4-2 Required Number and Length of Berths

4-2-1 Cargo Throughput by Terminal

The cargo throughput by terminal is estimated based on the following premises:

(1) The type of vessels which carries each type of cargo is assumed to remain the same as at Semarang Port at present, or at neighboring ports.

(2) All cargoes are classified into two main categories; commercial cargo and industrial cargo. Major industrial cargoes such as coal, cement, fertilizer and grain (wheat) will be handled at special wharves controlled directly or indirectly by private companies located in the industrial zone in order to maximize productivity.

(3) A container terminal and a multipurpose container terminal will be constructed in the future to cope with demand.

(4) The special industrial cargo wharf will play an important role in attracting industries to the port area.

The projected cargo throughput by terminal in 1995 and 2005 is presented in Table 4-2-1. For forecasting purposes, we have divided total cargo throughput into seven terminals, three international terminals and four domestic terminals, as follows:

International Terminals
(1) Conventional Terminal
(2) Container or Combo. Terminal
(3) Special Carrier Terminal

Domestic Terminals
(4) Coastal Harbour Terminal (Nusantara)
(5) Inner Harbour Terminal (Local Vessels)
(6) Sailing Vessel Terminal (Rakyat)
(7) Industrial Cargo Terminal (K husus)

In 1995, almost all of the cargo handled at the multipurpose container terminal will be containerized. By 2005 this terminal will become a full container terminal and will handle containerized cargo exclusively.

The cargo throughput listed under the industrial cargo terminal includes the cargo that will be handled at the multipurpose industrial terminal as well as other domestic industrial cargoes that will be handled at new private wharves.

Although the Coastal Harbour Terminal is listed as a domestic terminal, some foreign cargoes will also be handled at this terminal as the nusantara which utilize this facility sometimes carry cargo to and from Singapore.

Logs will continue to be handled offshore.

Table 4-2-1 Cargo Throughput by Terminal

(1) International Trade

	Conventional	Container Combo	Special Carrier	Total
1995				
Export				
Plywood	300			300
Lumber	23	19		42
Ag. Products	32	27		59
G/C Others	57	46		103
Sub Total	402	92		504
Import				
Iron/Scrap	285		285	570
Grain			316	316
Rice	60			60
G/C Others	370	302		672
Sub Total	715	302	601	1618
Total	1127	394	601	2122
2005				
Export				
Plywood	403			403
Lumber	25	37		62
Ag. Products	38	58		96
G/C Others	122	184		306
Sub Total	588	279		867
Import				
Iron/Scrap	700		650	1350
Grain			824	824
Rice	413			413
G/C Others	580	870		1450
Sub Total	1693	870	1474	4037
Total	2281	1149	1474	4904

(2) Domestic Trade

	Nusantara	Local	Rakyat	Khusus	Total
1955					
Outward					
Rice	21	12	11		44
G/C, Ag. Products	66	136	113		315
Sub Total	87	148	124		359
Inward					
Log				1000	1000
Lumber	15	181	307		503
Steel	270				270
Fertilizer				950	950
Cement				360	360
Coal				300	300
G/C, Ag. Products	39	79	66		184
Sub Total	324	260	373	2610	3567
Total	411	408	497	2610	3926
2005					
Outward					
Rice	27	17	15		59
G/C, Ag. Products	140	288	240		668
Sub Total	167	305	255		727
Inward					
Log				1340	1340
Lumber	74	421	744		1239
Steel	980				980
Fertilizer				1240	1240
Cement				820	820
Coal				1050	1050
G/C, Ag. Products	107	218	183		508
Sub Total	1161	639	927	4450	7177
Total	1328	944	1182	4450	7804

4-2-2 Average Size of Vessels and Number of Callings

1. Premises

The number and size of berths which will be required at Semarang in the future must be forecast considering all the various cargoes which will be handled at the port. As part of the development plan, container ships and special bulk carriers for coal, fertilizer, grain and cement will begin calling at Semarang Port. Proper facilities will have to be constructed to accommodate these new vessels as well as all the different types of vessels which currently call at the port.

The number and size of the berths which will be needed in the future are forecast based on the following premises:

A. The average size of conventional oceangoing vessels, nusantara, local vessels and rakyat is assumed to remain the same as at present.

B. Considering the present situation at Tg. Priok and Surabaya, the average cargo handling volume per vessel for oceangoing vessels and nusantara is assumed to be 1.5 times the current average at Semarang.

C. The average cargo handling volume per vessel for oceangoing vessels and nusantara is assumed 3,000 tons almost equal to the current value at Tg. Priok (2,750 tons) at present and the others are same as it is.

D. As all the special bulk carriers are domestic vessels, the size of these carriers is assumed to remain the same as at present, 8,000 to 9,000 DWT.

E. Queuing theory will be applied to determine the appropriate number of berths for conventional vessels, that is, oceangoing vessels, nusantara, local vessels and rakyat.

F. On the other hand, as container vessels and special bulk carriers usually follow more regular patterns, the required number of berths will be determined by the berth occupancy ratio.

G. The percent of workable days at berth is assumed to be 96 percent, and the percent of workable days offshore is 88 percent, based on SPJV observations. These percentages are higher than at present: as the cargo handling systems improve, the number of workable days per year will increase accordingly.

2. Present Activities of Calling Vessels by Type and Size

In this section, we examine the present activities of the vessels calling at Semarang Port. There are four main types of vessels: oceangoing vessels, nusantara, local vessels and rakyat. The vessels are each classified by size (DWT class). Statistics are presented on vessel length, number of calls per year, total annual throughput, average handling volume per vessel, average stay and cargo handling productivity measured in the number of tons of cargo per day per vessel.

A. Oceangoing Vessels

Oceangoing vessels are grouped into three categories: 15,000 DWT class (10 m depth), 5,000 DWT class (7.5 ~ 6.0 m depth) and 2,000 DWT class (5.5 ~ 4.0 m depth). Within each category the average DWT is also presented. The statistical data are presented in Table 4-2-2.

Table 4-2-2 Present Activities of Oceangoing Vessels at Semarang Port

DWT	Length	Port Calls/ Year	Annual Throughput ('000 Tons)	Average Handling Volume (Tons)	Average Stay (Days)	Productivity (Tons/vessel/day)
5,001 - (AV. 12,240)	140	267 (69%)	562 (76%)	2,105	4.0	526
3,001-5,000 (AV. 3,629 DWT)	88	58 (15%)	121 (17%)	2,081	4.7	443
-3,000 (AV. 1461)	62	62 (16%)	53 (7%)	854	5.2	164
Total (Weighted Average)	-	387 (100%)	736 (100%)	1,901	4.3	(442)

Source: Semarang ADPEL 1983

Remark: LOA =3.878 x (Average DWT) $^{0.38064}$

B. Nusantara

Nusantara are also classified into three groups as shown in Table 4-2-3.

Table 4-2-3 Present Activities of Nusantera at Semarang Port

DWT	Length	Port Calls/ Year	Annual Throughput ('000 Tons)	Average Handling Volume (Tons)	Average Stay (Days)	Productivity (Tons/vessel/day)
5,000- (AV 7404)	115	3 (1%)	10 (4%)	3,341	13.7	244
3,001-5,000 (Av. 3538)	80	24 (19%)	104 (40%)	2,540	8.2	310
-3,000 (Av. 1083)	50	417 (80%)	146 (56%)	454	8.6	53
Total	-	444 (100%)	260 (100%)	586	8.6	68

Note: Figures in parentheses are percentages.

C. Local Vessels and Rakyat

Since local vessels and rakyat are of a fairly standard size, they are not divided into classes. As the DWT of these vessels is relatively small, the depth of the berths is only 3.0 m. The statistical data on local vessels is presented in Table 4-2-4, and the data for rakyat is presented in Table 4-2-5.

Table 4-2-4 Present Activities of Local Vessels at Semarang Port

DWT	Length (Meters)	Port Calls/ Year	Average Handling Volume (Tons)	Average Stay (Days)	Productivity (Tons/Vessel/Day)
165	27	534	215	6.1	35

Table 4-2-5 Present Activities of Rakyat at Semarang Port

DWT	Length (Meters)	Port Calls/ Year	Average Handling Volume (Tons)	Average Stay (Days)	Productivity (Tons/Vessel/Day)
215	30	285	127	8.4	15

3. Future Activities of Calling Vessels by Type and Size

In this section, we consider the future activities of the vessels that will call at Semarang Port in 1995 and 2005. Tables 4-2-6 and 4-2-7 present the total cargo throughput, the average handling volume and the total number of port calls in 1995 and 2005 for conventional and nusantara vessels. Table 4-2-8 presents similar data for local vessels and rakyat.

Table 4-2-6 Future Activities of Oceangoing Vessels and Nusantara at Semarang Port

Oceangoing

DWT (Average)	Total Cargo Throughput	
	1995 (1000 Tons)	2005 (1000 Tons)
12,000	860	1,730
4,000	190	390
1,500	80	160
Total	1,130	2,280

Nusantara

DWT (Average)	Total Cargo Throughput	
	1995 (1000 Tons)	2005 (1000 Tons)
7,500	20	50
3,500	160	530
1,000	230	750
Total	410	1,330

Remark: The distribution of cargo volume by size of vessel is assumed to remain the same as at present.

Table 4-2-7 Average Handling Volume and Port Calls

DWT (Average)	Total Cargo		Average Handling	Port Calls/Year		Days of Stay
	1995	2005	Volume(Tons/Vessel)	1995	2005	
Oceangoing						
12,000	860	1,730	3,000	290	580	4.46
4,000	190	390	3,000	60	130	5.95
Nusantra						
7,500	20	50	3,000	10	20	4.46
3,500	160	530	2,500	60	210	4.96
1,000 -1,500*	310	910	500	620	1,820	1.49
	1,540	3,560		1,041	2,560	-

*include oceangoing vessels

Table 4-2-8 Future Activities of Local Vessels and Rakyat at Semarang Port

DWT	Total Cargo Throughput		Average Handling Volume (Tons/Vessel)	Port Calls/Year	
	1995 (1000 Tons	2005 (1000 Tons)		1995	2005
Local	410	940	220	1,860	4,270
Rukyat	500	1,180	130	3,850	9,080
Total	910	2,120	-	5,710	13,350

Finally we consider the data for container vessels and special bulk carriers. The figures are presented in Table 4-2-9.

Table 4-2-9 Future Activities of Container Vessels and Special Bulk Carriers at Semarang Port

DWT		Total Cargo Throughput		Average Handling Volume (Tons/Vessel)	Port Calls/Year	
		1995 (1000 Tons)	2005 (1000 Tons)		1995	2005
Containers	24,000	358	1,035	2,750 (1995) 5,500 (2005)	130	188
Grain	30,000	316	824	20,000	16	42
Fertilyzer	10,000	950	1,240	8,000	119	155
Cement	8,000	360	820	7,000	51	117
Coal	7,000	300	900	6,000	50	150
Scrap and Iron	7,000	285	650	4,000	71	163

4-2-3 Future Cargo Handling Productivity

As noted before, it is of the utmost importance to increase the cargo handling rate at Semarang Port. The forecast productivity in terms of cargo volume per vessel per day is presented below for each type and each size of vessel.

A. Conventional Vessels

The future productivity is presented in Table 4-2-10. A working day rate of 96% is assumed for these vessels.

Table 4-2-10 Future Productivity for Conventional Vessels

Type of Vessel	Productivity per Hour (Tons/Vessel/Hour)	Average Working Hours (Hours/day)	Productivity per Day (Tons/Vessel/Day)
15,000 DWT	48	14	672
5,000 DWT	36	14	504
2,000 DWT	24	14	336
Local & Rakyat	12	10	120

B. Container Vessels

The future productivity at the multipurpose container terminal is shown in Table 4-2-11, and the forecast productivity at the full container terminal is shown in Table 4-2-12. We predict a working day rate of 100 percent at these terminals. The hourly productivity is presented in terms of TEU. We assume that 1 TEU = 8.0 tons.

Table 4-2-11 Future Productivity for Container Vessels at the Multipurpose Container Terminal (Including Empty Containers)

Type of Vessel	Productivity per Hour (TEU/Vessel/Hour)	Average Working Hours (Hours/Day)	Productivity per Day (Tons/Vessel/Day)
Full Container with Shiptainer	20	21	3,360
Combo Ship	2 x 8 TEU/Hour	14	1,790
Average			2,575

Average Stay: 2,750/2,575 = 1.07 days

Table 4-2-12 Future Productivity of Container Vessels at the Full Container Terminal

Type of Vessel	Productivity per Hour (TEU/Vessel/Hour)	Average Working Hours (Hours/Day)	Productivity per Day (Tons/Vessel/Day)
Full Container Ship (3rd Generation)	2 x 0.8 x 20	24	6,140

Average Stay: 5,500/ 6,140 = 0.90 days

C. Special Bulk Cargo Carriers

The future productivity for special bulk cargo carriers, that is, those vessels which will carry grain, fertilizer, cement, coal and scrap iron is presented in Table 4-2-13.

D. Passenger Vessels

As for the new passenger terminal, most of the calling vessels are for transmigration.

The future productivity is as follows.

Table 4-2-13 Future Productivity of Passenger Vessels

DWT	Length (m)	Average Carrying*	Stay of Days	Passengers/Day Meter
300	45	80	1	1.7
700	60	200	1	3.3
3,400	144	1,400	1	9.7

*80% of Capacity

4-2-4 Required Number of Berths

The relation among the berth occupancy ratio ρ, the number of vessels calling per day λ, the number of working hours per day μ and the number of berths S is as follows:

$$\rho = \frac{\lambda}{\mu S} \qquad S = \frac{\lambda}{\mu \rho}$$

In general, for conventional vessels, it is said that when the berth occupancy ratio is over 0.6 and the number of berths is small, the port begins to be congested. However, when the number of berths is large, a berth occupancy ratio of 0.7 ~ 0.8 is ordinary.

On the other hand, for container vessels and special bulk carriers, ordinarily 0.35 ~ 0.60 is adopted.

Table 4-2-14 Future Productivity for Special Bulk Carriers

Cargo	Vessel Size (DWT)	Crane Capacity (Tons/Hr.)	Efficiency	Cargo Volume (Tons)	Working Hours (Hours/Day)	Working Day Rate (%)	1995			2005		
							No. of Cranes/ Berth	Productivity (Tons/Day)	Stay (Days)	No. of Cranes/ Berth	Productivity (Tons/Day)	Stay (Days)
Grain	20,000	250	0.7	20,000	21	96	1	3,530	5.67	2	7,060	2.83
Fertilizer	10,000	300	0.7	8,000	21	96	1	4,230	1.89	2	8,460	0.95
Cement	8,000	450	0.7	7,000	21	96	1	6,350	1.10	1	6,350	1.10
Coal	7,000	350	0.7	6,000	14	96	1	3,360	1.82	2	6,720	0.91
Scrap Iron	5,000	20	0.6	4,000	21	100	3	756	5.29	3	756	5.29

The variables are defined as follows:

S = Number of Berths

$$\lambda = \frac{\text{Number of Port Calls per Year}}{\text{365 days}}$$

$$\mu = \frac{1}{\text{Days of Stay}}$$

The relationship among these variables for conventional oceangoing vessels, container ships and special bulk carriers, and for the vessels which will utilize the multipurpose industrial terminal (scrap iron and rice carriers) are presented in Tables 4-2-15 and 4-2-16, respectively.

