel".

In case of one way channel, required channel width is calculated by the PIANC formula as follow:

$$W = W_{BM} + \Sigma W_i + W_{Br} + W_{Bg}$$

Table 11.3.4 Calculation of Channel Width by PIANC

W_{BM}	Basic Maneuvering Lane	Moderate	1.5 B
W_1	Vessel Speed (knots)	8 - 12	0.0 B
W_2	Prevailing cross wind (knots)	<15 - 33	0.4 B
W_3	Prevailing cross current (knots)	negligible	0.0 B
W_4	Prevailing Longitudinal current (knots)	1.5 – 3.0	0.1 B
W_5	Significant wave height H (m) and length λ (m)	H < 1m, λ < L	0.0 B
W_6	Aid to Navigation	moderate with infrequent poor visibility	0.2 B
W_7	Bottom Surface	D < 1.5T, smooth & soft	0.1 B
W_8	Depth of waterway	1.15T < d < 1.5T	0.2 B
W_9	Cargo hazard level	Low	0.0 B
W_{Br}	Width of red side bank clearance	Sloping channel edge	0.5 B
W_{Bg}	Width of green side bank clearance	Sloping channel edge	0.5 B
	Total		3.5 B

Therefore, required channel width is:

$$W = 3.5 \times 45.5 = \mathbf{160\ m}$$

However, if this channel is not protected by sand protection dyke cum breakwater, the channel width should be calculated with the same formula but as an "Open Channel":

Table 11.3.5 Calculation of Channel Width by PIANC (Open Channel)

W_{BM}	Basic Maneuvering Lane	Moderate	1.5 B
W_1	Vessel Speed (knots)	8 - 12	0.0 B
W_2	Prevailing cross wind (knots)	<15 - 33	0.4 B
W_3	Prevailing cross current (knots)	$0.2 < v < 0.5$ kt	0.2 B
W_4	Prevailing Longitudinal current (knots)	1.5 – 3.0	0.1 B
W_5	Significant wave height H (m) and length λ (m)	$1 < H < 3, \lambda = L$	1.0 B
W_6	Aid to Navigation	moderate with infrequent poor visibility	0.2 B
W_7	Bottom Surface	D < 1.5T, smooth & soft	0.1 B
W_8	Depth of waterway	1.15T < d < 1.5T	0.2 B
W_9	Cargo hazard level	Low	0.0 B
W_{Br}	Width of red side bank clearance	Sloping channel edge	0.5 B
W_{Bg}	Width of green side bank clearance	Sloping channel edge	0.5 B
	Total		4.7 B

Therefore, required channel width is:

$$W = 4.7 \times 45.5 = \mathbf{210\ m}$$

Above channel width will require sufficient tug assistance and appropriate navigation control system like VTS (Vessel Traffic Service).

11.3.3 Depth of Channel

As explained in 11.1.1 Design Vessel, 50,000DWT vessel with full load and 100,000DWT vessel with partial load are proposed to be applied from Initial stage development by SAPROF study.

The maximum design container vessel of 100,000DWT will put service into a trans-pacific route and Lach Huyen port will be terminal port. Therefore, ships will not call/leave with its full loaded condition. Thus, the average operation draft of 80% of maximum draft is considered for the design of channel depth. Depend on the PIANC guideline, the depth of inner channel may be 1.1 times of ship draft:

$$D_1 = 14.6\text{m} \times 0.8 \text{ x } 1.1 = 12.8\text{ m} \quad \rightarrow \quad 13.0\text{ m}$$

On the other hand, 50,000DWT container vessels which will be shifted from present trunk routes to the main feeder routes will provably call at Lach Huyen port with its full capacity. In this case, required channel depth become as follow:

$$D_2 = 12.7\text{m} \times 1.1 = 14.0\text{m} > D1$$

Therefore, the depth of channel is proposed to be **14.0m below CDL**.

However, in the Decision by MOT No.3793/QD-BGTVT dated December 22, 2008, the depth of vessel channel was mentioned as "ship running depth is 13.3m and designed elevation of channel bottom: -10.3m for 30,000DWT vessel with full load and 50,000DWT vessel with partial load".

Above vessel channel was intended to be constructed by 2013 as Initial stage development. However, considering the present situation of the Project, it is impossible to complete by 2013 and estimated to be completed in 2015. On the other hand, based on the approved FS prepared by TEDI, the 2nd stage development of this vessel channel is expected to be deepened up to -14.9m deep (at +3.0m tide level) and designed bottom elevation of -11.9m for 50,000DWT vessel with full load and 80,000DWT vessel with partial load by 2020.

Considering the above facts and following reasons, SAPROF study recommend to develop this vessel access channel **-14m bottom elevation below CDL** from Initial stage.

(1) 50,000DWT full loaded container vessel requires -14m water depth. This water depth should be available at any tidal conditions for such a large container vessel operation to keep the fixed tight shipping schedule. This is the international standard for international gateway ports like Lach Huyen Port.

(2) It is impractical condition to apply +3.0m tide level for access channel planning since occurrence probability of more than +3.0m is only 10% which means that only 2.4 hours are available in a day in average. Considering the length of this access channel of 18km, it is impossible for large vessels to enter the port after waiting for leaving of other large vessels. Further more, during neap tide period of around one week or so, there are no tide more than +3.0m which means large vessels shall wait more than one week for next calling and the available dates change every month. It is impossible for shipping companies to provide regular service.

(3) Even +2m tide level, occurrence probability is about 50% and ships more than 30,000DWT should wait more or less before enter into/ leaving from the port. In order to compare the economical viability between channel depth of -14m case and -12m case, an economic analysis was conducted by SAPROF study. The former case requires more initial and maintenance dredging cost than latter case but no ship waiting cost is required. The result showed that EIRR of -14m case was 12% which means -14m case is economically viable.

(4) Another economic analysis was conducted from the investment view point by the comparison of following two cases.

- Case 1: -14m channel is constructed at once by ODA loan.
- Case 2: -12m channel is constructed as 1st step development by ODA loan and it will deepened to -14m as 2nd step development 5 years later by Vietnamese own budget.

The results showed that NPV (Net Present Value) of Case 1 was 4,393 million USD and NPV of Case 2 was 5,855 million USD which means Case 1 is more economical than Case 2.

(5) If a port requires large container vessels to wait high tide before entering or leaving, such a port will lose the competitiveness against other ports in the region, since there are many ports which have more than -14m berths already (such as Shenzhen, Guangzhou, Manila, Laem Chabang, Port Klang, Cai-Mep, etc.).

(6) This project was determined to be developed by the PPP scheme. The shipping companies who are intended to participate in this project as private investors desire to introduce container mother vessels of Trans-Pacific routes by expanding their service range into Lach Huyen Port. To success the PPP scheme, the public sector should provide favorable investment environment to the private sector. Provision of -14m depth of channel is one of important investment environments for shipping companies.

11.3.4 Slope of Dredged Channel

Based on the concept of underwater stability of slopes, the following rules of thumb for side slopes are presented in technical standard of Sea Channel Design Process of MOT.

Table 11.3.6 Side Slope of Channel

Soil Type and Soil Condition	Slope Value (m_o)
Clay mud, sandy clay, - strain condition	20 - 30
Clay mud, sandy clay, - fluid-plastic soil	15 - 20
Mud with shell	10 - 15
Plastic mud, sandy clay, dusty clay	7 - 10
Loose sand	7 - 9
Medium compact sand	5 - 7
Compact sand	3 - 5
Shell limestone	4 - 5
Clay and sandy clay, - soft and plastic	3 - 4
Clay and plastic sandy clay	2 - 3
Clay and sandy clay, - plastic and hard	1 - 2

Note: Side slope for channel depth of more than 5m shall be $2m_o$.

(Source: MOT Sea Channel Design Process 1998)

According to the subsoil boring data of KL 1 to 15 obtained by TEDI port, subsurface subsoil along the proposed channel is classified as CLAY. This clay deposit is classified as sandy/silty clay of which consistency is very soft to stiff having N-value in a range of 1 to 15 to the depth of CD-15m. Based on subsoil condition of loose fine sand (7 - 9) or the intermediate value between the sandy clay (7 - 10) and mud with shell (10-15) as indicated in the above table, it is proposed that a slope in 1 (V) to 10 (H) is applied for capital dredging work to deepen Lach Huyen access channel to the depth of CD-14m in initial development.

11.3.5 Turning Basin

The diameter of turning basin shall be more than 3 times of design vessel length when no tug assistance and 2 times of design vessel length when tug assistance is available.

In this design, it is assumed that sufficient tug assistance is available:

- For container vessel
  R = 2.0 × 330m = 660m
- For general and bulk cargo vessel
  R = 2.0 × 225 = 450m

The depth of turning basin shall be the same as depth of access channel.

11.3.6 Depth and Width of Berth

- Container Berth:
  Depth: 14m CDL (Fully loaded 50,000DWT container vessel)
  Width: 50m
- General/Bulk Berth
  Depth: 13m CDL (Fully loaded 50,000DWT bulker)
  Width: 50m

11.3.7 Distance between Quay and Access Channel

In TEDI's FS, the face line of berth was determined at around the existing -5.0m contour line and the distance between face line of berths and edge line of access channel were 260m at container berths to 365m at general cargo berths. No any other reasons were shown in their FS report and it is difficult to find out any technical and economical reasons. In general, when determining the distance between the face line of berth and edge line of navigation channel, it should be considered that the ship waves generating by sailing vessels in the navigation channel will not influence adversely to the cargo handling operation of the ship at berth.

Considering the navigation speed of vessels in Lach Huyen access channel of less than 10 knots in normal conditions, it is enough that the clearance between sailing vessels and moored vessels at berths is at most 100m. Therefore, from view points of saving the costs for capital and maintenance dredging, the distance between the face line of berths and bottom edge line of access channel is proposed to be reduced to **150m** instead of 260m – 365m of TEDI's FS.

11.4 Road and Railway behind Terminal

120m wide road and 80m wide railway were proposed behind the port terminal in the feasibility study on Lach Huyen Gateway Port (VINAMARINE, 2006). From the interview to F/S consultant, it was confirmed that the cross section for road and railway has not been studied in detail, and thus the road and railway width has not been fixed yet.

SAPROF study has estimated the road traffic volume for the container terminals and multi-purpose terminals in 2020 as follows:

1) Container Terminal

a) Container Tractor Trailer (2ways)

- Container Throughput (High growth case): 3,012,000 TEU/year = 2,008,000 box (=3,012,000/1.5)
- Number of tractor trailer with container = 2,008,000/365 = 5,500 vehicles/day
- Number of tractor trailer with empty container = 5,500 vehicles/day
- Number of tractor trailer with additional empty container = 5,500 x 10% x 2 ways =1,100 vehicles/day
- Number of tractor trailer without container = 5,500 x 2 + 1,100 = 12,100 vehicles/day
- Total number of tractor trailer = 24,200 vehicles/day

b) Other Vehicles (2 ways)

- Small car = 100 cars/day/berth = 100 x 6 berths x 2 ways = 1,200 cars/day
- Large car = 10 cars/day/berth = 10 x 6 berths x 2 ways = 120 cars/day

c) Number of PCU (Passenger Car Unit)

(24,200 + 120) x 3 + 1,200 = 74,160 PCU/day

2) Multi-purpose Terminal

a) Cargo Truck (2 ways)

- General Cargo Throughput (High growth case): 3,853,000 ton/year
- Average Load of Truck: 10 ton/vehicle
- Number of truck with load = 3,853,000/10 = 385,300 vehicles/year = 1,060 vehicles/day
- Number of truck without load = 1, 060 vehicles/day

- Total number of truck = 2,120 vehicles/day

b) Other Vehicles

- Small car = 100 cars/day/berth = 100 x 3 berths x 2 ways = 600 cars/day
- Large car = 10 cars/day/berth = 10 x 3 berths x 2 ways = 60 cars/day

c) Number of PCU (Passenger Car Unit)

(2,120 + 60) x 3 + 600 = 7,140 PCU/day

3) Required Lanes of Road

- Total Number of PCU = 74,160 + 7,140 = 81,300 PCU/day
- Number of PCU per peak hour = 81,300/24 x 2.0(peak ratio) = 6,775 PCU/hr.
- Capacity of 1 lane: 1,800 PCU/hour
- Required Number of lane = 6,775/1,800 = 3.77 lanes say, 4 lanes for 2 way

Therefore, 4 lanes of travelling lanes are required for Medium Term Development of target year 2020.

In addition to above travelling lanes, 2 lanes of waiting lanes along the terminal side are provided and 2.5m wide paved shoulders for motor-bike passage and emergency parking at accident are provided in both directions. Median is planned as 10m in consideration of U-turn of 45 feet container trailer. The total width of port road behind terminal is proposed to be 44m for Medium Term Development as illustrated in Figure 11.4.1.

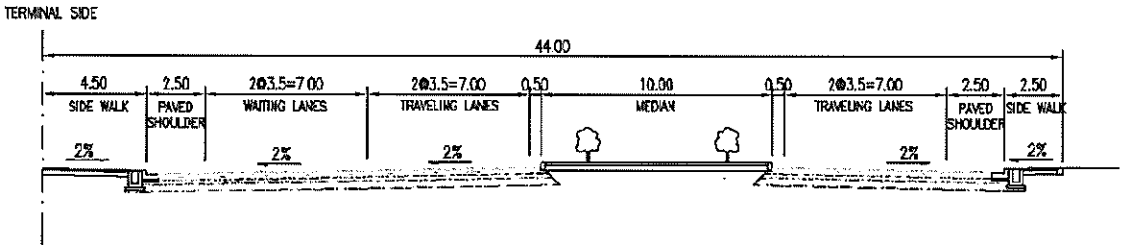


Figure 11.4.1 Typical Cross Section of Port Road for Medium Term Development (2020)

SAPROF study also considered that the road space for future port development should be reserved. However, there is no concrete future port development plan yet, therefore, in this study the number of reserved lanes for future development was estimated based on the following assumption:

Prerequisite: "Similar port development with Medium Term Development will be continued in future along the Lach Huyen access channel up to 15km offshore from container Berth No.1".

Total berth length of Medium Term Development is approximate 3km and another 4 times of berthing structures can be developed along the access channel. In such a condition, the hourly peak ratio will not be so high as 2.0 and may be reduced to 1.2 - 1.3. Therefore, the road traffic volume will become:

81,300/24 x 5 times development x 1.3 (hourly peak ratio) = 22,000 PCU/Hr

Required Number of lane = 22,000/1,800 = 12.2 lanes say, 12 lanes for 2 way

Therefore, considering the future port development of 15km long berths in total along access channel, road expansion space for 8 travelling lanes should be reserved.

Considering the smooth traffic flow in port roads, the terminals along access channel should be divided into several terminal groups and 4 travelling lanes roads are arranged just behind the each group of terminal and 8 travelling lanes road is arranged behind the terminal roads as a passing main road and finally total road width will be 95m as shown in Figure 11.4.2 and Figure 11.4.3.

The railway construction schedule is not determined yet and the land of 200m wide behind terminal area will be kept for future development as shown in Figure 11.4.4.

The connection of port road and access road of Cat Hai Island is proposed to be as shown in Figure 11.4.5 and Figure 11.4.6.

The length of transit section in each stage should be determined based on the design speed of Tan Vu – Lach Huyen Highway, 80km.

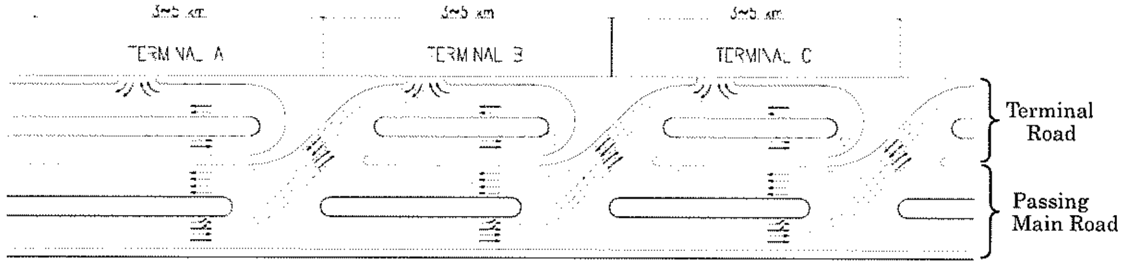


Figure 11.4.2 Layout of Each Terminal Road and Passing Main Road (Future)

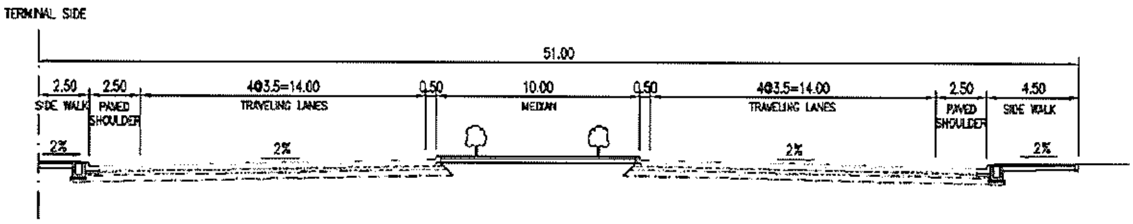


Figure 11.4.3 Typical Cross Section of Passing Main Road (Future)

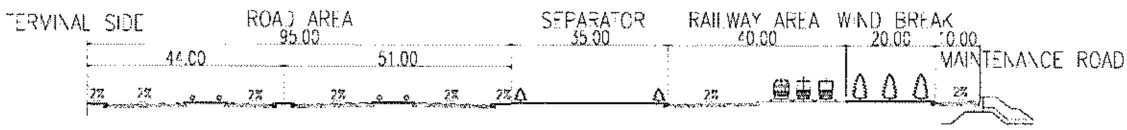


Figure 11.4.4 Typical Cross Section of Road and Railway behind Terminal (Future)

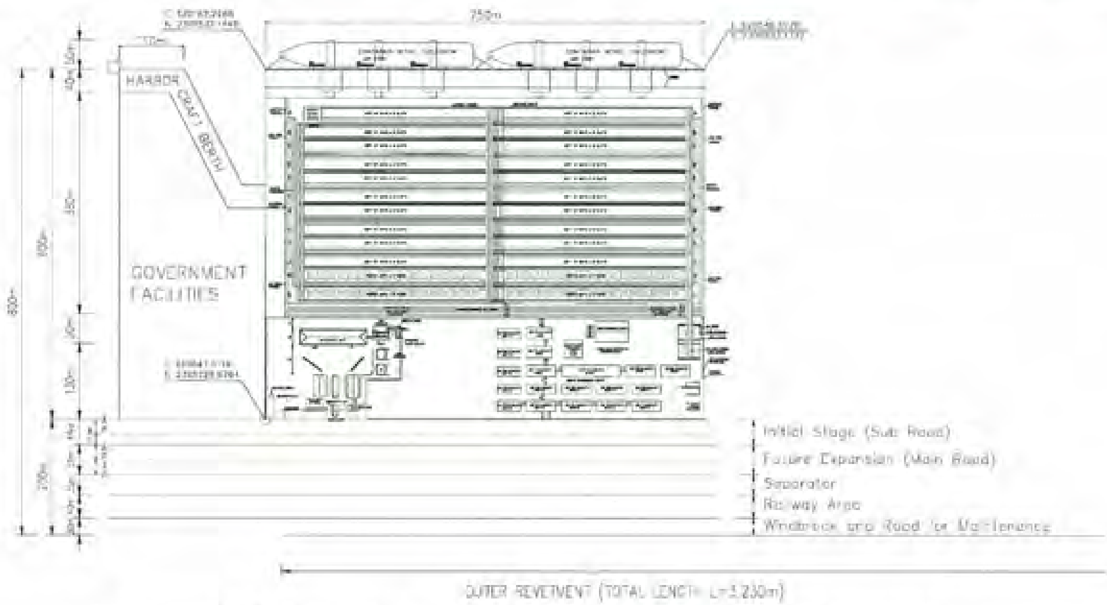
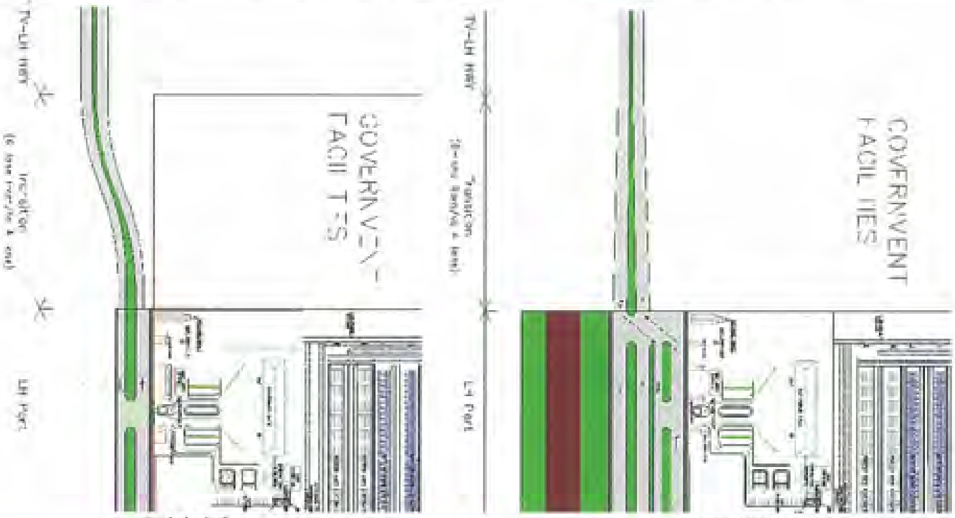


Figure 11.4.5 General Layout of Road and Railway behind Terminal



Initial Stage　　Future Stage

Figure 11.4.6 Connection Portion Detail of Port Road and Cat Hai Access Road (2015 & Future)

11.5 Port Protection Facilities

11.5.1 Outer Revetment

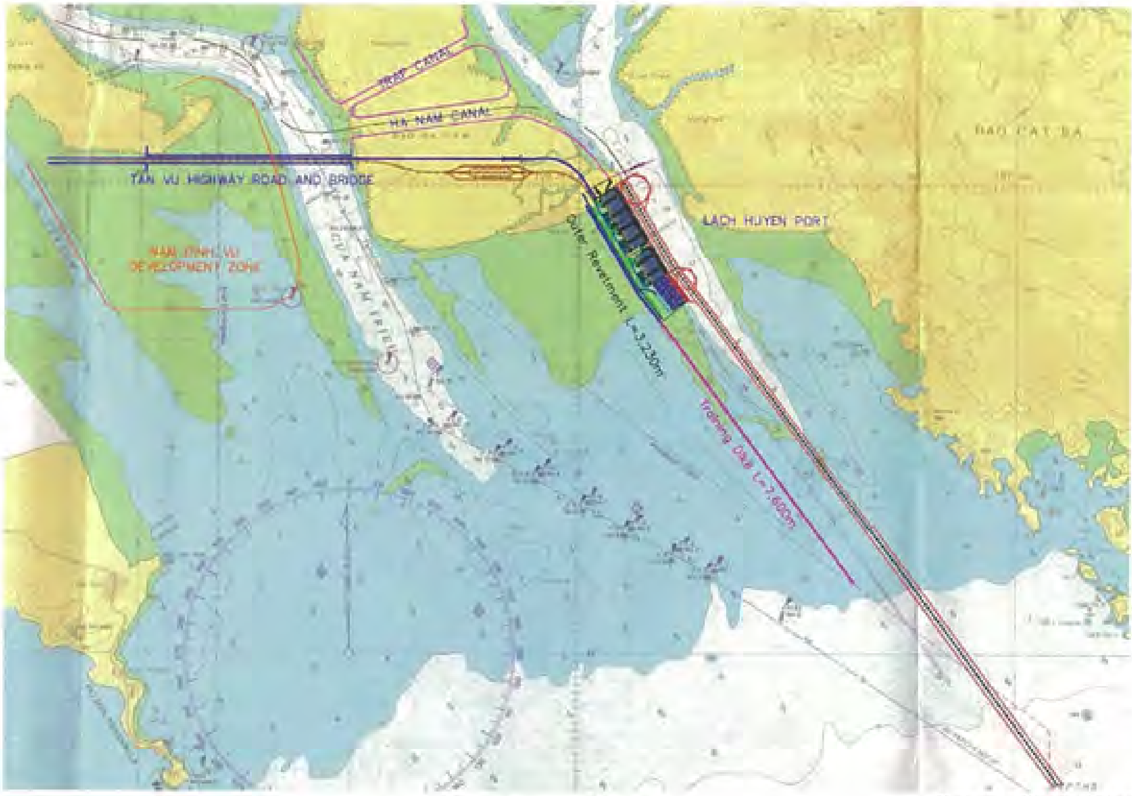
Almost once a year, Lach Huyen offshore area is subject to extreme wave attack which is generated by tropical typhoon. Therefore, it is essential that outer peripheral revetment of the reclamation area is protected as Seawall which is properly designed and constructed against to the extreme wave attack with provision of armored protection by wave-dissipating precast concrete units.

This seawall type of structure is required for 3,230m along the west side of reclamation area including future developing area by the year 2020. But, the south side area of the reclamation is provided with a sloped revetment armored by relatively smaller size of rocks for a length of around 750m once this water area shall be sheltered by offshore training dyke construction.

11.5.2 Sand Protection Dyke

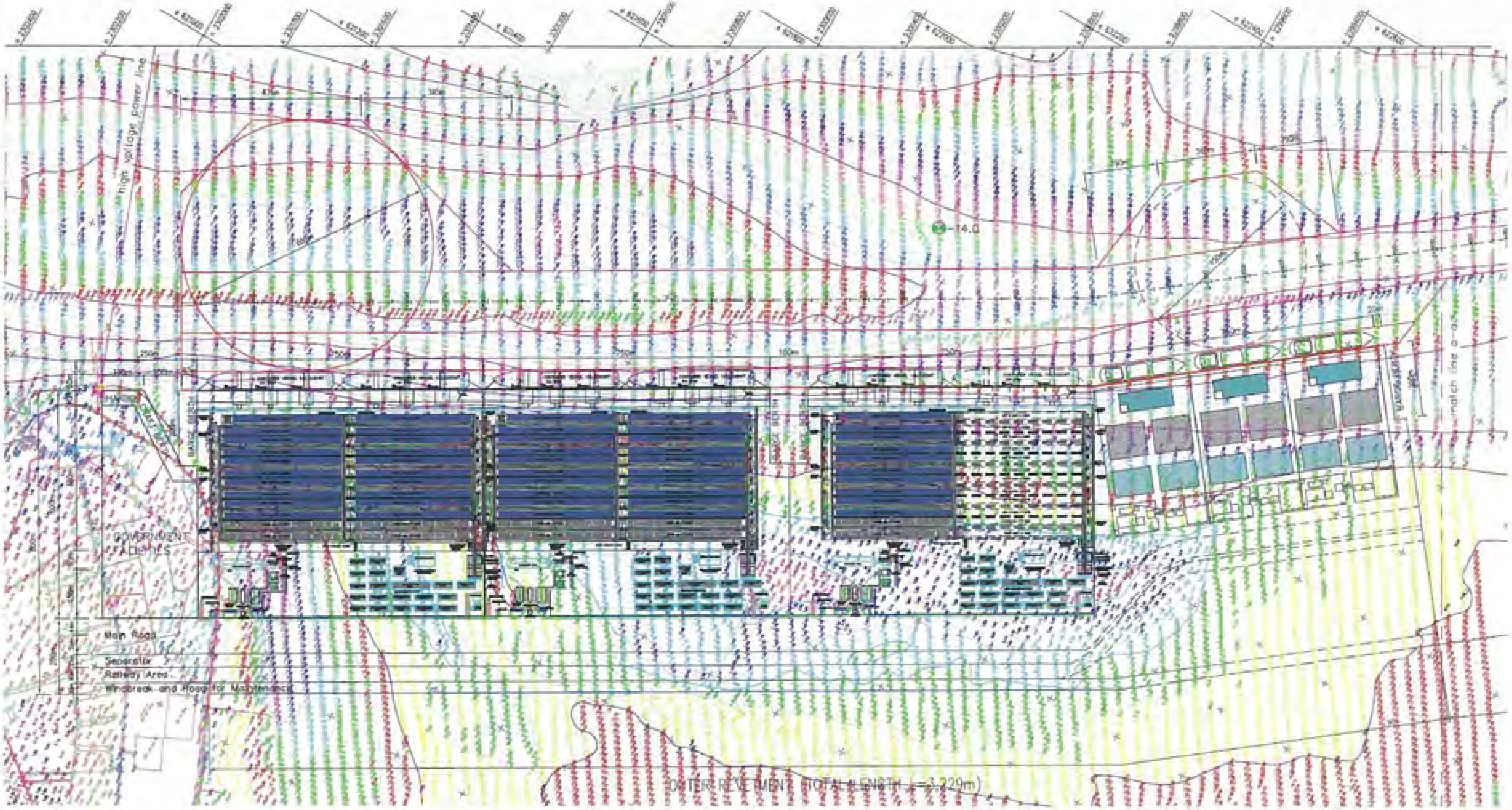
A dyke is provided on the same alignment of the outer revetment to protect the access channel from sedimentation of sand. It is recommended that the dyke is non-permeable type of structure with provision of enough stability against for extreme wave action. Based on the sedimentation simulation study results presented in Chapter 8, it is determined that the top elevation of dyke is positioned to be +2.00m above CDL to trap sand transportation and properly function as breakwater to shelter access channel water area and the dyke is extended up to sea bottom elevation of -5.0m CDL for a length of around **7,600m.**

Proposed general port layout plan which shows alignment of access channel and port protection facilities is illustrated in Figure 11.5.1, and Container and Multipurpose terminal layout plan is presented in Figure 11.5.2 and Figure 11.5.3.



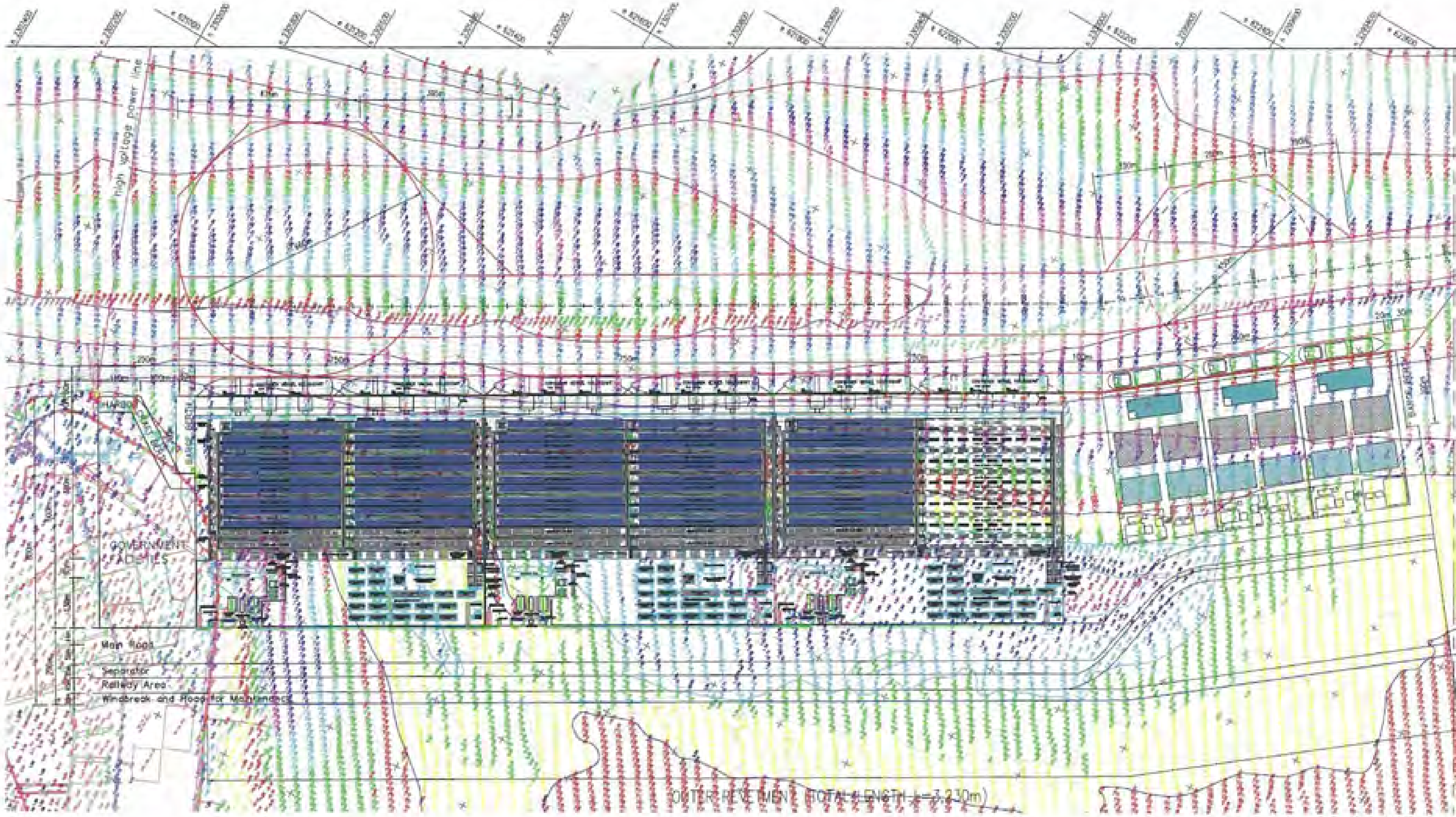
Source: Study Team

Figure 11.5.1 Development Layout Plan



Source: Study Team

Figure 11.5.2 General Layout Plan of Terminal Facilities (Alternative 1: Barge Berth Basin is arranged)



Source: Study Team

Figure 11.5.3 General Layout Plan of Terminal Facilities (Alternative 2: Barge Berth Basin is not arranged)

11.6 Port Layout Plan

11.6.1 General Port Layout

1) General Layout of Container Terminal

The layout for the container terminal conceived while bearing in mind the efficiency and safety of terminal operations in order to achieve maximum terminal output at reasonable cost. Road traffic in Vietnam is anchored on the "keep right lane rule". It is desirable to keep traffic direction for vehicles in the yard in one way, and road marks and boards to show the right way clearly.

a) Quay Length and Width

A 750 m long berth is adopted to accommodate the simultaneous mooring of two Post Panamax type container vessels. The berthing length at 750 m is inclusive of the mooring bit structures to be provided at both ends of the berthing facility. Seven hundred fifty meters long quay will be provided with a 50 m wide of the berthing structure. Along the north edge of terminal a barge berth of 200m long and 30m wide is secured.

b) Apron width

The apron is 50 m wide and is to be provided with Crane rails 30 m in gauge for the installation of quayside gantry cranes to cater for container handling operations of Post Panamax type vessels. Sufficient space will be provided at the back of gantry cranes land-side rail for the placing of the vessel's hatch covers, and for 4 truck lanes.

c) Container Yard

For efficient container handling operations, the stacking yard will be rectangular in shape. Each dry container lane has two 47 bays with 6 slots stowage space except north-east block and reefer container blocks. One container lane consists of 6 container bays and 1 truck lane under the RTG, of which tire spun is standard 77 feet or 23.47m.