Table 4-2-15 Relationship among the Variables for Conventional Oceangoing Vessels

	1995				2005			
	λ	μ	ρ	S	λ	μ	ρ	S
Oceangoing 12,000 DW	0.80	0.224	0.4 0.5 0.6 0.7	8.9 7.1 6.0 5.1	1.60	0.224	0.4 0.5 0.6 0.7	17.9 14.3 11.9 10.2
Oceangoing 4,000 DW	0.16	0.168	0.4 0.5 0.6 0.7	2.4 1.9 1.6 1.4	0.36	0.168	0.4 0.5 0.6 0.7	5.4 4.3 3.6 3.1
Nusantara 3,500 DWT	0.16	0.202	0.4 0.5 0.6 0.7	2.0 1.6 1.3 1.1	0.58	0.202	0.4 0.5 0.6 0.7	7.2 5.7 4.8 4.1
Nusantara 1,000 DWT	1.70	0.671	0.5 0.6 0.7 0.8	5.1 4.2 3.6 3.1	4.99	0.671	0.5 0.6 0.7 0.8	14.8 12.4 10.6 9.3
Local	5.10	0.545	0.6 0.7 0.8 0.9	15.6 13.4 11.7 10.4	11.70	0.545	0.6 0.7 0.8 0.9	35.8 30.7 26.8 23.9
Rakyat	10.50	0.923	0.6 0.7 0.8 0.9	19.0 16.3 14.2 12.6	24.90	0.923	0.6 0.7 0.8 0.9	95.0 35.6 33.7 30.0
Nusantara 7,500 DWT	0.02	0.224	0.4 0.5 0.6 0.7	0.2 0.2 0.1 0.1	0.05	0.224	0.4 0.5 0.6 0.7	0.6 0.5 0.4 0.3

Table 4-2-16 Relationship among the Variables for Container Ships and Special Bulk Carriers

	1995				2005			
	λ	μ	ρ	S	λ	μ	ρ	S
Container Ships	0.356	0.936	0.38	1	0.512	1.116	0.46	1
Grain Carriers (20,000 DWT)	0.044	0.353	0.12	1	0.115	0.353	0.33	1
Fertilizer Carriers (10,000 DWT)	0.326	1.053	0.31	1	0.425	1.053	0.40	1
Cement Carriers (8,000 DWT)	0.140	0.907	0.15	1	0.321	0.907	0.35	1
Coal Carriers (7,000 DWT)	0.137	0.561	0.19	1	0.410	1.123	0.37	1
Scrap Iron Carriers	0.20	0.19	0.4 0.5 0.6 0.7	2.5 2.0 1.7 1.4	0.45	0.19	0.4 0.5 0.6 0.7	5.9 4.7 3.9 3.4

Based on the above calculations of the berth occupancy ratios, the recommended number of berths is presented in Table 4-2-17. The recommendations for conventional oceangoing vessels, local vessels and rakyat are determined based on queuing theory assuming a 80 ~ 90 percent probability can be accommodated at the quaywall whereas the recommendations for container vessels and special bulk carriers are based solely on the berth occupancy ratio calculations. This port also should be designed so that 95 percent of all calling vessels can moor alongside berths or at the offshore anchorage.

Nusantara 7,500 DWT class will be negligible small.

Table 4-2-17 Recommended Number of Berths

Vessel	Number of Berths		95% Probability	
	1995	2005	1995	2005
Conventional				
12,000 DWT	6	10	8	11
4,000 DWT	2	4	4	6
Nusantra				
3,500 DWT	2	4	4	9
1,000 DWT	4	10	7	13
Local	12	26	15	31
Rakyat	14	32	18	37
Container	1*	1	2*	3
Grain	1	1	1	2
Fertilizer	1	1	2	3
Cement	0~1	1	1	2
Coal	1	1	1	2
Iron & Steel	2	4	4	7
Passengers	1*	1	1*	1

* Multipurpose

4-2-5 Berth Length

A. Conventional Vessels

(12,000 DWT)

Actually the 12,000 DWT class includes all vessels over 5,001 DWT, and the average DWT of this class is 12,240 DWT in 1983. So the average required length should be determined based on 12,000 DWT vessels.

Berth Length = Vessel Length + Allowance = 140 + 10 = 150 m

(Conventional 4,000 DWT and Nusantara 3,000 DWT)

This class includes vessels between 3,000 and 5,000 DWT.

The average DWT of this class is 3,600 DWT.

Berth Length = Vessel Length + Allowance = 87 + 10 = 97 ≒ 100 m)

(1,000 DWT)

The average DWT of this class is 920 DWT.

Berth Length = Vessel Length + Allowance = 63 + 7 = 70 m

B. Container Vessels

Containerization at Semarang Port should proceed step by step. The type of container vessels that will call at the port is estimated based on the container vessels which are calling at neighboring ports as shown in Table 4-2-18.

Table 4-2-18 Type of Container Vessels at Semarang Port

Year	Majority of the Container Vessels	Maximum Size Container Vessel
Until 1995	Combo Feeder Ship, 1st Generation	2nd Generation
1995-2005	2nd Generation	3rd Generation

As only one container berth is planned, the size of the berth is determined by the maximum size of the container vessels that will call at the port. The size of various container vessels throughout the world is presented in Table 4-2-19.

Table 4-2-19 Dimensions of Various Types of Container Vessels

Generation	Capacity (TEU)	DWT	LOA	Breadth	Draft
1st	600 - 700	16,000	180	26.0	9.3
2nd	800 - 1500	24,000	200 - 215	30.0	10.5
3rd	Over 2,000	35,000	250 - 270	32.2	11.5
4th	Over 3,000	48,000	260 - 270	32.2	11.5 - 12.0
Feeder Combo	400 - 500	7,000	120	20	6.35

Thus, the required berth lengths are calculated as follows.

(Multipurpose Terminal)

L = 2nd Generation Vessel + Allowance

= 210 m + 10 m = 220 m

(Container Terminal)

L = 3rd Generation Vessel + Allowance

= 270 m + 10 m = 280 m

C. Special Bulk Carriers

Berth length is determined as shown in Table 4-2-20.

Table 4-2-20 Berth Length for Special Bulk Carriers

	LOA	Allowance	Total L	Planning
Grain (Max. 30,000)	190 m	30 m	220 m	220 m
Fertilizer (Max. 10,000)	130 m	20 m	150 m	150 m
Cement (Max. 8,000)	120 m	20 m	140 m	150 m
Coal (Max. 7,000)	120 m	20 m	140 m	150 m
Scrap Iron (Ave. 5,000)	90 m	10 m	100 m	100 m

4-2-6 Conclusion

The required berth length for all the different berths is summarized in Table 4-2-21. The productivity per meter at the public wharves is presented in Table 4-2-22.

Table 4-2-21 Future Required Berth Length

(Public) Conventional	Exsisting	1995 Gross Required	2005 Gross Required	Short Term Plan Net Required Length	Remarks
12,000 DWT - 10m	555 m 3.7	900 m 6	1,500 m 10	345 m 2.3	General Cargo
4,000 - 3,500 DWT - 7.5 m	-	400 m 4	800 m 8	400 m 4	
1,000 DWT -5.5m	320 m 4.6	280 m 4	700 m 10	- -	
Container	-	220 m	280 m*	220 m	
24,000 DWT Class		1		1	* Full Container Terminal
*35,000 DWT Class			1*		
Scrap and Iron Terminal	-	200 m 2	400 m 4	200 m 2	Scrap and Iron
Local, Rakyat	1,865** m 53	910 m 26	2,030 m 58	- -	** Rehabilitation Required
(Private)					
Grain	-	220 m 1	220 m 1	0 ~ 220 m 0 ~ 1	
Fertilizer	-	150 m 1	150 m 1	150 m 1	
Cement	-	150 m 1	150 m 1	150 m 1	
Coal	-	150 m 1	150 m 1	150 m 1	

Table 4-2-22 Productivity per Meter of Public Wharves

Vessel	1995			2005		
	Annual Cargo Vol. x 1,000 ton	Length m	Productivity Ton/m. year	Annual Cargo Vol. x 1,000 ton	Length m	Productivity Ton/m. year
12,000 DWT	860	900 (600)	960	1,730	1,500	1,150
4,000 DWT	350	400	880	920	800	1,150
1,000 DWT	310	280 (320)	959	910	700 (320)	1,300
Container	358	220	1,628	996	280	3,560
Multipurpose Industrial Terminal (Steel)	285	200	1,425	650	400	1,630
Local, Rakyat	730	1,050 (1,865)	802	1,706	2,030 (1,865)	826

Note: Figures in parentheses represent existing wharves length.

4-3 Channels and Basins

4-3-1 Width and Depth of Main Channels

The width and depth of channels are generally determined based on the frequency of passage and the size of vessels.

(1) Width

The frequency of large vessels (over 5,000 DWT) calling at Semarang Port is forecast as shown in Table 4-3-1.

Table 4-3-1 Future Port Calls of Large Vessels

Year	Port Calls/Year	Passages/Year	Passages/Day
1995	716	1,432	3.92
2005	1,394	2,788	7.64

Assuming that the average distance from the entrance of the port to the wharves is about 4,000 m and that the vessels generally move through the channels at an average speed of about 7 knots, the time it takes each vessel to make one passage is: 4,000 m ÷ (7 knots x 1,852 m/knot) = 18.5 minutes, or roughly, 20 minutes.

Further, assuming that these large vessels only enter and leave the port during daytime and that there are roughly 12 hours of daylight per day, the average passage interval for these vessels is forecast as follows:

1995 12 ÷ 3.92 = 183 minutes
2005 12 ÷ 7.64 = 94 minutes

In other words, in 1995 one large vessel will pass through the channels every 183 minutes, and in 2005 one large vessel will pass through the channels every 94 minutes, on the average.

The probability of passage per minute, λ is:

$\lambda 1995 = 5.46 \times 10^{-3}$
$\lambda 2005 = 10.63 \times 10^{-3}$

Service productivity $\mu 1995 = \frac{1}{20} = 0.05$

If S equals one (there is only one channel), the occupancy ratio δ is as follows:

$$\delta 1995 = \frac{\lambda}{S\mu} = \frac{5.46 \times 10^{-3}}{1 \times 0.05} = 0.11$$

$$\delta 2005 = \frac{\lambda}{S\mu} = \frac{10.63 \times 10^{-3}}{1 \times 0.05} = 0.21$$

In general, the appropriate channel width for channels where two vessels will never to pass each other is equal to the length of the largest vessel that will usually pass through the channel of the L_{max}.

At Semarang Port there will actually be three channels. The east channel will serve the multipurpose industrial terminal. Based on the size of vessels that will call at this terminal, a channel width of 150 m should be sufficient. In the third phase of the port development, after 1995, the container handling facilities will be moved from the west channel to the central channel. Considering the largest vessels that will utilize each channel in each stage of the development, the appropriate channel widths are as shown in Table 4-3-2.

Table 4-3-2 Channel Widths

Unit: m

	Today	1995	2005
1			
West Channel	150 m	220	220
Center Channel	-	-	280
East Channel	-	100	100

(2) Depth (West and Central Channel)

The largest vessels that will regularly call at Semarang Port are container vessels. Considering the service patterns of these vessels, no container carrier will call at Semarang Port fully loaded, as follows:

A. Indonesia/Japan Shuttle Service will become fully loaded at Surabaya or Jakarta (Tg. Priok).

B. Singapore Feeder will become fully loaded at Surabaya or Singapore.

The standard drafts of 2nd and 3rd generation container vessels are 10.5 and 11.5 meters, respectively. However, the actual drafts are generally 1 ~ 2 meters less than the standards. The TPC (the cargo weight ton per centimeter sinkable) of container vessels is said to be about 50/60 tons/cm.

If 2nd generation ships (1,500 TEU loaded) and 3rd generation ships (2,100 TEU loaded) are 30 percent empty when they call at Semarang, their drafts at Semarang Port can be calculated as follows:

(2nd Generation Vessels)

$$10.5 \text{ m} - (1{,}500 \text{ TEU} \times 0.3) \times \frac{17 \text{ ton/TEU}}{55 \text{ ton/cm}} \cdot \frac{1}{100} = 10.5 \text{ m} - 1.53 \text{ m} \fallingdotseq 9.11 \text{ m}$$

(3rd Generation Vessels)

$$11.5\text{ m} - (2{,}100\text{ TEU} \times 0.3) \times \frac{17\text{ ton/TEU}}{55\text{ ton/cm}} \cdot \frac{1}{100} = 11.5\text{ m} - 1.94\text{ m} \fallingdotseq 9.56\text{ m}$$

In general, under-keel allowance is 10 percent of draft, but as for long channels, more detailed analysis is necessary. Basically, under-keel allowance is calculated as follows.

Under keel allowance = Error of Map + Sinkage + Movement
Error of Map: International Average Allowance = 0.30 m
Japanese Specification = 0 m
Sinkage
1,500 TEU = 0.20 m (Premise L = 200 m, V = 7 knots)
2,100 TEU = 0.26 m (Premise L = 260 m, V = 7 knots)

Movement: Within the breakwater, no waves will strike vessels broadside, so we need only consider the effects of waves which will strike the vessels from the bow or the stern. According to our observations, these waves are always less than one meter high, year-round, and because the area is shallow, the wave lengths are much smaller than the length of the large vessels. Thus, the movement (pitch and roll) of these vessels due to waves is negligible, and need not be considered in calculating the design depth of the channels.

Dredging Errors: In general, if the dredging work follows Japan's checking system, there should be no shallow areas. A 60 cm allowance is sometimes made for dredging errors.

However, if we consider the policy of compulsory pilotage and the fact that dredging work will take place under the supervision of Japanese experts, the following under-keel allowances will be sufficient. The entrance of the harbour should be 0.5 m deeper than the inner channel.

1995: 9.11 m + 0.5 m = 9.61 m ≒ 10.0 m
2005: 9.56 m + 0.5 m = 10.06 m ≒ 10.5 m

So, based on the size of vessels that will call at Semarang Port and their actual load conditions, the recommended channel depths are as presented in Table 4-3-3.

Table 4-3-3 Channel Depths

Unit: m

	1985	1995	2005
West Channel	9.0	10.0	10.0
Center Channel	-	-	10.5
East Channel	-	7.5	7.5
Entrance of Harbour	9.5	10.5	11.0

4-3-2 Mooring Basins

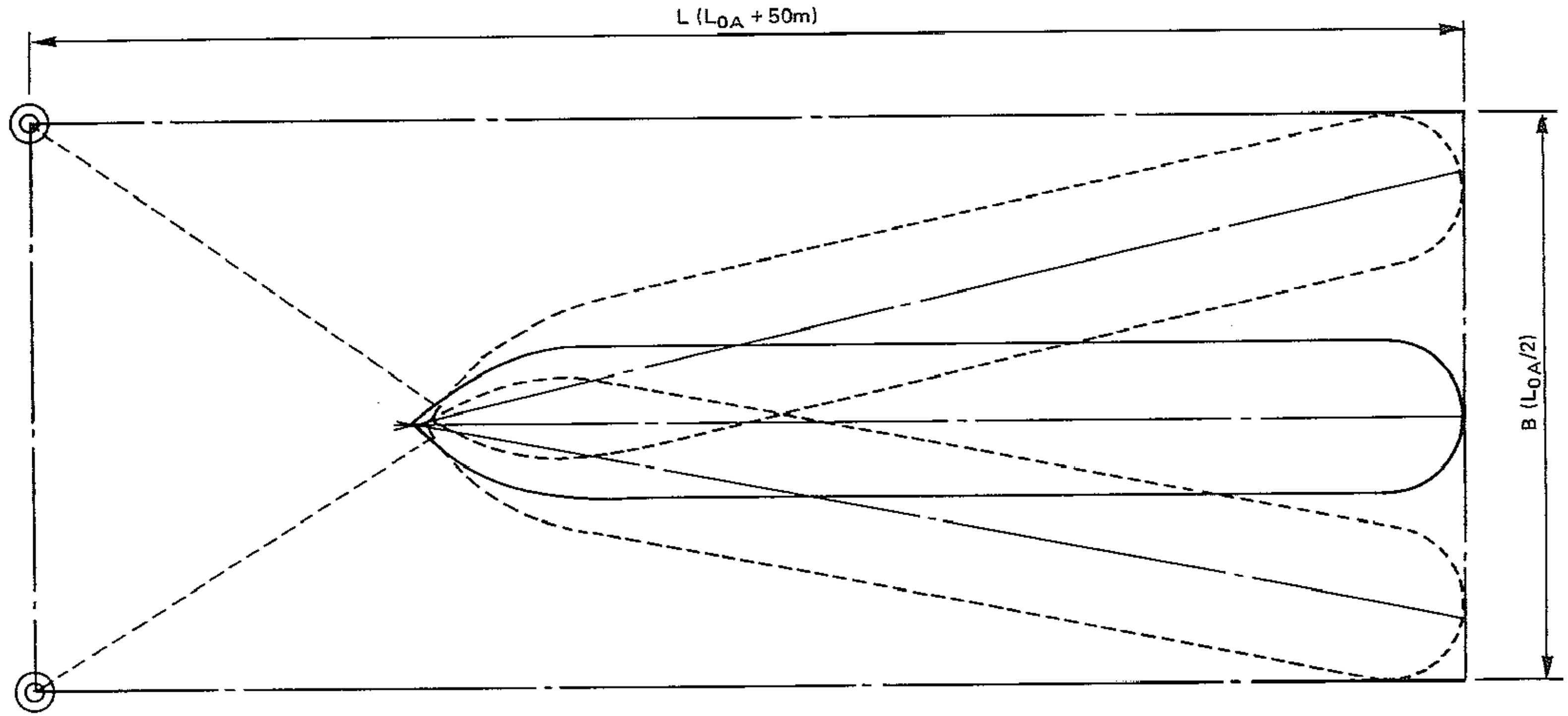
This port is planned assuming an average berth occupancy of 0.6 ~ 0.9 for conventional vessels, so that vessels will have to wait for berths around 1 day at most. Some waiting vessels may request offshore cargo handling at the anchorage. The Study Team has designed the anchorage so that 95 percent of conventional vessels except local and rakyat can be accomodated within the breakwater eithter alongside berth or at the anchorage.

The number of berths and the number of offshore mooring basins at the anchorage are presented in Table 4-3-4.

Table 4-3-4 Number of Berths and Number of Offshore Mooring Basins at Semarang Port

	Conventional 12,000 DWT		Conventional 4,000 DWT		Conventional 1,000 DWT	
	1995	2005	1995	2005	1995	2005
95% Accomodation	8	11	8	15	7	13
Number of Berths	6	10	4	8	4	10
Number of Anchoring Basins	2	1	4	7	4	3

Figure 4-3-1 shows required basin area per ship by mooring with two anchors.



	12,000 DWT	4,000 DWT	1,000 DWT
L_{0A} (m)	140	90	55
d_f (m)	10	7.5	5.5
Area (ha)	1.3	0.6	0.3

Fig. 4-3-1 Required Basin Area

4-4 Road Network within the Port Area

4-4-1 Premises

(1) Modal Split

For planning purposes, the Study Team assumes that all of the cargoes that will be carried between the port area and the hinterland will be transported by truck. As mentioned above, some commodities, especially fertilizer, cement, and coal will probably be carried by rail. Considering the weight of these cargoes and their distribution pattern, it would be economical to transport them using rail service.

However, as the rail system in Indonesia, particularly around Semarang, is not in good repair, various unforeseen difficulties may occur if certain commodities are carried to an from the port by rail. A major renovation of the rail system would involve large outlays of capital which may not be available at this time. Thus, for this section, the Study Team assumes that the modal split by truck at most will be 100 percent. This has the extra advantage that if railway transport were to break down in some emergency, virtually all of the port cargoes would still be able to be moved by truck.

(2) Container Transportation

In the industrialized nations, containers are generally transported door to door. That is to say, packed containers are carried to the port of origin, transported by ship to the port of destination, and then carried, just as they were shipped, to the consignee. The containers are carried to and from the ports by special trucks and railroad cars which are designed to carry containers.

In developing countries, however, only a small percentage of containers are carried door to door. Most of cargoes are carried to the port as break bulk and are then packed into containers at the port. Similarly, after the containers are unloaded at the port of destination, most of them are first unpacked at the port and then carried by trucks or trains as break bulk.

As transportation infrastructures develop, the percentage of containers which are carried door to door increases. At Semarang Port we predict that the ratio of containerized cargo that will be carried in containers door to door will reach 30 percent. The remaining 70 percent will be packed and unpacked at the freight station which will be located near the truck pool. The flow of container cargo is presented in Figure 4-4-1.

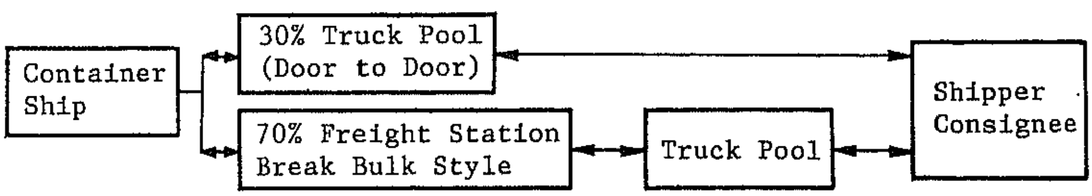


Fig. 4-4-1 Future Container Cargo Flow at Semarang Port

4-4-2 Concept of the Road Network

The concept of the road network within the port area is presented in Figure 4-4-2. Road section A-A runs to the container wharf and the general cargo wharf. Road section B-B runs towards the eastern section of the port and will service the private wharves for cement, coal and iron and steel. Road Section D-D runs towards the western part of the port and will service the old port. Road Section E-E runs towards the western part of the port and will service the grain and fertilizer wharves. Road Section F-F is a new section which was just constructed this year (1985).

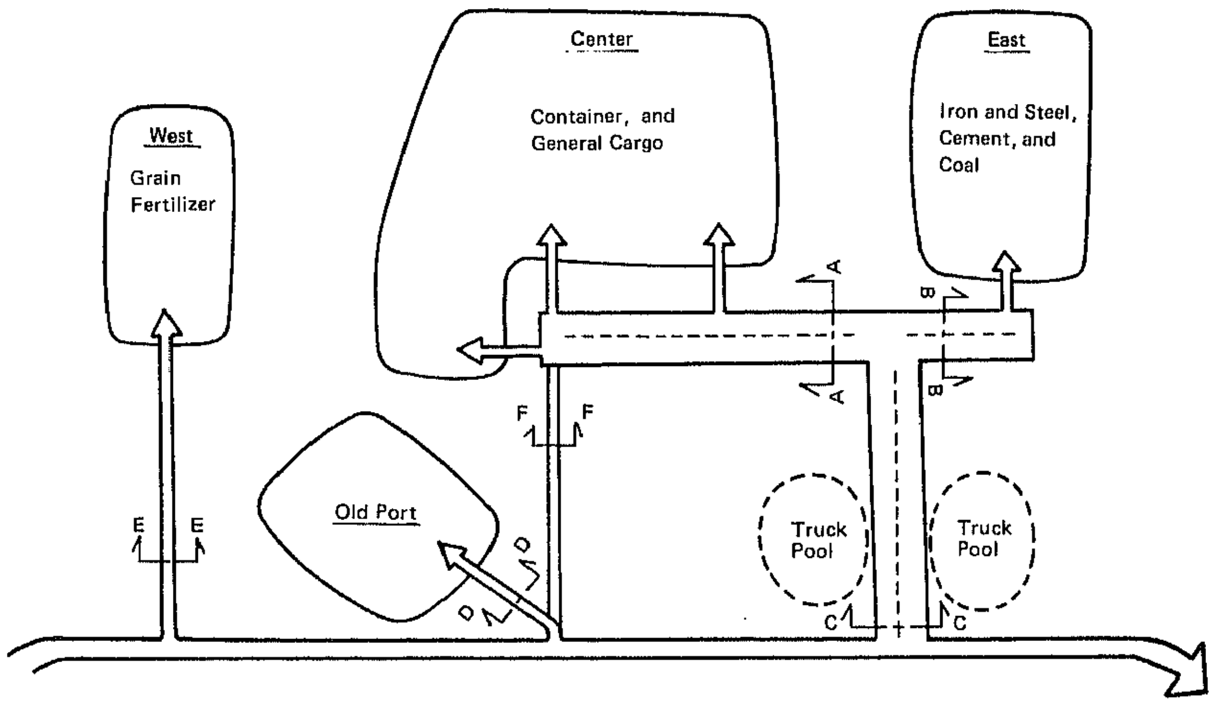


Fig. 4-4-2 Comcept of the Road Network within the Port Area

4-4-3 Traffic Volume Forecast

(1) Method

The traffic volume which will be generated by port activities is forecast as follows, based on the cargo volume.

A. Conventional Cargo

$$\text{Volume} = N \times \frac{\alpha}{W} \times \frac{\beta}{12} \times \frac{\gamma}{30} \times \frac{(1+\delta)}{\epsilon}$$

(Vehicles/day)

Where: N = Cargo volume per annum
α = Modal split ratio by truck
β = Variation ratio per month
γ = Variation ratio per day
W = Actual carrying capacity by truck
ϵ = Actual vehicle ratio
δ = Cargo related vehicle ratio

B. Container Cargo

$$\text{Volume} = (T_1) + (T_2) + (T_3) + (T_4) + (T_5)$$

Where: (T_1) = Number of loaded container trucks

$$= \frac{\text{Cargo Volume (tons/year)}}{\text{10.0 tons (Volume per Container)}} \times \frac{1}{365} \times 0.3 \quad \text{(Ratio of containers carried door to door)}$$

(T_2) = Number of empty container trucks = $(T_1) \times 1.0$

(T_3) = Number of loaded trucks

$$= \frac{\text{Cargo Volume (tons/year)}}{\text{10.0 tons (Volume per Container)}} \times \frac{1}{365} \times 0.7 \times 3$$

(T_4) = Number of empty trucks = $(T_3) \times 1.0$

(T_5) = Number of vehciles = $[(T_1) + (T_2) + (T_3) + (T_4)] \times 0.4$

(2) Traffic Volume Generated by Conventional Cargo

The total traffic volume generated by port activity is approximately 11,800 trucks per day in 1995 and 24,500 trucks per day in 2005 as shown in Table 4-4-1.

Table 4-4-1 Traffic Volume Generated in the Port

Wharf	Commodity	N ('000 tons)	α	β	γ	W	ε	δ	Number of Trucks
East	Iron & Scrap	285 (650)	1.00	1.20	1.37	6.0	0.49	0.15	500 (1,100)
	Cement	360 (820)	1.00	1.23	1.50	6.0	0.5	0.5	900 (2,100)
	Coal	300 (1,050)	1.00	1.22	1.80	6.0	0.5	0.5	900 (3,200)
	Sub Total	945 (2,520)							2,300 (6,400)
Center	Lumber & Steel	308 (725)	1.00	1.20	1.37	6.0	0.49	0.15	500 (1,300)
	Agricultural Products & Rice	92 (489)	1.00	1.22	1.80	6.0	0.5	0.5	300 (1,500)
	General Cargo	427 (702)	1.00	1.22	1.80	6.0	0.5	0.5	1,300 (2,100)
	Sub Total	827 (1,916)							2,100 (4,900)
Old Port	Rice	44 (59)	1.00	1.22	1.80	6.0	0.5	0.5	100 (200)
	General Cargo, Ag. Products	499 (1,176)	1.00	1.22	1.80	6.0	0.5	0.5	1,500 (3,600)
	Lumber & Steel	773 (2,219)	1.00	1.20	1.37	6.0	0.49	0.15	1,400) (4,000)
	Sub Total	1,316 (3,454)							3,000 (7,800)
West	Grain	316 824	1.00	1.22	1.80	6.0	0.5	0.5	1,000 (2,500)
	Fertilizer	950 (1,240)	1.00	1.22	1.80	6.0	0.5	0.5	2,900 (3,800)
	Sub Total	1,266 (2,064)							3,900 (6,300)
Total		4,354 (9,954)							11,300 (24,100)

Note: Figures in parentheses are for the year 2005

(3) Traffic Volume Generated by Container Cargo

The estimated volume of container cargo will reach 358,000 tons in 1995 and 1,027,000 tons in 2005. The estimated number of trucks for each year is shown below.

1995: $(T_1) = \frac{394{,}000}{10} \times \frac{1}{365} = 108$ trucks/day

$(T_2) = (T_1) = 108$

$(T_5) = [(T_1) + (T_2)] \times 0.4 = 86$

$(T_1)' = 108 \times 0.3 = 32$

$(T_2)' = 32$

$(T_3)' = 108 \times 0.7 \times 3 = 227$

$(T_4)' = 227$

$(T_5)' = [(T_1)' + (T_2)' + (T_3)' + (T_4)'] \times 0.4 = 207$

Total $T_1 + T_2 + T_5 = 302 = 300$ trucks/day

$T_1' + T_2' + T_3' + T_4' + T_5' = 756$ trucks/day = 800 trucks/day

2005: $(T_1) = \frac{1{,}149{,}000}{10} \times \frac{1}{365} = 315$

$(T_2) = (T_1) = 315$

$(T_5) = [(T_1) + (T_2)] \times 0.4 = 252$

$(T_1)' = 252 \times 0.3 = 76$

$(T_2)' = (T_1)' = 252$

$(T_3)' = 252 \times 0.7 \times 3 = 530$

$(T_4)' = (T_3)' = 530$

$(T_5)' = [(T_1)' + (T_2)' + (T_3)' + (T_4)'] \times 0.4 = 555 = 600$ trucks/day

Total $T_1 + T_2 + T_5 = 882$ trucks/day

$T_1' + T_2' + T_3' + T_4' + T_5' = 1{,}943 = 1{,}900$ trucks/day

Note: Ti = trucks/day in the port area
Ti' = trucks/day in the urban area

(4) Estimated Traffic Volume and Required Number of Lanes by Road Section

The estimated traffic volume and the required number of lanes are presented by road section for the target years in Table 4-4-2.

The trucks which will carry conventional cargo to and from the central area are assumed to use routes C-C and F-F on an equal basis (50-50), but the trucks which will carry container cargoes to and from the central area are assumed to use route C-C which passes through the truck pool area exclusively, thus minimizing the road congestion in the city area.

Table 4-4-2 Estimated Traffic Volume and Required Number of Lanes by Road Section

Road Section	Year	Traffic Volume per Day					Traffic Volume per Hour	Required Number of Lane
		East	Center	Old Port	West	Total		
A-A	1995		1,100 800			1,900	250<600	2
	2005		2,500 1,900			4,400	580<600	2
B-B	1995	2,300				2,300	300<600	2
	2005	6,400				6,400	830<1,200	4
C-C	1995	1,299	1,100 800			4,200	550<600	2
	2005	6,400	2,500 1,900			10,800	1,400÷1,200	4
D-D	1995			3,000		3,000	390<600	2
	2005			7,800		7,800	1,010<1,200	4
E-E	1995				3,900	3,900	510<600	2
	2005				6,300	6,300	820<1,200	4
F-F	1995		1,100			1,100	150<600	2
	2005		2,500			2,500	330<600	2

Note: 1) In the "Center" column, the upper figures represent converted trucks, and the lower figures represent container trucks.