The whole yard will be divided into two, north and south yards. Each yard will include 10 dry container lanes and 2 reefer container lanes.

Three RTG traversing passages will be provided at both ends and among the north and south yard. One reefer container lane has 17 bays with 6 slots only for 40 ft in one block. In case that 20ft reefer container is stowed, the remaining 20 feet length will be intentionally left vacant. Dry containers will be able to be stacked 4 tier-high containers, and reefer containers 2 tier-high.

Total Ground Slots for dry container are:

(47 + 47) bays × 9 lanes × 6 Slots =	5,076 TEU	
(43 + 47) bays × 1 lanes× 6 Slots =	540 TEU	Total 5,616 TEU

Reefer Container Ground Slots for 40 ft are:

16 bays ×4 lanes × 6 Slots =	384 FEU	
1 bay × 4 lanes × 3 slots =	12 FEU	Total 396 FEU

Naturally dry containers can be stored in reefer container lanes on demand.

d) RTG Traversing Passage

The traversing passages for the RTGs will be provided for easy transferring to another lane and to RTG maintenance area. The extreme south end traversing passage will reach close to the maintenance shop up to the maintenance depot of the RTGs.

e) RTG Repairing Depot

A depot will be provided closed to the maintenance shop to cater for the maintenance of RTGs. In the depot, other equipment and yard vehicles can be repaired and washed in addition to the RTGs. The perimeter of the depot will be provided with a trench as a measure against oil spillage. Bilge that has accumulated will be deposited onto a waste water treatment plant, and purified by the equipment here.

f) Reefer Receptacles

Each two reefer lanes in 2 blocks with 17 bays of 40 ft refrigerated containers will be provided electrical receptacles to provide power supply for two-tier stacked containers. All spaces are for 40 foot reefer containers in length, and will be secured with door-opening spaces for contents inspection. Twenty foot reefer containers will be also stored here with another 20 feet of vacant space.

g) Empty Container Depot (ECD)

An empty container depot will be provided outside of the stacking yard in a separate area in the container terminal. The space can be secured in the south of the terminal office building where respective container blocks for owners, and kinds and type of containers. A maintenance shop is located in the vicinity of empty container yard and dirty containers can be washed on clients' request here. The containers returned from consignees for delivery to shippers will be stored in sound condition for delivery.

h) Container Checking Gate

The checking gate is the dividing point of responsibility between the terminal side and cargo side. Container inspectors are tasked to examine outlook conditions of the containers and to check whether the container seals are intact on the container doors or broken. The checkers together with the truck drivers will verify the condition of the container and seals for any damage, and confirm contents on Equipment Interchange Receipt (EIR) with signature, whereas for the reefer containers, their inside temperatures will be confirmed by checkers and drivers.

Each gate lane will be provided with a processing booth to be installed on the elevated platform alongside the checking lanes. Weighing scales will be installed in certain selected In-lanes for checking of cargo payload of containers, for compliance with safety requirements and the formulation of the stowage plan on board the vessel to be prepared by the GM and individual discharging ports. The checking gate will be provided with overhead catwalks to facilitate the inspection of container roofs by checkers.

Open wide area will also be provided on the checking gate side to cater to oversized or huge cargo, and heavy equipment and machineries that cannot not pass through the checking gate lane and free trailers after the container delivery in the yard.

i) Terminal Operations Office

This building, which will be connected by passage with the terminal main gate, will house terminal operation personnel except for those involved with maintenance and stevedores. Both departments have their own offices separately in the terminal. The terminal office will be provided with compartments for members of the managing unit, documentation department, operation department, and computer facilities among other amenities to facilitate the 24 hours continuous operation of the terminal.

The office will be provided with parking spaces for customers including shippers, consignees, customs brokers, forwarders and truckers.

j) Container Freight Station (CFS)

No CFS is considered to be built inside of the container terminal at present. There are many ID, IZ, and independent industrial zones in suburbs of Hanoi and Hai Phong, in where several logistic companies have their own bonded warehouses. Cargos will be stuffed/unstuffed and delivered there on request from the factories and traders in the area. Consolidation of cargo is one of the important roles for them. It seems that most container cargos will be carried as CY containers from/to the terminal.

k) Maintenance Shop

The container terminal will be provided with a "maintenance shop" for repair and maintenance of all yard equipment and facilities including vehicles used in the terminal. The shop will be equipped with an overhead crane for lifting heavy objects and a trench-pit for the inspection of the under-flooring of vehicles.

Similarly, the RTGs will be maintained in RTG anchoring area.

Electricians will monitor the required temperature of reefer containers that are stacked in the reefer container lanes.

Office, spare parts stores, various repairing machines, and other amenities for persons in charge of maintenance will be secured in the shop. The shop has a partial 2nd floor for office, technicians' amenity. Showers corner and washing area are separately at ground floor.

Refer to the proposed layout plan of container terminal shown in Figure 11.6.1.

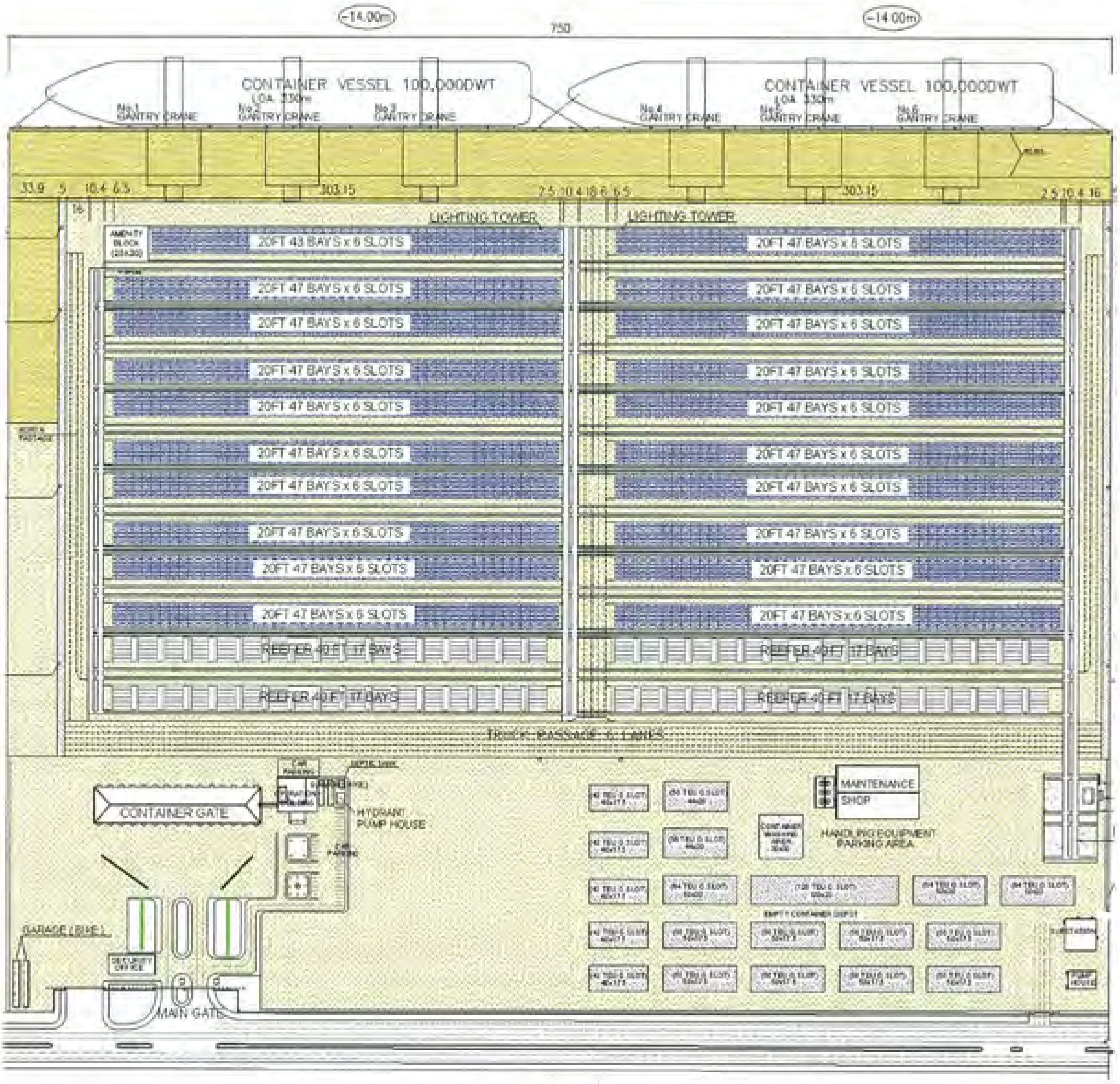


Figure 11.6.1 Layout of Container Terminal

2) General Layout of Multipurpose Terminal

General layout plan of multipurpose terminal in Lach Huyen Port is prepared considering the following issues.

Main general cargos discharged and loaded in Lach Huyen Port are mainly machinery & equipment, manufactured goods, ores for export and importing logs & timbers, gravel and grain.

The points for handling these cargos in the multipurpose terminal are described as follows:

- General cargo, non-containerized: To be discharged by ships' gears and jib cranes and carried into the sheds.
- Logs & Lumbers: To be carried to open yards by forklifts or trucks.
- Cargo in bulk: To be carried by belt conveyors through hoppers to the shed, or by truck to open yards. Gravel is carried to the open yard by dumping trucks.
- Containers: To be discharged by jib-Cranes and carried by trailers to open yards for stacking.

- Ore: excavators/declaimers to scoop ore to pour into hoppers, and belt conveyors to carry to ships hold.

a) Quay Length and Width

A 250 m long berth is adopted to accommodate the 50,000DWT type general and bulk cargo vessels. The berthing length at 250 m is exclusive of the mooring bit structures to be provided at both ends of the berthing facility. Two hundred fifty meters long quay will be provided with a 38 m wide of the berthing structure. The barges go on berth at the vacant space of the berth.

Two jib-type rail-mounted shore cranes of which rail spun is 20m are installed on each multipurpose terminal. One of them has the 45tons lifting capacity and the other has 20 tons. They are useful for handling containers with spreader, and cargo in bulk with buckets for assistance of ships' gears.

b) Apron Width

Considering the various kind of cargo type including containers from/to semi-container vessel to be handled in this terminal, apron will be better to have a wide space between transit shed and 50m was allocated.

c) Transit Shed

A transit shed is provided behind the apron with the area of 7,000 m^2. Four openings are settled along the quay side with lifting shutters; two double doors are in both gable ends, and two in the opposite side of the quay in the transit shed for easy cargo handling and truck passing. The floor of the shed keeps the same level as the apron.

When general cargos on pallets are stowed in this shed, the total storage capacity will be 10,917tons as following calculation.

The valid space in the shed: 7,000 m^2 – (Office and Substation Space) = 6,550 m^2
Half is to be deducted for forklift moving passage: 6,550 m^2 × 0.5 = 3,275 m^2
Pallet size: 1.8 m^2 (1.2 m × 1.5 m), 2 tons cargos on a pallet, and 3 tiers to be stowed.
Total storage capacity: 3,275 m^2 / 1.8 m^2 × 3 tiers × 2 tons = 10,917 tons

When bulk cargos are stowed in the shed, they will be poured from the vessel side into the shed by belt conveyor, and made conic piling. The side walls of the shed inside are to be strengthened by stations and protected panels.

The stanchions, the walls and the windows of the shed should be protected from the cargo stored to be piled inside. About 2m high brick from the floor will sustain grain piled inside in order to stow it for silos.

d) Open Storage

Four separated open yard sections will be provided to stow main/lot cargo, ore, logs & lumbers, and iron & steel goods. Some cargos will need provisional canvas covers in protection from rain.

On both end-side of the transit shed, broad passage will be secured in order to carry long length goods like as logs & lumbers, and steel pipes on forklifts.

e) Terminal Office

A terminal office will be provided with separated compartments for related organizations, which consist of terminal management/administration and documentation.

f) Amenity Block

An Amenity Block is necessary for stevedores to rest and stand by for following duties, including at night time. The building includes various amenity facilities such as a dining room, rest rooms, etc.

g) Maintenance Shop

A Maintenance Shop is indispensable to maintain equipment in good condition. The shop is furnished with ceiling cranes of 7-10 tons, spare part shelves and an engineer's office. In addition, a special treatment facility for oil leakage will be required around the shop.

The layout plan of multipurpose terminal is presented in Figure 11.6.2.

3) Arrangement of Terminals

In TEDI's FS, the face lines of general cargo berths and bulk cargo berths were planned to be bent in U-shape. This plan has some advantages such as saving reclamation area and effective use of the waterfront along the access channel, however, this plan has also some disadvantages which make impossible to use full length of each berth. If face lines of neighboring berths are arranged in straight line, various lengths of ships can be berthed with minimum vacant berth space. Therefore, the berth arrangement of multipurpose terminal is proposed to be straight in this study.

Regarding the arrangement of container berths and multipurpose berths, it is preferable that the shallower berths, multipurpose berths shall be located landside of channel and the deeper berths, container berths shall be arranged in offshore side. However, in this study the container berths for medium term development are arranged landside and multipurpose berths are arranged in offshore side of the container berths by the following reasons, (1) the first 2 container berths are planned to be constructed at the beginning but initial investment cost become high if these berths are arranged offshore side, (2) the difference of depths of both kinds of berths is not so much only one meter, (3) TEDI's FS which was already approved by GOV adopted such arrangement.

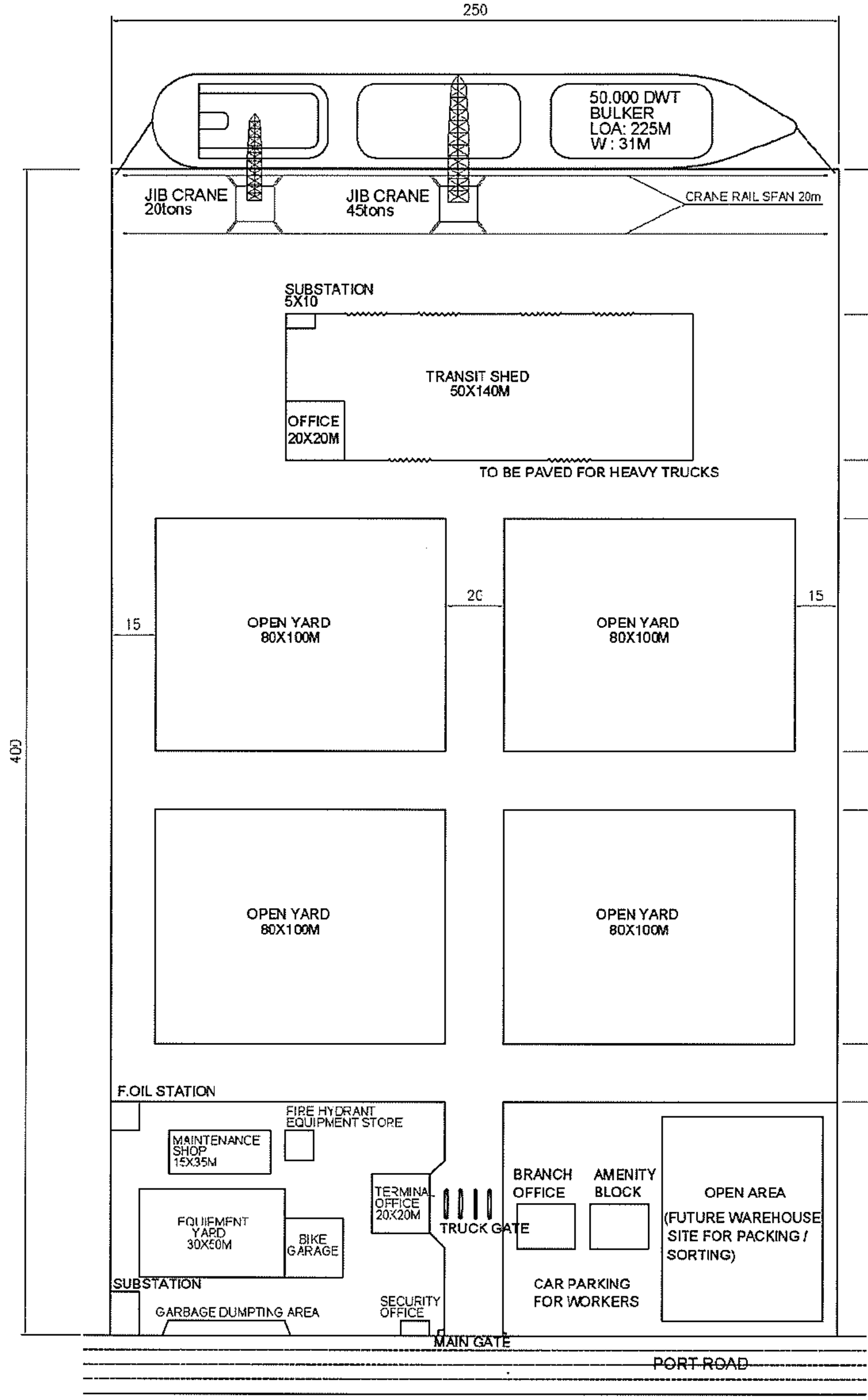


Figure 11.6.2 Layout of Multipurpose Terminal

11.6.2 Access Channel

1) Alignment of Access Channel

In this SAPROF study, an additional bathymetric survey around the existing Lach Huyen access channel was conducted in November 2009. The survey results showed that nevertheless no maintenance dredging for the existing Lach Huyen access channel haven't been carried out after 2006 when this channel was newly developed under the Hai Phong Port Rehabilitation Phase 2 Project, the deepest water is still located almost in the center of access channel. From this situation, there is no reason to rearrange or modify the alignment of existing access channel.

However, as mentioned in 11.3.7, the distance between quay and access channel should be reduced from original distance of 260m to proposed distance of 150m. This reduction of distance can be achieved by 2 options, i.e., one is to shift the face line of quay to channel side and another one is to shift channel alignment to quay side. Even latter case no significant influence for ship navigation or sedimentation phenomenon is anticipated since the alignment shifting area has wide enough deep water.

Therefore, above 2 options were compared by the construction cost regarding reclamation work and dredging work, and concluded that it is economical to keep face line of quay as TEDI's plan and to shift channel alignment westwards by 110m at berth No.1 point.

Therefore, the upstream side of channel alignment from existing bending point of Lach Huyen channel will be realigned by 2 degree westward.

2) Direction of Future Widening

Considering the number of ship calls to Hai Phong ports and Lach Huyen port and to minimize the capital and maintenance dredging costs, this channel will be developed as one lane channel at first and when number of ship calls will increase, the channel must be widened to two lanes channel. In such a case, it will be no problem to widen the channel to eastern wards, since future berth development will be done along the western side of access channel and the center of water flow of channel will gradually move to eastern side.

On the other hand, it is not recommendable to widen the access channel so much to the Cat Ba Island side because there are some possibilities that the rock will appear in seabed subsoil in the vicinity of island. However, it is not anticipated that such situation will no occur because required widening for two lanes channel will be about 100m only. To assure this issue, it is recommendable to carry out a seismic exploration during the field investigation for detailed design stage.

3) Turning Basin

In front of berths, the turning basin having a diameter of two times of LOA of berthing /deberthing vessel is required. Since Lach Huyen access channel is one lane and its navigation capacity is restricted, there is an idea that the turning basin should be arranged not to overlap with access channel in order to secure the navigation capacity of access channel.

However, as analyzed in previous section, it was proved that this Lach Huyen channel have an enough navigation capacity for the calling vessels in year 2020, even if turning operation will disturb the navigation of other vessels. The idea which arranges turning basin without overlapping access channel will require larger volume of capital dredging and following maintenance volume as well. Therefore, in this study this idea was discarded and the plan which turning basin is arranged to overlap with access channel as adopted in Hai Phong ports and Saigon ports at present.

12. Conceptual Design and Cost Estimate

12.1 Conceptual Design

12.1.1 Dredging Access Channel

1) Subsoil Profile

Present access channel is deepened to a water depth CD-14.0 m wide in Initial development to allow larger size of vessels to approach the Lach Huyen New Gateway port.

Subsoil data on borings KL1 to KL15 (located along the bottom of access channel) by TEDI Port Subsoil investigation (Nov. 2007) indicates that:

(1) The subsurface sediments to the depth of CD −14m are mostly very soft to soft, plastic and unconsolidated silty or clayey deposit of low liquid limit (CL or ML) with 60 to 85% of materials in particle distribution range of silt (0.075 to 0.005 mm) and clay (less than 0.005mm).

(2) But, at a certain depth of the area from KL5 (X=2,298,061, Y=622,752) to KL 8 (X=2,295,652.9, Y=624,540.1 according to VN200 Co-ordinate System) for around 3 km along the access channel way, the subsurface deposits are fine granular sandy soils of the particle range of 0.5 mm to 0.1 mm by 50 to 80% of content.

No SPT N-value is available for borings KL1 to KL15. But, according to the subsoil data along the access channel, the subsurface clayey deposit is classified as clay or silt of which consistency is very soft to stiff having N-value in a range of 1 to 15 to the depth of CD-15m.

The sea bottom sediment to be dredged is mostly clayey soil but its consistency may differ from very soft to stiff, although SPT N-value was not obtained by a series of the previous subsoil investigation works carried out for the Project. Dredgeability of Lach Huyen access channel dredging is likely to be good and it is expected that fairy high production rate of dredging work could be achieved. The physical properties of the seabed materials to be dredged may require a deployment of Trailer Suction Hopper Dredger (TSHD) or Cutter Suction Dredger (CSD) or its combination dependent upon difference in subsoil nature of various strata and places.

2) Side Slope for Dredging

The stability of underwater slope for dredging depends upon the physical properties of the seabed subsoil and seawater conditions at the dredging site.

As recommended in Chapter 11, a slope in 1 (V) to 10 (H) is applied for capital dredging work to deepen Lach Huyen access channel to the depth of CD-14m in initial development. This may be derived from considerations to Vietnamese Standard as for the soil nature of Plastic Mud, Sandy Clay, Dusty Clay (1 to 7-10) or about 2-time of the value (1 to 3-4) as for the soil Clay and Sandy Clay—soft and plastic in the case of channel depth more than 5m as indicated in Table 11.3.6: Side Slope of Channel by Vietnamese Standard in Chapter 11.

The stability of underwater slope for dredging depends upon the physical properties of the seabed subsoil and seawater conditions at the dredging site. The typical side slopes for various types of subsoil are given in Vietnamese or Japanese Standard as follows.

Hon Dau Station records (3-year period from 2006 to 2008) shows that wave height less than 1.0 m occupies 91.4% of occurrence. Since the site water environment is normally calm with no significant wave actions or strong currents except in occasional rainstorm weather, the design dredging slope of

1(V): 10 (H) could be considered moderate in the planning stage and is expected to be likely stable. Previous study also applied a side slope of 1 (V): 10 (H). Submerged subsurface deposits are not fully consolidated and of relatively low density, and may not be stable during extreme dynamic marine environment such as storm weather. Though the average angle of repose of side slope is dependent primary upon the nature of the materials on the side slope and the manner in slope cutting, there may be resulted in side slope slumping down over time to the average angle of repose in more gradual slope. Therefore, the dredged slope in 1 to 10 for capital dredging might require recurrent maintenance dredging.

3) Use Dredged Materials in Reclamation

Material suitable for fill materials for reclamation will be well-graded, free-draining sand with a particle size distribution in the range of around 0.1 to 1.0mm. Sand mixed with gravel may be also suitable.

In view of the above, the dredged material from access channel is generally not suitable for the use of reclamation fill and therefore the bulk of the dredged soils should be disposed at designated offshore dumping site. But, the sandy materials at a certain depth in the area where KL5 to KL 8 borings were carried out could be considered as being suitable for use in reclamation fill. Once strict inspection and quality control on the dredged materials shall be exercised, reclamation fill may allow the use of these dredged materials which are sourced from a certain depth of the area where KL5 to KL 8 borings were located.

12.1.2 Natural Conditions for Port Facility Design

The design criteria were determined for the purpose of executing preliminary design works for the Project. In the process of determination of design criteria, primary design criteria proposed by the previous studies were carefully reviewed.

Chapter 7 of this report summarizes data and information on meteorology, oceanography and subsoil that were derived from the previous study report collected or supplementary obtained through the site survey and investigation during our 1st Field Survey. Based on these data and information, and the study on such design code of practice as British & Japanese Standard, meteorological, oceanographic and subsoil conditions are interpreted to produce key parameters in common use for the purpose of designing port facility components of the Project.

a) Tides

HHWL	: CD + 4.43m
HWL	: CD +3.55 m
MWL	: CD +1.95 m
LWL	: CD +0.43 m
LLWL	: CD+0.03 (observed on January 2, 1991)

Note: CD referred and equals to Chart Datum which is nearly the level of Lowest Astronomical Tide.

b) Waves

Deep Offshore Wave
50 Years in Return Period

Wave Height	Hs = 5.6 m
Wave Period	T = 11.6 sec
Predominant Wave Direction	S to E

For offshore waves less than 50-year return period, the following waves are used.

Table 12.1.1 Offshore Waves

Return Period (Yr)	Wave Height (m)	Wave Period (Sec)
1	1.22	5.8
5	3.18	8.9
10	3.71	9.7
30	4.45	10.8

Wave Period: estimated by the relationship T=1.5539H+3.9222
(Source: Report on Port Capacity Reinforcement Plan in Northern Vietnam: Nippon Koei Co., Ltd. & Associates, September 2009)

c) Design Seismic Coefficient for Quay Wall Structure

Horizontal Design Coefficient kh = 0.00g
Vertical Design Coefficient kv = 0.00g

Special consideration to TCXDVN leads to apply Level 3 (kh=0.04 or less for the projected area among 3 seismic activity levels in Vietnam. This criteria needs to be paid for evaluation of seismic effects on earth pressures of subsoil around marine structures and foundation for onshore structures. But, since the regional earthquake activities in and around the project area are deemed to be negligible, possible seismic effect on structures' stability will be neglected in this Study.

d) Wind Velocity

Design Wind Velocity 60 m/sec
Wind in Operation 20 m/sec

e) Subsoil Conditions

A series of offshore boring works was carried out at the Project as presented in Chapter 7. The design property of existing subsoil for each proposed facility is determined based on the subsoil data collected from each boring work at the relevant location as follows.

Table 12.1.2 Boring Data for Each Facility

Port Facility	Boring Data
Container Berth:	B-4 (Jan. 2009) and KB1 & KB3 (Nov. 2007) by TEDI Port
Multi-purpose Berth:	KB7 (Nov. 2007) by TEDI Port
Reclamation Area & Revetment:	SBH-1 to 4 (JICA Study Team) and KB2 & KB4 (Nov. 2007 by TEDI Port)
Sand Protection Dyke:	SBH-8 to 10 (JICA Study Team)

Table 12.1.3 Soil Properties along Container Berth

Layer	Depth (CD)	Soil Properties
Upper Clay	GL to-10m	Soft Clay, N=1-3, N_{av}=2, Unit Weight γ' =7 kN/m^3 q_u=44kN/m2, C= 22 kN/m^2, Lateral Pile Resistance Kh=3 N/cm^3
Middle Clay	-10 to -13m	Stiff Clay, N=8-17, N_{av}=13, Unit Weight γ' =9 kN/m^3 C= 100 kN/m^2, Lateral Pile Resistance Kh=20 N/cm^3
Lower Clay	-13 to -21m	Firm to Stiff, N=6-9, N_{av}=7, Unit Weight γ' =8 kN/m^3 q_u=88kN/m^2, C= 44 kN/m^2, Lateral Pile Resistance Kh=10 N/cm^3
Base Siltstone	> -21m varies	Very Dense, N>50, q_u=30 N/mm^2

Source: JICA Study Team

Table 12.1.4 Soil Properties along Multi-Purpose Berth

Layer	Depth (CD)	Soil Properties
Upper Clay	GL to-13m	Soft Clay, N=3, Unit Weight γ' =7 kN/m^3 C= 30 kN/m^2, Lateral Pile Resistance K_h=4.5 N/cm^3
Middle Clay	-13 to -26m	Stiff to Very Stiff Clay, N=8-23, N_{av}=17, Unit Weight γ' =9 kN/m^3 C= 100 kN/m^2, Lateral Pile Resistance Kh=20 N/cm^3
Lower Clay	-26 to -28m	Firm to Stiff, N=4-9, N_{av}=7, Unit Weight γ' =8 kN/m^3 C= 44 kN/m^2, Lateral Pile Resistance K_h=10 N/cm^3
Base Siltstone	> -28m varies	Very Dense, N>50, q_u=30 N/mm^2

Source: JICA Study Team

Table 12.1.5 Soil Properties at Reclamation Area & Revetment

Layer	Depth (CD)	Soil Properties
Subsurface Sand	+0.5 to -1.0m	Loose, N=5, Unit Weight γ' =10 kN/m^3, ϕ=25°
Upper Clay	-1.0 to -9m	Soft Clay, N=2-5, N_{av}=3, Unit Weight γ' =7 kN/m^3 q_u=44kN/m^2, C= 22 kN/m^2 Consolidation e-logP Curve: C1, Cc=0.65, Cv=65cm^2/day
Middle Clay	-9 to -12m	Stiff Clay, N=8-15, N_{av}=13, Unit Weight γ' =9 kN/m^3,C= 100 kN/m^2 Consolidation e-logP Curve: C2, Cc=0.25, Cv=87cm^2/day
Lower Clay	-12 to -27m	Firm to Stiff, N=4-7, N_{av}=6, Unit Weight γ' =8 kN/m^3 q_u=88kN/m^2, C= 44 kN/m^2 Consolidation e-logP Curve: C3, Cc=0.54, Cv=89cm^2/day
Base Siltstone	around -27m (varies)	Very Dense, N>50, q_u=30 N/mm^2

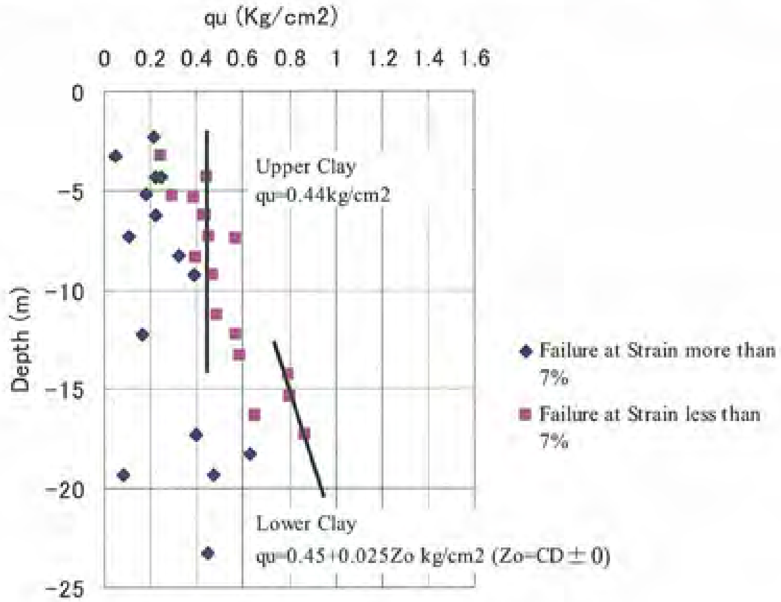
Source: JICA Study Team

Laboratory test on the undisturbed samples shows the following Unconfined Compression Strength (q_u).