2) The required number of lanes is calculated based on a capacity of 600 trucks per hour per/2 lanes. Traffic Volume per hour is Volume/per day x 0.13.

4-4-4 Design of the Road Sections

In designing the road sections, the following points should be considered:

(1) The roads must be able to accommodate the further increases in traffic volume which will occur after 2005 along with the continuing growth of the port.

(2) In order to minimize the noise pollution in the immediate area, roads should be flanked by buffer green belts.

(3) Workers and visitors travelling to and from the business area and the government area will primarily travel by light vehicle, that is, by bicycle or on foot. Thus, an appropriate sidewalk or bicycle path should also be prepared.

Figure 4-4-3 shows the layout and classification of roads in the port area in 2005. The roads are classified into three types: trunk roads, branch roads and local roads which are located within individual sections of the port.

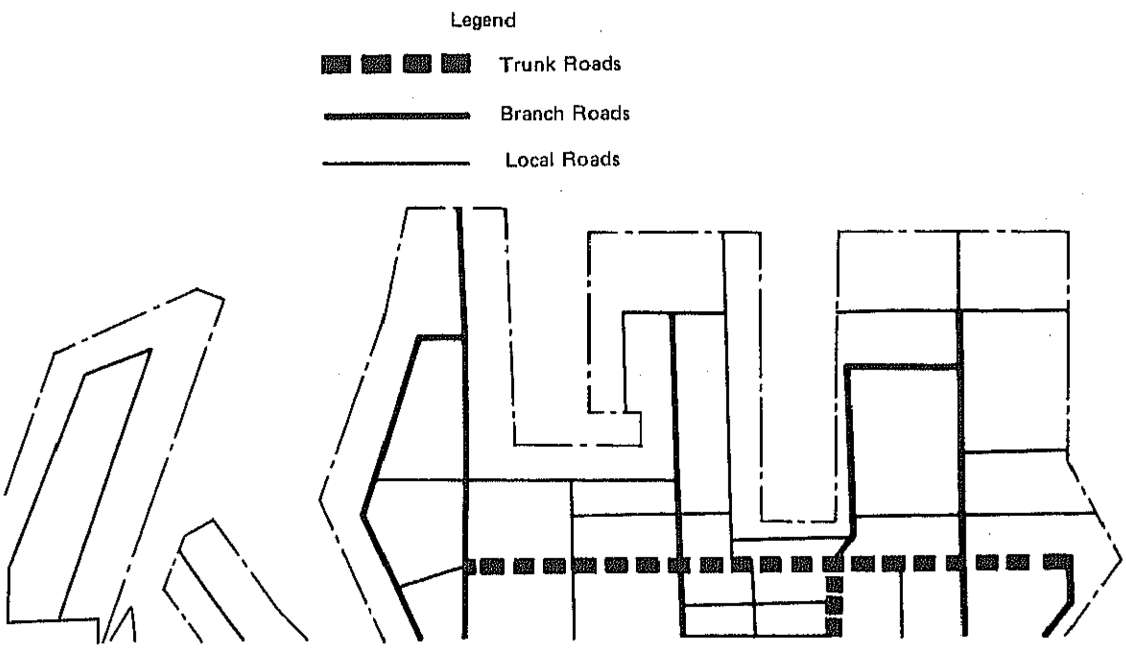


Fig. 4-4-3 Classification of Roads in the Port Area

A. Trunk Roads

1) Sections A-A, B-B and C-C

These roads are the main east/west arteries which will serve the eastern industrial zone, the central zone and the government and business areas. Most of the traffic here will consist of container carriers and heavy trucks.

The traffic volume of section B-B will reach 800 vehicles per hour in 2005. Thus, the appropriate number of lanes is 4. The traffic volume in section A-A is less than the volume in section B-B, but as there are many office buildings with workers and visitors, the appropriate number of lanes here is also 4.

To accommodate heavy trucks, the width of each lane is 3.5 m, the shoulders are 2.5 m, the central separator 4.0 m, the buffer green belts 2.0 m, and the drains 1.5 m wide. The designs of these road sections are presented in Figure 4-4-4.

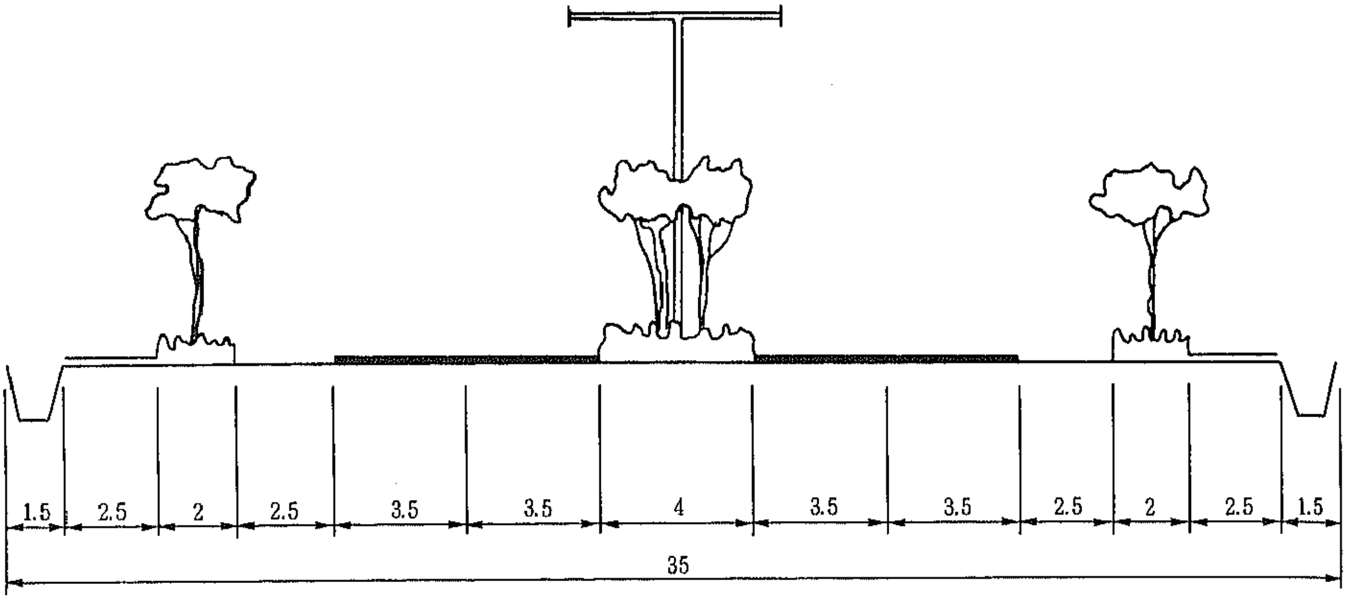


Fig. 4-4-4 Design of Road Section A-A, B-B and C-C

B. Branch Roads

The branch roads connect the trunk roads with each part of the port, and also connect various local roads. The traffic volume on the branch roads will be relatively small, so 2 lanes will be sufficient. Like the trunk roads, the branch roads will also have 2.5 m wide shoulders which can be used for parking when necessary. The design of the branch roads is presented as Figure 4-4-5. The total width is 24 m.

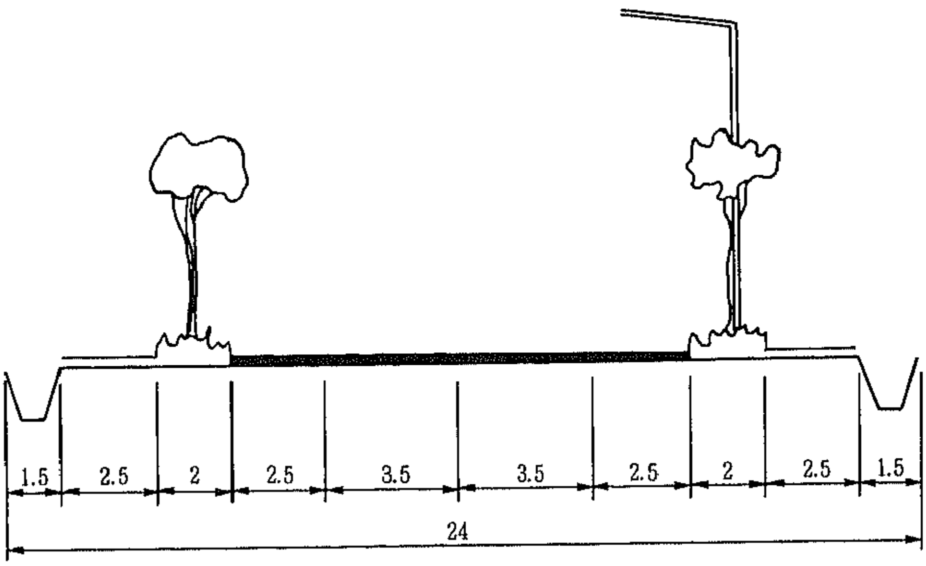


Fig. 4-4-5 Design of Branch Roads

C. Local Roads

As the traffic volume on the local roads will also be relatively low, the appropriate number of lanes is 2. The total width of the local roads is 20 m as shown in Figure 4-4-6.

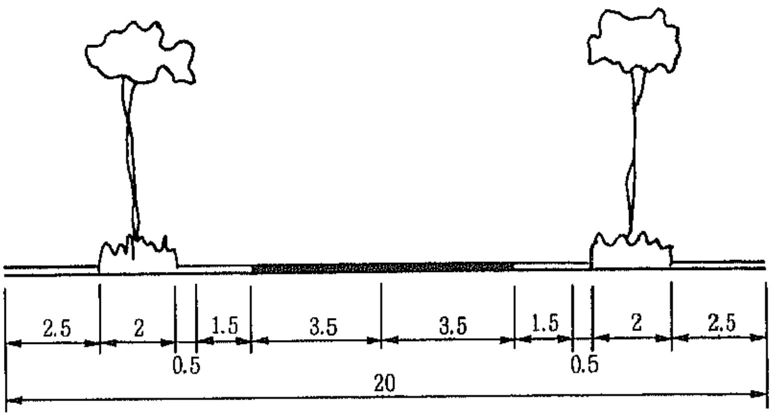


Fig. 4-4-6 Design of Local Roads

4-4-5 Total Road Area

Based on the road designs presented in Section 4-4-4, the total area of the roads which will be developed by the year 2005 is approximately 504,000 m^2 as shown in Table 4-4-3.

Table 4-4-3 Total Area of Roads in the Port Area

Class / Location	Trunk Roads	Branch Roads	Local Roads	Total
	(W) (L) (A)	(W) (L) (A)	(W) (L) (A)	(A)
East and Center	35m x 2,700m = 94,500 m2	24m x 6,300m = 151,200 m2	20m x 10,000m = 200,000 m2	445,700 m2
West	-	24m x 600m = 14,400 m2	20m x 2,200m = 44,000 m2	58,400 m2
Total	94,500 m2	165,600 m2	244,000 m2	504,100 m2

Note: The total length of the municipal road which runs along the outside of the port is 5,100m, but this road is not included in the table.

4-5 Rail Network within the Port Area

4-5-1 Traffic Volume and Number of Freight Vans

Major commodities carried by rail are coal, fertilizer, grain and cement. The traffic volume of these commodities for the Short-term Plan and the Master Plan are assumed as follows.

Table 4-5-1 Traffic Volume by Rail

Unit; ,000 tons

Commodity			Traffic Volume	
Line		Modal Split by Rail	Short-term Plan	Master Plan
West	Fertilizer	30%	290	370
	Grain	30%	90	250
	Total	-	380	620
East	Coal	100%	300	900
	Cement	50%	180	410
	Total	-	480	1,310

The number of freight cars is calculated as follows.

Table 4-5-2 Number of Trains

	Year	Traffic Volume('000tons)	Number of Freight Cars (000 cars)	per day (cars)	Trains in and out per days
West	1995	380	16	44	4
	2005	620	31	85	6
East	1995	480	24	66	6
	2005	1,310	66	180	12

Note: Each freight car can accommodate 20 tons of cargo in average.
One train consists of 30 freight cars.

4-5-2 Required Number of Tracks

Although the details must be investigated later during the engineering works, the west and east lines should probably have 1 track and 2 tracks, respectively.

The land area necessary for these railway lines is summarized in the following table.

Table 4-5-3 Required Area for Railways

	Length(m)	Area('000 m^2)
East	3,000(2 tracks)	30
West	2,000(1 track)	10
Total	-	40

Note: Each track is 5 m in width.

4-6 Terminal Layout

This section considers the terminals which will be prepared during the Short-term development (until 1995). These are the multipurpose container terminal, the conventional cargo terminal, the grain terminal, the coal terminal, the cement terminal, the fertilizer terminal, the scrap iron terminal and the passenger terminal. The rehabilitation of the old port, the Inner Harbour area and Kali Baru are also considered, as well as the demolition and reinforcement of sections of the West Breakwater and construction of a new additional breakwater.

4-6-1 Multipurpose Container Terminal

This terminal will be required from around 1995 as a temporary terminal.

(1) Terminal Dimensions

The dimensions of the multipurpose container terminal are as follows:

Berth Length:	220 m	Import Container Yard:	4.2 ha
Apron Width:	55 m	Export Container Yard:	5.6 ha
Depth:	10 m		

(2) Cargo Handling System

A. Loading and Unloading

For full container ships and combination vessels which have no container cranes, two truck cranes will be used for loading and unloading. The cargo handling rate per crane is one TEU every 8 minutes for combo vessels.

As for full container ships which are equipped with container cranes, the vessels' cranes will be used. The cargo handling rate is one TEU every 3 minutes.

B. Yard Operations

To facilitate smooth operations, the container yard should be divided into an import container yard and an export container yard. Imported containers will be carried directly to the import container yard or to bonded warehouses belonging to the consignees.

Containers that will be shipped abroad will be stacked in the export container yard, arranged according to the order of ship departures. All containers will be carried between the container yards and the aprons on chassis. Within the container yards, containers will be handled using forklifts. The equipment for handling containers is as follows:

6 Chassis
2 units of 35-40T Forklifts (Import Container Yard)
2 units of 35-40T Forklifts (Export Container Yard)

C. Yard Capacity

The required capacity of the yards is 200 TEU for the export yard and 180 TEU for the import yard. The calculations are shown in Table 4-6-1.

Table 4-6-1 Required Capacity for Container Yard in 1995

	Export	Import
Annual Volume ('000 Tons)	92	302
Annual Container Throughput @ 12T/TEU (TEU)	7,700	25,200
Daily Container Throughput (TEU)	21	69
Average Stay (Days)	7	2
Fluctuation Ratio	1.3	1.3
Required Capacity of Yard (TEU)	200	180

(3) Terminal Layout

The layout of the multipurpose container terminal is presented in Figure 4-6-1.