Table 12.1.6 Uni-axial Compression Test Result

BH	Depth (m)	Layer	qu (kg/cm^2): failure at strain	
			Less than 7 %	More than 7%
Reclamation Area				
SBH1	2.0-2.6	Upper Clay		0.218
	4.0-4.7	Upper Clay		0.246
	6.0-6.6	Upper Clay		0.222
	8.0-8.6	Upper Clay		0.326
	13.0-13.6	Upper Clay	0.588	
	15-15.6	Lower Clay	0.803	
	17.0-17.6	Lower Clay		0.402
	19.0-19.6	Lower Clay		0.471
	23.0-23.6	Lower Clay		0.449
SBH2	4.0-4.6	Upper Clay	0.444	
	6.0-6.6	Upper Clay	0.429	
	17.0-17.6	Lower Clay	0.872	
SBH3	5.0-5.4	Upper Clay		0.185
	7.0-7.6	Upper Clay	0.453	
	9.0-9.6	Upper Clay	0.475	
	11.0-11.6	Upper Clay	0.492	
	19.0-19.6	Lower Clay		0.087
SBH4	3.0-3.6	Upper Clay	0.247	
	5.0-5.8	Upper Clay	0.393	
	7.0-7.8	Upper Clay	0.571	
	18.0-18.5	Lower Clay		0.629
Revetment B/Sand Protection Dyke				
SBH5	3.0-3.6	Upper Clay		0.049
	5.0-5.6	Upper Clay	0.298	
	7.0-7.6	Upper Clay		0.106
	9.0-9.6	Upper Clay		0.390
	12.0-12.6	Upper Clay	0.568	
SBH6	4.0-4.6	Upper Clay		0.220
	6.0-6.5	Upper Clay	0.439	
	8.0-8.8	Upper Clay	0.394	
	12.0-12.6	Upper Clay		0.168
	14.0-14.6	Lower Clay	0.796	
	16.0-16.6	Lower Clay	0.655	
Average		Upper Clay	0.45 (= 44.1 kN/m^2)	
		Lower Clay	0.78 (= 76.4 kN/m^2)	

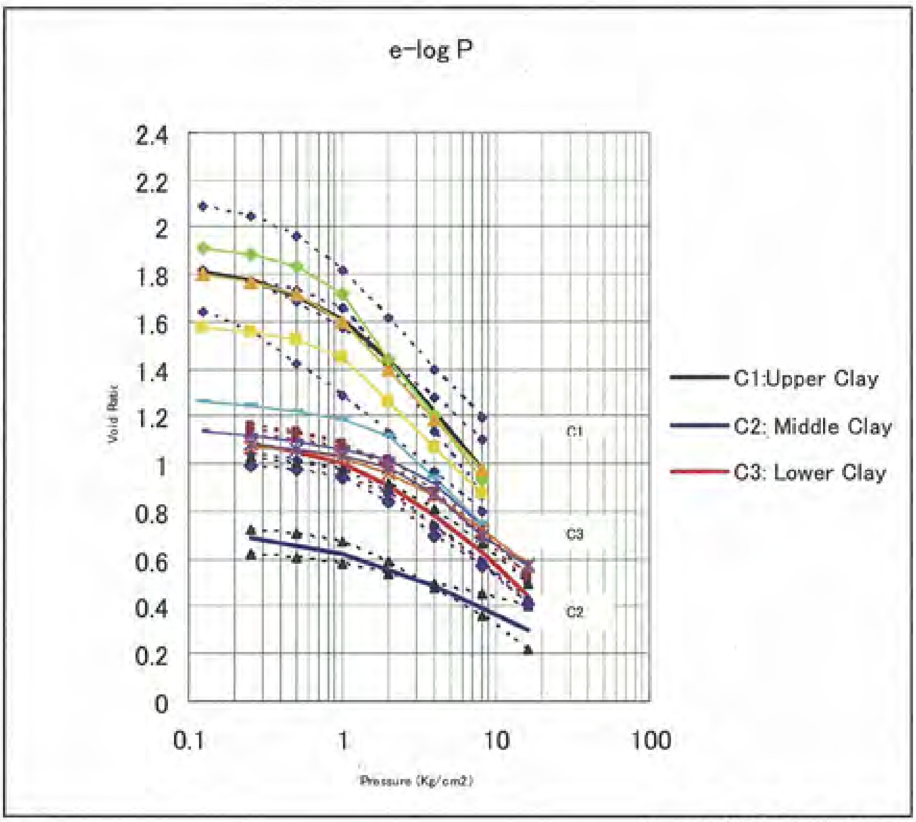
Source: JICA Study Team



Source: JICA Study Team

Note: Data on Boring No. SBH1~6 at Reclamation Area

Figure 12.1.1 Uni-axial Compression Strength vs. Depth



Source: JICA Study Team

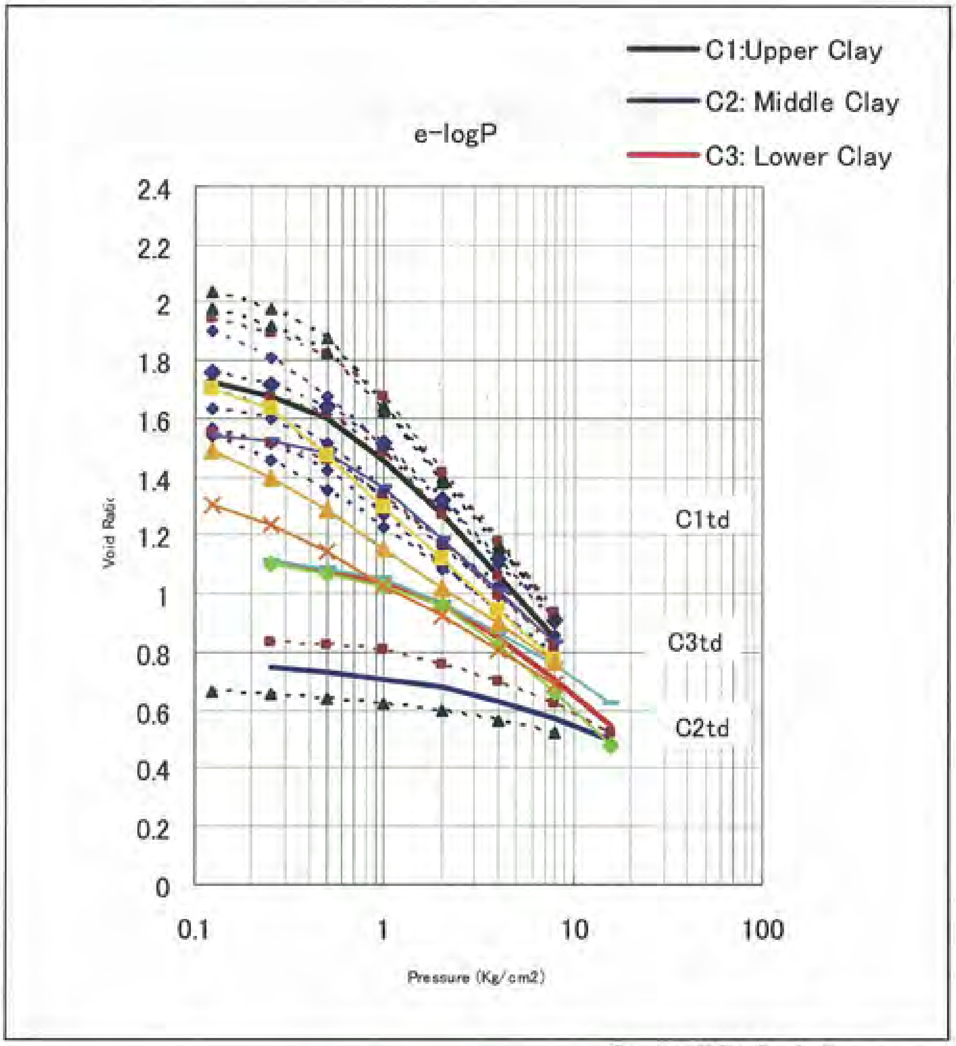
Note: Data on Boring No. SBH1 to 4 at Reclamation Area

Figure 12.1.2 e-log P Curve

Table 12.1.7 Soil Properties along Sand Protection Dyke

Layer	Depth (GL)	Soil Properties
Subsurface Sand	GL to -2.0m	Loose, N=7, Unit Weight γ' =10 kN/m^3, ϕ=25^o
Upper Clay	-2.0 to -8m	Very Soft Clay, N=0-2, N_{av}=1, Unit Weight γ' =7 kN/m^3 q_u=44 kN/m^2, C= 22 kN/m^2 Consolidation e-logP Curve: C1td, Cc=0.65, Cv=65cm^2/day
Clayey Sand	-8 to -11m	Loose Sand, N=3-8, N_{av}=6, Unit Weight γ' =10 kN/m^3, ϕ=25^o
Lower Clay	-11 to -16m	Firm Clay, N=3-6, N_{av}=5, Unit Weight γ' =8 kN/m^3 q_u=88kN/m^2, C= 44 kN/m^2 Consolidation e-logP Curve: C3td, Cc=0.54, Cv=89cm^2/day
Base Layer	> -16m varies	Stiff to Very Stiff, N=13-21, N_{av}=18, Unit Weight γ' =8 kN/m^3 C=110 kN/m^2

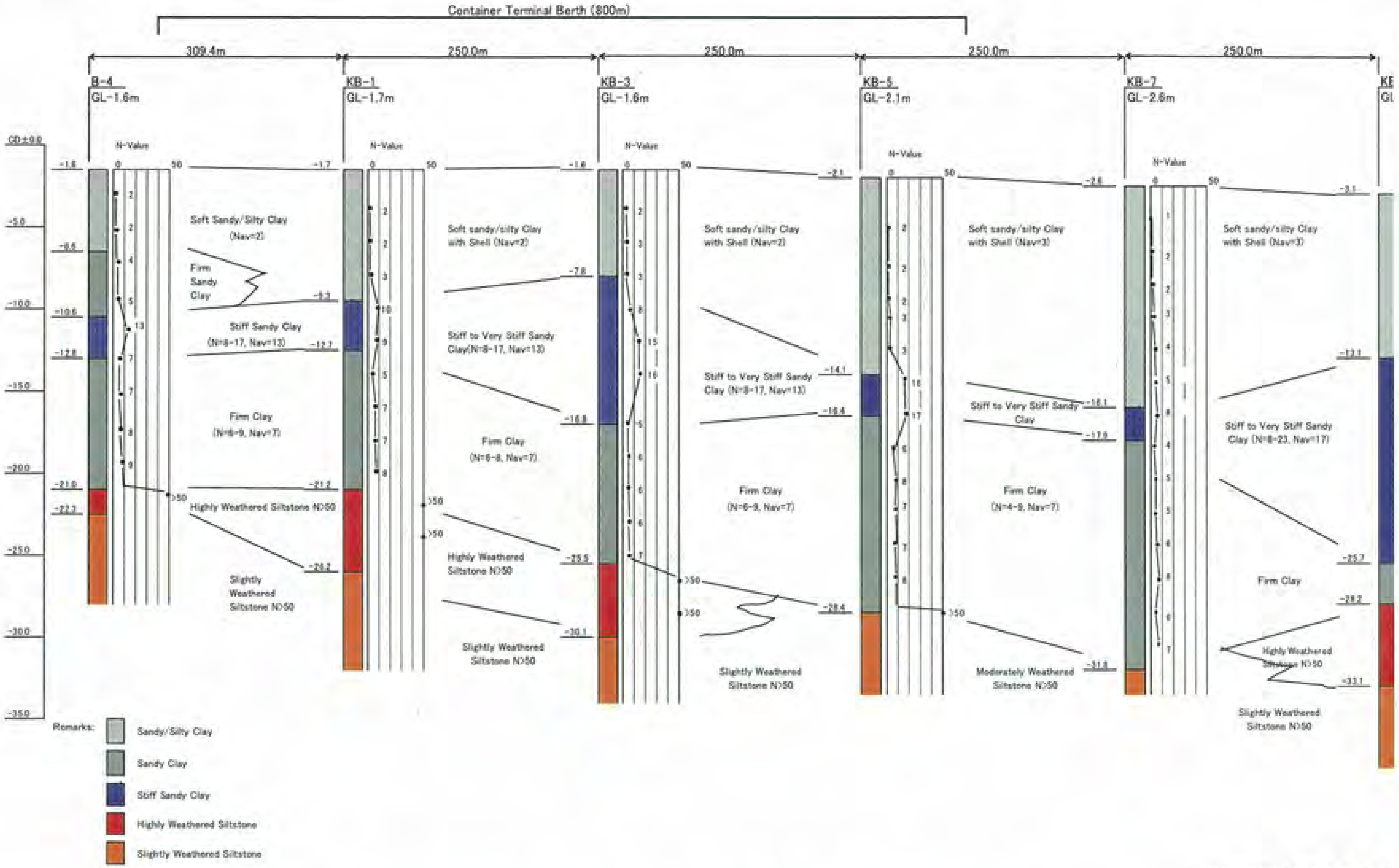
Source: JICA Study Team



Source: JICA Study Team

Note: Data on Boring No. SBH5 to 10 along Alignment of Sand Protection Dyke

Figure 12.1.3 e-log P Curve (Clay along Sand Protection Dyke)



Source: JICA Study Team

Figure 12.1.4 Subsoil Profile Along the Proposed Faceline of Berth

12.1.3 Land Reclamation and Revetment

1) Reclamation Fill

Reclamation area is planned to fill up to CD +5.5 to +6.0m. It is proposed that materials for reclamation fill will be sourced from river sand dredging. The materials may contain some amount of silty or clayey soils, but even though, considerable losses of materials finer than 0.1mm may occur during dredging, handling and placing. The materials with large amount of coarse sands more than 1.0 mm particle may not be properly conveyed through hydraulic pipeline for dredging. Fine materials have a tendency to segregate during hydraulic placing method for reclamation.

Because of the use of granular fill materials, even if these materials are placed through the hydraulic method, the settlement is normally rapid or instant once the surcharge load is applied. Any soil improvement techniques to accelerate the process of consolidation of the reclamation fill materials will not be required.

2) Consolidation Settlement by Reclamation Fill

The sandy/silty clay sediments below ground level at the Project site for reclamation are soft to firm with an N-value of 2 to 5 for upper clay or 4-7 for lower clay. These soils are clay or silt (CL or ML) of low liquid limit, plastic, cohesive and unconsolidated kind. The deposits are of a relatively low strength and decisively exhibit moderate compressibility once the overburden pressure is applied by reclamation fill and surcharges are loaded onto the reclamation fill for its intended use.

Therefore, unless proper method of soil improvement is applied, the clayey subsoil at the site is decisively subject to a process of consolidation by reclamation fill, which cause a considerable extent of settlement. The settlement is estimated to be more or less 1.5 m and will be quite slow because of its unconsolidated properties and low permeability (Refer to Table 12.1.8 & Figure 12.1.5). The consolidation test results show that the coefficient of consolidation (Cv) which governs the time rate of consolidation is in a range of 65 to 89 cm2/day.

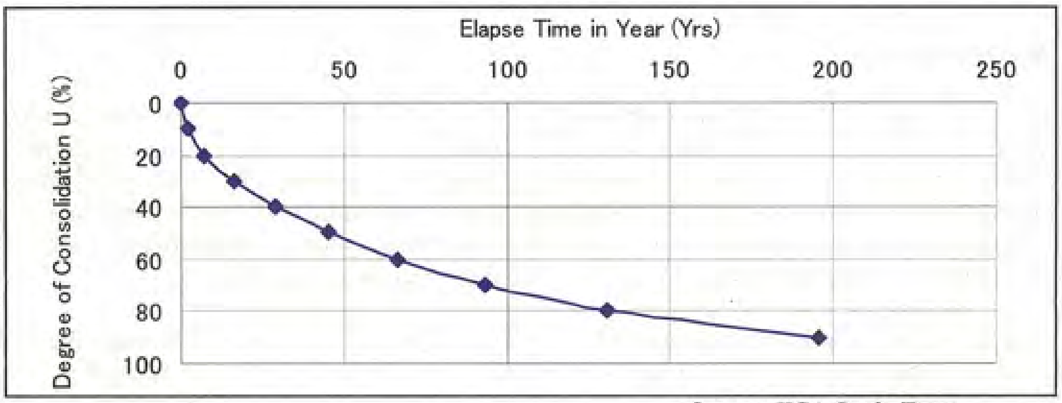
The value of pre-consolidation pressure indicates that the subsoil is over-consolidated clay (Refer to Figure 12.1.6). Therefore, the estimate on the consolidation settlement by reclamation fill and operational load is made based on e-logP curve for each layer of clayey deposits (C1, C2 & C3) and the following results are obtained.

Table 12.1.8 Consolidation Settlement at Reclamation Area

Layer	Layer Thickness (h) (cm)	Initial Earth Pressure (P_o) (kg/cm^2)	Vertical Pressure (ΔP) (kg/cm^2)	Total Pressure ($Po+\Delta P$) (kg/cm^2)	Initial Void Ratio (e_o)	Final Void Ratio (e_1)	Settlement (S) (cm)
C1:Upper Clay	800	0.43	1.03	1.46	1.72	1.49	68
C2:Middle Clay	300	0.85	1.03	1.88	0.63	0.56	13
C3:Lower Clay	1500	1.58	1.03	2.61	0.93	0.85	62
							Total 143

Source: JICA Study Team

Settlement (S)= h × $(e_o-e_1)/(1+e_o)$
Ground Elevation of Reclamation Area: CDL+5.5m
Planned Operational Surcharge in Yard: max. 4.5 t/m^2, 2.5 t/m^2 average
Ground Water Level: CDL+2.0m

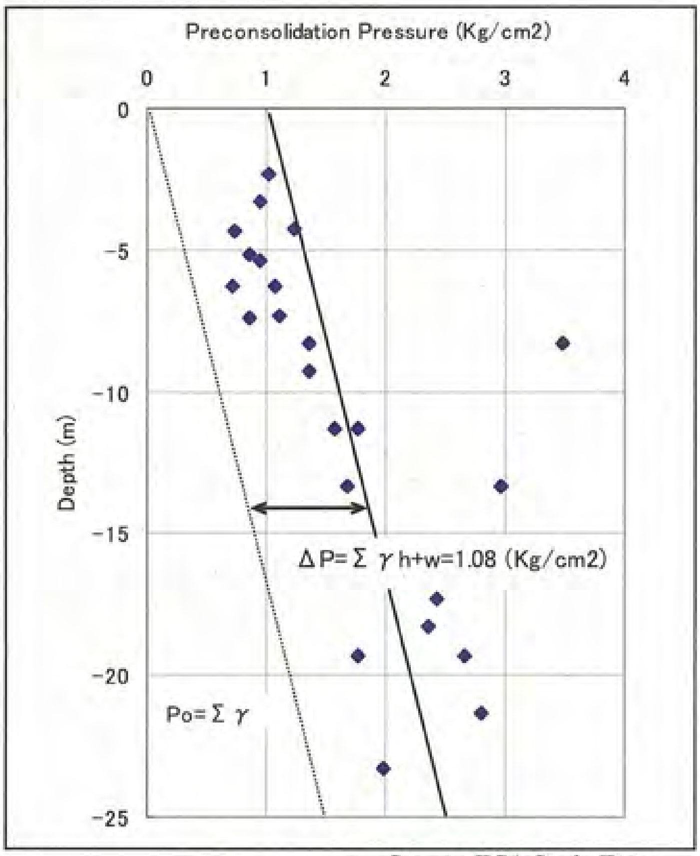


Source: JICA Study Team

$t = H^2 \times T/Cv1$

$H = \Sigma hi \sqrt{(Cv1/Cvi)}$

Figure 12.1.5 Consolidation Settlement Curve



Source: JICA Study Team

Remarks
1) Overburden Pressure In Site: $Po = \Sigma \gamma h$
2) Increase of Pressure by Reclamation Fill and Operational Load: $\Delta P = \Sigma \gamma h + w$
3) Data on Boring No. SBH1-4 at Reclamation Area

Figure 12.1.6 Pre-consolidation Pressure and Depth

3) Soil Improvement at Reclamation Area

Various construction techniques for subsoil improvement such as pre-loading, soil replacement, vertical sand drain pile or prefabricated plastic board drain, cement deep mixing (CDM), etc., are currently applicable to improve very weak subsoil properties. Previous F/S report prepared by TEDI proposes vertical sand pile drain method (SD) to apply to the subsoil improvement for reclamation area, though the details thereof is silent in the report. It may be generally said that vertical sand pile drain method (SD) requires good quality control of sand material for the use of sand pile and sand piling work.

It is recommended to apply plastic board vertical drain method (PVD) in combination with preloading to accelerate the process of consolidation which may be caused by reclamation fill and surcharge loading during operation period. This method (PVD) is:

(1) Currently one of popular methods and frequently applied to subsoil improvement in various project constructions at very weak clayey soil condition,

(2) Applicable to this Project (Drain pile length less than 30m) and easier in construction,

(3) Minimum in disturbance of subsoil during piling work and drastically shorten the time for piling construction as compared with sand pile method,

(4) Economy in construction among others applicable (Unit Rate by rough comparison PVD=1.0: SD=1.3－1.5: CDM=4－10), and

(5) Technically improved nowadays and is proven its effectiveness to accelerate the rate of consolidation of clayey soil in combination of preloading during construction.

In the reclamation area, PVD method is applied in the following design.

(1) Tip Elevation of Plastic Board: Around CD-26 m till the bottom of lower clay layer,

(2) Plastic Board Interval: In square arrangement of 1.2 m interval (This scheme is equivalent to sand pile drain of 40cm dia. driven at about 2 m interval),

(3) Surcharge Load: To fill up to CD+9.5m by sandy materials of 18 kN/m^3 for preloading,

(4) Reclamation and Preloading: Step-by-step filling which may be divided into three (3) stages of filling and preloading,

(5) Objective degree of consolidation (U): U=80% which may be required the following elapse of time for each stage of preloading.

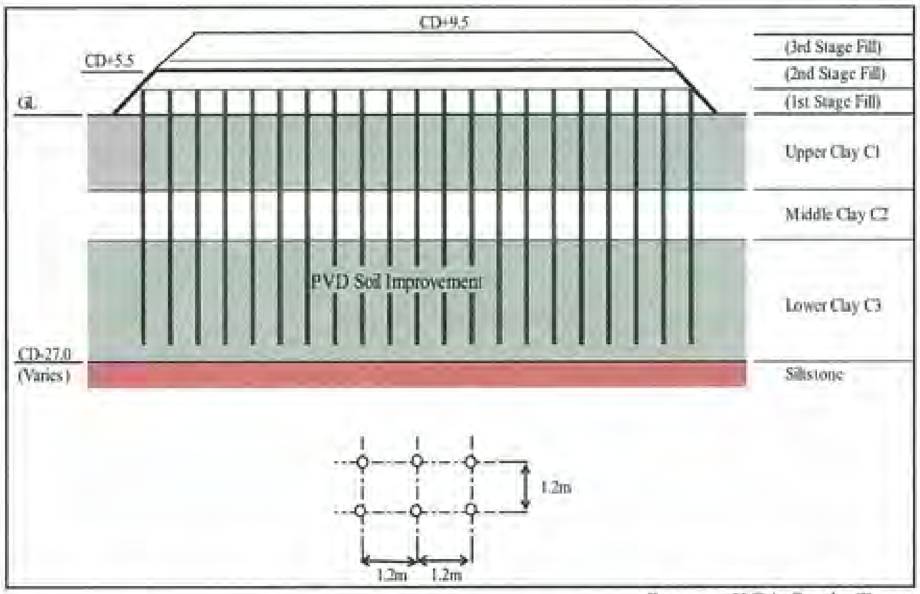
Table 12.1.9 Soil Improvement at Reclamation Area

Layer	Coefficient of Consolidation (cm^2/d)		Time Factor for U=80%	Consolidation Period (Day)	Consolidation Settlement (cm)
	Cv	Ch=2Cv	Th	t	S
C1:Upper Clay	65	130	0.5	71	68
C2:Middle Clay	87	174	0.5	53	14
C3:LowerClay	89	178	0.5	52	68

Source: JICA Study Team

Interval of drain pile: D=120cm in square alignment
Diameter of drain: Dw=5cm (equivalent to sand pile diameter)
Effective Diameter of Drain Pile: De=1.13 D=136cm
n=De/Dw=27
Consolidation Period: $t=De^2 \times Th/Ch$

It is anticipated that each stage of preloading needs 3.5 month period for preloading, measurement and settlement confirmation and 3 stages of pre-loading work will be complete in about 1.2-year period to obtained 80% degree of consolidation for the overburden pressure by pre-loading.



Source: JICA Study Team

Figure 12.1.7 Subsoil Improvement at Reclamation Area

4) Design of Outer Revetment (Revetment along West-side of Reclamation Area)

Due to the exposure conditions to the offshore wave action, Outer Revetment is subject to the extreme high wave which may be generated by tropical typhoon almost at least once a year. The following design offshore wave for the Project Site is applied for designing seawall (West-side Revetment at the reclamation area).

Deep Sea Offshore Wave of 1 in 50 years (50 years return period)
Wave Height Ho= 5.6m
Predominant Wave Direction S to E
Wave Period To= 11.6 sec

In this study, equivalent deep-sea wave height (Ho') for the Project site is assumed as follow.

$$Ho' = Kr \times Kd \times Ho = 1.0 \times 1.0 \times 5.6 \text{ m} = 5.6 \text{ m (Assumption)}$$

The water depth at the project site for reclamation varies from CD +1.0 m to ±0.0 m. Significant Wave Height ($H_{1/3}$) at each shallow water depth is calculated as follows by applying Goda's diagram (Figure 12.1.8) of significant wave height in breaker zone for irregular wave.

Tide level for estimating significant wave height ($H_{1/3}$): HHWL+4.43m CD
Water depth at each revetment: h= 4.43m
$Ho'/Lo=5.6/1.56 \times 11.6^2=0.026$
Seabed slope: 1/100

$h/Ho'=0.79$
$H_{1/3}/Ho'=0.56$
$H_{1/3}=0.56 \times 5.6=3.2$m

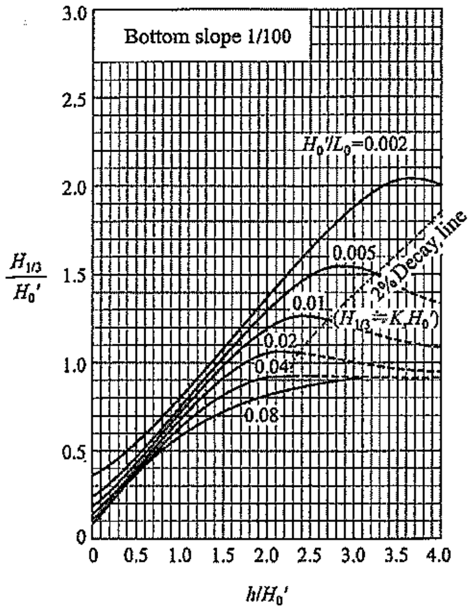
The above design wave ($H_{1/3}$) is used for designing revetment (Outer revetment for reclamation area).

The existing subsoil is subject to soil improvement by a combination of PVD and Preloading method to accelerate consolidation. Once the soil improvement shall be completed, the end of fill sand for pre-loading will be removed to the original seabed level.

Outer Revetment is designed as a seawall structure in the form of sloped protection from the wave action properly covered by armor units. Based on the significant wave height in 1 to 50 years, around 4 ton per piece is required for armor protection layer. Therefore, wave dissipating precast concrete units of 4 t/pc are used for armor layer of the revetment. The weight of armor unit (M: Mass of an armor unit in the primary cover layer) is calculated 4 t/pc using Hudson's equation for 50 year return period wave of H=3.2 m as follows:

$M = \rho H^3/Ns^3(Sr-1)^3$
= 2.3 x 3.23/11.04(2.3/1.03 – 1)3 = 3.6 t/pc

Where ρ: Density of Armor Unit =2.3 t/m³
H: Wave Height= 3.2 m
Ns: Stability Number of Armor Unit used
($Ns^3 = K_d \cot \alpha$= 8.3 x 1.33 = 11.04)
Sr: Ratio of Specific Gravity of Armor Unit to Sea Water=2.3/1.03



(Source: Technical Standards and Commentaries for Port and Harbor Facilities in Japan)

Figure 12.1.8 Diagram of Significant Wave Height in Breaker Zone for Seabed Slope in 1/100

The core rubble stones in weight from 15 kg to 150 kg per piece are placed to form a mound on which vertical precast concrete gravity walls are installed. The seaside mound slope is formed in 1 (V) to 4/3 (H) and is protected by two layers of armor stones units, 4 ton/pc of wave dissipating precast unit for the first layer and armor stones of more or less 400 kg/pc for the second layer placed on the riprap mound. The toe of the seaside slope is protected by precast concrete blocks of 4 ton/pc.

The crest height of revetment wall is poisoned at CD +6.5m, which is roughly equivalent to the elevation of HHWL+ 4.43m plus 0.6 times of design wave height 3.2 m. In order to maintain the rate of overtopping (q) less 0.05 m3/m/s for Ho'= 5.6 m under the conditions h/Ho'=4.43/5.6=0.79 and Ho'/Lo=5.6/210=0.027, the ratio (hc/Ho' = 0.51) of the height above water level (hc) against Ho' is obtained by using Goda's graph (Figure 12.1.9 for wave of Ho'/Lo=0.017 as well as the graph for Ho'/Lo=0.036 which is not attached hereto) for estimating the rate of overtopping for a wave absorbing seawall.

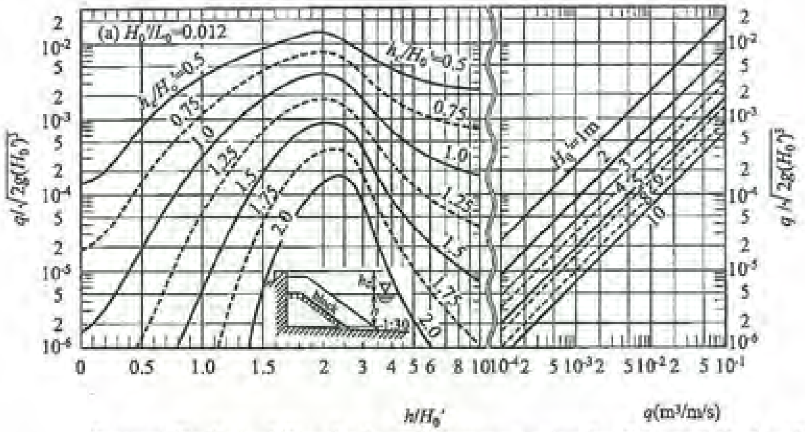
This ratio (hc/Ho') is reduced by 75% in considering diagonal wave direction to the revetment alignment.

β=1-sin^{2}30° for case of |θ|>30°
where θ: Wave direction perpendicular to revetment alignment

Therefore,

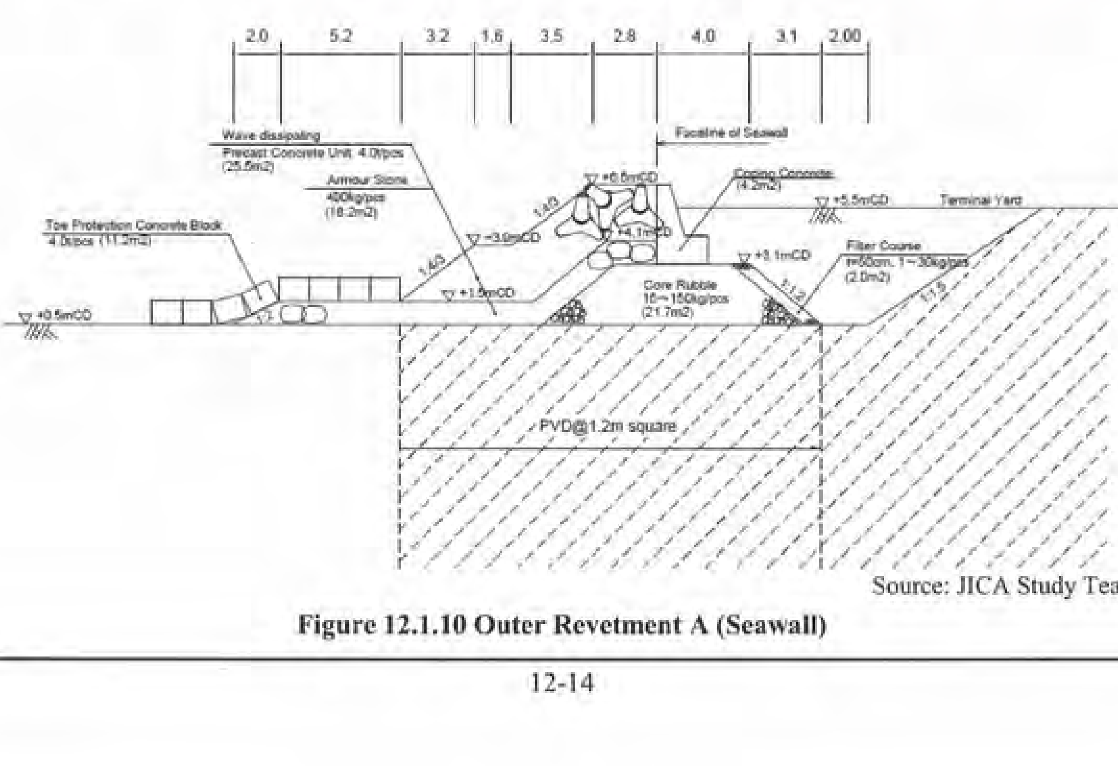
β = 0.75 for θ=60°
hc/Ho'=0.51 × 0.75=0.38
hc=0.38 × 5.6=2.1 m
Crest elevation of Revetment =HHWL + hc=CD4.43+2.1=CD+6.53m
Say positioned at CD+6.5 m

The degree of wave overtopping q=0.05m^3/m/s is allowable range for a revetment with unpaved apron immediately behind the wall. The above estimation on the crest height of revetment is based on the standard wave breaking work in front of the vertical wall, which is placed at 2-row of wave dissipating precast concrete units at the top of the work (TEDI F/S report suggests the crest elevation of CD+5.5m with provision of 13.7 m wide of wave breaking works or CD+9.0m with normal width of wave breaking works, i.e., 2-row of 2.9 m wide at the top in front of the revetment work).



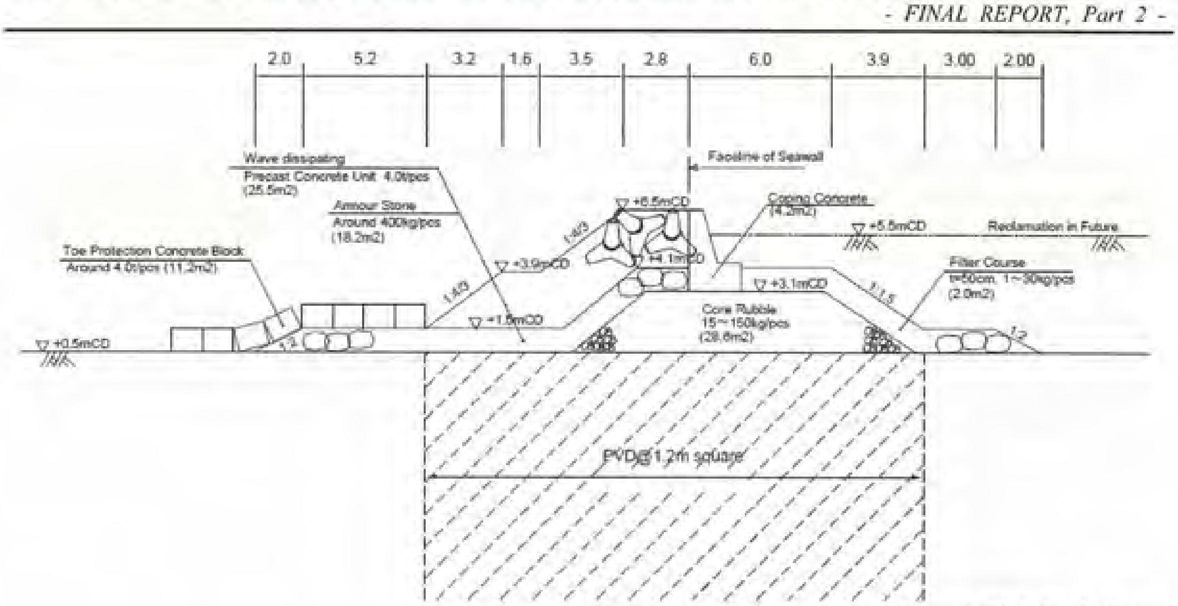
Source: Technical Standards and Commentaries for Port and Harbor Facilities in Japan

Figure 12.1.9 Goda's Graph for Estimating the Rate of Overtopping for a Wave Absorbing Seawall (Seabed Slope 1/30)



Source: JICA Study Team

Figure 12.1.10 Outer Revetment A (Seawall)



Source: JICA Study Team

Figure 12.1.11 Outer Revetment B (Seawall backfilled in future)

5) Inner Revetment (Revetment along the south-side of Reclamation Area)

Since Inner (South-side) revetment for reclamation area is temporary for future expansion of the proposed berth terminal, it should be designed in considering possible re-use of the materials for future expansion of new container terminal to offshore.

The following design offshore wave for the Project site is applied for designing Inner Revetment (South-side Revetment at the reclamation area).

Deep Sea Offshore Wave of 1 in 5 years (5 years return period)
Wave Height Ho= 3.18m
Predominant Wave Direction S to E
Wave Period To= 8.9 sec

In this study, equivalent deep-sea wave height (Ho') for the Project site is assumed as follow.

$$Ho' = Kr \times Kd \times Ho = 1.0 \times 1.0 \times 3.18 \text{ m} = 3.18 \text{ m (Assumption)}$$

The seabed elevation at the project site for reclamation varies from CD +1.0 m to ±0.0 m. Once the water area shall be sheltered by the construction of Sand Protection Dyke, inner revetment is subject to waves transmitted through Sand Protection Dyke or inner harbor waves, which may be estimated 1.0 to 1.5 m height in 1 to 5 years return period intruding from and diffracted at the entrance of access channel or waves generated inside port area.

Table 12.1.10 Design Wave Height for Inner Revetment

Condition	Seabed EL (CDL)	Water Level (m)	Water Depth (m)	h/H_o'	$H_{1/3}/Ho'$	$H_{1/3}$ (m)	$H=Kt \times H_{1/3}$ (m)
Inner harbor wave	±0.0	CD+4.43	4.43	---	---	1.0-1.5	---
Wave through sand protection dyke	±0.0	CD+4.43	4.43	1.39	0.84	2.7	1.8

Source: JICA Study Team

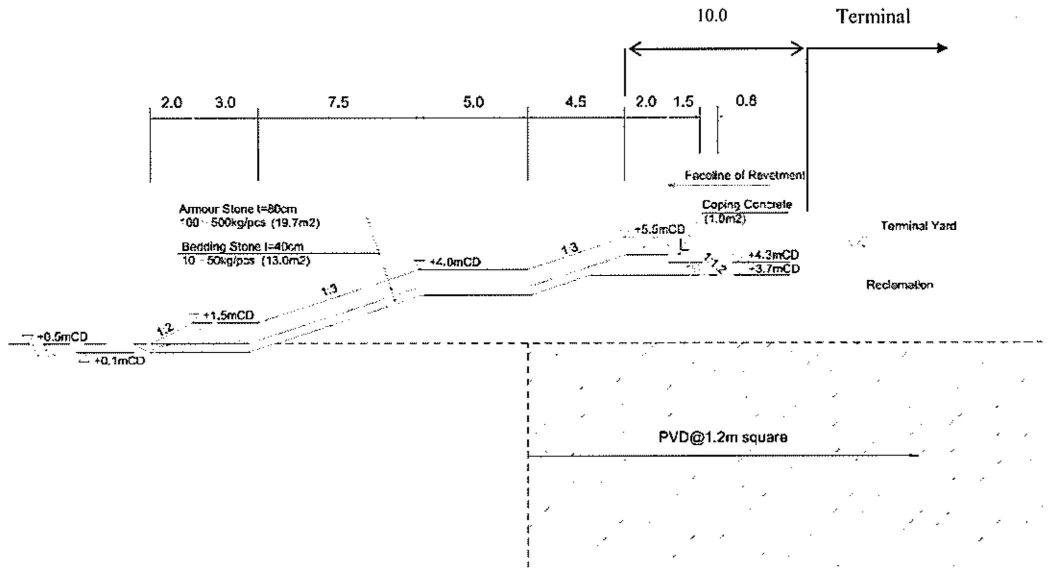
Ho'/Lo=3.18/1.56 × 8.92=0.026, Seabed slope: 1/100
Kt: Rate of wave transmission through sand protection dyke = 0.68

Inner Revetment area is provided with soil improvement by application of PVD and preloading in combination. After completion of soil improvement work, the seaside surface slope of the reclamation fill (preloading fill for soil improvement) is formed to a gentle slope of 1 (V) to 3 (H) along the south-side boundary of the reclamation area.

The revetment is designed in a form of sloped protection from the wave action covered by armor stones. The bedding stones of 10 to 50 kg/pc is placed in a seaside slope in 1 (V) to 3 (H) on which one layer of armor stone of 100 to 500 kg per piece are installed in considering design wave of around 1.8 m height (wave transmitted through sand protection dyke).

$$M = \rho H^3/Ns^3(Sr-1)^3$$
$$= 2.65 \times 1.8^3/12(2.65/1.03 - 1)^3 = 0.33 \text{ t/pc}$$

where $Ns^3 = Kd \cot \alpha = 4 \times 3 = 12$



Source: JICA Study Team

Figure 12.1.12 Inner Revetment (Temporary Revetment for Future Terminal Expansion)

12.1.4 Design of Berth Structure

1) Review of Berth Structure proposed by Previous Studies

The previous Feasibility study reports on Hai Phong-Lach Huyen Gate Way Port by TEDI summarized the preliminary design concept for facilities envisaged in the development plan. The previously established design concept are carefully examined and reviewed based on the scale of the port facilities and cargo handling operation which was formulated through updated future cargo demand forecast.

According to previous studies, primary criteria and berth concept of New Berth for the development plan in the year of 2015 and 2020 are summarized in Table 12.1.11.

a) Container Berth

Table 12.1.11 Outline of Container Berth Structure designed by Previous Studies

	TEDI F/S Report	NK Study 2009
1. Design Vessel	• Target Yr:2015 30,000 DWT • Target Yr:2020 50,000 DWT (3,000-4,000TEU) Loa=280m, B=35m, d=13.0m • Target Yr:2030 (if there is a demand) 80,000DWT (5,000-6,000TEU) Loa=325m, B=45m, d=15.5m	50,000 DWT Loa=278m, B=32.3m, d=12.7m
2. Berth Number & Length	• Target Yr: 2015 2 berth of 300m long each, total 600 m long • Target Yr: 2020 4 berths of 300m long each, total 1,200 m long • Target Yr: 2030 18 berths of 6 x 300m long for -14 m depth and 12 x 367m long for -17 m depth, total 6,200 m long	• Target Yr: 2015 2 berth of 300m long each, total 600 m long • Target Yr: 2020 (Case 2) 4 berths of 300m long each, total 1,200 m long • Target Yr: 2030 (Case 2) 5 berths of 300m long each, total 1,500 m long
3. Tides	• HWL= CDL+3.60m • LWL=CDL+0.43m	• HWL=CDL+3.6m • MSL=CDL+2.06m • LWL=CDL+0.60m
4. Geometry of Berth	• Water Depth: CDL-14.0 m for accommodation of 50,000 dwt vessel • Berth Cope-line Height: CDL+5.5m • Apron Width: 40 m • Depth of Terminal Yard: 600 m	• Water Depth: CDL-14.0 m for accommodation of 50,000 dwt vessel • Berth Cope-line Height: CDL+5.5m • Apron Width: 39.5 m • Depth of Terminal Yard: 880 m
5. Surcharge on Apron	4 t/m^2 ($40kN/m^2$)	20 kN/m^2
6. Quayside Crane	• Quayside Gantry Crane (Rail Gauge: 30m) Lifting Capacity: 50 tons Other Specifications: N.A. • Mobile Crane (Wharf No.1 subject to the use of mobile crane to ship-to-shore operation for handling miscellaneous packaged cargoes) : Specifications N.A.	• Quayside Gantry Crane (Rail Gauge: 30.5m) Crane Weight: 1,000 tons (Report indicates 10,000 tons) Lifting Capacity & Other Specifications: N.A. • Mobile Crane: Specifications: N.A.
7. Berth Fittings	Fender: at 15 m interval along copeline of berth Bollard: 150 tons pull capacity per unit at 30 m interval along copeline of berth	Fender: Height of 1000H for 1.5 times normal berthing by ship berthing of 50,000dwt at 10 cm/sec and 5 degree max berthing angle (Report indicates Fender reaction of 300 kN/unit) Bollard: 100 tons pull capacity per unit at 25 m interval

8. Concept of Recommended Structure	Based on the comparative study among structure of Type a) Concrete Caisson Box Gravity Wall b1) Open Piled Deck with Retaining Wall b2) Open Piled Deck Detached Pier with Access Bridge c) Steel Sheet Piled Walls with Relieving Platform, and d) Steel Sheet Piled Cellular Gravity Wall Type b1) Open Piled Deck with Retaining wall is recommended as best alternative and economy in construction. • Open Piled Concrete Quay 50 m wide reinforced concrete (RC) slab (cover concrete 15 cm on concrete slab 40 cm) deck & girder supported on Pre-stressed Concrete (PC) piles of 80cm dia. with 12 cm wall thickness (10 pile rows 5 m apart and transverse spacing of 5 m). One block of deck is 75 m wide. Three (3) pile rows including pile foundation for crane rail girders are provided with coupled rake piles in 1 (H) to 6 (V) verticality. Under the deck, the sea bed is formed in slope of 1 (V): 2.5 (H) and 1 (V): 2.5 (H) by rock mound placed on 1 (V) to 4 (H) sea bed slope • Retaining Wall L-Shaped RC retaining wall on the rubble mound under the deck and supported by two (2) rows of 45 cm square concrete piles (one vertical pile and one rake pile)	Based on the comparative study among structure of Type A: Open Piled Concrete Platform B: Concrete Platform on Braced Pile Foundation C: Steel Sheet Piled Wall supported by PC Piles and anchored by Coupled Rake Steel Pipe Piles, and D: Double Concrete Wall supported by PC Piles, Type A: Open Piled Concrete Platform is recommended as best economical in construction. • Open Piled Concrete Quay 39.5 m wide reinforced concrete (RC) slab (cover concrete 15 cm on concrete slab 40 cm) & girder deck supported on (8 pile rows 5 to 5.25 m apart in transverse direction). One block length of deck is not available. Two (2) pile rows for crane rail girders foundation is supported by coupled rake steel pipe pile of 1,016 mm dia. of 14 mm wall thickness which are driven in 1 (H) to 6 (V) verticality while other pile rows are supported by Pre-stressed Concrete (PC) vertical piles of 80cm dia. with 12 cm wall thickness. Under the deck, the sea bed is formed in slope of 1 (V): 3 (H) protected by rubble stone and geo-textile. • Retaining Wall Steel sheet piled curtain wall is provided at the extreme end longitudinal beam and fixed to the concrete deck for retaining back fill material
9. Subsoil Conditions along the proposed berth	Apply the TEDI subsoil data obtained for port area by TEDI port. • Layer ② Very soft to soft lean clay, elastic silt, sandy silty clay, silt with sand • Layer ⑤ Stiff fat clay, sandy lean clay with sand • Layer ⑥ Medium stiff fat clay elastic silt • Layer ⑧ Highly weathered siltstone • Layer ⑨ Moderately to slightly weathered siltstone The boundary level for each layer above is indicated in TEDI F/S report drawings. But the report is silent on the design subsoil parameters.	Apply subsoil profile at KB-4 (NK report indicates KB-1) boring for the whole area of New Berth as follow: 3) Reclamation to CDL-0.5m: γ =18 kN/m3, N=10 4) Clay with shell from CDL-0.5 to -11.0m: C=10 kPa, γ =17 kN/m3, N=3 5) Sandy Clay from CDL-11.0 to -13.0m: C=35 kPa, γ =20 kN/m3, N=12 6) Clay from CDL-13.0 to -27.0m: C=32 kPa, γ =18 kN/m3, N=6 7) Hard Clay from CDL-27.0 to -31.0m: C=28 kPa, ϕ =15°, γ =20 kN/m3, N>50 8) Lightly weathered dark purple silt/clay stone from CDL-31.0m

Source1): Feasibility study reports on Hai Phong-Lach Huyen Gate Way Port by TEDI
Source2): Report on Port Capacity Reinforcement Plan In Northern Vietnam, September 2009, Nippon Koei., Ltd. & Associates

b) Multi-purpose berth

TEDI F/S report is silent for the structural design for bulk cargo berth to accommodate 50,000 DWT vessel as well as general and bagged/packed cargo berths for 30,000 DWT vessels. No preliminary design work may have not studied for the proposed multi-purpose terminal berth to be developed in 2020 and 2030 in NK 2009 Study.

The geometry of these berths proposed by TEDI F/S report is summarized as follow.

- Design Vessels:

Cargo Ship	DWT	LOA (m)	Beam (m)	Draft (m)	Remarks
General	30,000	185	27	11.0	2020 Yr
Bulk	50,000	225	31	12.0	2020 Yr

- Geometry of General Cargo Berth

Water Depth:	CD -12.0 m
Berth Length:	210 m
Berth Cope-line Height	CD+5.5 m
Quayside Gantry Crane:	Rail mounted crane with outreach 32m × 40 tons hook operation

- Geometry of Bulk Cargo Berth

Water Depth:	CD -13.0 m
Berth Length:	260 m
Berth Cope-line Height:	CD+5.5 m
Quayside Gantry Crane:	Rail mounted loader of capacity 1,200 t/hr for loading export bulk cargo to vessel and Rail mounted unloader with outreach 36m × 32 tons hook operation for import bulk cargo

(Source: Feasibility study reports on Hai Phong-Lach Huyen Gate Way Port by TEDI)

c) Comments or Issues on the Proposed Container Berth Structure

Berth Planning

(1) In future, the proposed berth can not cope with possible future enlargement of container vessel size to the expected 80,000 DWT or more in view of the water depth as well as berth length. The typical ship dimension of 80,000 DWT container vessels may be 300 to 310 m LOA of 38 m beam to allow 15 rows of container box in deck and more or less 14.5 m fully loaded draft.

(2) Berth apron width is too narrow. Since the ship hutch cover of around 11 to 16m wide is placed at the backyard of quay gantry crane, the berth apron should have a width of around 55 to 60 m to provide a space of 3-5 m from berth cope-line to seaside crane rail, 30 m gantry crane rail span, 20 m back space for 16m for hutch cover placement and 3.5 m wide chassis passage.

(3) No criterion is given for cargo handling operation for container barge unloading and loading operation.

Berth Design

(1) All the Pre-stressed Concrete (PC) Pile foundation piles are designed to drive into very hard siltstone strata having more than 50 N-value. To drive PC pile into a subsoil layer of 30 N-value is possible but generally not easy to drive into hard layer for more than 1-2 m depth. The laboratory test result indicates that this base rock has very high compression strength of 400 to

700 kg/cm^2.

(2) A combination of pile hammer driving and rock auger drilling may be necessary for the piles to be properly driven into these very hard deposits to the intended depth for the piles to rest. Pre-stressed Concrete pile driving into base rock layer is possible but not so easy to drive pile, particularly in case of rake pile due to heavy weight of a pile.

(3) Careful attention must be exercised for possible negative skin friction which may work on piles due to possible residual settlement or secondary consolidation process of the original subsoil on which slope protection rock mound is placed under the deck.

(4) During irregular berthing or de-berthing operation, there may be an accident that a bulbous bow of ship hit seaside raked pile provided at the extreme seaside pile row along cope-line of berth.

2) Basic Considerations for Berth Structure Design

The berth structure is designed based on the understanding of detailed site information on natural conditions such as subsoil at the proposed site, operational requirements and other project conditions. The following understanding will be so important to be reflected in the process of the conceptual design of berth.

(1) Berth Water Depth of -16m

Proposed berth is dimensioned to have -16.0 m water depth (for future), so deep enough to accommodate Super Post Panamax type container vessels.

(2) Quayside Gantry Crane Operation

Container unloading/loading operation will be carried out by the use of heavy Ship-to-Shore Gantry Crane (approx. 1,100 - 1,300 tf/unit) capable of handling container 18 rows on ship deck. In addition, Harbor Mobile Crane may be used for unloading from/loading to container barge.

(3) Site Marine Condition

Sea condition at the proposed site for construction is normally calm during whole seasons of a year. Therefore, there is no difficulty in productive execution of offshore works such as pile driving (normally only workable less than 0.5 m wave height condition) or setting out concrete blocks or caisson boxes (workable less than 0.7 m wave height).

In particular, the subsoil condition is one of the important factors to select the type of structures which will critically govern the suitability of structure such as its structural stability and efficiency for construction. The followings are the major factual findings at the proposed site obtained from the subsoil investigation done by JICA Study Team and previous subsoil investigation works.

(4) Site Subsoil Conditions

The subsoil at the Project site composes of;

- Upper Clay

  This layer is basically composed of very soft to soft plastic sediment of N-value ranging 1 to 4. This layer is compressive and is subjected to consolidation of clayey deposits once overburden pressure shall be applied on the subsoil. But, consolidation test results indicate that this underlying subsoil is over-consolidated clayey deposit for about 6 t/m^2 pressure. The thickness of this subsoil layer is changeable in places but exists at deeper depth of more or less CD-10 to -12m. In places or offshore area, 1-3m thin loose sandy sediment is observed on this clayey layer.

- Middle Clay

  Middle clayey Soil is firm to stiff plastic clay having N-value of 8 to 17. In certain places, this layer shows a larger content of sand materials and changes to silty/clayey sand deposits. This layer is also compressive.

- Lower Clay

  This layer is clayey sediment deposited on the moderately/highly weathered siltstone base rock at the Project site. The thickness of this layer is 6 to 16m, changeable in places. The consistency of this layer is low having N-value of 2 to 9 and is compressive due to consolidation.

- Base Rock

  Base Rock layer composes of moderately/highly weathered siltstone layer which exists at the shallowest depth of CD-21 m and becomes deeper to direction for the offshore area. Uni-axial compression test shows that the strength of this layer is about 300 kg/cm^2 ranging from 70 -760 kg/cm^2, which is approximately equal or higher value of artificial concrete strength.

3) Comparative Evaluation on Suitable Type of Structure

Typical type of marine berthing structure has their own characteristics for suitability to the specific subsoil conditions or adaptability to the requirements of the proposed facility such as water depth of wharf, which should be rationally reflected into technical evaluation of structural stability, efficiency in construction, cost for construction, easiness for maintenance during post-construction stage;

The type of berth structure may be classified as either solid (gravity walls and sheet piled walls) or open-piled suspended deck. A variety of different type of structures is firstly examined among the type of structures which commonly used for the projected type of berth structure (marginal wharf) for screening off on the following viewpoints:

- Structural Adaptability
- Suitability to Subsoil Condition
- Durability
- Construction Method
- Overall Cost

Previous F/S report by TEDI port has studied container berth structure in details. Among such other alternatives as Concrete Caisson gravity wall, Steel Sheet Piled Cellular type gravity wall and Steel Sheet Piled Walls with Relieving Platform, the technical solution recommended is Open Piled concrete deck structure as the best alternative among applicable type of structure for the designated container berth. The JICA Study Team is in the same opinion as recommend by TEDI in technical view of the subsoil conditions at the Project site which mainly consist of clayey layer deposits.

The following is our comparative evaluation among common types of structure which is considered practical and applicable to the projected berth structure. Piled Open type of reinforced concrete slab deck and beam structure is one of the most common and practical and is recommended for the new berth structure for container terminal and Multi-purpose terminal as well.

Table 12.1.12 Comparative Evaluation for Various Types of Berth Structure

	A. Gravity Walls				B. Sheet Piled Cellular Gravity Walls		C. Steel Sheet Piled Wall		D: Open Piled Deck	
	A1:Concrete Caisson Box		A2:Concrete Blocks							
Structural Adaptability	△	Need to install on rubble mound of 45-60 t/m2 (caisson) or 50-60t/m2 (block) bearing capacity which is placed on subsoil sustainable to withstand for 45 t/m2 (caisson) or 50 t/m2 (block) pressure load. Seaside and landside crane rail rests on each different foundation.			△	Normally stable for medium dense or hard subsoil condition. Seaside and landside crane rail rests on each different foundation.	△	Normally less -10m water depth. But, Steel Sheet Pipe Piles Walls may be applicable for deeper water. Seaside and landside crane rail rests on each different foundation.	○	Applicable for more than -16m deep water. Quay Gantry Crane rest on the united deck and slab structure.
Suitability to Subsoil Conditions	△	Not suitable for weak subsoil or not applicable especially for very soft clayey soil except for the case in a combination with subsoil improvement such as sand replacement or CDM. Considerable scale of Subsoil Foundation Improvement work required to change subsoil nature up to the depth around CD-27.0m			△	Require Subsoil Foundation Improvement as well as Soil Improvement for subsoil inside cell	△	$\Sigma\gamma h+q-4C\leqq 0$. Hence, subsoil improvement is necessary for subsoil in front to sheet pile wall. Penetration of pile into very dense deposit required	△/○	Most common for weak subsoil conditions. Penetration of pile into very dense deposit required
Durability	○	Use only concrete members. No steel corrosion protection needed and generally maintenance-free.			△	Steel Sheet Pile materials subject to corrosion	△	Steel Sheet Pile materials subject to corrosion	△/○	PHC Concrete Pile may be applicable but with limitation in pile size up to 100 -120cm. Steel Pipe Pile subject to corrosion
Construction Method	×	Floating Dock (FD) required to fabricate concrete caisson. Around 13-14m water depth is required to tow prefabricated caisson box to site	△	Large capacity of Lifting Equipment is required to convey and install pre-fabricated concrete blocks at site	△	Pre-fabrication yard for cell construction and Large capacity of Lifting Equipment is required to prefabricate, convey and install pre-fabricated cell at site.	○	Steel sheet piles are relatively light and easy to handle for construction	○	Piling works are relatively light and easy to handle for construction. Construction equipment will be comparatively easy to be mobilized.
Overall Cost	△	Costly	△	Relatively costly	△	Relatively costly	△	Relatively costly	△	Relatively Costly
Evaluation	×	Not Applicable	△	Not Recommended	△	Not Recommended	△	Not Recommended	○	Recommended

Source: JICA Study Team

4) Design of Container Berth

The followings are our conceptual design output on open concrete deck piled structure.

a) Design Container Vessel

Table 12.1.13 Design Container Vessels

	Possible Future Maximum Size (Super Post Panamax)	Possible Maximum Size (Post Panamax) Phase 2	Ordinary Size (Sub Panamax or Panamax)
Capacity (TEU)	8,000-9,000	5,000 – 6,000	3,000 – 4,000
Weight (DWT)	100,000	80,000	50,000
LOA (m)	330	305	270
Beam MLD (m)	45.5	38.0	32.2
Molded Depth (m)	29.1	25.7	21.2
Full loaded Draft (m)	14.8	14.5	13.0
Stacking Row on Deck	18	15	13
Design Condition	Fully loaded	Fully loaded	Fully draft

The container berth is planned to accommodate partially loaded 100,000dwt vessel in initial stage of Lach Huyen Port development. But, the structural design of container berth is made for accommodation of fully loaded 100,000DWT container vessel.

b) Geometry of Container Berth

Berth Length	400 m/berth
Top Elevation at Cope-line of Berth	CD +5.5 m
Planned Water Depth	CD -16.0 m
(Water Depth in front of berth	CD -14.0m for initial construction of Phase 1)
Design Water Depth	CD -16.0 m or -16.5 m dependent upon the type of structure and dredging
Apron Width	around 60 m

c) Loading Conditions

(1) Surcharge Load

Surcharge on Apron	35 kN/m^2
Surcharge on Yard (full loaded stacked 3.5 layers average)	45 kN/m^2

Surcharge load by container is considered as indicated in the following table which provides equivalent uniform distributed load for container stacking by BS6349-1:

Table 12.1.14 Container Stacking Load

Type of container stacking	Equivalent Load (kN/m^2)
Empty stacked 4-high	15
Full load by 1-high	20
Full load stacked 2-high	35
Full load stacked 4-high	55

Source: BS6349-1

(2) Quay Crane:

1,300 ton/ unit Quayside Gantry Crane For container vessel of 18 rows container on deck
Mobile Crane 250 ton capacity Class

(3) Ship Docking Load

According to the established design method of docking fender by Technical standards for port and harbor facilities in the Japan and BS 6349 codes of practice, the fender system is designed under the following conditions for berthing and the selection of type of fender system. In designing docking fender system, berthing velocity of ships with tug assistance is assumed to be 0.10 m/sec perpendicular to berth cope line for the design container vessels.

Table 12.1.15 Ship Berthing Condition – Container Berth

Design Vessel		8,000 – 9,000 TEU Container Vessel
Ship Impact Load	Ship approach velocity normal to the dock face	0.1 m/s with tug assistance
	Approach angle	10° perpendicular to dock face
	Berthing Method	1/4 point contact to berth
	Interval	Rubber Fender spaced at 15 m ~20.0 m

Source: JICA Study Team

The rubber type docking fenders with high energy absorption under low reaction force H 1150 mm × one (1) unit are installed at around 15 m interval to accommodate objective vessels berthing ranging from conventional vessels to 8,000 – 9,000 TEU capacity vessels.

Energy Absorption = 939.8 kN-m (95.8 t-m)
Fender Reaction Force = 1,621 kN (157 t)

(4) Load on Bollard

Japanese Standard recommends mooring bollards of 1,000 kN Hawser Pull force capacity per unit for vessels from 50,000 to 100,000 GT (equivalent to 57,000 to 114,000 DWT) to berth at a mooring conditions of 15 m/sec wind speed. Standard interval of installation is 45 m or 8-unit per berth. But, considering possible berthing by smaller size of vessel less than 50,000 GT, 1,000 kN Hawser pull bollards are provided at 15 - 30 m c/c spacing along the face-line of berth (min. 8 nos. per berth).

d) Outline of Open Deck Type of Piled Structure

Designed typical section of open type berth structure is shown in Figure 12.1.13. Open piled concrete deck structure is applied. The berth structure has an overall width of 43.5 m to fully support Quayside gantry crane and consists of:

(1) Pile Foundation

A combination of vertical pile and coupled rake pile foundation is used to support concrete deck structure. It is imperative that the pile foundation is driven into hard base rock for a certain depth of penetration to obtain sufficient end bearing capacity of a pile which is attributed to this base rock stratum. In this design, all the piles are embedded into hard base rock layer for a length of 3-4 times of its diameter so as to obtain full bearing capacity of the base rock layer. In order to drive foundation piles into hard base rock layer, steel pipe piles are used in view of easiness in handling, and driving operation of rake piles with supplemental method of rock auger drilling. The transverse and longitudinal beams for concrete deck are supported by steel pipe piles in diameter 1.0 m of 14mm wall thickness. In transverse direction of berth, four (4) number of coupled piles by rake pile in 1 (H) to 5 (V) are provided for each docking fender installation to resist lateral force working on the fenders while ship docking.

(2) Deck Structure

RC longitudinal front beam installed at each pile foundation row. The 1st and 5th pile rows support Quayside Gantry Crane Load on Rail. The seaside beam is provided with service outlets for utility supply pipelines and box-outs for electrical and communication cables. An RC side apron along the cope line is extended down to around CD+2.5 m level with a provision of rubber fenders on the seaside face and bollards on top of the cope line.

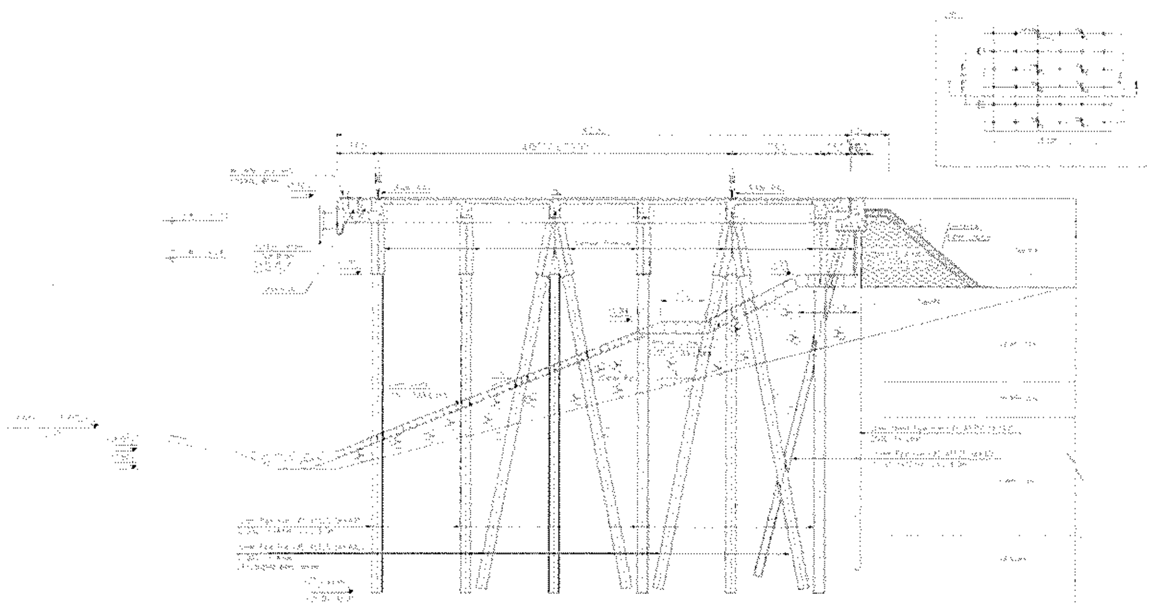
The RC deck superstructure is divided into each block of approximately 34 m width for construction. The 1st seaside row of pile is positioned at 3.5m distance behind the cope-line of berth. A thick RC deck slab of about 40 cm is cast on which paving concrete of 10cm thick is provided for container cargo handling operation on berth apron. The deck is supported by RC transverse beams of every 6.0 m interval and by longitudinal beam of every 7.5 m interval.