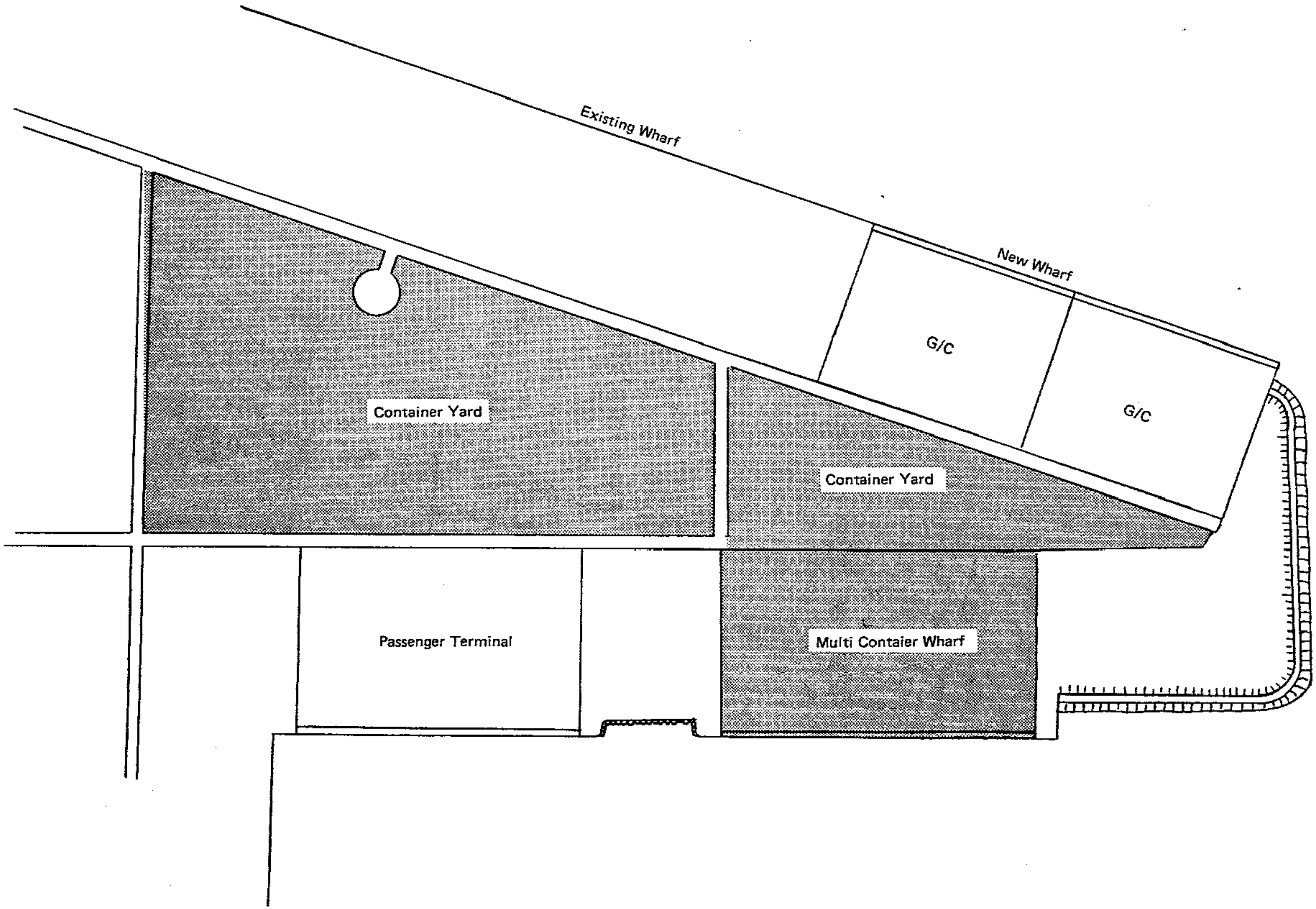


Fig. 4-6-1 Multiplurpose Container Terminal Layout

4-6-2 Conventional Terminal

(1) Wharf Dimensions

The dimensions of the wharves at the conventional cargo terminal for 15,000, 5,000 and 2,000 DWT class vessels are presented in Figure 4-6-2.

(2) Cargo Handling System

A. Loading and Unloading

No special port crane or other handling equipment will be required. Ship gear should be used for loading and unloading conventional cargo vessels.

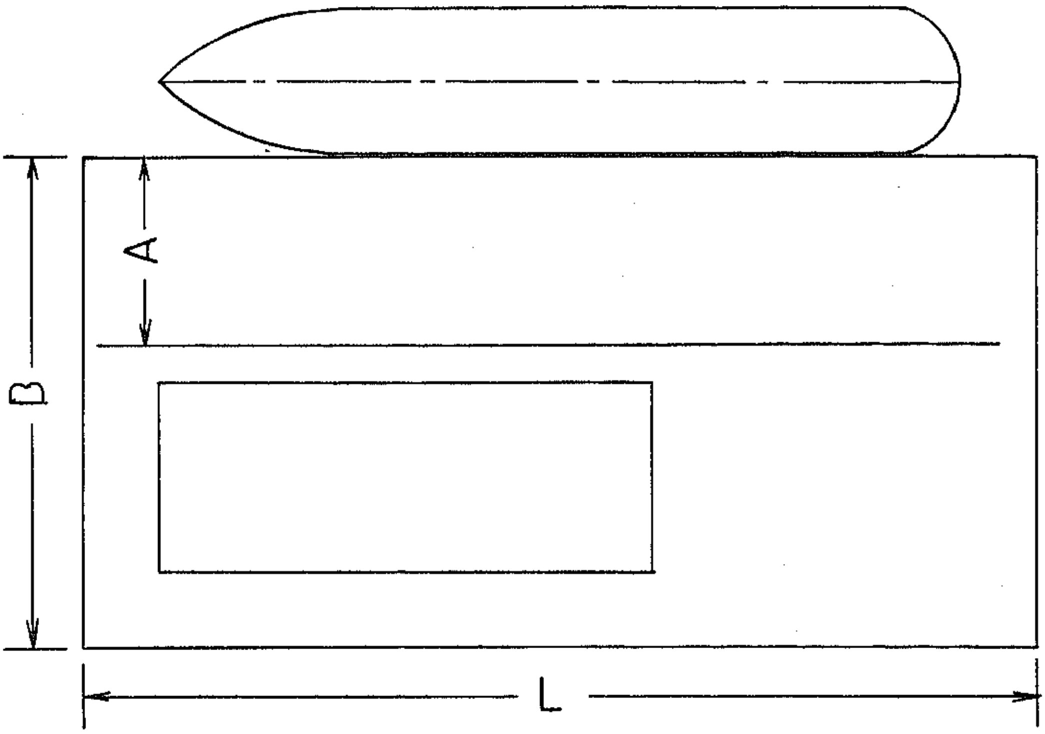
B. Apron/Transit Shed Operation

A variety of forklifts should be used to handle conventional cargo, especially for the larger vessels in the 5,000 ~ 15,000 DWT class. Labour intensive cargo handling is not economically efficient for larger vessels.

Previously, it was thought that the construction of a large transit shed would be necessary. However, as the customs procedures have been simplified and cargo delivery expedited as directed by INPRES 4/1985, an extraordinarily large shed will not be needed. Fortunately, cargo turnover in the sheds has been improving.

Ideally, import cargoes should be removed from the apron as soon as possible. All the import cargoes should certainly be moved to warehouses located somewhat far from the quaywall to minimize congestion. Only export cargoes should be allowed to accumulate in the front line sheds, in preparation for the port calls of vessels which will carry these cargoes abroad. This system will further improve cargo handling efficiency.

Further, more detailed study of the flow of cargo will be necessary in order to design an optimal operation system based on INPRES 4/1985. The current system whereby shipping companies have the exclusive use of the transit sheds should be reexamined. These preferential use warehouses should be constructed in the distribution center.



Unit: m

	15,000 DWT	5,000 DWT	2,000 DWT
L	150	100	60
A	40	25	25
B	120	100	80
Draft	10	7.5	5.5 ~ 4.0

Fig. 4-6-2 Dimensions of the Wharves at the Conventional Cargo Terminal

4-6-3 Rehabilitation of the Old Port

(1) Raising the Level of the Ground

As shown in Chapter 2 (Figure 2-6-3), several sections of the port are regularly flooded during high tide. It is necessary to raise the ground level of these areas so that they can be used at all times. In these sections, the ground will be raised to 2.0 m above sea level. As high tide reaches 1.3 m above sea level, this ground level includes an allowance of 70 cm.

Roads in these sections will be maintained at 2.2 m above sea level as compared with the 2.4 m elevation of the newly constructed roads in other sections of the port.

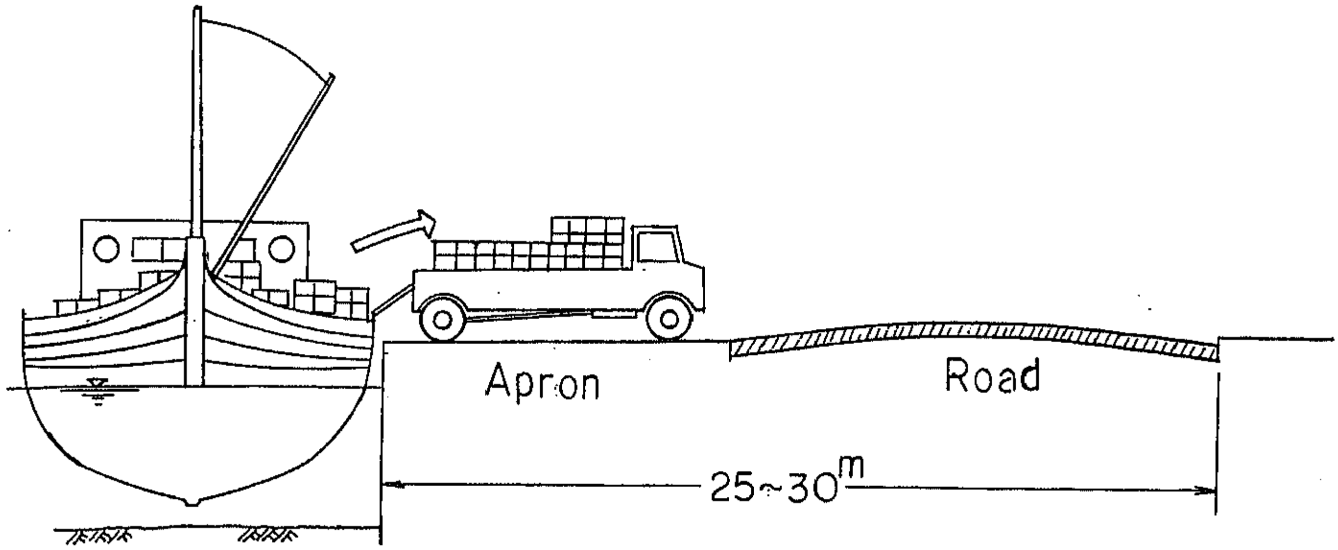
(2) Preparing New Aprons and Demolishing Unused Warehouses and Railways

A. Cargo Handling System

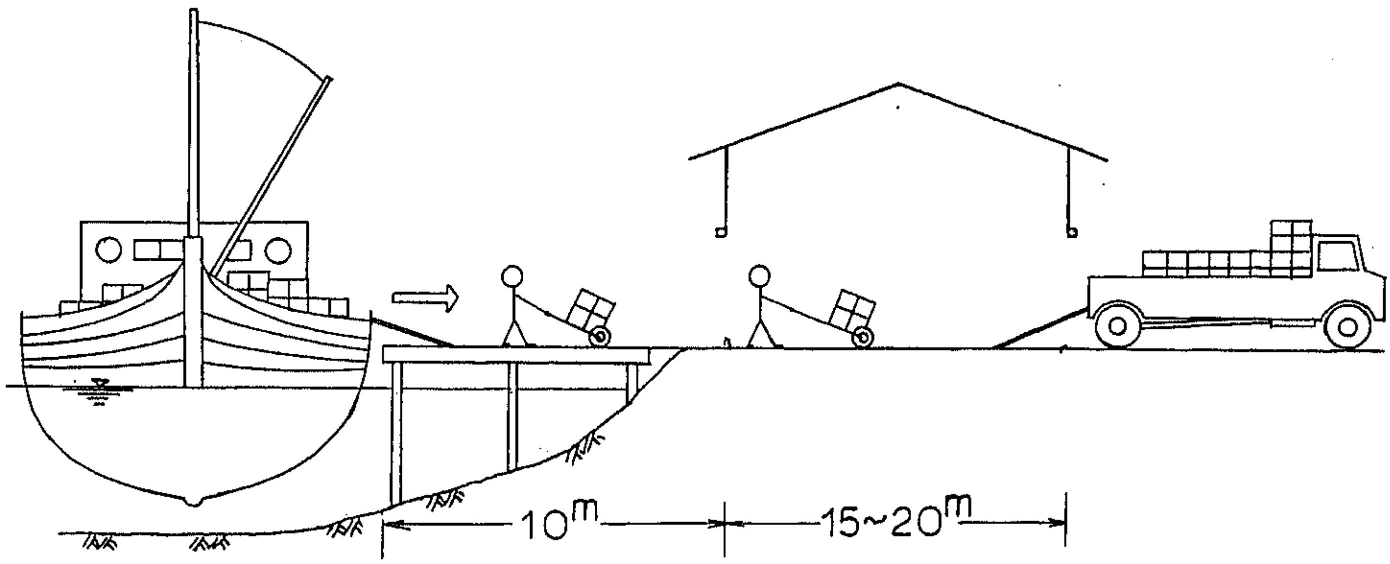
From observations of the cargo handling by local vessel and rakyat at Kali Mas, Banjarmasin (Martapura) and Pontianak, we note that two different handling systems are being used for the cargo handled by local vessels and rakyat. The systems which are used at Kali Mas (system A) and at Banjarmasin and Pontianak (system B) are presented graphically in Figure 4-6-3.

Under system A, cargoes are transferred directly from the ships to trucks waiting on the apron. Under system B, the cargoes are first carried to a transit shed, and then, later on, they are carried from the transit shed and loaded onto trucks.

System B may be a historical anachronism. It is left over from the time when all imported cargoes had to pass through lengthy customs procedures in the transit shed. As the customs procedures have been simplified, it seems that the transit sheds are no longer necessary. Site observations reveal that cargoes generally remain in the transit sheds for only a short period of time.



At Surabaya (Kali Mas) (A)



At Banjarmasin and Pontianak (B)

Fig. 4-6-3 Cargo Handling Systems for Local Vessel and Rakyat

Under the older system, system B, cargoes have to be handled twice. This is inefficient. With smooth planning and coordination of the arrival of trucks and vessels, cargo can now be moved much more efficiently by system A.

The cargo handling costs under the two systems are compared as follows:

Total Cargo Volume	Q	(tons)
Working Hours	H	(hours)
Required Labour	N	(persons)
Actual Working Hour Ratio	P	
Carrying Distance	L	(meters)
Carrying Lot per Labour Cycle	q	(tons)
Carrying Speed	V	(m/hour)

$$Q = N \times P \times \frac{V}{2L} \times H \times q$$

Premises

Q : 125 tons/day

P : 0.3

H : 7 hours

Carrying Distance L	System A	5 m
	System B	35 m
Carrying Lot q	System A	30 kg (Labour's Shoulder)
	System B	100 kg (Cart)
Carrying Speed V		2,000 (m/hour)

System A

$$125 = N \times 7 \times 0.3 \times \frac{2{,}000}{2 \times 5} \times 0.03 \qquad N = \frac{125}{7 \times 0.3 \times \frac{2{,}000}{2 \times 5} \times 0.03}$$

System B

$$125 = N \times 7 \times 0.3 \times \frac{2{,}000}{2 \times 35} \times 0.1 \qquad N = \frac{125}{7 \times 0.3 \times \frac{2{,}000}{2 \times 35} \times 0.1}$$

System A: $N = 9.9 \doteqdot 10$

System B: $N = 20.8 \doteqdot 21$

Number of Workers:

System A	10 persons
System B	21 persons

In actual cargo handling operations, there are 3 labours in the hold and 2 labours on the truck in addition to the labours carrying cargo.