(3) Earth Retaining Wall

Steel Sheet Pipe Pile (SSPP 500mm diameter of 12mm wall thickness, JISA5530, SKY400) wall is installed immediately behind the concrete deck structure. SSPP wall is supported by the 1 (H) to 4 (V) rake piles (Steel Pipe Pile of 700 mm diameter, 12mm wall thickness) which are installed at interval of 6 m along the berth alignment. SSPP wall and rake supporting pile as well is driven into hard base rock in order to preclude any downward settlement of the wall which may be possible caused by residual or secondary consolidation settlement of subsoil.

(4) Seabed Slope under the Deck

Under the deck, an excavation is carried out to the depth of CD-16.0m at the face line of berth to form 1 (V) to 4 (H) seabed slope on which a slope of 1 (V) to 2.5 (H) with the provision of a slope protection stone layer is provided by placing crusher run. The surface of slope under the deck is protected by armor stone of 200-500kg/pc to the depth CD-5.0m, below which level smaller size of rock ranging 100-300kg/pc is used for covering the seabed slope.



Source: JICA Study Team

Figure 12.1.13 Typical Section of Container Berth

The structural outline of the berth is as follows.

- Top Level of Structure at Faceline of Berth: CD +5.5 m
- Width of Structure: 43.5 m
- Designed Dredging Level: CD −16.0 m
- Spacing of Deck Structure Expansion Joints: 34 m
- Spacing of Pile: Pile Rows: 7.5 m, Pile Bent: 6.0m
- Material of Piles:

  Deck Foundation: Steel Pipe Pile of 1.0 m dia., 14 mm wall thickness (JIS A5525, STK400) with anti-corrosion protection to the level at CD-1.0m and cathodic protection under water

  Earth Retaining Wall: Steel Sheet Pipe Pile (SSPP 500mm Diameter of 12mm wall thickness, JIS A5530, SKY400) and Supporting Rake Pile (SPP of 700mm diameter, 12 mm wall thickness, JIS A5525 STK400) for earth retaining wall, all of which are with provision of anti-corrosion protection to the depth CD-1.0m.
- Pile Tip Elevation: varies from CD-25m to CD-30m
- Working Axial Load on a Pile:

  By Dead and Surcharge Load: Pv= 2,820kN/pile
  By Dead Load and Seaside Gantry Crane Wheels: Pv= 4,245 kN/pile
  By Dead Load and Landside Gantry Crane Wheels: Pv= 4,290 kN/pile
  Ditto but Pull-out Force: Pp=460kN/pile
- Ultimate Bearing Capacity of a Pile:

  Ru=Qd x Ap + Fi × As
  Where Ru: Ultimate bearing capacity of a pile (kN)
  Qd: Bearing capacity of ground at the pile toe (kN/m^2)
  Ap: Tip area of a pile (m^2)
  Fi: Friction between the pile face and pile embedded ground (kN/m^2)
  As: Total peripheral area of a pile (m^2)

  For 1.0 m diameter pile embedded into base rock layer for a length of 4 × D, it is estimated that:
  Ultimate Bearing Capacity of a Pile: Ru=12,370 kN/pile
  Ultimate Pull-Out Resistance of a Pile: Rup=4,950 kN/pile

5) Design of Multi-Purpose Berth

a) Design Vessel

Table 12.1.16 Design Vessels for Multi-purpose Berth

	General Cargo	Bulk Cargo
Weight (DWT)	30,000	50,000
LOA (m)	185	225
Beam MLD (m)	27	31
Molded Depth (m)	---	---
Full loaded Draft (m)	11.0	12.0
Design Condition	Fully loaded	Fully loaded

Source: JICA Study Team

b) Geometry of Container Berth

Berth Length	250 m
Top Elevation at Face-line of Berth	CD +5.5 m
Planned Water Depth	CD -13.0 m
Design Water Depth	CD -13.0 m or -13.5 m dependent upon the type of structure and dredging
Apron Width	35-40 m

c) Loading Conditions

(1) Conventional Cargo Loads at Berth Apron

Table 12.1.17 Loading Conditions – Multi Purpose Berth

Uniformly Distributed Load at Apron	40 kN/m^2 (without Quay Crane)
	30 kN/m^2 (for the space not occupied by Quay Crane)

Source: JICA Study Team

Uniformly distributed load due to rubber-tyred port vehicle is normally less than 30 kN/m^2 (BS 6349-1:2000, Clause 45.6)

(2) Quay Crane and Other Movable Equipment

The following multi-purpose quay-side crane is considered.

Number of Wheel per corner: 8 wheels at 1.0m interval
Maximum Wheel Load: Seaside 35 ton/wheel, Land side 30 ton/wheel

In addition, various type of movable crane or equipment will be expected to mobilize for unloading cargoes at multi-purpose berth. But, since these are light weight furniture even under cargo loaded during operation, the intensity of such dead loads deems less than the uniformly distributed design load of 30kN/m^2 for wharf apron.

(3) Ship Docking Load

In designing docking fender system of wharf, berthing velocity of ships with tug assistance is assumed to be 0.10 m/sec perpendicular to berth cope line for the design vessels. Rubber type of fenders spaced at 10 to 20 m will be installed to accommodate design vessels up to 50,000DWT carrier.

Table 12.1.18 Ship Berthing Conditions – Multi-Purpose Berth

Design Vessel		50,000 DWT bulk Carrier Vessel
Ship Impact Load	Ship approach velocity normal to the dock face	0.1 m/s with tug assistance
	Approach angle	10° perpendicular to dock face
	Berthing Method	1/4 point contact to berth
	Interval	Rubber Fender spaced at 15 m ~20.0 m

Source: JICA Study Team

Fender used for the multi-purpose berth is selected as follows:

- Type of System: Rubber formed fender system (Elastomeric Unit Type)
- Type of Rubber Fender: Hollow Cylindrical to absorb high berthing energy of ship at low fender reaction

The following is the summary of the selection of the fender system for critical cases of ship berthing:

Table 12.1.19 Selection of Fender Size

Size of Ship	Berthing Velocity (m/sec)	Fender Interval (m)	Berthing Energy of Ship (kN-m)	Fender H (mm) × Unit	Energy Absorption (kN-m)	Fender Reaction (kN)
A. Japanese Standard						
50,000DWT	0.10	---	275.4	H800 × 1 Unit	280.6	659.2
				H600 × 2 Unit	280.6	882.9
B. BS Standard (Including Safety Factor of 1.5)						
50,000DWT	0.10	---	421.3	H900 × 1 Unit	451.3	943.7
				H900 × 2 Unit	447.3	1,202.7

Source: JICA Study Team

The rubber type docking fenders with high energy absorption under low reaction force H 900 mm × one (1) unit are installed at around 15 -18 m interval to accommodate design vessels berthing ranging from conventional vessels to 50,000DWT vessels.

- Energy Absorption = 421.3 kN-m (46.0 t-m)
- Fender Reaction Force = 943.7 kN (96.2 t)

(4) Load on Bollard

Japanese Standard recommends mooring bollards of 1,000 kN Hawser Pull force capacity per unit for vessels from 20,000 to 50,000 GT (equivalent to 37,000 to 92,000 DWT) to berth at a mooring conditions of 15 m/sec wind speed. Standard interval of installation is 35 m or 8-unit per berth. But, considering possible berthing by smaller size of vessel less than 50,000DWT, 1,000 kN Hawser pull bollards are provided at 15 - 30 m c/c spacing along the face-line of berth (min. 8 nos. per berth).

d) Outline of Open Deck Type of Piled Structure

Designed typical section of open type deck structure is shown in the Figure 12.1.14. Open piled concrete deck structure is applied. The berth structure has an overall width of 39 m to fully support Quayside gantry crane and consists of

(1) Pile Foundation

Only vertical concrete pile foundation is used to support concrete deck structure in view of easiness for handling, and pile driving operation into hard base rock layer with supplemental method of rock auger drilling. Lateral working force on a deck is supported by the lateral bending momentum resistance of a group of vertical piles. Pre-stressed Spun High Strength Concrete Pile (PHC Pile) is used. The dimension of PHC pile is 1.0 m diameter, 130mm wall thickness which is locally available within a few years period in future. All the piles are embedded into hard base rock layer for 2 m long of 2 times of its diameter so as to obtain the end bearing capacity of the pile required to sustain the working load on pile.

(2) Deck Structure

RC longitudinal front beam installed at each pile foundation row. The 1st and 4th pile rows support Quayside Gantry Crane Load on Rail. The seaside beam is provided with service outlets for utility supply pipelines. An RC side apron along the cope line is extended down to around

CD+2.5 m level with a provision of rubber fenders on the seaside face and bollards on top of the cope line.

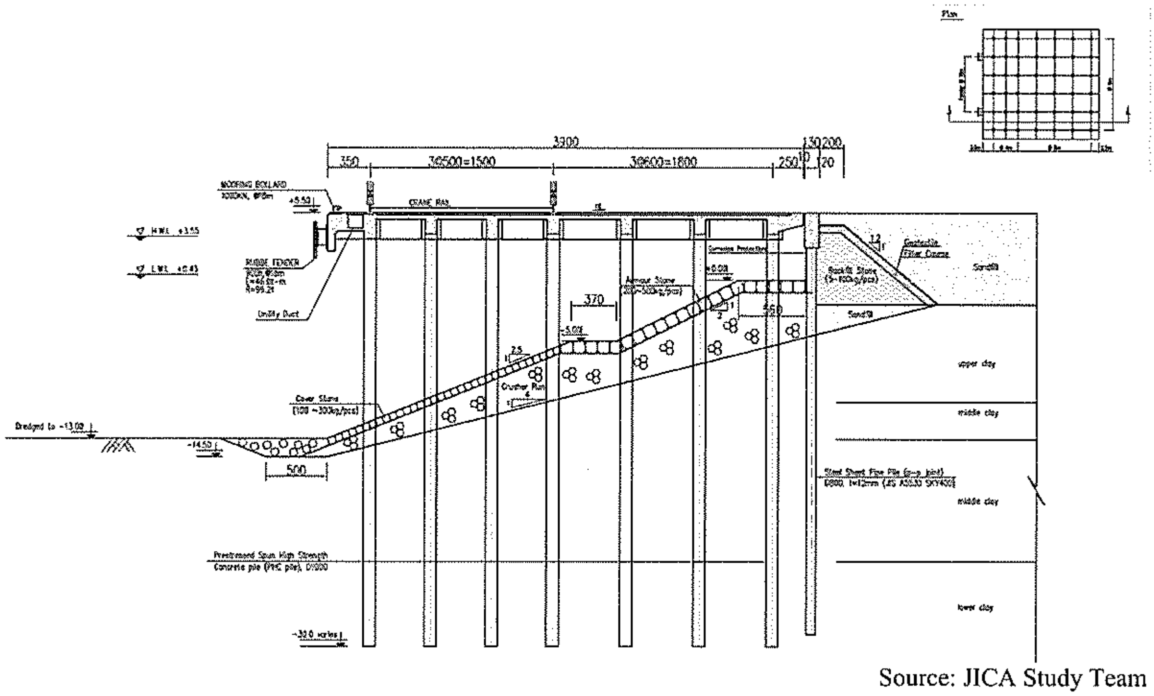
The RC deck superstructure is divided into each block of approximately 34 m width for construction. A thick RC deck slab of about 40 cm is cast on which paving concrete of 10cm thick is provided for cargo handling operation on berth apron. The deck is supported by RC transverse beams of every 6.0 m interval and by longitudinal beam of every 5.0m or 6.0 m interval.

(3) Earth Retaining Wall

Self-standing Steel Sheet Pipe Pile (SSPP 800mm Diameter of 12mm wall thickness, JIS A5530, SKY400) wall is installed immediately behind concrete deck structure. SSPP wall is driven onto hard base rock in order to preclude any downward settlement of the wall which may be possible caused by residual or secondary consolidation settlement of subsoil.

(4) Seabed Slope under the Deck

Under the deck, an excavation is carried out to the depth of CD-13.0m at the face line of berth to form 1 (V) to 4 (H) seabed slope on which a slope of 1 (V) to 2.5 (H) with the provision of a slope protection stone layer is provided by placing crusher run. The surface of slope under the deck is protected by armor stone of 200-500kg/pc to the depth CD-5.0m, below which level smaller size of rock ranging 100-300kg/pc is used for covering the seabed slope.



Source: JICA Study Team

Figure 12.1.14 Typical Section of Multi-purpose Berth

The structural outline of the multi-purpose berth is as follows.

- Top Level of Structure at Face-line of Berth: CD +5.5 m
- Width of Structure: 40 m
- Designed Dredging Level: CD −13.0 m
- Spacing of Deck Structure Expansion Joints: 34 m

- Spacing of Pile: Pile Rows: 5 m under the crane gauge and 6 m, Pile Bent: 6m
- Material of Piles:

  Deck Foundation Pile (PHC Pile of 1,000mm diameter, 130mm wall thickness, Type B: 8N/mm^2 Effective Pre-stress)
  Earth Retaining Wall: Steel Sheet Pipe Pile (SSPP 800mm Diameter of 12mm wall thickness, JIS A5530, SKY400) with anti-corrosion protection to the depth CD-1.0m and cathodic Protection under water
- Pile Tip Elevation: varies but more or less CD-30m
- Working Load on a Pile:

  By Dead and Surcharge Load: Pv= 2,512kN/pile
  By Dead Load Gantry Crane Wheels: Pv= 3,003 kN/pile
  Bending Moment at Pile Top while docking: M=562 kN-m
- Ultimate Bearing Capacity of a Pile:

  Ru=Qd x Ap + Fi x As
  Where Ru: Ultimate bearing capacity of a pile (kN)
  Qd: Bearing capacity of ground at the pile toe (kN/m^2)
  Ap: Tip area of a pile (m^2)
  Fi: Friction between the pile face and pile embedded ground (kN/m^2)
  As: Total peripheral area of a pile (m^2)
  For 1.0 m diameter pile embedded into base rock layer for a length of 2xD (Pile diameter), it is estimated that:
  Ultimate Bearing Capacity of a Pile: Ru=10,500 to 11,150 kN/pile

12.1.5 Pavement

1) Container Terminal Yard

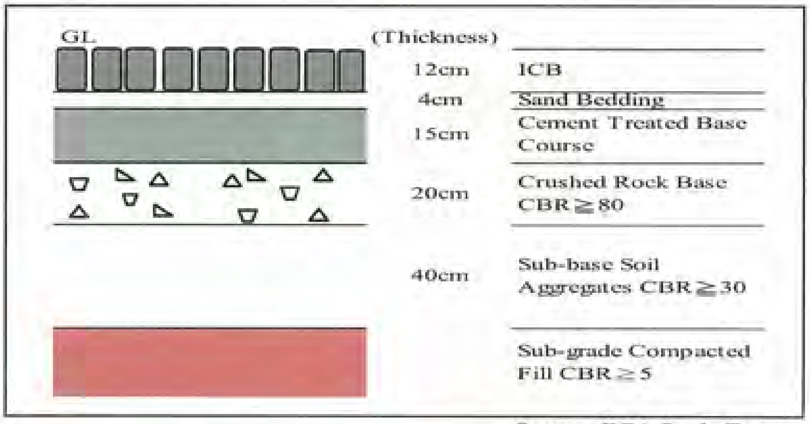
Containers are stacked at maximum 4-layer high at container stacking yard as follows:

- Laded Container: 2-4 layers
- Empty Container: 4 layers

Live Load at Container Yard is estimated to be 45 kN/m^2 for fully loaded containers stacked in 3.5 layers.

Interlocking Concrete Block (ICB) heavy duty pavement will be applied. Paving surfacing is covered by the use of 120 cm thick heavy duty Interlocking Concrete Blocks above 4cm bedding sand layer. A 15cm cement treated base and 20cm crushed stone base layer is placed on the sub-base course of 40 cm sand compacted to 98 % modified AASHOTO density. Sub-grade course is formed by sand layer of 30cm on well compacted in-situ material.

In container yard, RTG crane foundation is used along with interlocking concrete block yard pavement in the same area to support higher loads of crane wheels. RTG crane foundation will be of cast-in-place type, pre-stressed with post-tensioning system or RC slab structure. RC container stacking foundation slab is provided to place at the edge corner of container for stacking container in layers at yard.



Source: JICA Study Team

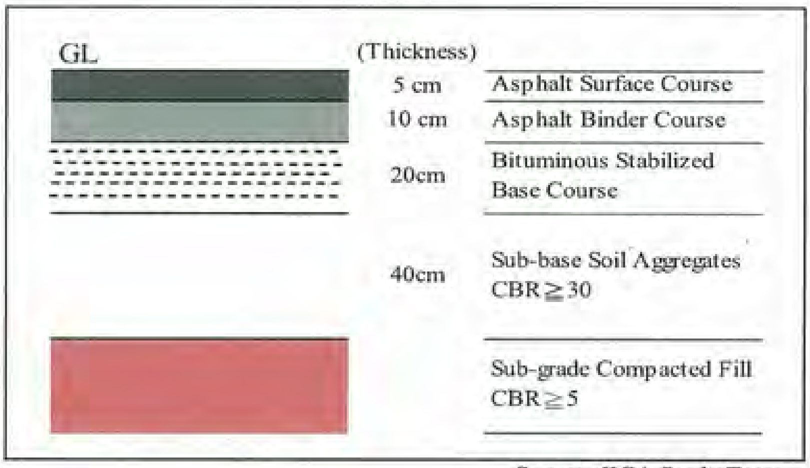
Figure 12.1.15 Container Terminal Yard Pavement Structure

2) Multi-purpose Terminal Yard

Uniformly distributed load due to rubber-tyred port vehicle which may be used in the terminal yard is normally less than 30 kN/m2 (BS 6349-1:2000, Clause 45.6).

Open yard will be used for conventional cargoes, of which loads imposed depends on the commodities of cargoes, the height of stacking and effective density of the commodities as stacked. BS 6349-1 recommends that if better information is not available, the loading from general cargo can be taken as 20 kN/m^2.

Asphalt pavement is applied to multi-purpose terminal yard pavement in view of economy for construction. Heavy duty two (2) bituminous layer of surface with bituminous stabilized base layer is placed on substantially compacted sub-base and sub-grade courses.

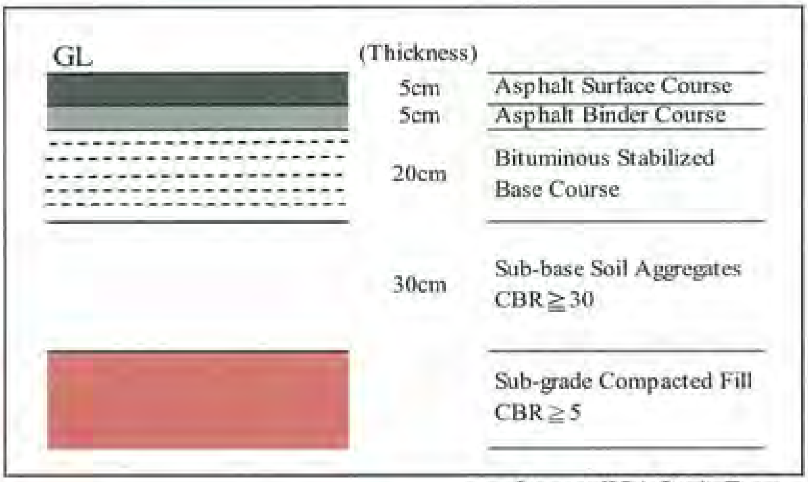


Source: JICA Study Team

Figure 12.1.16 Multi-Purpose Terminal Yard Pavement Structure

3) Access Road

Asphalt pavement is applied to access road in view of economy for construction and easiness for maintenance.



Source: JICA Study Team

Figure 12.1.17 Access Road Pavement Structure

12.1.6 Sand Protection Dyke

1) Principles for Designing Structure:

Shoaling is a sedimentation or siltation progressed in such area as port basin, navigation channel or anchorage areas to shallow water depth by accretion of suspended sediment discharged out of river or tidal flow, by deposition of littoral material transported by wave or current agitation in littoral breaker zone, or wind-blown sand. Shoaling phenomenon in question along the Lach Huyen access channel waterway area is possibly caused by:

(1) Shoaling by subsidence and deposition of suspended sediment discharged from the Lach Huyen waterway flow,

(2) Shoaling by suspended sediment transport discharged out of Bach Dang or Nam Trieu and Cam river in the Haiphong Bay area and extended to the part of the littoral surf zone area where Lach Huyen access channel locates and runs to south offshore , and

(3) Accretion by invasion or deposition of suspended sediment drift agitated from the seabed surface by wave turbulent action and transported by breaking wave flow and/or current action in the littoral surf zone of the Haiphong Bay estuary.

The protection dyke for the Project is designed under the following principles:

(1) The Primary function is to train and confine river or tidal flow into access channel waterway and prevent or reduce possible shoaling at the water area for access channel. The dyke should be therefore a structure non-permeable on water flow and is extended southerly to offshore in parallel with and as closer as practically possible to Lach Huyen access channel waterway (**Training Jetty Function to minimize shoaling of access channel by suspended sediments out from river flow**).

(2) The dyke also serves to interpose a total littoral barrier to shelter the access channel in the littoral surf zone. This function is to barrier off the access channel area from suspended sediment inflow from Bach Dang or Nam Trieu, and Cam river or possible littoral suspended sediment transport agitated from the seabed surface by wave turbulent actions and transported by breaking wave flow or current in littoral breaker zone. For this function, the structure should be designed as non-permeable in general to prevent suspended sediment transport from intrusion through its structure by currents or waves (**Sand Protection Jetty or Groin Dyke Function to barrier off or trap littoral suspended sediment transport into access channel**).

(3) The crest elevation of the dyke is so positioned to direct river or tidal flow, and to minimize inflow of suspended sediments in overtopping water to access channel area.

(4) Nearly once a year, Lach Huyen offshore area is subject to extreme high wave attach generated by tropical typhoon. Therefore, due to exposure condition to offshore waves, the dyke must maintain structural stability against extreme high wave action. This requirement for the dyke incidentally serves as breakwater to shelter access channel water area from offshore waves **(Incidental Breakwater Function to protect port area from wave and to create calm water in access channel waterway)**.

(5) Since possible consolidation settlement of subsoil layer is expected not considerable, any subsoil improvement is not applied in designing structure. Instead, a 1.0 to 1.5 m thick rubble mound is placed onto the seabed subsoil to sustain overburden pressure loaded by its core materials and to function as counter weight to preclude underlying clayey soil from circular failure. Some allowance is provided in positioning the top of dyke for possible future settlement of consolidation in foundation subsoil mass.

The function as groin dyke seems imperative to the proposed Lach Huyen Sand Protection Dyke structure because that, according to the post-dredge survey for capital dredging in 2005,

- It show substantially small rate of shoaling at Lach Huyen section (from P19 to P15 buoy) where the Lach Huyen waterway substantially becomes wider run of flow;
- The progress of substantial shoaling is observed at the section from P15 buoy to offshore, but relatively high rate of shoaling occurs at Inner Sea Reach (from P5 to P9 buoy) though this rate is a record obtained immediately after initial dredging work;
- At deeper area of Outer Sea Section (from P0 to P3 buoy), the seabed level is relatively stable;
- The high rate of accretion may occur during wet season (June to September)

High rate of accretion at section P5 to P9 buoy may indicate that:

- The downstream velocity of Lach Huyen waterway becomes minimum at theses sections due to the widening water flow, and
- The progress of shoaling along Lach Huyen waterway is sensitive to possible littoral suspended sediment transport which may be caused by wave agitation, because this area (original water depth around CD-1.0 to -3.0 m) seems to be wave breaker zone of relatively high waves ($H_{1/3}$= about 1.5m for 1Yrs return period) which are generated by strong rainstorm or tropical typhoon in particular.

There may be high risk of possibility that the higher rate of accretion is most likely to occur due to marine conditions agitated by tropical typhoon when the extreme high waves intrude into the Lach Huyen water area. Therefore, it is important that the dyke also functions as sand protection jetty or groin dyke to trap littoral drift or sediment transport agitated by offshore waves or current movement.

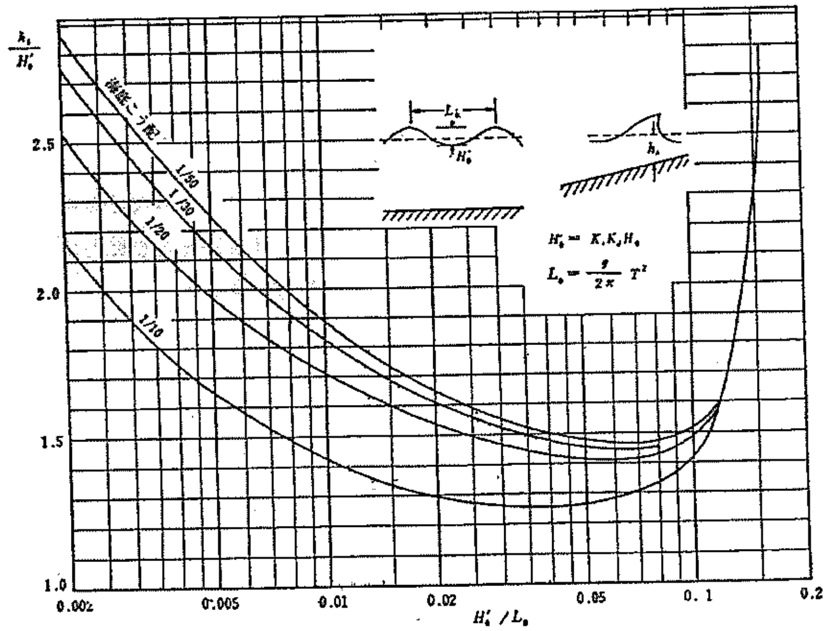
2) Length of Sand Protection Dyke

The length of dyke will be determined based on the simulation study on quantitative sedimentation estimate along the Lach Huyen waterway.

It is common practice that Training Jetty is extended to offshore water depth where water depth is the same as access channel or, in economical way of construction, till the offshore zone in wave breaker line. And in case of Sand Protection Jetty or Groin Dyke structure, the offshore head of structure is located at water zone where water depth is the same as for the access channel waterway or at wave breaker line with provision of recurrent maintenance dredging since seabed agitation is mostly caused in breaker line.

So called breaker zone is changeable dependent upon heights of waves intruding into the water area where sand protection dyke is constructed. In Lach Huyen offshore area, the breaker line is considered around 6 to 10 m water depth (h) based on the estimate of breaker depth as follows for the case of the wave braking in assuming of extreme high waves of 3.71 m to 4.45m height in 10 to 30 years return period:

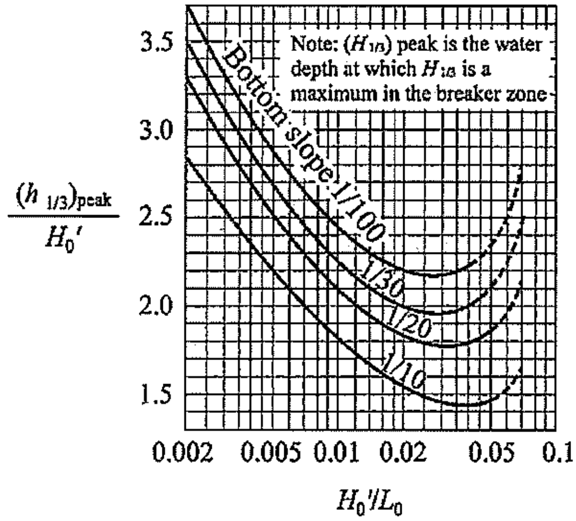
- By estimation for Regular Wave based on Figure 12.1.18.
  Ho'/Lo = 3.71/147 or 4.45/182=0.025 or 0.024
  Seabed gradient=1/50
  h_b/Ho'=1.6
  Breaker Depth: h_b =1.6 × Ho'=1.6 × (3.71 to 4.45) = 5.9 to 7.1m



Source: Manual for Construction of Shore Protection Facilities in Japan

Figure 12.1.18 Diagram of Breaker Depth and Wave Steepness for Regular Waves

- By estimation for Irregular Wave based on Figure 12.1.19)
  Ho'/Lo = 0.025 or 0.024
  Seabed gradient=1/100
  (h1/3) peak /Ho'=2.2
  Breaker Depth: (h1/3) peak =2.2 x Ho'=2.2 x (3.71 to 4.45) = 8.1 to 9.8m



Source: Technical Standards and Commentaries for Port and Harbor Facilities in Japan

Remark: $(h_{1/3})$ peak=Water Depth at which significant wave height become maximum:

Figure 12.1.19 Diagram of Water Depth at which maximum Significant Wave Height occurs in Breaker Zone for Irregular Waves

In design practice, therefore, the offshore head of the sand protection dyke could be located at a water level around CD-6 to -10 m with provision of recurrent maintenance dredging or may be extended to deeper offshore area of the same depth as access channel waterway.

3) Crest Elevation of Sand Protection Dyke

As far as sediment transport caused by wave agitation at offshore breaker zone, most suspended sediments remains in sea bottom layer of flow near the seabed under bed load transport condition. In addition, since overtopping water contains minimum sediments, wave overtopping could be permeable in case of sand protection dyke for this Project. Therefore, in view of economy in construction, the crest elevation of training dyke is positioned at the level of CD+2.0m. The followings are discussion on crest elevation for each function required to the dyke.

a) Elevation as for Training Jetty

For training jetty function, it should be a structure extended into offshore area with ample crest elevation to guide or confine river flow so as to maintain water depth of access channel waterway by bed-load transport force of the river flow under ebb tide as well as flood tide conditions. Therefore, the crest elevation for training jetty is so positioned at the level of the water level plus allowance to properly stabilize the water flow by guiding river water flow even during flood period, which is preferable to elevate:

- Crest Elevation as for Training Jetty:

  = Water Level (=MWL) + Allowance for Tide and Settlement

  = CD+1.95m + Allowance for Flood Tide (=1.0~1.5m) +Allowance for Settlement (=0.5m)

  =CD+3.45~ +3.95m

b) Elevation as for Sand Protection Jetty

It is common and preferable that sand protection jetty does not allow wave overtopping in order to prevent the inflow of suspended sediments which are raised up from the seabed by wave turbulent action and the top elevation of sand protection jetty is basically determined under the following guidelines.

Table 12.1.20 Guideline of Crest Elevation for Sand Protection Jetty

Function	Water Zone	Guideline	Top Elevation
Sand Protection Jetty	Around Shoreline	A wave run-up should not be allowed to overtop the dyke. Sediment transport may overtop the dyke with overtopping water when the dyke is elevated low.	HWL + the height of wave Run-up
	Between Shoreline and Breaker Zone	It is common to elevate the top of dyke at a level of $0.6H_{1/3}$ above the HWL. Raising the top of dyke by 0.6H1/3 above HWL may preclude substantial suspended sediments in overtopping water.	$HWL+0.6H_{1/3}$
	Area Off-Breaker Zone	The top of dyke can be elevated at a level above HWL with some allowance. As far as sediment transport caused by wave agitation at this zone, most suspended sediments remains near the seabed and overtopping water contains minimum sediments. Therefore, wave overtopping can be permeable.	HWL + Some Allowance

Source: JICA Study Team derived from Commentaries of Technical Standards and Commentaries for Port and Harbor Facilities in Japan

In case of sand protection jetty at breaker zone, it is preferable that the crest height is positioned at the level of $0.6H_{1/3}$ above HWL in order for the jetty to trap suspended sediment and prevent suspended sediment inflow into channel area by normal wave overtopping. Breaker zone is changeable dependent upon the wave heights. In determine the crest height of the sand protection jetty, ordinary high waves ($H_{1/3}$=1.0 - 1.5 m height for waves of 1 to 2 Years return period) and/or some allowance (for possible settlement by consolidation) is considered to determine the top of jetty to ensure essential functions for suspended sediment transport control while normal marine environment.

- Crest Elevation as for Sand Protection Jetty for Section Off-Breaker Zone:
  =HWL: CD+3.55 + 0.6 $H_{1/3}$ (=0.6~0.9m) +Allowance for Settlement (0.5 m)
  =CD+4.65 ~+ 4.95m

c) Elevation as for Groin Dyke

Outer section of groin dyke is extended from its intermediate sloped section and the crest height is set according to intended interruption of littoral sediment transport. Suspended sediment in littoral transport, which is agitated from the sea bottom surface by wave turbulent actions, is basically very dense near sea bottom layer under bed load transport condition in breaker zone and overtopping wave water contains minimum suspended sediments.

In view of the above, the top at outer offshore section of dyke can be elevated at a level above MLWL with some allowance. This section of most type of groins is set horizontally at such low elevation as practical in view of economy in construction. Therefore, it is recommended for such function as groin to position the crest height at MLWL plus allowance.

- Crest Elevation as for Groin Dyke of Section extended Offshore Water Zone:
  =MLWL (=CD+0.90) + Allowance for Wave (=0.6~0.9m) and Settlement (0.5 m)
  =CD+2.0 ~ +2.3m

d) Design of Dyke Structure

In order to barrier off the access channel area from suspended sediment inflow, Sand Protection Dyke is designed:

- To position the crest height at CD+2.0m,
- To be non-permeable for a core portion of the dyke about 3-5 m high above seabed and/or up

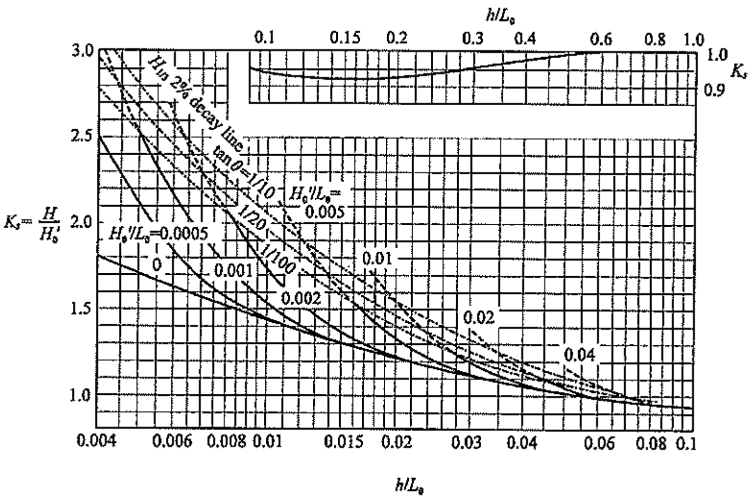
to the bottom level of wave dissipating concrete armor unit for deeper water section of the dyke, and

- To be stable against extreme high wave for around 30 to 50 years return period at the proposed offshore area.

The following design offshore wave for the Project Site is applied for designing sand protection dyke.

Deep Sea Offshore Wave: 1 in 30 years Return Period
Wave Height: Ho= 4.45 m (based on extreme wave height probability)
Predominant Wave Direction: S to E
Wave Period: To= 10.8 sec (based on extreme wave height probability)
Equivalent deep-sea wave height: Ho'= Kr x Kd x Ho=1.0 x 1.0 x 4.45 m = 4.45 m

The water depth along the alignment of sand protection dyke varies from CD -1.0 m to – 10.0 m to offshore. Significant Wave Height ($H_{1/3}$) at each shallow water depth point is calculated by applying Goda's diagram (Figure 12.1.8) of significant wave height in breaker zone for irregular wave or Shoaling Coefficient at relevant point based on Shuto's nonlinear long wave theory (Figure 12.1.20 below):



Source: Technical Standards and Commentaries for Port and Harbor Facilities in Japan

Figure 12.1.20 Shuto's Graph for Evaluation of Shoaling Coefficient

Table 12.1.21 Design Waves ($H_{1/3}$) for Sand Protection dyke at Each Depth of Water

Seabed EL (CD)	Water Level (m)	Water Depth (m)	h/Ho'	h/Lo	$H_{1/3}$/Ho'	Ks	$H_{1/3}$ (m)
-1.0	CD+3.55	4.55	1.02		0.66		2.9
-3.0	CD+3.55	6.55	1.47		0.86		3.8
	CD+0.43	3.43	0.77		0.55		2.4
-5.0	CD+3.55	8.55	1.92		0.98		4.4
	CD+0.43	5.43	1.22		0.77		3.4
-7.0	CD+3.55	10.55	2.37		1.0		4.5
	CD+0.43	7.43	1.67		0.91		4.0
-10.0	CD+3.55	13.55	3.04	0.074		0.96	4.3
	CD+0.43	10.43	2.34	0.057		1.0	4.5

Source: JICA Study Team

Water Level= HWL+3.55 m CD, LWL+0.43m CD
Ho'/Lo=4.45/1.56× 10.82=0.024
Seabed slope: 1/100

The above design waves ($H_{1/3}$) obtained is used for designing sand protection dyke at each seabed elevation.

Along alignment of sand protection dyke, quarry run and rocks in a weight of 100 to 200 kg/pc is placed to form bedding course of 1.0 to 1.5 m thickness. The same size of core rock in a weight of 100 to 200kg/pc is mounted on the bedding course and the core rock layer is protected by inner armor stone layer and by outer amour layer of wave dissipating precast concrete units on the relatively gentle surface slope of 1 (V) to 2 (H). Assuming significant wave height ($H_{1/3}$) in a range of 2.9 m to 4.5m for waves of 30 years return period, the weight of armor unit for outer protective layer required is obtained as follows.

$$M = \rho H_{1/3}{}^3 / Ns^3 (Sr-1)^3$$
$$= 2.3 \times H^3/16.6(2.3/1.03 - 1)^3 \quad t/pc$$

Where Ns^3 = Kd cot α= 8.3 $\times$ 2.0 = 16.6

Table 12.1.22 Armor Unit Weight Estimate for Sand Protection dyke

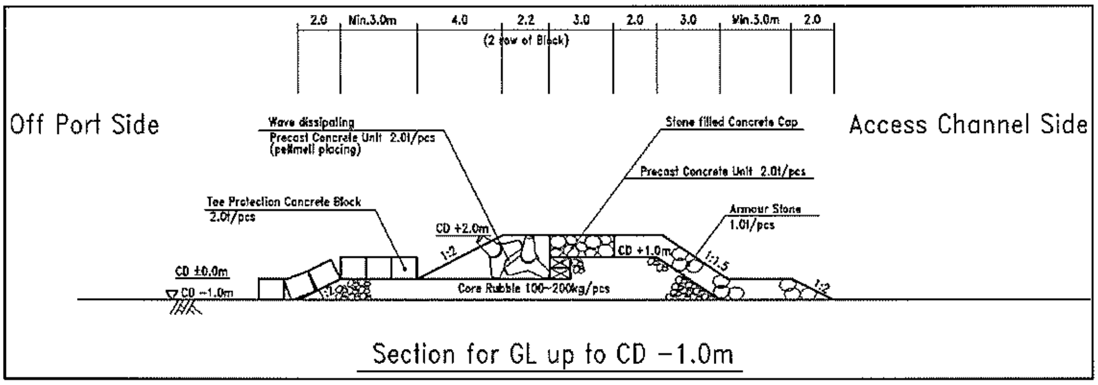
Seabed EL (CDL)	Water Level (m)	Water Depth (m)	$H_{1/3}$ (m)	M (ton)	Weight of Armor Unit (ton/pc)
-1.0	CD+3.55	4.55	2.9	1.80	2.0
-3.0	CD+3.55	6.55	3.8	4.06	4.0
	CD+0.43	3.43	2.4	1.02	
-5.0	CD+3.55	8.55	4.4	6.30	6.3
	CD+0.43	5.43	3.4	2.90	
-7.0	CD+3.55	10.55	4.5	6.73	8.0
	CD+0.43	7.43	4.0	4.73	
-10.0	CD+3.55	13.66	4.3	5.88	8.0
	CD+0.43	10.43	4.5	6.73	

Source: JICA Study Team

Therefore, the following schedule applied for the weight of outer layer of armor unit to be placed along alignment of training jetty.

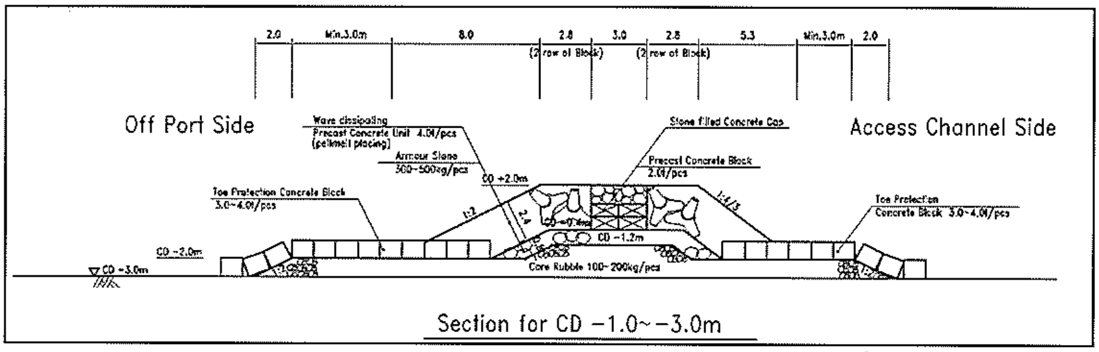
Seabed Elevation to CD-1.0m: 2t/pc Armor Unit
Ditto but from CD-1.0m to -3.0m: 4 t/pc Armor Unit
Ditto but from CD-3.0m to -5.0m: 6.3 t/pc Armor Unit
Ditto but from CD-5.0m to -10.0m: 8.0 t/pc Armor Unit

This outer armor layer forms by use of wave dissipating precast concrete units which rest on the crest concrete placed on the top of core stones to form non-permeable structure to the crest elevation of the dyke at CD+2.0m.



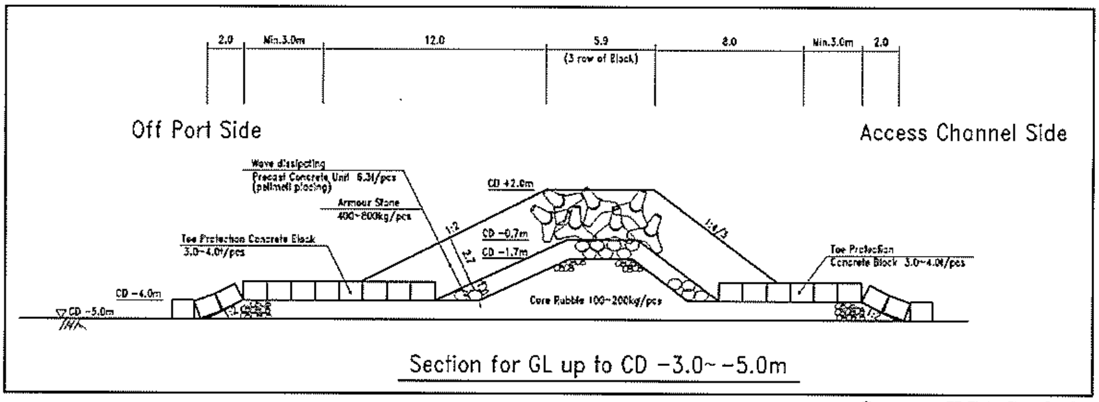
Source: JICA Study Team

Figure 12.1.21 Sand Protection Dyke at GL-1.0



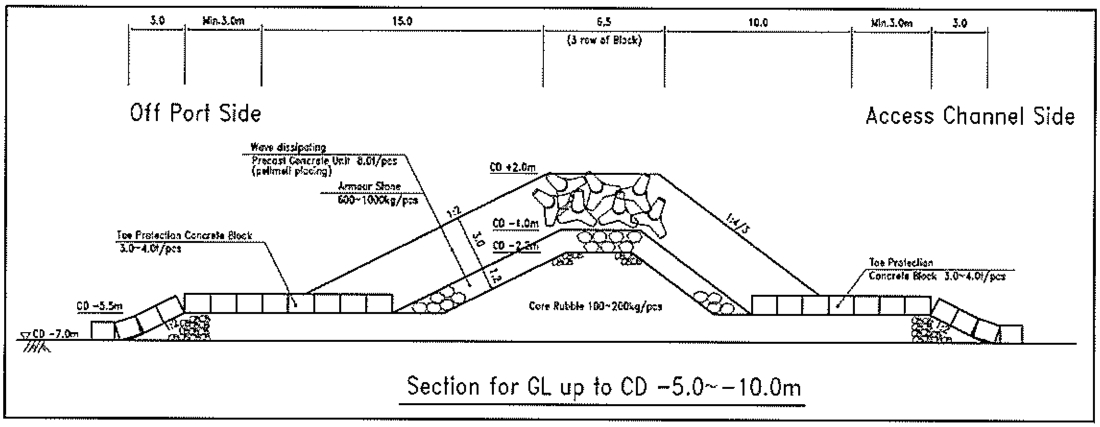
Source: JICA Study Team

Figure 12.1.22 Sand Protection Dyke at GL-1.0 to -3.0m



Source: JICA Study Team

Figure 12.1.23 Sand Protection Dyke at GL-3.0 to -5.0m



Source: JICA Study Team

Figure 12.1.24 Sand Protection Dyke at GL-5.0 to -10.0m

e) Bearing Capacity of Subsoil Mass

The section of the dyke induces overburden loads onto the subsoil by its own weight. At the section of the dyke installed at water depth of CD-7.0m, the overburden load by its own weight is equivalent to uniformly distributed load of around 7.5 t/m^2. Bearing capacity of upper clayey soil mass (q_d) is estimated as

$$q_d = (3.8 \text{ to } 5.14) \times Cu = 8.4 \text{ to } 11.3 \text{ t/ms}$$

Core stones for the dyke are installed onto 1.0-1.5m thick rubble mound. Therefore, it is expected that overburden load up to (8.4 ~11.3) + 1.5 (counter weight of 1.5 m thick rubble mound) = 9.9 to 12.8 t/ms of pressure could be applied onto the underlying subsoil without provision of subsoil improvement.

f) Expected Consolidation Settlement in Foundation Subsoil

It is estimated that possible settlement by consolidation along sand protection dyke is minimum and will be around 30 to 60 cm in long term basis which does not include instant settlement caused during construction work.

Table 12.1.23 Consolidation Settlement along Sand Protection Dyke

Layer	Layer Thickness (h) (cm)	Initial Earth Pressure (Po) (kg/cm^2)	Vertical Stress in Foundation Soil Mass ($\Delta P=\sigma \times Iz$) ($kg/cm^2$)	Total Pressure (Po+ΔP) (kg/cm2)	Initial Void Ratio (e_o)	Final Void Ratio (e_1)	Settlement (S) (cm)
1) Sand Protection Dyke at Water Depth of CD-3.0m							
Subsurface Sand	200	0.10	---	---	---	---	0
C1:Upper Clay	600	0.41	0.40	0.81	1.62	1.50	27
Clayey Sand	300	0.77	---	---	---	---	0
C3:Lower Clay	500	1.12	0.35	1.47	1.02	1.00	5
Total							32cm
2) Sand Protection dyke at Water Depth of CD-5.0m							
Subsurface Sand	200	0.10	---	---	---	---	0
C1:Upper Clay	600	0.41	0.51	0.92	1.62	1.48	32
Clayey Sand	300	0.77	---	---	---	---	0
C3:Lower Clay	500	1.12	0.47	1.59	1.02	0.98	10
Total							42cm
3) Sand Protection dyke at Water Depth of CD-7.0m							
Subsurface Sand	200	0.10	---	---	---	---	0
C1:Upper Clay	600	0.41	0.65	1.06	1.62	1.45	39
Clayey Sand	300	0.77	---	---	---	---	0
C3:Lower Clay	500	1.12	0.62	1.68	1.02	0.97	12
Total							51cm

Source: JICA Study Team

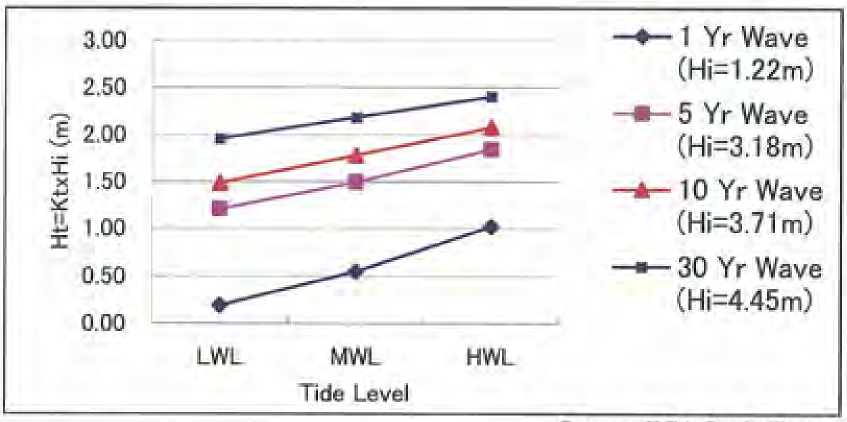
Settlement (S)= $h \times (e_o-e_1)/(1+e_o)$
Top Elevation of Sand Protection dyke: CDL+2.0m
Water Level: CD+2.0m
Vertical Stress in Foundation Soil Mass at the soil depth: as indicated as above at the center of the Dyke

g) Wave Height Transmitted through the Dyke

The sand protection dyke functions as breakwater to create calm waterway for vessel navigation once it shall be installed along access channel. The crest level of the dyke is elevated at CD+2.0m, wave height transmitted through the dyke is estimated as shown in Figure 12.1.25 for waves from 1 to 30-year Return Period under such tide level as LWL, MWL and HWL. For the wave of 1-year return period (Ho=1.22 m) for instance, the transmitted wave height through the dyke is estimated for tide level at LWL, MWL and HWL as follows.

- Wave Intrudes: One (1) Year Return Period Ho=1.22m
  Hi=Ks×Kr×Kd×Ho=1.0×1.0×1.0×1.22=1.22m
- Dyke Section: At Seabed Elevation of CD-7.0m
- Wave Height Transmitted (Ht):
  Ht= 0.20 m (at LWL=CD+0.43m),
  Ht= 0.55m (at MWL= CD+1.95m), and
  Ht= 1.02m (at HWL= CD+3.55m)

Since the crest height is elevated at low level, it is very likely that the rate of wave height reduction through the protection dyke is not so significant to protect access channel water area particularly in case of tide level at HWL.



Source: JICA Study Team

Figure 12.1.25 Wave Height Transmitted Through Sand Protection Dyke

12.2 Construction Method and Schedule

12.2.1 General

The construction of Lach Huyen terminal is planned in two phases: 2015 and 2020. In initial phase of 2015, two container terminals are planned to be constructed. While in 2nd phase of 2020, total of five container terminals and three multi-purpose terminals are planned of which the total length is 3,150m. The major scope of work is as follows, and the construction quantity for 2020 stage is shown in the Table 12.2.1. The detail of each scope is explained in the following sections.

- Dredging of the access channel
- Dumping of the dredged material
- Reclamation of the terminal yard
- Soil improvement work
- Construction of berth structure
- Port protection facilities (Outer revetment and Training Dike)

Table 12.2.1 Major construction volume for 2020

Item	Unit	Quantity	Remarks
1.Berth structure			
Container terminal L=750m	berth	5	2 berth by 2015
Multi purpose terminal L=250m	berth	3	-
2. Dredging works			
Access channel	m3	32,300,860	-
Wharf slope	m3	2,239,000	Private scope
Berth box	m3	338,000	Private scope
Between berth box and access channel	m3	654,000	Private scope
3. Reclamation works			
Terminal area	m3	12,090,000	
4. Protection Works			
Inner Revetment	m	750	-
Outer Revetment	m	3,230	-
Sand Protection Dike	m	7,600	-
5. Soil Improvement work			
Terminal area	m2	2,095,000	-
Inner revetment	m2	4,550	-
Outer revetment	m2	65,500	-
Access Road behind Port	m2	601,600	
6. Access road			
Access road behind port	m	3,150	W=200m
7. Public facility area			
CIQ building and service boat berth	m2	130,200	-

Source: JICA Study team
Note: quantity is including the initial phase of 2015

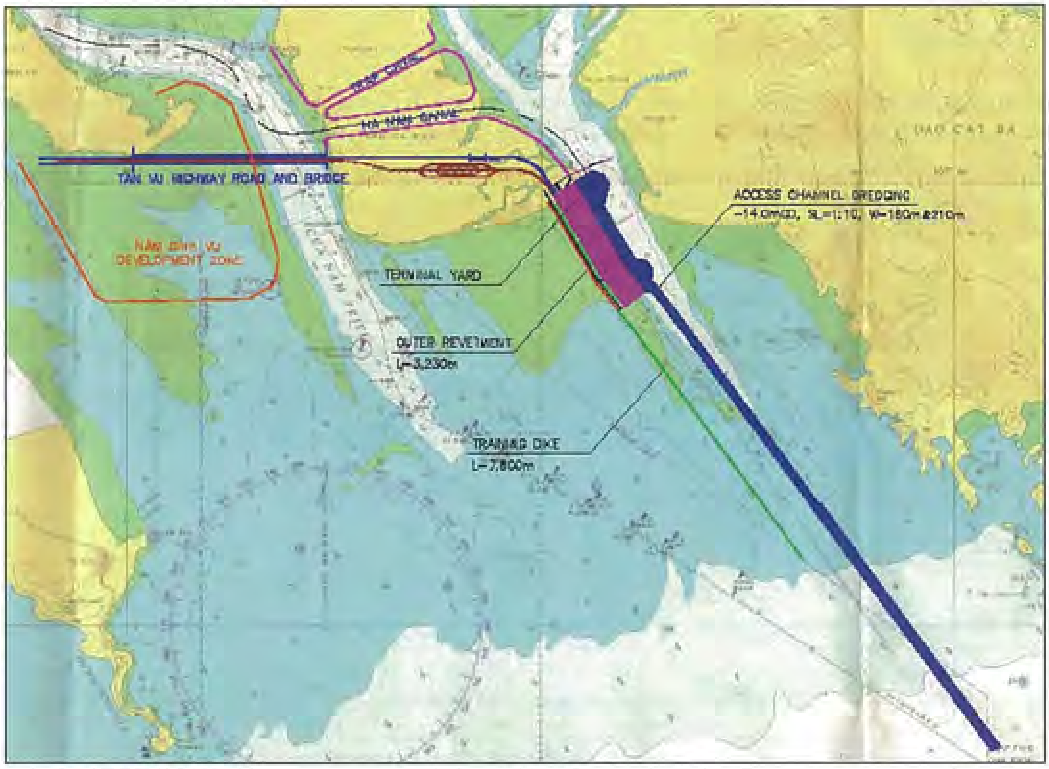


Figure 12.2.1 Work Plan

12.2.2 Dredging of the Access Channel

The existing access channel with design depth of -7.2m CD and the width of 100m will be dredged to the elevation of -14.0m CD with the width of 160m by 2015. After 2015, maintenance dredging of the channel shall be necessary and its estimate volume is subject to the simulation result.

The design slope is 1:10 considering the actual soil condition on site, and the total dredging volume is estimated around 32,300,860 m^3.

Cutter suction dredger (CSD) and Trailing Suction Hopper Dredger (TSHD) will be used for the dredging work. Both types of dredgers are available at the local dredging company, but their capacity is rather small and insufficient to complete the dredging work on time. Therefore, foreign dredgers with larger capacity such as CSD of 6,000ps class and TSHD with hopper capacity of 10,000 - 20,000m^3 shall be mobilized.

For the maintenance dredging, it is recommended to use TSHD (which requires no anchoring) in order not to disturb the ongoing port operation and to ensure safety of berthing/un-berthing of the vessel.

12.2.3 Dumping Area for the Dredging Material

Since existing soil of the channel is not suitable as the reclamation material, basically all the dredged material will be dumped at the designated dumping sites. When CSD is used, the dredged material is pumped into the hopper barge moored alongside, and it will be pushed to the dumping ground by pusher tug boat for dumping. After dumping is completed, the barge will be moored alongside CSD for next loading. As for TSHD, she will sail to the dumping ground by herself once her hopper is full.

12.2.4 Reclamation of the Terminal Yard

The terminal yard including access road of 200m in width behind the terminal will be reclaimed to the elevation of +5.5mCD to +6.0mCD. Main reclamation material is the sand from river, and the total reclamation volume is estimated to be around 12,090,000m^3.

The sand will be transported to the site by barges, and it will be pumped into the terminal yard by sand pump. The reclamation will basically start from the land side towards the sea.

12.2.5 Soil Improvement Work

After reclamation, the ground will be improved by PVD (Plastic board Vertical Drain) method. The base machine will install casing with plastic drain material into the reclaimed ground @1.2m square as shown in Figure 12.2.2. The total area to be improved for the terminal yard (including access road width of 200m behind the terminal) is around 2,380,000m^2.

After the installation of the plastic board drain material, thin layer of the sand (Sand mat: thickness around 0.5m to 1.0m) will be laid in order to create drain layer. Then preloading will be commenced by embankment. Embankment will be carried out by excavator, bull dozer and pay loader. Embankment material will be transported by barge, and loaded up to the sand stock yard within the reclamation site. Once the required consolidation degree is achieved, the embankment will be removed and leveled to the design elevation for the next step of work.

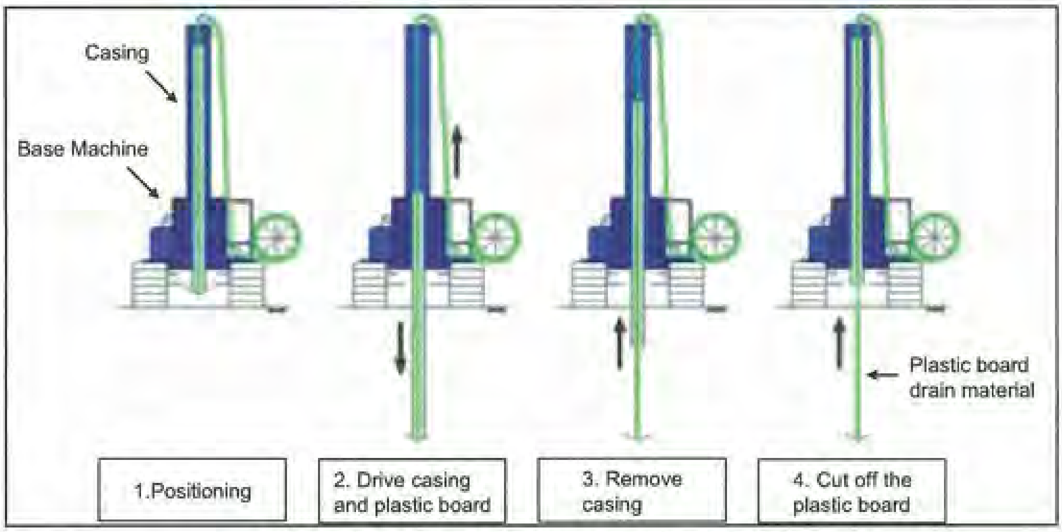


Figure 12.2.2 Construction procedure of PVD

12.2.6 Construction of Container Wharf Structure

1) Construction of the Earth Retaining Wall

Once reclamation and soil improvement is completed for some area, steel sheet pipe pile (SSPP) of D800mm and steel sheet pile anchor wall (SP) will be driven by land piling machine equipped with the diesel hammer or hydraulic hammer to construct earth retaining wall. SSPP will be driven until 1/4D (200mm) of the pile penetrates into the silt stone layer. The driven SSPP and SP will be connected with tie rod or tie cable. After tie rods or cable ties are tensioned, capping concrete will be casted and the area will be backfilled by sand or soil.

2) Dredging of the Slope in front of the Quay and Berthing Box

After the construction of the earth retaining wall, the slope in front will be dredged with the slope gradient of 1:3 by grab dredger. The slope near the earth retaining wall may require trimming from the land in order not to damage the retaining wall.

3) Marine Piling

After the dredging of the slope is completed, piling for the berth structure will be commenced by piling barge. The piles are transported and stocked on a barge and moored alongside the piling barge. Pile position will be checked and confirmed by the survey from the land before the driving. The piles needs to be driven into the silt stone layer in order to obtain sufficient bearing and tension capacity, and may require pre-boring by earth auger prior to the driving in case when sufficient penetration cannot be achieved.

4) Slope Protection Work

The slope will be protected by placing small stone and armor stone transported to the site by barges. The stone work will be carried out both from the land and from the sea. Crawler crane and long arm excavator will be used on the land, while crane barge with orange bucket and/or flat barge with long arm excavator mounted will be used for the sea. The stone will be placed by hand as well.

5) Superstructure Work

Where the slope protection is completed, temporary staging (H-beam) will be installed on the piles. Then the pre-fabricated beams will be launched by crawler crane on land and crane barge from the sea.

After launching, rebar tying and form work will start followed by in-situ concrete casting to joint pre-fabricated beams. The slab will be pre-fabricated on land as well and they will be launched by crawler crane on land and crane barge from the sea. The final elevation of the jetty surface will be adjusted by the topping concrete casted on top of the precast slab. It is planned to make prefabricated concrete as much as possible so that the construction period can be shorten.

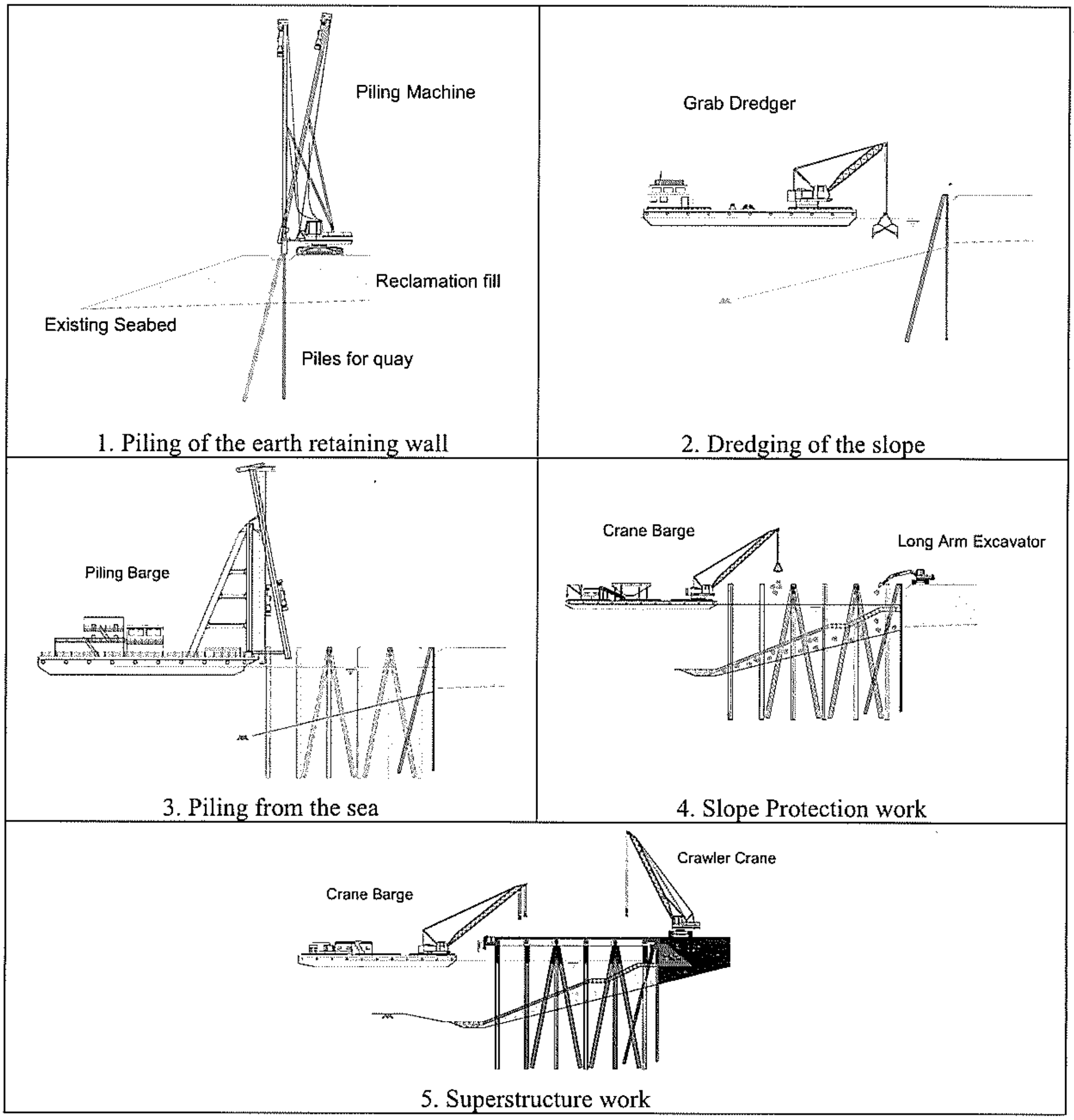


Figure 12.2.3 Sequence of the Berth Construction

6) Pavement

Interlocking concrete block (ICB) heavy duty pavement and asphalt pavement will be applied for the container terminal and multi-purpose terminal / access road respectively.

ICB pavement consists of Base (sub-base soil and crushed rock base), Concrete base, Sand bedding and ICB. Base material will be transported by barge and loaded up into the dump truck from the temporary jetty by excavator and bulldozer. It will be compacted with required thickness and CBR by compaction roller and/or tire roller. Concrete base will be casted on top of the compacted Base followed by the sand bedding. ICB will be installed by man power after adjusting the elevation of sand bedding.

Asphalt pavement consists of Sub-base, Base course, Binder course and Surface course. Base material will be transported, loaded up and compacted in the same method as ICB base material. Then bituminous stabilized base course delivered from the asphalt plant will be laid and compacted. Prime court will be sprayed on top of bituminous stabilized base, and Asphalt binder course will be spread by asphalt finisher and compacted by roller. Tack coat will be applied on the binder course surface, and Asphalt surface course will be sprayed by asphalt finisher and compacted by roller. All the asphalt will be produced in the asphalt plant set up in the project site.