Total number of workers:

System A	10 + 3 + 2 = 15 persons
System B	21 + 3 + 2 = 26 persons

This explains why 2 gangs (30 persons) were always observed handling the cargo for small local boats at Martapura and Pontianak.

On the other hand, the direct truck loading system used at Kali Mas requires relatively few labours. The labour cost of system A is almost half that of system B. Thus, the Study Team would like to recommend that system A be adopted at Semarang Port.

Under system A, no transit sheds are necessary, so the unused sheds and railways located in the old port can be removed to acquire some space at Kali Baru. It is important to plan sufficient space behind the quaywall for cargo handling and for the trucks which may be waiting. To avoid congestion near the berth, inward cargoes should rapidly be conveyed to warehouses or distribution centers located further back from the quay. Similarly, outward cargoes should be stored at private warehouses until shortly before the vessels arrive, especially for large shipments.

At any rate, system A, the direct loading system, is definitely superior. This system should be introduced to improve cargo handling efficiency and also to prevent pilferage.

The rehabilitation plans for Kali Baru are presented in Figures 4-6-4 and 4-6-5.

At Inner Port (Darum II), the unused transit sheds are not necessary; demolishing of these sheds will create an effective space behind the quaywall shown in Fig. 4-6-6.

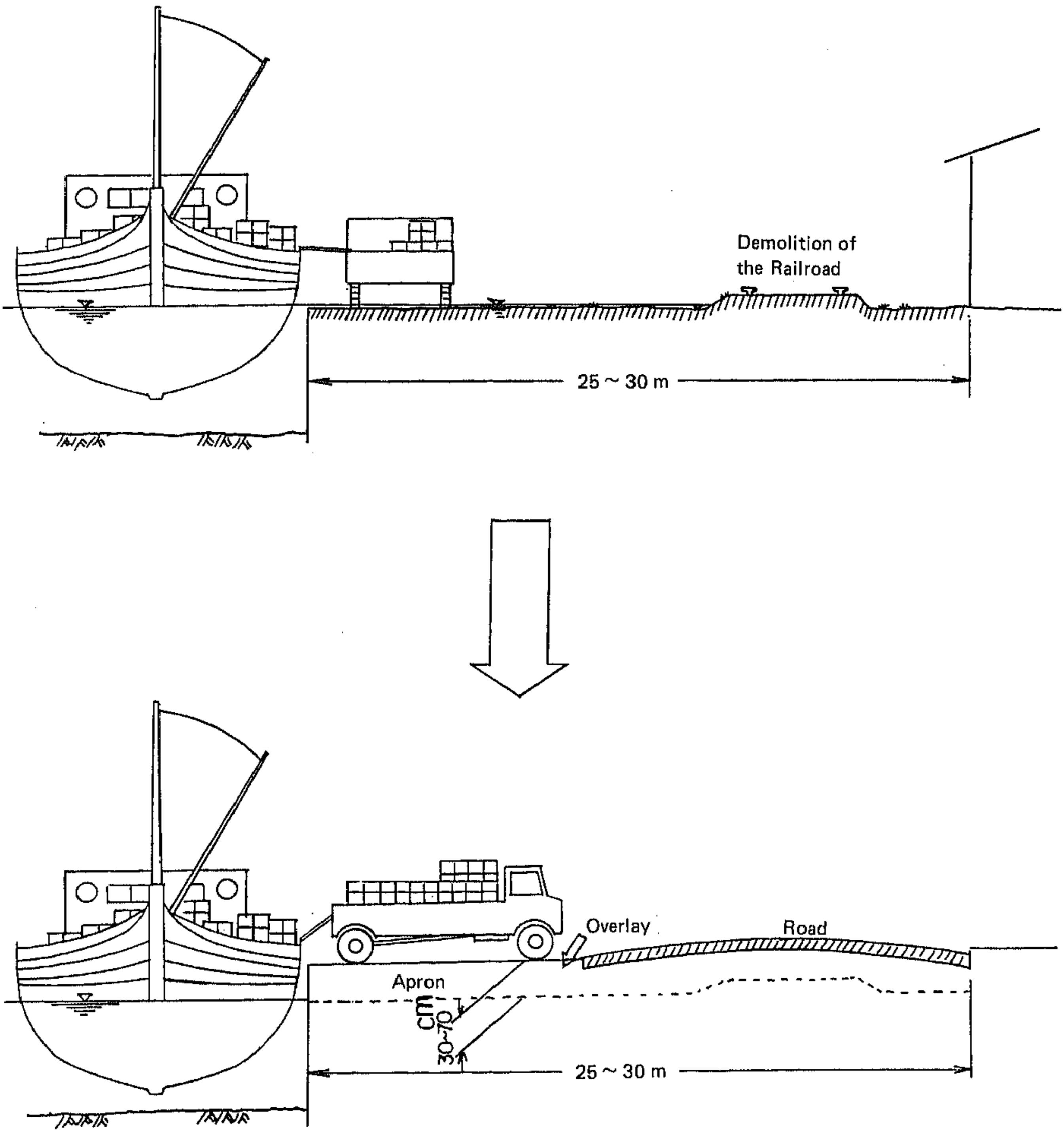


Fig. 4-6-4 Rehabilitation of Kali Baru

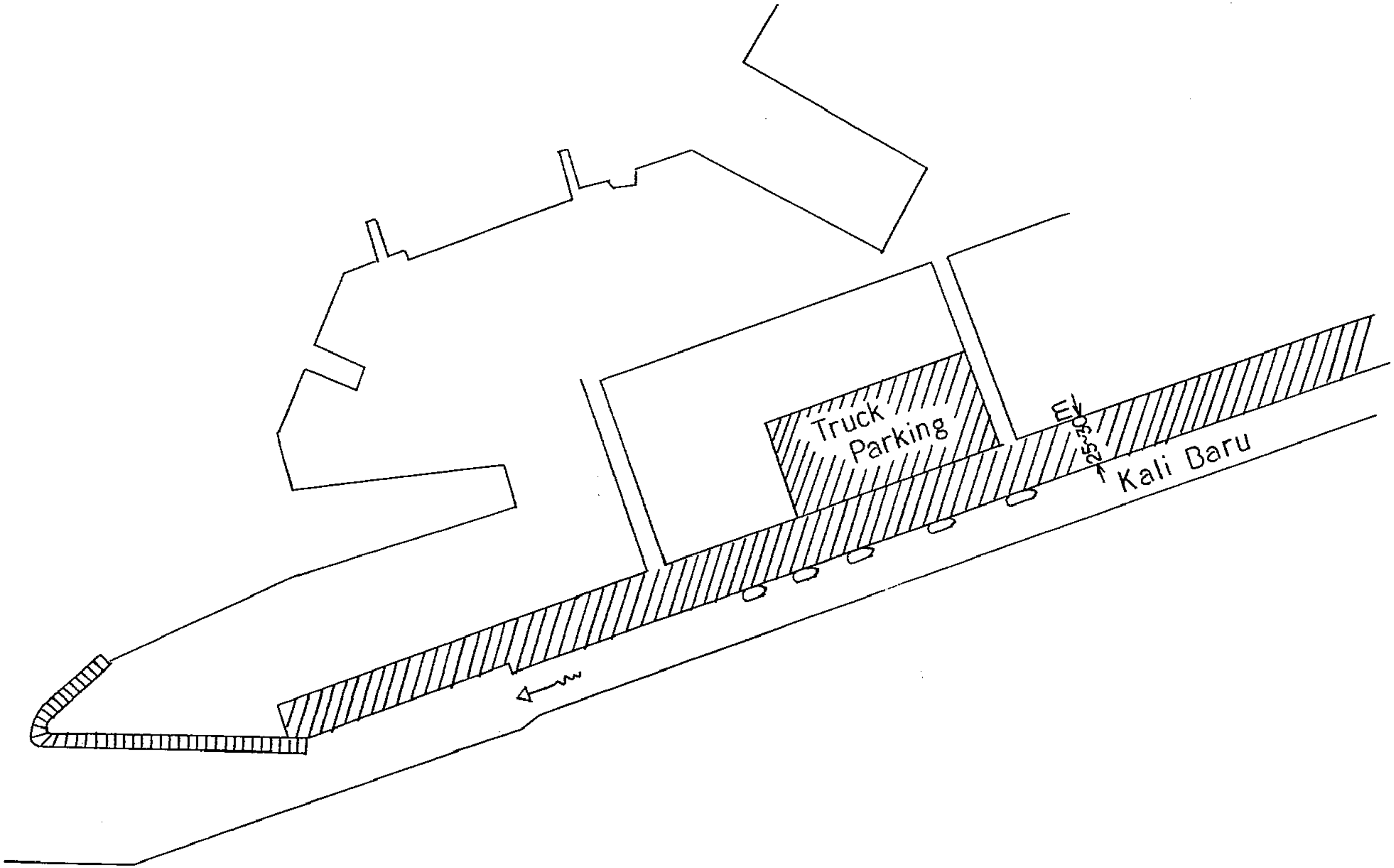


Fig. 4-6-5 Rehabilitation Area of Kali Baru

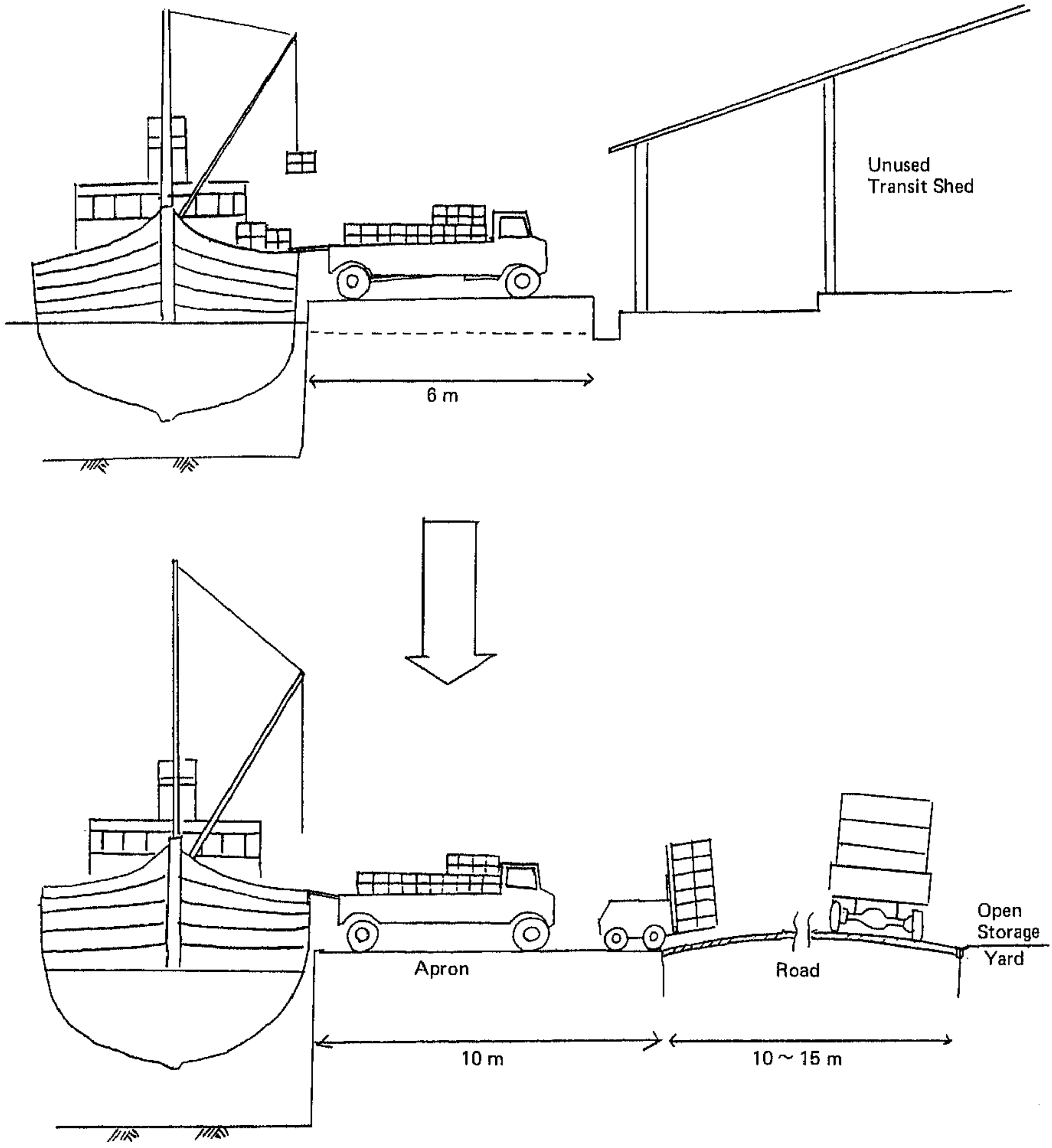


Fig. 4-6-6 Rehabilitation of Inner Port (Darum II)

4-6-4 Coal Terminal

(1) Terminal Dimensions

The dimensions of the coal terminal and other data related to the handling of coal at Semarang Port are presented in Table 4-6-2.

Table 4-6-2 Coal Terminal Dimensions and Related Data

Year	1995	2000
Annual Throughput	300,000 tons	900,000 tons (Maximum)
Max. Vessel Size	Max. 7,000 DWT	Max. 7,000 DWT
Average Volume/Voyage	6,000 tons	6,000 tons
Port Calls/Year	50	200
Unloading Capacity	350 tons/hour	350 tons/hour x 2
Average Stay	1.78 days	0.87/days
Berth Occupancy Ratio	18.5%	47.9%
Berth Length	150 m	150 m
Storage Area	Storage Yard 7,500 m^2 Total Area 25,500 m^2	Storage Yard 30,000 m^2 Total Area 45,000 m^2

(2) Cargo Handling System

The terminal is designed to accommodate coal carrier vessels which are assumed to be converted log carriers with a maximum size of 7,000 DWT.

Considering the cargo flow and the possibility of fire accidents in the coal storage yard, the capacity of the terminal should be equal to 1.5 months' consumption plus a 25 percent allowance.

(3) Terminal Layout

The layout of the coal terminal is presented in Figure 4-6-7.