12.2.7 Construction of Multi-Purpose Wharf Structure

The construction method and sequence of the multi-purpose terminal is more or less same as the container terminal. One of the differences is the pile design which is Pre-stressed Spun High Strength pile (PHC pile) instead of the steel pipe pile, but the driving method of the pile is basically the same.

12.2.8 Port Protection Facilities (Outer revetment and Sand protection dike)

1) Outer revetment

The total length of outer revetment is 3,230m and it will be constructed in the initial phase. The base of outer revetment requires soil improvement, and it will be reclaimed by sand pump to the elevation of around +4.0mCD in order to enable soil improvement work by land machine. After the ground soil is improved, the seabed will be excavated to +0.5mCD by long arm excavator to place core rubble and amour stone. Then capping concrete casting and backfilling will be commenced followed by the installation of toe protection concrete block and wave dissipating concrete blocks. All the work shall be carried out from the land.

2) Sand Protection Dike

The total length of sand protection dike is 7,600m and it will be constructed in the initial phase. The base of dike does not require improvement, and the stone mound will be directly placed on the existing seabed by flat barge with long arm excavator mounted and/or crane barge with orange bucket. Then capping concrete will be casted followed by installation of wave dissipating concrete blocks. Installation of wave dissipating concrete blocks will be done by crane barge.

As the construction of the terminals progress after the initial phase, the sand protection dike needs to be reinforced to be used as outer revetment.

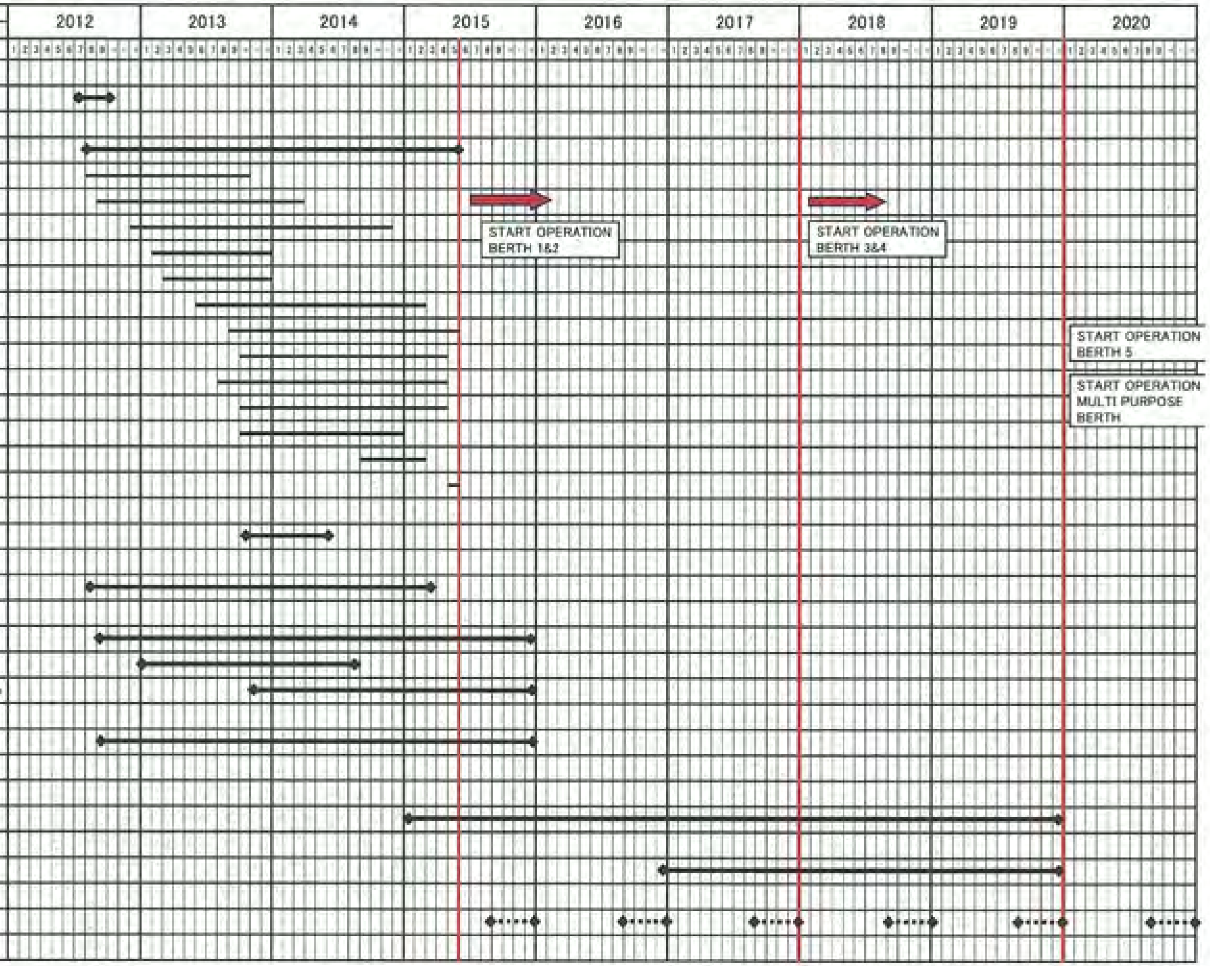
12.2.9 Construction schedule

Due to the weather condition on site, four days are not workable through the year; two (2) days due to foggy weather, and two (2) days due to the storm. Furthermore, there are nine (9) public holidays and fifty two (52) Sundays. Thus, the workable days for marine work are estimated to be 300days per year, which makes 25days per month.

The tentative construction schedule for medium term development is shown in the Table 12.2.2. It should be noted that this schedule is planned based on the estimation that all the steps such as the detail design, procurement as well as construction works will progress in a timely manner without any delay or accident. With reference to the berth 3 and 4, it should be developed when the cargos for berth 1 and 2 increased beyond its capacity. The actual time of development is decided based on the actual condition of the market at that time. Since the berth 1 and 2 will be developed by PPP scheme, the development of berth 3 and 4 are to be commenced when the public and private agree on the condition that the profitability of berth 1 and 2 will not be impaired by the development.

Table 12.2.2 Tentative Construction Schedule for Medium Term Development of Lach Huyen Port

ID	Task	Unit	Quantity	Remark
YEAR 2015 STAGE				
1	Preparation Work	ls	1	Office, loading jetty etc
2	Container Terminal Construction	m	750	375m x 2berth
2-1	Reclamation	m3	2,955,483	Sand Pump
2-2	Soil improvement	m2	625,769	CDM and PVD
2-3	Preload	m3	2,680,000	Sand
2-4	Earth Retaining Wall	m	750	Land Piling
2-5	Dredging of the slope	m3	568,000	Grab Dredger
2-6	Marine Piling	no	1,330	-
2-7	Berth Structure	m	750	-
2-8	Pavement	m2	409,500	ICB
2-9	Equipment	ls	1	Gantry crane etc
2-10	Utility	ls	1	-
2-11	Building	ls	1	-
2-12	Access Road behind the port	m	1,000	W=200m
2-13	Inspection and Clean up	ls	1	-
3	Inner Revetment (South)	m	750	-
4	Access Channel Dredging	m3	29,000,000	Cutter Suction Dredger
5	Outer Revetment	m	3,230	
	Type-A	m	720	Behind the terminal
	Type-B	m	2,510	Future reclamation on port side
6	Training Dike	m	7,600	
YEAR 2020 STAGE				
7	Container Terminal Construction	m	1,600	400m x 4berth
8	Multi-Purpose Terminal Construction	m	750	250m x 3berth
9	Maintenance Dredging of Channel	m3	-	-



12.2.10 Material Availability

Basically most of the construction material can be found around project site. For the reclamation sand, there are some concerns in the transportation capacity and permitted volume of dredging.

The survey on sand potential of two rivers in Hai Duong Province (about 70km distant by river from Lach Huyen port location) was carried out in 2004. After one year of the study, it was found that there are 19 sand accumulation sites which can be used for sand digging with the total volume of around 530,000,000m^3.

By the information obtained from local sand supplier in Hai Duong District, there is one area permitted to dredge about 6million m3 of sand at the time of SAPROF study (March, 2010) and the application of two other area with total estimated volume of 12million m3 was in progress, which are estimated to be approved by summer of 2010. The distance from their sand source to Lach Huyen project area is about 70km by river way, and according to them, it takes 3 days to make 2 trips (1.5days/trip). The size of the barge varies from 300m3 to 500m3, and all the barges are equipped with the sand pump. There are many barges which can be mobilized according to the necessity.

Table 12.2.3 Sand sources in Hai Duong District

No.	Name of sand area	Area (ha)	Borehole depth for reserve evaluation (m)	Reserve amount (m3)
I, Thai Binh River				23,281,785
1	Hiep Cat No, 1	32	-3	960,000
2	Hiep Cat No, 2	11	-3	330,000
3	Kenh Vang	20	-3	600,000
4	Thai Tan 2	53	-3	1,590,000
5	Duc Chinh	222.93	-3	667,000
6	Minh Tan	28	-3	840,000
7	Dai Dong	210	-5	4,630,765
8	Phuong Hoang	12	-3	360,000
9	Tu Xuyen	220	-5	4,404,020
10	An Thanh	96	-3	2,880,000
II, Kinh Thay River				30,556,634
1	Nam Hung	29.2	-9.5	2,774,000
2	Vinh Tru	223.71	- 6	8,485,714
3	Dong Lac	62	-9.5	5,890,000
4	Cong Hoa	218,0	- 8	7,317,920
5	Phuc Thanh	18.1	-9.5	1,719,000
6	Cau Quan	20	-9.5	1,900,000
7	Le Ninh	11	-9.5	1,045,000
8	Ben Trieu	03	-9.5	285,000
9	Kinh Chu	12	-9.5	1,140,000
Total (I+II):				53,838,419

Source: Hai Duong Government Electronic Getway; on August 2005 by Mr. Vuong Duc Tranh, Chief of Natural Resource Management Division, Hai Duong DONRE

12.2.11 Facility for the site

Currently the only access to the project site is by the ferry. Therefore, during the construction period it is necessary to set up concrete batching plant, asphalt plant and pre-cast concrete yard within the project area. Their location is either in the reclamation site, or in Cat Hai Island.

13. Consideration of Natural and Social Environment

After the comprehensive review of the TEDI's Lach Huyen port infrastructure construction study, SAPROF study team recommended some change in design of the TEDI's port design. After the fact finding mission by the JICA representatives in March 2010, MOT agrees the recommended change in design. Following are the major changes between TEDI-F/S and SAPROF study.

Item	TEDI F/S	SAPROF study team	Remarks
1. Design vessel for container berth	Fully loaded 30,000DWT vessel Partial loaded 50,000DWT vessel	Fully loaded 50,000DWT vessel Partial loaded 100,000DWT	Total berth length changes from 600m to 750m accordingly
2. Channel Width and Depth	130m wide, -10.3m deep below CDL	160m to 210m wide, -14m deep below CDL	Due to change of design vessels.
3. Length of sand protection dyke	Applying till -3m	Applying till -5m	Total length changes from 5,700m to 7,600m
4. Public Related Facilities/ Service Berth	Not included	1) Land reclamation 2) Service boats berth, 3) Port Admin. Bld., 4) Amenity Bld. 5) Pavement	1) Land Reclamation: 344,000 m^3/Berthfront dredging: 104,000 m^3 2) 375mL x 30m W, -4m, 3) & 4) 4,600 m^2 5) 121,000 m^2

Expected impacts on the natural and social environment with the SAPROF proposal are summarized as follows.

13.1 Natural Environment

Natural environmental consideration is concerned to basically both the construction and subsequent operation stages of the Lach Huyen gateway port development project as proposed by the Mid Term Development Plan up to the year 2020. In this report the related bridge across Bach Dang Estuary to facilitate road (and also railway) link between mainland Hai Phong and the port (in Cat Hai Island) is not taken into consideration. This Bridge Project is conducted as separate SAPROF Study.

Consequent of the changes in design by the SAPROF in comparison to the original TEDI F/S (The quantity of works are summarized in Table 12.2.1 of Chapter12), on overall basis, the following changes and it effects, if any, on natural environment are regarded as most significant.

(1) Effect due to extension of sand protection dyke from 5.7 km to 7.6 km and the resultant sedimentation phenomenon of sand trapped by the dyke in the exterior seabed area of the access channel facing the offshore of Nam Trieu (Bach Dang) Estuary

(2) Effect in the phenomenon of dispersion of oil in case of accidents due the expansion of port terminal area in addition to the extension of sand protection dyke as noted above and

(3) Effects due to expansion in lateral area (widening) and depth (deepening) of dredging (the length of access channel dredging in fact slightly decreased from 18 km to 17.4 km) that resulted in very significant increase in the quantity of dredged material to about 33 million m^3 from about 9 million m^3 as of TEDI F/S.

Still overall effects due to construction works and the required mitigation measures that are short-term effects confined to the period of construction works that basically involves reclamation works and dredging works remained unchanged even though the quantity of work requirement very significantly increased in case of dredging works. The entire effects (both natural and social environmental effects) due to both construction and operation of the port facility with relevant mitigation measures are summarized in the JBIC Environmental Checklist shown in Table 13.3.1. The significant relevant natural environmental aspects including mitigation measures separated between construction and operation stages of the project are briefly dealt with below.

13.1.1 Construction Stage Aspects

The natural environmental issues concerned to construction stage of the project falls into 3 broader categories. They are; (1) Effects due to sourcing of required material for construction works, in particular sand, soil, gravel, stones and rocks that would involve sourcing of these materials from natural environmental areas of lands and also underwater (in particular sand and gravel are widely sourced in Vietnam from rivers and estuaries), (2) Dredging and dredged material management issues which is very significant in particular considering the generation of high quantity of dredged material consequent to the deepening of access channel (the dredged material quantity is estimated around 33 million m3) and (3) EHS (environment, health and safety) management and monitoring aspects of construction works (by the construction contractor).

The relevant mitigation measures are incorporated in the approved EIA Report (2008) that basically proposed near-shore locations for the disposal of dredged materials. These aspects including the relevant alternative means of dredged material disposal and mitigation measures are further dealt with below.

1) Sourcing of Materials for Construction of Port Facilities

The locations for sourcing the required construction materials have been indicated in the Appendix 1 of the approved EIA Report (2008). Those locations are also agreed upon among all relevant stakeholders including MONRE (Ministry of Natural Resources and Environment). Accordingly, those locations are regarded as legally approved quarry sites determined with due diligence so as not no cause significant adverse environmental effects consequent to the sourcing of those materials like sand, soil and other natural resources. Still, considering the rapid pace of ongoing infrastructure development in Vietnam, in this region of northern Vietnam in particular (Hai Phong being the third largest city with closest port facility from Hanoi), these identified sites might run out of the sources by the time for the start of actual construction works for the project. Accordingly, during construction planning by the construction contractor, availability and suitability of these sites has to be reevaluated and reconfirmed along with other potential alternative legally approved sites so that the required source material could be procured. Due diligence has to be exercised by the construction contractor to ensure all procurement of such natural resources for construction of port facilities like sand, soil and stones are obtained from legally certified and approved suppliers located as close as possible from the construction site so as to economize the procurement cost as well.

The proposed construction plan for the project duly confirmed that the procurement of all required natural resources for construction could be supplied by legally certified suppliers located close to project site in Hai Phong and nearby Hai Duong areas. In this regard it is noted that some of those areas mentioned in the EIA Report (Appendix 1) for souring of construction materials like sand are located far away from the project site (the proposed locations for souring of sand at Son Lo, Viet Tri and Phu Tho are located very far at upstream Red River reaches of Hanoi) and it is not necessary to go this far to procure materials required for construction works.

2) Dredging and dredged material management

Maintenance dredging works for the existing approach canal to the Hai Phong port has been done periodically over a long period of time and hence Hai Phong port has a lot of experience in dredging and dredged material management disposal in the area planned for the port construction works. In this regard also locations suited for disposal of dredged materials have been agreed upon among all relevant stakeholders and included in the Appendix 1 of the EIA Report (2008). Those locations that have been agreed upon are the coastal inland lowland area located in the vicinity of Bach Dang Estuary with the planned South Dinh Vu (Nam Dinh Vu) reclamation area being the largest and easily accessed coastal area with capacity to receive even up to 50 million m^3 of dredged material. The quantity of dredged material, though not significantly contaminated and could be regarded as natural dredged material (refer to Section 9.2 of Chapter 9), is quite large of about 33 million m^3 principally due to access channel widening and deepening requirement up to 14 m below CDL for the planned Lach Huyen Port. Still it is less than the available capacity of 50 million m^3 in the South Dinh Vu Area. Accordingly it is possible to dispose the entire dredged material derived by this project in this easily accessed Nam Dinh Vu area (Refer to Figure 16.1.5 of Chapter 16 for the disposal location of Nam Dinh Vu area and also other smaller disposal areas located in communes as also identified in the approved EIA Report of 2008).

Still this Nam Dinh Vu area is also targeted for reclamation to be an industrial estate and it may not be available for dredged material disposal during the conduct of (capital) dredging works of this project if the reclamation work has already been accomplished by that time. Accordingly, during detailed engineering more alternative sites for the disposal of dredged materials may be required to be investigated including potential sites for offshore disposal since such large quantity of dredged material could not be disposed in a timely manner other than in Nam Dinh Vu area.

In such a case environmental effects and mitigation measures for other locations and means of disposal like offshore disposal shall be studied as component of change in design of dredging works of the detailed engineering design and the relevant additional (supplementary) EIA Report shall be formulated for approval by MONRE prior to the start of construction works. There is sufficient time frame to conduct such environmental impact studies during detailed engineering design works (that would also include tendering stage, if necessary) and to formulate and obtain approval for additional EIA Report if additional alternative disposal means like offshore disposal for dredged material is deemed necessary.

A time frame of 6 months is considered adequate to conduct EIA study focused on alternative offshore locations for dredged material disposal (due to capital dredging). Since offshore disposal seems to be the physically viable option, alternative offshore locations with seawater depth of at least 20m and possibly located in between the offshore area bounded by the planned Sand Protection Dyke and Do Son (also known as Bac Bo Bay as shown in Figure 16.1.5 of Chapter 16) is regarded as suitable since this offshore area should have naturally high turbidity (located at offshore of Bach Dang/Nam Trieu Estuary with high sediment load and also sufficiently far away from Cat Ba Island but still close to the dredging area). Alternative locations in this offshore area shall be studied with simulation on the area and extent of spread of turbidity (SS/suspended solids) consequent to the disposal of dredged material with due consideration to significant constraints like effect due to spread of turbidity on important fishing grounds, Cat Ba Island and other coral reef islands.

During this capital dredging work navigation safety of dredger operation is very important since this access channel targeted for dredging is traversed by vessels to Hai Phong Port (functional access channel). It is also noted that some adverse effects due to dredging works for widening and deepening of the existing access channel on marine biota (in particular on seabed benthos) are inevitable. Still any adverse effect is regarded as not that significant in consideration to the past experience of similar works and also the availability of vast unaffected seabed area in the vicinity of the dredged area serving as habitat for marine biota.

3) EHS Aspects of Construction Works

Due diligence to ensure implementation of necessary environment, health and safety (EHS) measures in integral manner during the execution of the construction works by the construction contractor (also could be referred to as proper construction management or good construction practice) need not be overemphasized considering also the location of the construction works in offshore area. Contractor as the first priory shall ensure the safety of his construction works and workers with strictly in compliance with "Safety First" concept that would also include mandatory use of necessary safety gears by the workers like protective clothing, helmets, ear plugs, goggles, safety shoes and others (personal protective equipment/PPE) as appropriate. Navigation safety of transport barges of construction materials (with proper scheduling to avoid congestion and interference to other boats and ships in the area adjacent to the functional Hai Phong port) is also very important. Waterway is the only available accessible means to the project site in Cat Hai Island.

Moreover, all wastes generated due to the construction works including living wastes generated by the work force has to be managed sanitarily and treated as appropriate and disposed in such a manner so as not to cause water pollution and in the sensitive offshore area of the construction site located near Cat Ba Island (protected national park and ecotourism area) and also to ensure the cleanness of the work environment, which is also important to mitigate any disease and health issues in the work force attributed to unsanitary or unhealthy environmental condition. This also includes due focus on 3R (reduce, reuse and recycle) with segregation and management disposal of solid wastes generated. Fugitive (dust) emission from stock piles of sand and others need to be duly controlled with water spray or vinyl covering as appropriate. This is regarded as the most significant mitigation measure of air pollution control at construction site.

Moreover, contractor shall conduct (contractor may be obliged to conduct) periodic regular environmental monitoring in both on-land area of Cat Hai Island and offshore area of the construction site at Lach Huyen Estuary by using the services of an independent reputed organization to conduct all such environmental monitoring related sampling and analysis work.

In this regard, the required environmental monitoring plan is basically incorporated on a preliminary basis in Chapter 6 in the EIA Report (2008), which is also updated in the SUPPLEMENTAL EIA Report study by the SAPROF. Still this is a tentative monitoring plan that needs to be reviewed and reformulated in detailed engineering. The reformulated environmental monitoring plan for construction stage during detailed engineering will be duly included in the technical specifications and contract tender documents in accordance with relevant contract packages (in this case 2 construction contract packages are proposed separated between dredging works and port terminal and related facility construction works as given in Section 17.4 of Chapter 17). The tentative environmental monitoring plan (program) as updated by the SUPPLEMENTAL EIA Report is given in Appendix 13-1

13.1.2 Operation Stage Aspects

Operational safety in port terminal including navigational safety in ship berthing and effective measures to handle emergency situation like ship accidents, fire and oil spills is the most significant aspect of port operation. Moreover, effective surveillance system to ensure all ship originated wastes are duly disposed in the port terminal and not illegally dumped into the port waters is also very important. The other significant aspect is management of maintenance dredging works including disposal management of dredged materials. These measures have added significance also considering the location of the port in the vicinity of Cat Ba Island (a protected national park). In effect port operational (and also navigational) safety and both port operation and ship related pollution control issues (including maintenance dredged material management that is dealt with under port waste management of below and also in Chapter 22) are the most significant aspects of port operational impacts. All these port operational aspects could be comprehensively categorized as EHS (environment, health and safety) of port operational management.

The relevant mitigation measures of these aspects are basically incorporated in Chapter 4 of the approved EIA Report (2008), which is further dealt with below.

Concerned to the aspects of change in design due to sedimentation phenomenon of sand trapped by the dyke in the exterior seabed area of the access channel facing the offshore of Nam Trieu (Bach Dang) Estuary and effect in phenomenon of dispersion of oil in case of accidents due the expansion of the area of berth development (as well as extension of sand protection dyke) the relevant simulation studies done in approved EIA Report were redone based on the revised project design by the SAPROF as a very significant component of SUPPLEMENTAL EIA Study. The study results confirmed that any potential effect due to change in design is not that significant from the original projection both with respect to spread of oil in case of accidents and any potential change in the exterior seabed topography of the sand protection dyke. In effect potential accumulation of trapped material at the exterior area of the sand control dyke is not that significant and also the dispersion of oil in case of rare accident could be controlled.

1) Port Operational Safety

Concerned to direct port terminal operation, overall operational safety including the safety in cargo handling work and work force (stevedores and others), in particular with respect to the handling of container cargo, is the most important aspect to be duly enforced by port operator/authority. In addition navigational safety of ship maneuver and berthing is the important aspect of near-shore safety of ships and vessels around the coastal waters of the port area. (The required navigational safety and vessel traffic control is described in Chapter 23.) Moreover, the necessary facilities and resources to deal with emergency situation like vessel accidents, vessel drifting, and fires including accidental oil spills (that might occur in rare instance) need to be incorporated and ready for action at short notice as the emergency management system of the port operation. These should also be regarded as essential technical requirement to be met for effective port operational management. These aspects including the management system to handle potential accidents and even simulation study on areas potentially affected in case of accidental oil spills are incorporated in Chapter 6 of the approved EIA Report (2008). The simulation study on oil spill is updated in the SUPPLEMENTAL EIA Report by SAPROF as mentioned above.

Still, at present in this port development plan up to the year 2020, the proposed port berth development is confined to handle only container and general cargo. So it is presumed that no oil terminals to handle significant (and large) quantity of oil as cargo (oil tanker vessels) and also significant noxious liquid cargo in bulk form (chemical tanker vessels) that would correspond to also generation of significant wastes corresponding the Annex I and Annex II of MARPOL 73/78 of IMO (International Maritime Organization) would be involved at this stage of port development. Still ships (in particular large container vessels) could carry significant quantity of bunker oil for combustion power requirement for ship movement. So accidental oil spills could occur in some rare instances due to damage of storage tanks of bunker oil in case of ship accidents. Accordingly, emergency management system to deal with potential oil spills as well (in addition to other emergency situations) is necessary as included in the approved EIA Report even when oil as cargo is not involved in the current port development plan (2020).

In this respect, even in future, provision of oil terminal facility in such a sensitive coastal water environmental area located in the vicinity of a number of protected and ecotourism oriented terrestrial and marine environmental areas of both national and international importance, namely, Cat Ba Island cum Lan Ha Bay and Ha Long Bay need to be carefully investigated along with alternative sites elsewhere since the risk of ecological damage caused by potential accidental (and large-scale) oil spill consequent to oil tanker vessel accidents to the protected coastal marine environment (and also to tourism) could be very severe even with the provision of all the necessary facilities well-intended to handle potential oil spill as significant component of emergency management system of port operation.

2) Port waste management

Considering the proximity of the port to Cat Ba Island (with its Cat Ba National Park, protected area) located basically at a distance in the range of only about 1 to 3 km away from the port across the Lach Huyen Estuary, minimization of waste generation at source in the first place consequent to the operation of port terminal and related facilities such as warehouses and cargo handling works (in particular potential excessive fugitive dust generation consequent to the handling of general cargo need to be controlled with proper cargo packaging and use of proper cargo handling equipment and methods since container cargo is in packed form within containers and hence could be regarded as clean cargo as long as packing work takes place elsewhere) and effective management of all wastes generated both consequent to port operation and ship berthing activities is utmost important. In this respect the necessary waste reception, treatment and disposal systems shall be incorporated as integral component of the port design. The necessary port waste management facilities are included in Chapter 4 of the EIA Report (2008).

Such waste reception and treatment facilities would include sewage (wastewater) treatment system to treat both human waste generated due to port terminal operation and also sewage disposed by berthing ships and vessels (waste corresponding to Annex IV of MARPOL 73/78), waste oil reception facility to receive oily bilge waste from berthing ships and vessels (waste corresponding to Annex I of MARPOL 73/78) and solid waste (garbage) reception facilities to manage both solid waste generated due to port terminal operation and also solid waste disposed by berthing ships and vessels (waste corresponding to Annex V of MARPOL 73/78).

The effective operation of all relevant waste reception facility in the port shall be complemented with an effective surveillance system to mitigate illegal dumping of wastes by ships and vessels (with high levy as fine to deter illegal dumping) within the port waters and its vicinity.

The waste management system for the port operation would also include effective management of periodical maintenance dredged materials. Periodic maintenance dredging would be necessary in the access channel to ensure continuity of design navigation depth. As far as possible near-shore disposal as practiced currently in the existing Hai Phong Port will be continued. This aspect on maintenance dredging is further dealt with in Chapter 22.

The above environmental protection and mitigation measures focused on the EHS of overall port operation shall be complemented with the implementation of regular periodical port environmental monitoring focused at least as the first priority on the monitoring of surrounding estuarine coastal port water environment of Lach Huyen Estuary. An overall port environmental monitoring plan is included in the EIA Report (2008) that is further updated in the SUPPLEMENTAL EIA Report formulated by this SAPROF and given in Appendix 13-1. This environmental monitoring plan is tentative and need to be reviewed and reformulated during the detailed engineering as also noted under Item 3) on EHS aspects of construction works (Section 13.1.1 of above).

13.2 Social Environment

13.2.1 Preparation Stage Aspects

For the consideration of the social environmental impacts during the preparation stage, following two primary issues are expected to be addressed. They are; 1) land acquisition, and 2) development and enforcement of safeguard policy for loss of coastal fishing area (Figure 13.2.1).

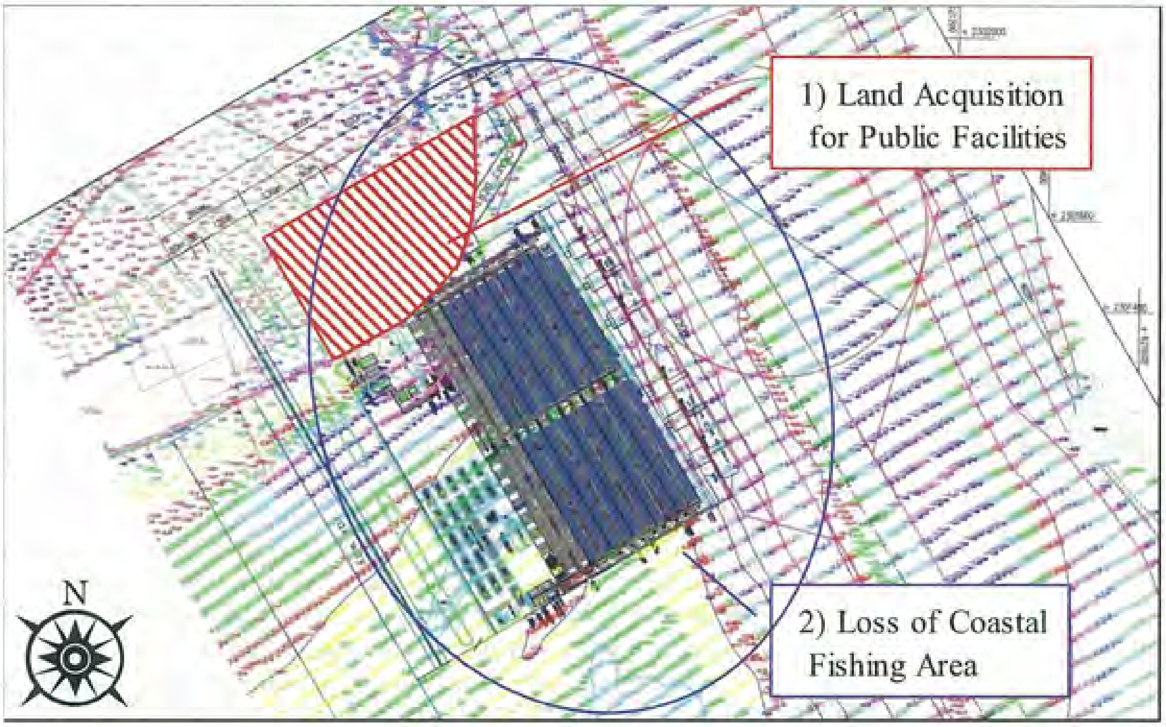


Figure 13.2.1 Special Attention Area for Social Environmental Consideration

1) Land Acquisition

Expected land acquisition area is shown in Figure 13.2.1 with red hutching area. Based on the field survey, there are no residential houses in the land clearance area. Based on the field survey at the project site with MPMU II, there are five (5) old graves along the coast, a border patrol office, a VINAMARINE VTS station, two roads, six (6) blocks of aquaculture ponds, and some bare ground and community forest. Due to the function of the border patrol office and VTS station, they are likely to sustain their function and facilities as present condition within the additionally proposed public facilities.

The expected impact of land use change would be 11.4Ha (considerable impact) excluding the existing government facilities, which is likely to function as a part of the new port's public facilities without major change (Table 13.2.1). Based on the field observation by SAPROF experts and MPMU II representatives at the site, there are no aquaculture activities in the expected land clearance pond.

At this moment, MPMU II is preparing the detailed land survey and land acquisition plan with the collaboration with relevant authorities. Detailed land use information and land acquisition plan will be given and implemented in six (6) month after MPMU II starts the initial process (Appendix 13-1). Thus, we assumed the potential impacts on the land as follows:

Table 13.2.1 Expected Impacts by the Land Acquisition

Present Use	Area (m^2)	Potential Impacts
1. Unknown use	7,200	There are no sign of land use at this moment. However, the property is just next to residential area so that the land use rights may belong to private. In case it does not belong to public, it is necessary to acquire the land with market price as defined by the effective regulations.
2. Gov. facilities	13,600	No potential impacts are expected due to its continuous functionality and no or little change in their facilities and properties for the new port.
3. Bare ground	26,300	There are no sign of land use at this moment except 5 graves. 5 graves will be relocated by the full support of responsible authorities.
4. Salt pan	1,500	This salt pan is still active in use. Though the acquired portion of the land would be minority of the targeted area, but it would be majority of the targeted area in case we count affected area by TanVu-LachHuyen Highway land clearance. In the case of the minor impacts, it would be only compensated by monetary under present regulation. In the case of the major impacts with the consideration of highway construction, not only monetary or land to land compensation but also support for livelihood recovery is also needed.
5. Aquaculture pond	64,700	Based on the MPMU II's explanation, the aquaculture ponds belong to the border control office adjacent to the ponds. Since there are no activities in the pond at this moment, we assumed no impacts on the either local communities and the border control office.
6. Forest	10,200	The forest belongs to the local community and there are no sign of the environmentally essential species. Due to the land clearance for the highway, majority of the community forest will be cleared.
7. Road	4,300	These two (2) roads are primary connection between Cat Hai TT (town) and Got harbor at this moment. Reroutes along the public facilities of the port will be constructed and present necessary connection between Cat Hai TT and Got harbor.
Total	127,800	Total area
Considerable impacts	**114,200**	**Potentially required area for the land clearance**

There are three items (graves, aquaculture ponds, bare ground) belong to private property or economic activities, which are likely to be covered by effective land law and relevant safeguard policies. However, as described in section 9.3.2, there are some gaps between the JBIC Guideline/WB OP 4.12 and Vietnamese safeguard policies. Also, the separately studied connecting highway between Tan Vu and Lach Huyen port is likely to be required to adapt the JBIC Guideline. Thus, a CONSISTENT POLICY on resettlement, compensation, and support for the recovery of PAP's livelihood between port portion and shall be considered as the Japanese ODA projects in the same area under MOT.