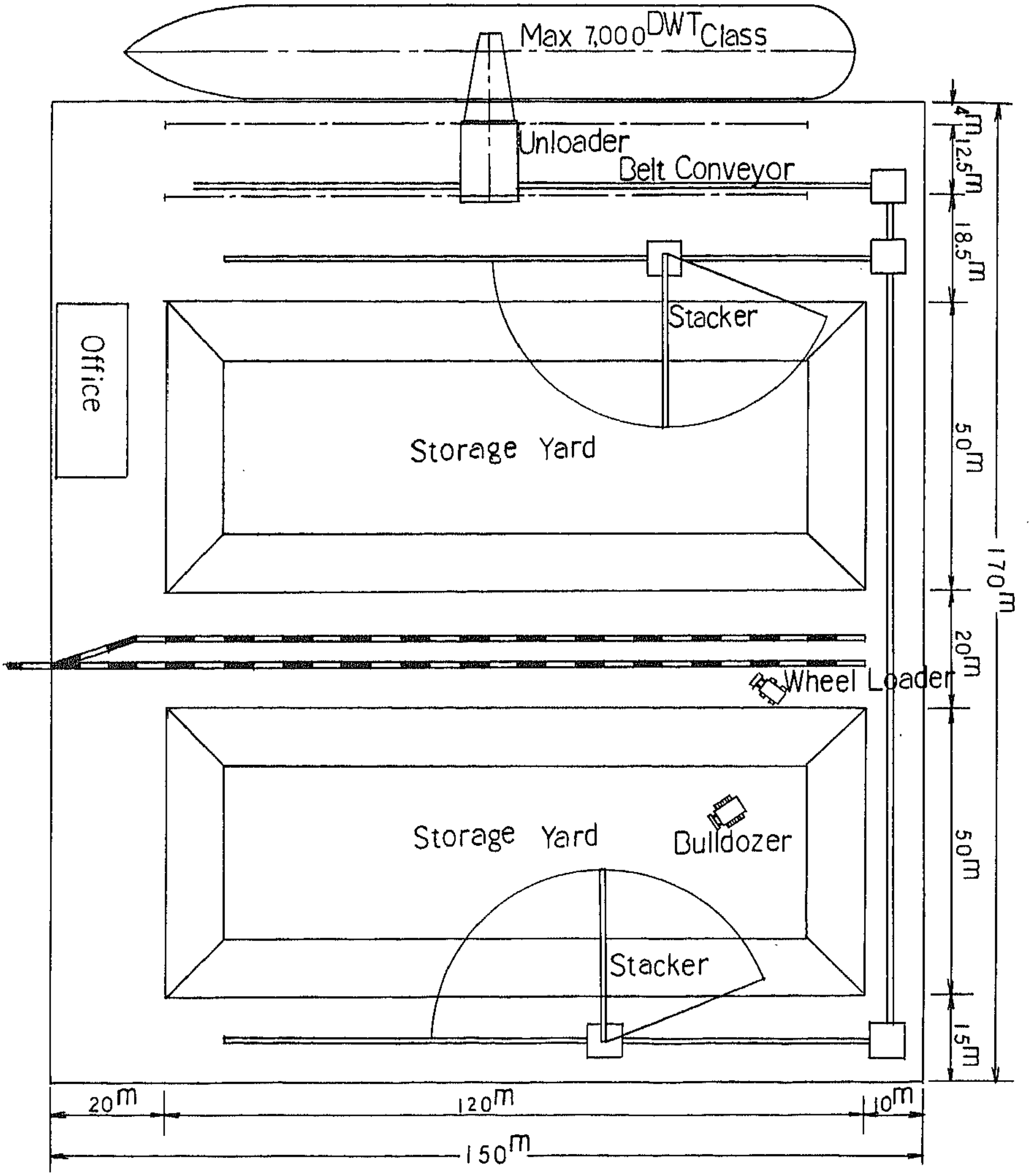


Fig. 4-6-7 Layout of Coal Terminal

4-6-5 Cement Terminal

(1) Terminal Dimensions

The dimensions of the cement terminal and other data related to the handling of cement at Semarang Port are presented in Table 4-6-3.

Table 4-6-3 Cement Terminal Dimensions and Related Data

Year	1995	2005
Annual Throughput	360,000 tons	820,000 tons
Max. Vessel Size	8,000 DWT	8,000 DWT
Average Volume/Voyage	7,000 tons	7,000 tons
Port Calls/Year	51	117
Unloading Capacity	450 t/hr x 1	450 t/hr x 2
Average Stay	1.1 days	1.1 days
Berth Occupancy Ratio	15%	35 %
Berth Length	150 m	150 m x 2 = 300m
Storage and Handling Area	Silos 10,800 m^2 Total 14,550 m^2	10,800 m^2 18,300 m^2

(2) Cargo Handling System

Considering the size of specialized cement carriers at Tg. Priok and in Japan, we assume that the vessels which will call at Semarang will be approximately 8,000 DWT. The corresponding ship length is about 130 m, so the length of the berths is set at 150 m.

One unloader will be installed at first, and then as cargo throughput increases in the future, a second unloader will be installed later on.

We assume that cargo will be handled 21 hours per day. The required capacity of the unloading equipment is 450 tons per hour. The bulk cement will be unloaded and conveyed into the cement silos. The cement will then be bagged behind the silos and carried by rail or truck or both to the hinterland.

Assuming that the turnover of the cement silos will be 36 times per year and that the storage capacity will be 9,000 tons per silo, the total number of silos required will be 3 in 1995 and 6 in 2005.

The required storage area will be 10,800 m^2 in the silo area. The cargo handling area along the waterfront will be 3,750 m^2 in 1995 and 7,500 m^2 in 2005. Thus the total required storage and handling area will be 14,550 m^2 in 1995 and 18,300 m^2 in 2005.

(3) Terminal Layout

The layout of the cement terminal is presented in Figure 4-6-8.

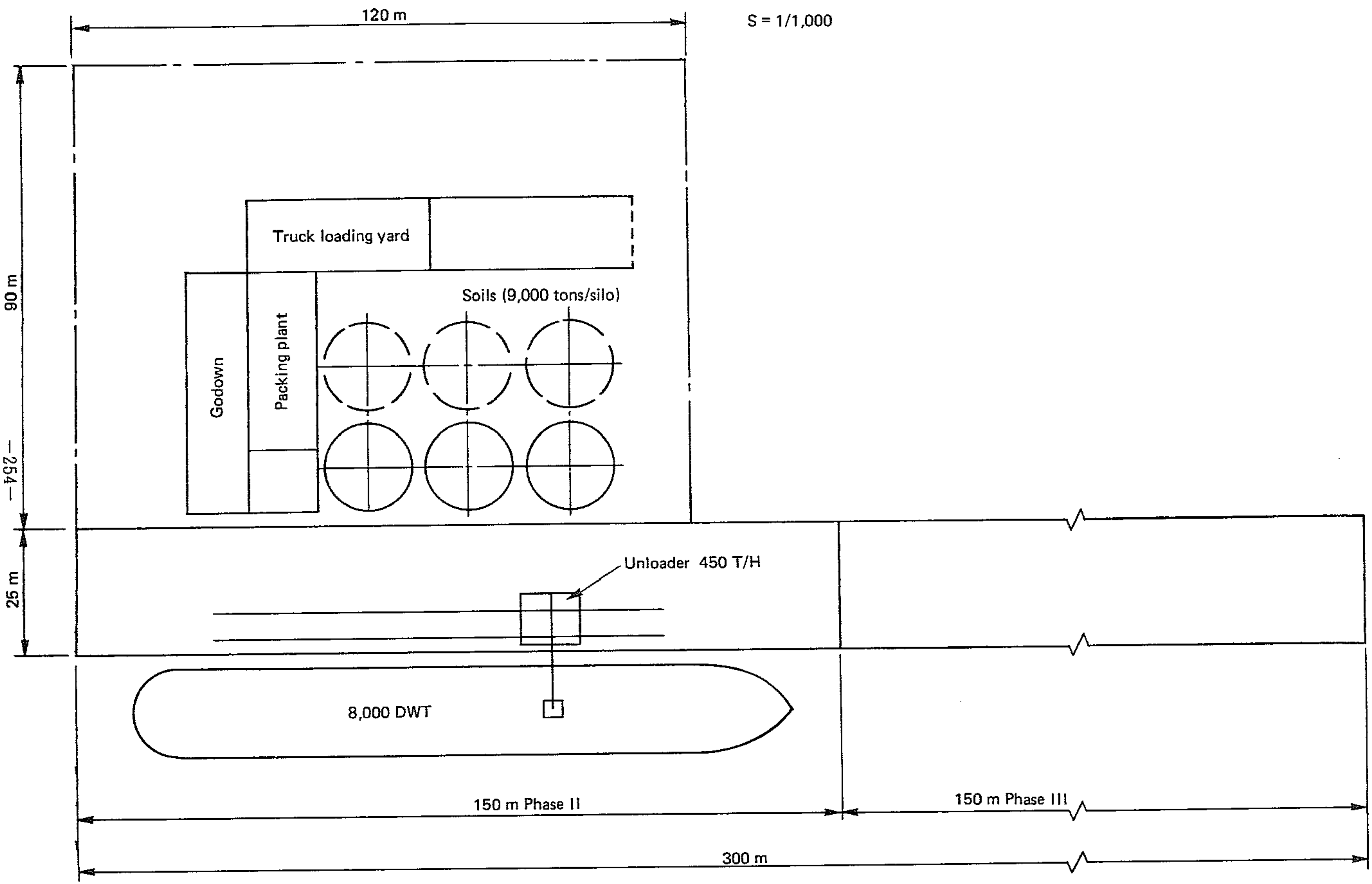


Fig. 4-6-8 Layout of Cement Terminal

4-6-6 Fertilizer Terminal

(1) Terminal Dimensions

The dimensions of the fertilizer terminal and other data related to the handling of fertilizer at Semarang Port are presented in Table 4-6-4.

Table 4-6-4 Fertilizer Terminal Dimensions and Related Data

Year	1995	2005
Annual Throughput	950,000 tons	1,240,000 tons
Vessel Size	10,000 DWT	10,000 DWT
Average Volume/Voyage	8,000 tons	8,000 tons
Port Calls/Year	119	155
Unloading Capacity	300 t/h	300 t/h x 2
Average Stay	1.9 days	0.9 days
Berth Occupancy Ratio	43%	45%
Berth Length	150 m	150 m
Storage Area	40,000 tons	50,000 tons

(2) Cargo Handling System

Bulk fertilizer is conveyed into the silos and then bagged and carried to end users by truck and rail. The handling system is shown in Figure 4-6-9.

(3) Terminal Layout

The layout of the fertilizer terminal is presented in Figure 4-6-10.

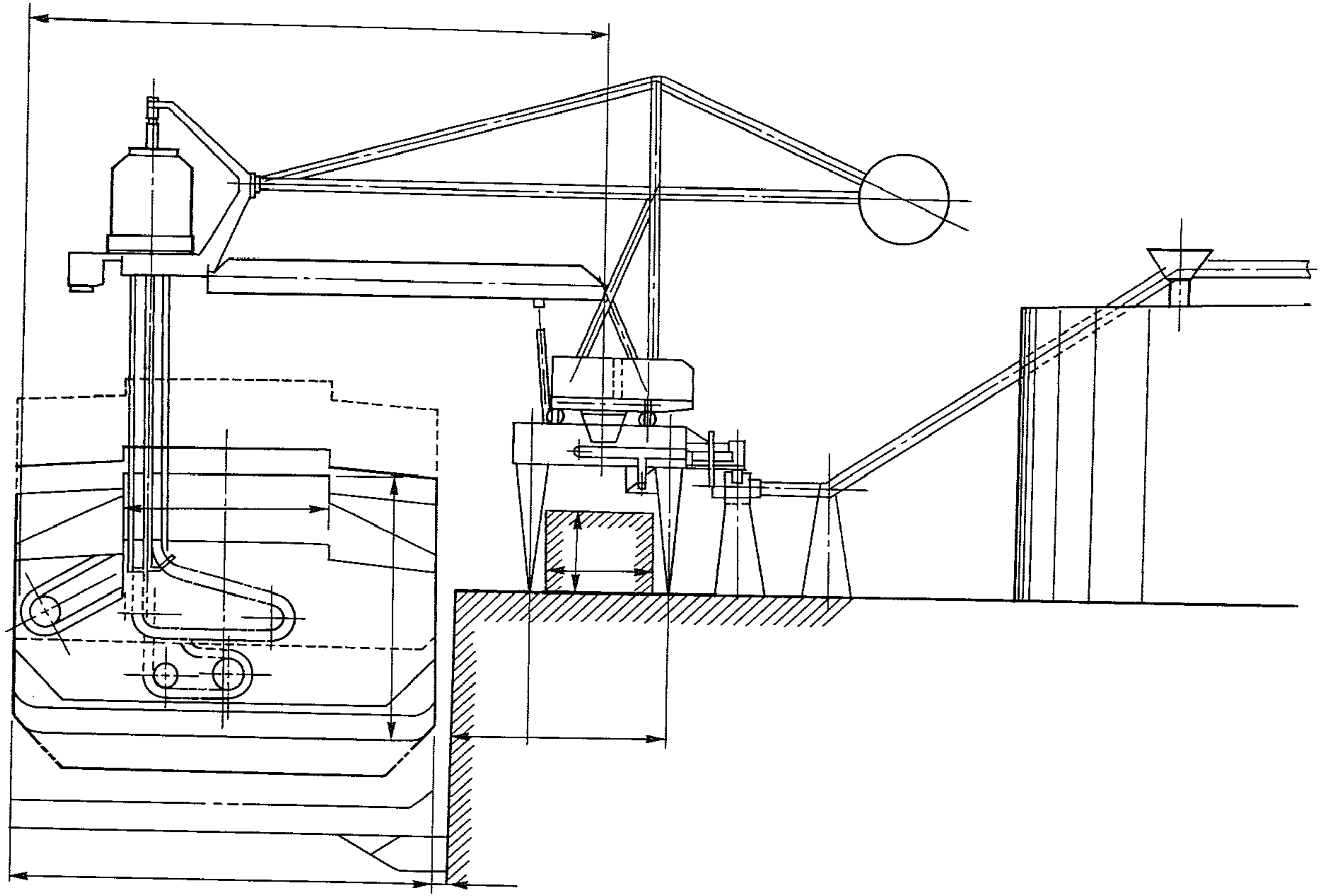


Fig. 4-6-9 Fertilizer Handling System

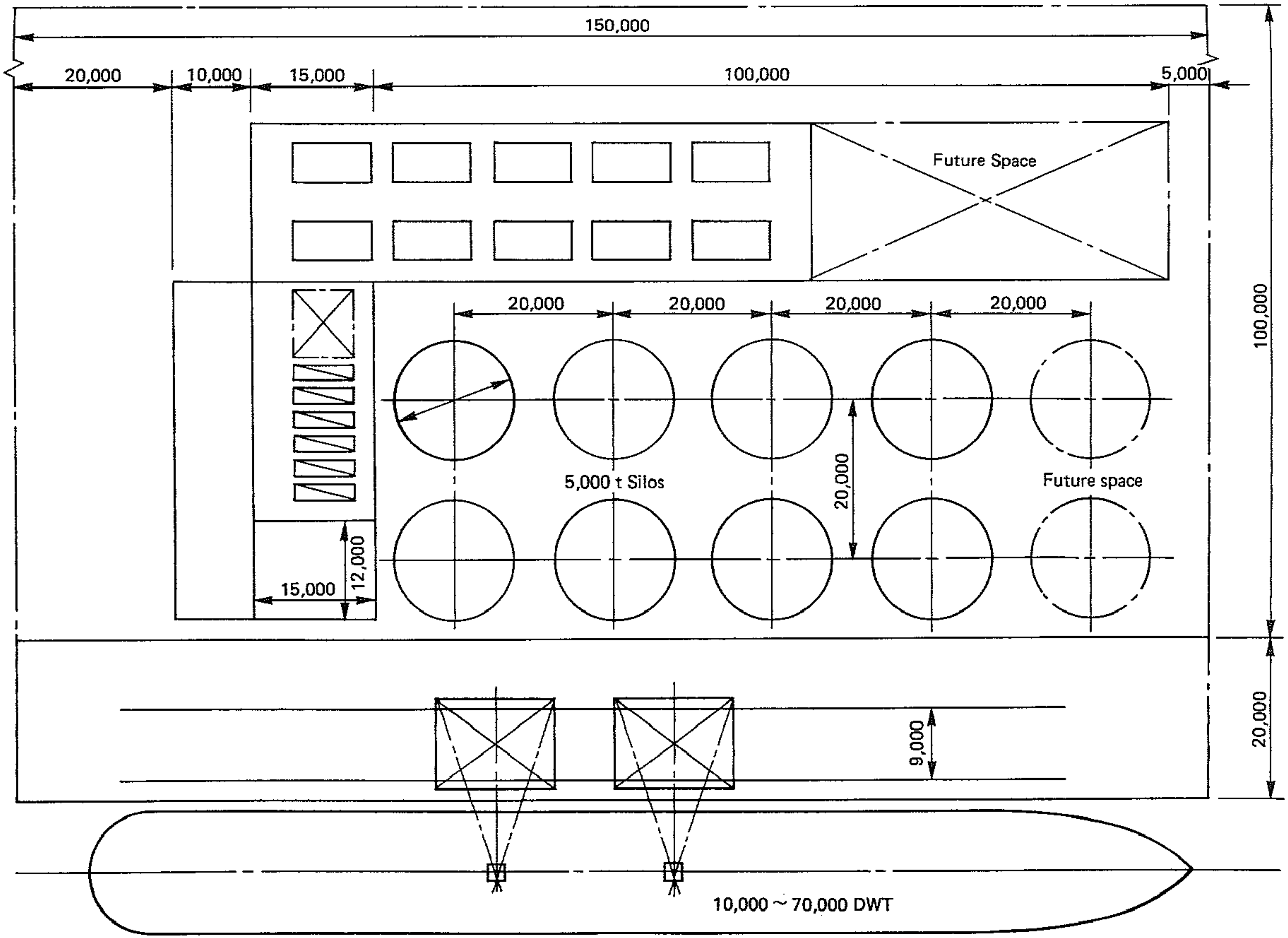


Fig. 4-6-10 Layout of Fertilizer Terminal

4-6-7 Grain Terminal

(1) Terminal Dimensions

The dimensions of the grain terminal and other data related to the handling of grain at Semarang Port are presented in Table 4-6-5.