2) Development and Enforcement of Safeguard Policy for Coastal Fishing Activities

Expected loss of coastal fishing area is shown in Figure 13.2.1 with blue circle area. Based on the sample fishing survey at the project site and surrounding area, there are continuous and regular fishing activities at the proposed port development area. The project affected fishing boats (PAB) could be a couple of hundred to several hundred. However unlike farming, fishermen regularly move around to gain the fish yield so that impacts for such fishermen are relatively smaller than that of other land related economic activities, but it is not easy to estimate for the consideration of safeguards. However, it is highly recommendable to conduct detailed base line survey to consider the potential safeguard policy for such affected people.

In addition, unlike aquaculture and other farming activities, there are many immigrant fishermen living on their boats. Some of such immigrant fishermen regularly take fish, shrimp, shell fish at and around the proposed port area. As described in the previous section (9.3.4 Fishing Activities around the Proposed Project Site 2), the potentially affected fishermen do not have strong opinion for or against the proposed port development.

As shown bellow, the maximum source of impact area would be 208 ha in and around Lach Huyen estuary adjacent to Cat Hai island.

Table 13.2.2 Expected Impacts on Coastal Fishing

Proposed Use	Area (m^2)	Potential Impacts
1. Container terminal with service road	561,750	There is active coastal fishing in the area due to the favorable environment for small fish, shell fishes, and shrimp, and octopus are actively taken by local and immigrant fishermen living on the fishing boats. The fishing area will be permanently removed so that it is highly recommendable to provide reasonable safeguard measures to maintain or improve the standard of living for those who depend on coastal fishing in the project area. Though there are no safeguard policies at this moment under Vietnamese law and regulation, Hai Phong people's committee (the responsible authority) and MPMU II (the responsible implementation agency of the project) shall pay attention to such fishermen and implement a safeguard policy for such people on time.
2. Access Channel	278,400	Few potential impacts are expected due to its present functions. Though there are some fixed fishing nets along the existing channel, they have already been compensated for the relocation of the net for the port development project. However, deepening and widening of the channel might lead further loss of the fishing area.
3. Turning Basin	342,200	Some fixed fishing nets are observed at the proposed turning basin. Such fishing net owner may have already been given a 500,000VND for the relocation of the fishing net in the past. There are also some coastal fishing activities in the area at this moment.
4. Sand Protection Dyke	334,400	The cross section of the dyke increases water depth respectively. The dyke is also constructed on the shallower area along the channel where preferable fishing area at this moment. It is highly recommended to conduct detailed fishing survey to estimate the potential loss of fishing and discuss any possibility of occupation change as a sustainable solution.

For the consideration of the safeguard measures for the project affected fishermen, it is not quite common to consider such measure in Vietnam due to the lack of legal status/rights for offshore fishing activities. WB's safeguard policy also recognized the difficulties for a government of loan bellowers to provide compensation without legal status even if the government is willing to provide some safeguards. Considering the JBIC policy/WB OP 4.12, such safeguard measures could be considered by "Resettlement assistance." By the definition of WB OP 4.12, "Resettlement assistance may consist of land, other assets, cash, employment, and so on, as appropriate" for the compensation of land without any legal rights.

Based on the records of public consultation in the approved EIA and public hearing by MPMU II in

April 2010, vocational training is the highest interest for local residents to adapt the new environment and enjoy the potential benefits from the proposed port development. In order to address such interests and cooperatively guide the local communities, all concerned authorities as well as privates, for the potential employment in the construction and operation stage, should provide adequate training programs not only for project affected people but also those who are willing to work in the region at construction and operation stage.

Following column is the extraction of the JBIC Guideline on the safeguard policy.

Table 13.2.3 Extraction of the JBIC Guidelines for Confirmation of Environmental and Social Considerations, 2002

Part 2.

1. Environmental and Social Considerations Required for Funded Projects

In principle, appropriate environmental and social considerations are undertaken, according to the nature of the project, based on the following:

(Involuntary Resettlement)

· **Involuntary resettlement and loss of means of livelihood** are to be avoided where feasible, exploring all viable alternatives. When, after such examination, it is proved unfeasible, effective measures to minimize impact and to compensate for losses must be agreed upon with the people who will be affected;

· People to be resettled involuntarily and people whose means of livelihood will be hindered or lost must be sufficiently compensated and supported by the project proponents, etc. in timely manner. The project proponents, etc. **must make efforts** to enable the people affected by the project, **to improve their standard of living, income opportunities and production levels, or at least to restore them to pre-project levels.** Measures to achieve this may include: providing land and monetary compensation for losses (to cover land and property losses), supporting the means for an alternative sustainable livelihood, and providing the expenses necessary for relocation and the re-establishment of a community at relocation sites; and

· **Appropriate participation** by the people affected and their communities must be promoted in **planning, implementation and monitoring** of involuntary resettlement plans and **measures against the loss of their means of livelihood.**

Following column is the extraction of the OP 4.12 for the reference of relevant safeguard policy.

Table 13.2.4 Extraction of the World Bank Operations Manual: Involuntary Resettlement (OP 4.12)

< http://go.worldbank.org/DZDZ9038D0>

Impacts Covered

3. This policy covers direct economic and social impacts[5)] that both result from Bank-assisted investment projects,[6)] and are caused by

(a) the involuntary[7)] and are caused by taking of land[8)]

i. relocation or loss of shelter; resulting in
ii. lost of assets or access to assets; or
iii. loss of income sources or means of livelihood, whether or not the affected persons must move to another location; or

(b) the involuntary restriction of access to legally designated parks and protected areas resulting in adverse impacts on the livelihoods of the displaced persons.

5) Where there are adverse indirect social or economic impacts, it is good practice for the borrower to undertake a social assessment and implement measures to minimize and mitigate adverse economic and social impacts, particularly upon poor and vulnerable groups. Other environmental, social, and economic impacts that do not result from land taking may be identified and addressed through

environmental assessments and other project reports and instruments.
7) For the purposes of this policy, "involuntary" means actions that may be taken without the displaced person's informed consent or power of choice.
8) "Land" includes anything growing on or permanently affixed to land, such as buildings and crops. This policy does not apply to regulations of natural resources on a national or regional level to promote their sustainability, such as watershed management, groundwater management, fisheries management, etc. The policy also does not apply to disputes between private parties in land titling projects, although it is good practice for the borrower to undertake a social assessment and implement measures to minimize and mitigate adverse social impacts, especially those affecting poor and vulnerable groups.

Eligibility for Benefits[18)]

14. Upon identification of the need for involuntary resettlement in a project, the borrower carries out a census to identify the persons who will be affected by the project (see the Annex A, para. 6(a)), to determine who will be eligible for assistance, and to discourage inflow of people ineligible for assistance. The borrower also develops a procedure, satisfactory to the Bank, for establishing the criteria by which displaced persons will be deemed eligible for compensation and other resettlement assistance. The procedure includes provisions for meaningful consultations with affected persons and communities, local authorities, and, as appropriate, nongovernmental organizations (NGOs), and it specifies grievance mechanisms.

15. Criteria for Eligibility. Displaced persons may be classified in one of the following three groups:
(a) those who have formal legal rights to land (including customary and traditional rights recognized under the laws of the country);
(b) those who do not have formal legal rights to land at the time the census begins but have a claim to such land or assets--provided that such claims are recognized under the laws of the country or become recognized through a process identified in the resettlement plan (see Annex A, para. 7(f)); and[19)]
(c) those who have no recognizable legal right or claim to the land they are occupying.

16. Persons covered under para. 15(a) and (b) are provided compensation for the land they lose, and other assistance in accordance with para. 6. Persons covered under para. 15(c) are provided resettlement assistance[20)] in lieu of compensation for the land they occupy, and other assistance, as necessary, to achieve the objectives set out in this policy, if they occupy the project area prior to a cut-off date established by the borrower and acceptable to the Bank.[21)]
Resettlement Planning, Implementation, and Monitoring Persons who encroach on the area after the cut-off date are not entitled to compensation or any other form of resettlement assistance. All persons included in para. 15(a), (b), or (c) are provided compensation for loss of assets other than land.

18) Paras. 13-15 do not apply to impacts covered under para. 3(b) of this policy. The eligibility criteria for displaced persons under 3 (b) are covered under the process framework (see paras. 7 and 30).
19) Such claims could be derived from adverse possession, from continued possession of public lands without government action for eviction (that is, with the implicit leave of the government), or from customary and traditional law and usage, and so on.
20) Resettlement assistance may consist of land, other assets, cash, employment, and so on, as appropriate.
21) Normally, this cut-off date is the date the census begins. The cut-off date could also be the date the project area was delineated, prior to the census, provided that there has been an effective public dissemination of information on the area delineated, and systematic and continuous dissemination subsequent to the delineation to prevent further population influx.

13.2.2 Construction Stage Aspects

For the consideration of the social environmental impacts during the construction stage, following four (4) primary issues are expected to be addressed. They are; 1) labor safety and community health, 2) Socio economic, 3) Transport, 4) Coastal fishing. Such aspects and counter measures are described in the approved EIA report except 4) Coastal fishing.

1) Labor safety and community health

Due to the massive construction work, hundreds of construction workers are expected to settle at and around the construction site. Level of the immigrant workers are likely to vary so that fatal accidents could be occurred without proper training and safety gears. In order to secure the labor safety, sufficient and continuous training and management of EHS officers/managers would be minimal requirement for contractors. Either local or immigrant worker should also take sufficient vocational training for each requirement.

Another issue would be the control of the transmittable diseases. Introduction of transmittable disease by immigrant workers and spread not only in the workers community but also adjacent local communities are quite common issue for large scale long term project. As a primary part of HES training for EHS officers and workers as well as local residents, adequate education for such diseases and protection would be minimal requirements for contractors. Control of the physical contacts between immigrant workers and locals, such as workers' township, would be another possible option to reduce the risk of speeding the diseases.

2) Socio economic impacts

Due to the substantial numbers of non-local residents' inflow in the Cat Hai island, pricing of goods are likely to increase. Though the pricing of Cat Hai island will definitely increase even without project, gradual settlement is necessary for local communities. There would be many measures to reduce the negative impacts on local communities such as encouragement of higher income jobs and providing sufficient goods with competitive prices through cost-effective logistic system. Physical separation between local communities and workers community would be another solution for the initial stage by means of sufficient goods supply in the workers' township.

Follow-up for the resettlement would be another important matter in the construction stage. Due to no requirement for the residential resettlement, follow-up for livelihood support should be focused. Because the initial stage of the livelihood support is critical moment to reduce the failure of the support programs, active participation of monitoring and modification of support program are recommendable.

3) Coastal Fishing

Once the construction starts, the proposed port area will be closed for the safety purpose that may lead less fishing yield or higher cost of fishing due the longer trip to the new fishing location. Periodical sample survey to monitor the fish yield and income level of the project affected fishermen would be recommendable. If it is necessary to provide additional support based on the sample survey result, responsible authorities shall consider modification of the safeguard policy for coastal fishing or additional counter measures such as encouragement of job transfer.

13.2.3 Operation Stage Aspects

For the consideration of the social environmental impacts during the operation stage, monitoring the implemented safety guard measures in the previous stages would be the primary matter in this stage. As a part of environmental management plan (EMP) and responsibility of the implementation agency, MPMU II shall cooperate with VINALINE and other privates, expected operator of the port, to ensure the EMP including the proper implementation and follow-up of the safe guard measures.

Following column is the extraction of the JBIC Guideline on Required Monitoring items.

Table 13.2.5 Extraction of the JBIC Guidelines for Required Monitoring Items

· Monitoring 6. Items Requiring Monitoring Items requiring monitoring shall be decided according to the sector and nature of the project, with reference to the following list of items. Items: 1. Permits and approvals, explanations · Response to matters indicated by authorities 2. Anti-pollution measures · Air quality : SO2, No2, CO, O2, soot and dust, suspended particulate matter, coarse particulate, etc. · Water quality : pH, SS (suspended solids), BOD (biochemical oxygen demand) / COD (chemical oxygen demand), DO (dissolved oxygen), total nitrogen, total phosphorus, heavy metals, hydrocarbons, phenols, cyanogen compounds, mineral oils, water temperature, etc. · Waste · Noise and vibration · Odors 3. Natural environment · Ecosystems : Impact on valuable species, countermeasures, etc 4. Social environment · Resettlement · Lifestyle and livelihood

13.3 Environmental Check List for the Lach Huyen Port

Confirmation of the environmental and social considerations for the proposed port project is summarized with the environmental checklist of the JBIC Guideline.

SAPROF Experts' assessments on the project, MD/ updates, change of scope

Table 13.3.1 Environmental Checklist for Lach Huyen Port Development Project

Category	Environmental Item	Main Check Items	Confirmation of Environmental Considerations
I Permits and Explanation	(1) EIA and Environmental Permits	① Have EIA reports been officially completed? ② Have EIA reports been approved by authorities of the host country's government? ③ Have EIA reports been unconditionally approved? If conditions are imposed on the approval of EIA reports, are the conditions satisfied? ④ In addition to the above approvals, have other required environmental permits been obtained from the appropriate regulatory authorities of the host country's government?	① EIA Report has already been completed. ② EIA Report has already been officially approved by MONRE, responsible agency for the Government of Vietnam on October 31, 2008 (Official Letter No.2231/QD-BTNMT) ③ EIA Report was approved with commitment from the project owner VINAMARINE to implement the necessary environmental protection measures given in EIA and the EIA approval. Detailed conditions to be satisfied in future with beginning of construction works for the port ④ No additional permit requirement is considered necessary from any other regulatory agency of Vietnam
	(2) Explanation to the Public	① Are contents of the project and the potential impacts adequately explained to the public based on appropriate procedures, including information disclosure? Is understanding obtained from the public? ② Are proper responses made to comments from the public and regulatory authorities?	① Yes, adequate explanation was given and opinion of the potentially affected people (PAP) was collected by both responsible local authorities and PAP's communities (fatherland front committee), which are required by Law and relevant regulations. In addition to the required public consultation by the Vietnam regulations, the responsible implementation agency-MPMU II voluntary conducted a public consultation to have PAP understand the project further and encourage active participation of the project. Though there is little consideration for coastal fishing where the proposed port project will eliminate the fishing activities in approved EIA, adequate consideration will be defined in a supplementary EIA shortly, which is required by Vietnam regulations for the change in design after the approval of EIA and compliance of the JBIC loan policy. ② Yes, the local authorities and communities' responses are recorded and mentioned in the approved EIA. The regulatory authorities' comments are also given in the approval letter of the project EIA.

Category	Environmental Item	Main Check Items	Confirmation of Environmental Considerations
2 Mitigation Measures	(1) Air Quality	① Do air pollutants, such as sulfur oxides (SOx), nitrogen oxides (NOx), and soot and dust emitted from various sources, such as ships, vehicles, and the ancillary facilities comply with the country's emission standards and ambient air quality standards?	① During both construction and subsequent operation of the port the necessary national ambient air quality standard requirement of Vietnam has to be complied (TCVN5937-2005). It is presumed it could be duly complied with proper construction management and operation of the port with due diligence. The baseline ambient air quality is evaluated as clean in the planned project site of Cat Hai Island.
	(2) Water Quality	① Do general effluents from the related facilities comply with the country's effluent standards and ambient water quality standards? ② Do effluents from ships and ancillary facilities (e.g. dock) comply with the country's effluent standards and ambient water quality standards? ③ Are adequate measures taken to prevent spills and discharges of materials, such as oils and hazardous materials to the surrounding water areas? ④ Is there a possibility that oceanographic changes, such as alteration of ocean currents, and reduction in seawater exchange rates (deterioration of seawater circulation) due to modification of water areas, such as shoreline modifications, reduction in water areas and creation of new water areas will cause changes in water temperature and water quality? ⑤ In the case of the projects including land reclamation, are adequate measures taken to prevent contamination of surface water, seawater, and groundwater by lactates from the reclamation areas?	① Construction work contractor shall ensure the necessary waste management system is provided to meet the effluent and ambient water quality standards of Vietnam (QCVN10-2008/BTNMT, QCVN 14-2008/BTNMT). The necessary waste treatment facilities for port operation are included in the EIA Report. With proper operation of the treatment facilities the necessary effluent and ambient water quality standard requirement could be met. ② Operational management of the port shall make sure the ships comply with the necessary national and international standard requirement (TCVN5945-2005, TCVN5944-1995, TCVN5943-1995), including MARPOL 73/78 of IMO. ③ The emergency management plan in the EIA Report included oil spill response system with the necessary facilities like oil skimmers and also simulation study on oil spread area in case of accidental oil spills. Still, serious oil spill emergency situation is regarded as very rare occurrence under the current port development plan that is limited to handle only container and general cargo. In this respect even in future port expansion projects, considering the ecological importance of the vicinity of this area (near Cat Ba Island), terminals for oil and other hazardous liquid-bulk cargo handling development is not recommended. ④ No significant potential exists for shoreline change in the Lach Huyen Estuary consequent to the offshore extension of terminal and sand control

Category	Environmental Item	Main Check Items	Confirmation of Environmental Considerations
			dyke design by this project. Still, simulation study on exterior accumulation of sediments retained by the sand control dyke was done in the EIA Report and it was concluded as not that significant. ⑤ Necessary land reclamation and other construction material could be procured from nearby areas by the construction contractor (It is possible from Hai Phong and Hai Duong areas) . The contractor shall ensure the necessary quality requirement for the reclamation material is met so as not to cause significant sea water pollution (a short-term adverse effect basically confined to the period of reclamation works), though this issue is not dealt with in the EIA Report.
	(3) Wastes	① Are wastes from ships and the related facilities properly treated and disposed of in accordance with the country's standards? ② Is offshore dumping of dredged materials and soils properly performed in accordance with the country's standards to prevent impacts on the surrounding waters? ③ Are adequate measures taken to prevent discharge or dumping of hazardous materials to the surrounding water areas?	① Required waste reception facilities for ship originated wastes are included in the EIA Report (Sewage, garbage and oily bilge waste). Proper operational management of the treatment system is required in future port operation. Relevant standards to be followed are TCVN5945-2005, TCVN5944-1995 and TCVN5943-1995, including MARPOL 73/78 of IMO. Moreover, effective surveillance to mitigate illegal dumping of wastes by ships with high penalty levy as deterrence is also required. ② Both near-shore and offshore dumping of dredged material are taken into consideration in the EIA Report. Still, the areas approved for near-shore dumping (Official document No. 2702/UBND-GT dated May 19, 2008 as given in Appendix 1 of EIA Report) have sufficient capacity to accommodate all dredged material and hence offshore dumping is regarded as not necessary. ③ No significant quantity of hazardous material is expected to be generated due to the port plan to handle container and general cargo. The results of seabed material survey conducted for the EIA Report indicated

Category	Environmental Item	Main Check Items	Confirmation of Environmental Considerations
			no significant contamination in seabed area targeted for dredging.
2 Mitigation Measures	(4) Noise and Vibration	① Do noise and vibrations comply with the country's standards?	① No significant noise and vibration effect is anticipated due to construction works since it is offshore area located far from residential area. Noise and vibration effects due to port operation has to be regulated and controlled by the port operation authority so as to meet the national standard requirement (TCVN5949-1998, TCVN6962-2001)
	(5) Odor	① Are there any odor sources? Are adequate odor control measures taken?	① No significant odor source is expected due to the port development to handle container and general cargo
	(6) Sediment	① Are adequate measures taken to prevent contamination of sediments by discharges or dumping of materials, such as hazardous materials from ships and the related facilities?	① Any hazardous waste disposed by ships has to be properly managed by the port authority. Relevant national standards and decrees to be complied with respect to waste management include TCVN 6772-2000 on wastewater treatment, Decree No. 71/2006/ND-CP on seaport and maritime management and Circular No. 12/2006/TT-BTNMT on hazardous waste management.
3 Natural Environment	(1) Protected Areas	① Is the project site located in protected areas designated by the country's laws or international treaties and conventions? Is there a possibility that the project will affect the protected areas?	① The project area is located in the vicinity of Cat Ba national park, a protected forest park. Still, ship movement has been in occurrence in this area for long time with no apparent adverse effect. So as long as oil and other noxious liquid cargo are not handled any potential high risk to the protected area due to accidental spillage is minimized. Current port development plan does not include such cargo. Even in future it is recommended to not to develop port terminals in this area located in the vicinity of ecologically important areas like Cat Ba Island to handle such cargo like oil and other noxious liquid substance in bulk.

Category	Environmental Item	Main Check Items	Confirmation of Environmental Considerations
	(2) Ecosystem	① Does the project site encompass primeval forests, tropical rain forests, ecologically valuable habitats (e.g. coral reefs, mangroves, or tidal flats)? ② Does the project site encompass the protected habitats of endangered species designated by the country's laws or international treaties and conventions? ③ If significant ecological impacts are anticipated, are adequate protection measures taken to reduce the impacts on the ecosystem? ④ Is there a possibility that the project will adversely affect aquatic organisms? If significant impacts are anticipated, are adequate protection measures taken to reduce the impacts on aquatic organisms? ⑤ Is there a possibility that the project will adversely affect vegetation and wildlife of coastal zones? If significant impacts are anticipated, are adequate measures taken to reduce the impacts on vegetation and wildlife?	① Mangroves (near Cat Ba Island coast) and tidal flats (Bach Dang Estuary) of ecological significance are located in the vicinity of the project area. Moreover, Cat Ba Island has richly diversified and protected ecological area with primeval forests and tropical rain forests as well. Still, port is not anticipated to affect these areas as it is located not within such protected and ecologically important areas and would handle only container and general cargo. ② Project area does not encompass habitats of rare, endangered or other ecologically vulnerable species ③ No significant ecological impacts are anticipated due to the handling of cargo by this project development limited to container and general cargo. ④ No significant long-term adverse effect on aquatic organism is anticipated even due to very significant dredging works of 33 million m3 and offshore dredged material disposal when such works are planned and executed with due diligence (Still offshore dumping of dredged material is regarded as not required). The dredging works involve widening and deepening of the existing and already dredged access channel and there is no rare and endangered marine biota inhabiting the area. Moreover, similar dredging works for access channel and subsequent maintenance dredging for port and also IWT navigation has been done in variety of offshore and inland waterways both in Vietnam and other countries and there is no evidence of any serious long-term adverse effects on aquatic marine organisms due to the construction and operation of such navigation channels. This is attributed to availability of large area of unaffected seabed in the vicinity of navigation channels to serve as habitats for marine organisms. In particular offshore dredged material dumpsite location, if required in future, shall be selected away from coral

Category	Environmental Item	Main Check Items	Confirmation of Environmental Considerations
			reef areas to mitigate potential adverse effects due to turbidity on coral reefs. ⑤ Project is not anticipated to significantly affect wildlife of coastal zone even when the area is located near Cat Ba Island. This is particularly so since the cargo handled is limited to non hazardous container and general cargo as per this stage of port development plan.
	(3) Hydrology	① Is there a possibility that installation of port and harbor facilities will cause oceanographic changes? Is there a possibility that installation of the facilities will adversely affect oceanographic conditions, such as induced currents, waves, and tidal currents?	① The development facility for the port is not such large scale to cause significant change in natural oceanographic condition such as currents, waves and tides even though the port in Lach Huyen Estuary is located in a complicated area with respect to oceanography and sediment movement. In this respect simulation study was also conducted in the EIA Study and it was confirmed potential sedimentation beyond the sand control dyke is not that significant.
	(4) Topography and Geology	① Is there a possibility that installation of port and harbor facilities will cause a large-scale alteration of topographic and geologic features in the surrounding areas or elimination of natural beaches?	① No large-scale alteration of topographic and geologic features in the surrounding areas or elimination of natural beaches is anticipated since the port development facility is not such large scale to cause such effects as also noted just above. Also there is no beached in nearby areas of the planned port.

Category	Environmental Item	Main Check Items	Confirmation of Environmental Considerations
4 Social Environment	(1) Resettlement	① Is involuntary resettlement caused by project implementation? If involuntary resettlement is caused, are efforts made to minimize the impacts caused by the resettlement? ② Is adequate explanation on relocation and compensation given to affected persons prior to resettlement? ③ Is the resettlement plan, including proper compensation, restoration of livelihoods and living standards developed based on socioeconomic studies on resettlement? ④ Does the resettlement plan pay particular attention to vulnerable groups or persons, including women, children, the elderly, people below the poverty line, ethnic minorities, and indigenous peoples? ⑤ Are agreements with the affected persons obtained prior to resettlement? ⑥ Is the organizational framework established to properly implement resettlement? Are the capacity and budget secured to implement the plan? ⑦ Is a plan developed to monitor the impacts of resettlement?	① No, there is no resettlement required for the project. However, land acquisition is required for public related facilities, which requires resettlement of toms and assurance of PAP's living standard, who will lose the fishpond and may lose the job. ② Yes, Hai Phong city and local commune authorities, who are responsible for the resettlement and land acquisition by law and regulation, have already consulted with PAP for fishpond and relatives of the toms. The detail plans will be defined in detail design stage by the consultation with PAP. ③ Yes, since the proper compensation and restoration of livelihoods and living standards are required by law, a resettlement plan/land acquisition plan shall be prepared based on updated market values of the land and properties and actual situation of livelihoods and living standards. ④ No, based on the authorities, there are no vulnerable groups or persons in the affected area so that there no need for such attention. In case of the fishermen's communities coming from outside of the affected communities, particular attention might be needed though there is no detailed information at this moment. ⑤ Yes, though the detailed condition will be settled in detail design stage, agreements were given by the PAP through initial consultation. ⑥ Yes, Hai Phong city is responsible for the resettlement/land acquisition and has capacity to implement the resettlement/land acquisition throughout the variety of resettlement activities in the area. The budget will be secured and transferred from the MOT, responsible ministry of the project owner-VINAMARINE, to Hai Phong city. ⑦ Yes, preparation of monitoring is mandate by law and monitoring will be included in the land acquisition plan.

Category	Environmental Item	Main Check Items	Confirmation of Environmental Considerations
	(2) Living and Livelihood	① Is there a possibility that the project will adversely affect the living conditions of inhabitants? Are adequate measures considered to reduce the impacts, if necessary? ② Is there a possibility that changes in water uses (including fisheries and recreational uses) in the surrounding areas due to project will adversely affect the livelihoods of inhabitants? ③ Is there a possibility that port and harbor facilities will adversely affect the existing water traffic and road traffic in the surrounding areas? ④ Is there a possibility that diseases, including communicable diseases, such as HIV will be introduced due to immigration of workers associated with the project? Are considerations given to public health, if necessary?	① Yes, any price including daily food and other commodities is likely to increase due to the project implementation and substantial business activities at and around the project site. Separation of the immigrant workers and local residence at the initial stage and gradual merger are proposed for local residence to adapt such price rise. ② Yes, the proposed project will eliminate some part of coastal fishing area. Though the consideration for such fishermen was initially omitted due to the small scale of activities, the supplemental EIA will include the measures to maintain same or better level of the living standard for such fishermen. ③ Yes, the sand control dike (7,600m long) is likely to prevent daily transport by small transport boats/fishing boats between Cat Hai and Cat Ba. However, such impacts will be minimal and traffic will be taken over by the existing water traffic between the God port, Cat Hai and Cat Ba with road transport naturally. ④ Yes, during the construction and operation stages, a large number of construction workers and port workers may introduce some transmittable diseases such as HIV/AIDS, which are verified in Vietnam, in the communities. Not only for workers but also local communities, awareness education and prevention measures will be provided by the relevant authorities with the collaboration of local communities, contractors of the project and operator of the port. In addition, separation measures of immigrant workers and local residence, such as construction workers' temporally township, are recommended in the approved EIA. Detailed measures will be proposed in detail design stage.
	(3) Heritage	① Is there a possibility that the project will damage the local archeological, historical, cultural, and religious heritage sites? Are adequate measures considered to protect these sites in accordance with	① No, based on EIAs, there are no heritage sites in the proposed sites.

Category	Environmental Item	Main Check Items	Confirmation of Environmental Considerations
		the country's laws?	
	(4) Landscape	① Is there a possibility that the project will adversely affect the local landscape? Are necessary measures taken?	① No, though offshore land fill and long bridge & road will significantly change the landscape of the local communities, the change will be rather considered as positive change in landscape. The change of the landscape could be considered as the symbol of the contemporary development area as categorized as Hai Phong development master plan.
	(5) Ethnic Minorities and Indigenous Peoples	① Does the project comply with the country's laws for rights of ethnic minorities and indigenous peoples? ② Are considerations given to reduce the impacts on culture and lifestyle of ethnic minorities and indigenous peoples?	① Yes, though there are no concerned people in the project area, the proposed project will fully comply with minority protection if it's necessary. ② No, there are no concerned communities in the project area.
5 Others	(1) Impacts during Construction	① Are adequate measures considered to reduce impacts during construction (e.g. noise, vibrations, turbid water, dust, exhaust gases, and wastes)? ② If construction activities adversely affect the natural environment (ecosystem), are adequate measures considered to reduce impacts? ③ If construction activities adversely affect the social environment, are adequate measures considered to reduce impacts? ④ If necessary, is health and safety education (e.g. traffic safety, public health) provided for project personnel, including workers?	① The necessary mitigation measures are examined in the EIA Report. The contractor shall be obligated to strictly adhere to EHS (environment, health and safety) aspects of the construction works in integral manner with due formulation and execution of EHS management and monitoring. ② With due EHS management and monitoring by contractor as above adverse effects could be mitigated. ③ Yes, adequate measures will be applied to prevent the adverse effects on the local communities for the construction period, especially consideration for local communities and immigrant workers communities. Temporally township for immigrant workers and occasional opportunities, such as meeting or festival, to bridge the gap between locals and immigrant workers are proposed by the responsible authorities. ④ EHS management program and monitoring shall be implemented by construction contractors supervised by relevant authorities.

Category	Environmental Item	Main Check Items	Confirmation of Environmental Considerations
	(2) Monitoring	① Does the proponent develop and implement monitoring program for the environmental items that are considered to have potential impacts? ② Are the items, methods and frequencies included in the monitoring program judged to be appropriate? ③ Does the proponent establish an adequate monitoring framework (organization, personnel, equipment, and adequate budget to sustain the monitoring framework)? ④ Are any regulatory requirements pertaining to the monitoring report system identified, such as the format and frequency of reports from the proponent to the regulatory authorities?	① Overall monitoring program focused on all relevant environmental elements is included in the EIA Report. This has to be reviewed and detailed environmental monitoring program with clear separation between construction and operation stages of the project shall be formulated during detailed engineering of the project ② On preliminary basis at the feasibility study level of the project they are judged to be adequate and detailed environmental monitoring program shall be formulated during detailed engineering of the project. ③ Detailed environmental monitoring program formulated during detailed engineering of the project shall include the definite framework for monitoring as well. ④ Detailed environmental monitoring program formulated during detailed engineering of the project shall include the reporting system and other regulatory compliance of monitoring as well.
6 Note	Note on Using Environmental Checklist	① Where necessary, impacts on groundwater hydrology (groundwater level drawdown and salinization) that may be caused by alteration of topography, such as land reclamation and canal excavation should be considered, and impacts, such as land subsidence that may be caused by groundwater uses should be considered. If significant impacts are anticipated, adequate mitigation measures should be taken. ② If necessary, the impacts to transboundary or global issues should be confirmed (e.g. the project includes factors that may cause problems, such as transboundary waste treatment, acid rain, destruction of the ozone layer, and global warming).	① The project include offshore land reclamation. The necessary technical studies and design will be a component of project planning and detailed engineering. However, no significant long-term adverse effects are anticipated consequent to this limited offshore land reclamation works. ② No transboundary issues are anticipated considering the confined nature of the project for port development.

1) Regarding the term "Country's Standards" mentioned in the above table, in the event that environmental standards in the country where the project is located diverge significantly from international standards, appropriate environmental considerations are made, if necessary. In cases where local environmental regulations are yet to be established in some areas, considerations should be made based on comparisons with appropriate standards of other countries (including Japan' experience).

2) Environmental checklist provides general environmental items to be checked. It may be necessary to add or delete an item taking into account the characteristics of the project and the particular circumstances of the country and locality in which it is located.