Table 4-6-5 Grain Terminal Dimensions and Related Data

Year	1995	2005
Annual Throughput	316,000 tons	824,000 tons
Max. Vessel Size	30,000 DWT	30,000 DWT
Average Volume/Voyage	20,000 tons	20,000 tons
Port calls/year	16	42
Unloading Capacity	250 tons/h	250 tons/h x 2
Average Stay	5.7 days	2.8 days
Berth Occupancy Ratio	12%	33 %
Berth Length	220 m	220 m
Storage Area	Silos 7,150 m^2 Total 12,650 m^2	14,300 m^2 19,800 m^2

(2) Cargo Handling System and Silo Capacity

The terminal is designed to accommodate 20,000 DWT vessels. However, we must also consider that partially loaded vessels up to 30,000 DWT may sometimes use the facilities. The unloaded grain will be bagged behind the silo and then carried by truck and railway.

In general, the turnover of grain silos is 9 times per year. The planned scale of the silos is presented in Table 4-6-6.

As the cargo volume in 1995 is relatively small, the terminal may not be required in that year.

Table 4-6-6 Planned Scale of Grain Silos

Year	1995	2005
Main silos (1,100 tons per silo)	28 x 1,100 tons	64 x 1,100 tons
Sub silos (550 tons per silo)	18 x 550 tons	42 x 550 tons
Total Storage Capacity	40,700 tons	93,500 tons

(3) Terminal Layout

The layout of the grain terminal is presented in Figure 4-6-11.

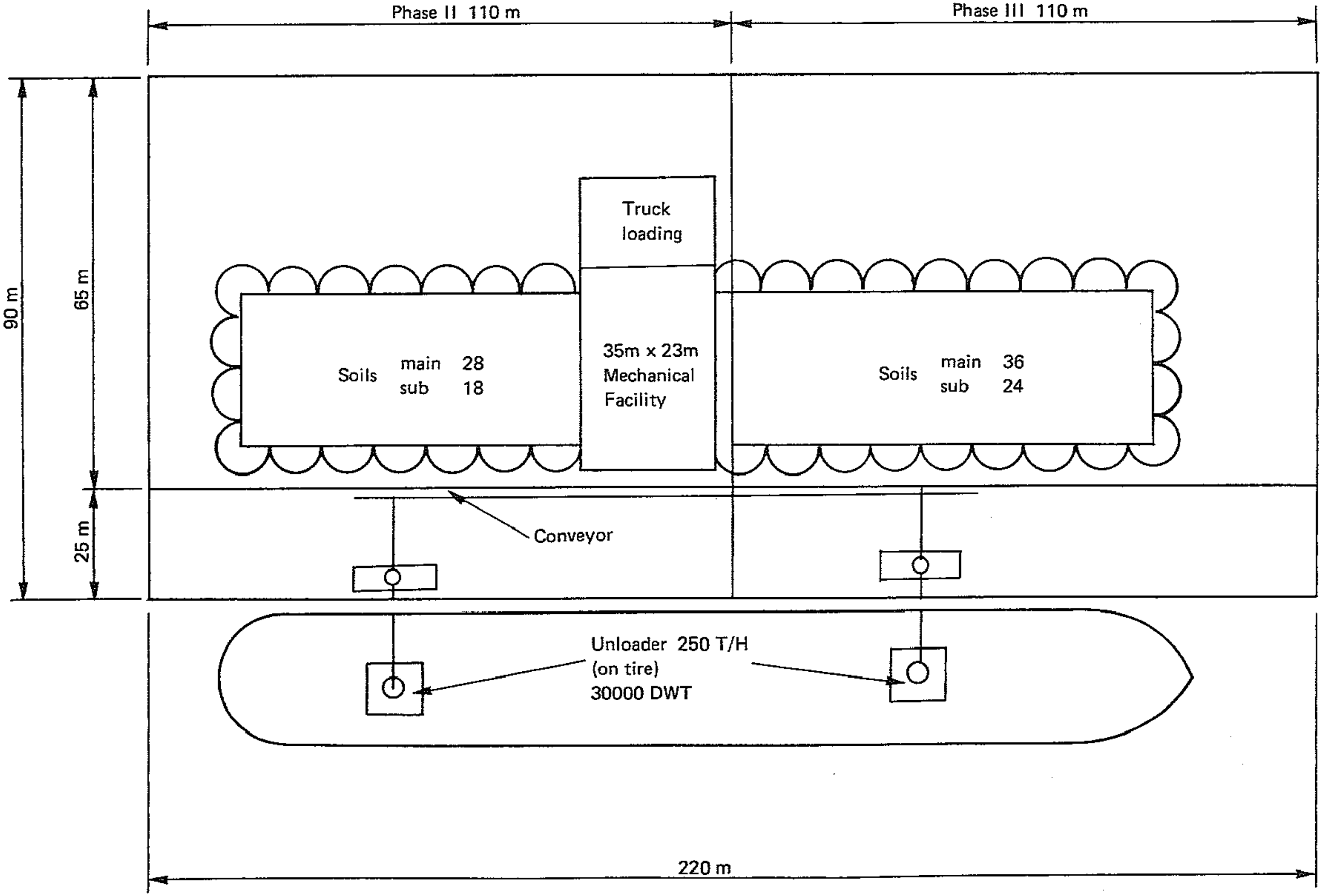


Fig. 4-6-11 Layout of Grain Terminal

4-6-8 Iron/Steel (Scrap) Terminal

(1) Terminal Dimensions

The dimensions of the scrap iron terminal and other data related to the handling of scrap iron at Semarang Port are presented in Table 4-6-7.

Table 4-6-7 Scrap Iron Terminal Dimensions and Related Data

Year	1995	2005
Annual Throughput	285,000 tons	650,000 tons
Vessel Size	5,000 DWT	5,000 DWT
Average Volume/Voyage	4,000 tons	4,000 tons
Port Calls/Year	71	163
Lifting Capacity	20 t x 2, cranes + Ship Gear 20(t)	20 t x 2, cranes + Ship Gear 20(t)
Average Stay	5.3 days	5.3 days
Berth Occupancy Ratio	51.5%	59%
Berth Length	2 berths 200 m	4 berths 400 m
Storage Area	4,300 t	4,300 t

(2) Cargo Handling System

Some of the unloaded scrap will be carried directly to the mills located in the industrial area behind the port. Other scrap cargo will be temporarily stored in the storage yard.

(3) Terminal Layout

The layout of the scrap terminal is presented in Figure 4-6-12.

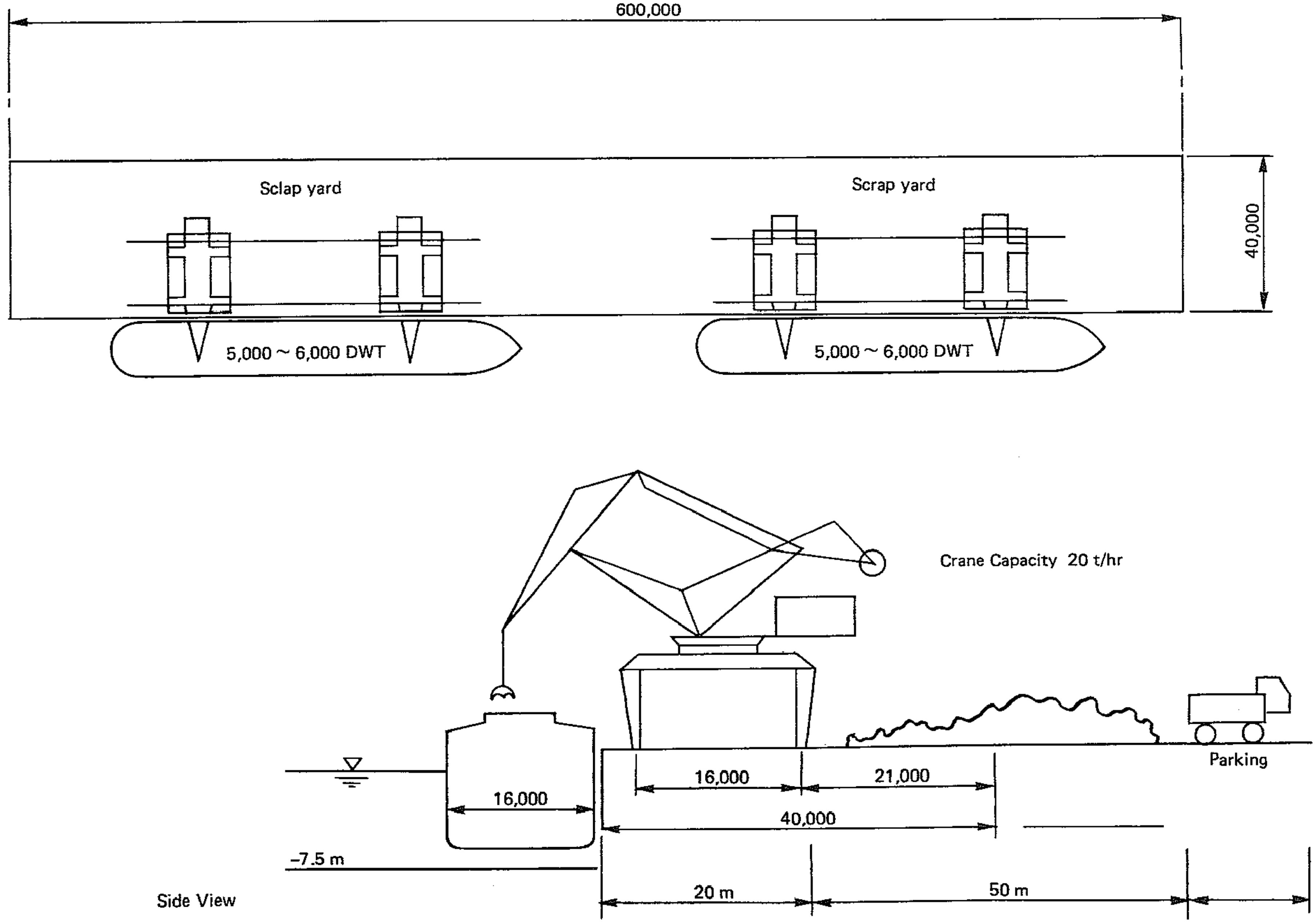


Fig. 4-6-12 Layout of Scrap Terminal

4-6-9 Passenger Terminal

(1) Required Quay Length

Since the new deep seaport was opened, large excursion boats and transmigration vessels which began operating in 1983 can now call at the port.

Assuming the frequency of calling of each vessel as shown in Table 4-6-8 and using the usual berth occupancy ratio, the required quay length for the passenger terminal is obtained in Table 4-6-9.

Table 4-6-8 Frequency of Calling and Productivity of Passenger Boats

DWT	Frequency per Week	Average No. of Passengers	LOA + Allowance	Productivity (Persons/day/m)
300	1	80	50	1.6
700	1	200	65	3.1
3,400	1	1,400	155	9.0
Average	1	1,680	270	6.2

Table 4-6-9 Required Quay Length of Passenger Terminal (Weekly Service)

	1983	1985	1990	1995	2000	2005	(Year)
Passenger Projection	12	19	48	69	103	143	(thousands)
Vessel Occupancy Ratio	14	22	55	79	*118	*164	(70)
Required Quay Length	1,930	3,050	7,714	11,100	16,600	23,000	*twice a week Meter-days
Required Length Occupied 52 days/year	37	59	148	214	319	443	m
Berth Occupancy 60%	9	14	35	51	76	105	m

From the table, we can see that small size vessels would not be efficient to cope with the demand in the 1990's.

If all passengers are carried by small vessels, the required quay length is obtained as follows.

Table 4-6-10 Required Quay Length Using Only Small Vessels (2 Vessels per Week)

	1983	1985	1990	1995	2000	2005
(52 week) (Occupancy)	95	150	380	540	810	1,130 (m)

On the other hand, introducing two large vessels per week, the required quay length is obtained as follows.

Table 4-6-11 Required Quay Length Using Large Vessels

	1983	1985	1990	1995	2000	2005
(52 weeks (Occupancy)	13	20	50	70	110	150 m

Based on the above tables, we note the following points:

1) As the demand is not so large, a fully equipped passenger terminal is not necessary for the time being.

2) Even if all the passengers were carried by large passenger boats, the occupied quay length would still be very small.

(In case of a berth occupancy rate of 60%, the required length is 1990 would only be 25 m).

3) The passenger terminal should be designed as a multi-purpose teminal to save cost.

(2) Terminal Dimensions for 2005

The dimensions of the terminal are presented in Table 4-6-12.

Table 4-6-12 Dimensions of the Passenger Terminal

Wharf Length	200m
Apron Width	15m
Terminal Width	120m
Depth	6.5m

(3) Terminal Layout

The passenger terminal will be located behind the government office area. There will be good public transport service to and from the terminal. The maximum size of the passenger boats which will call at the terminal will be 3,000 GRT. The terminal is designed to accommodate 3,000 persons and also to handle cargoes.

Although the detailed design of the terminal must be considered after further investigation, a proposed terminal layout is presented as Figure 4-6-13. The terminal at Semarang is atypical in that the peak fluctuation is remarkably high. Thus temporary facilities such as large tents may be appropriate.

This terminal can also be used to handle conventional cargo for 167 days per year (170 thousand tons/year). Thus the cargo handling capacity of the terminal is equivalent to two 5.5 m berths.

(4) Temporary Passenger Terminal in 1990

According to our forecast, a fully equipped passenger terminal will not be necessary for the time being.

Nonetheless, a facility for oceangoing sightseeing vessels and transmigration vessels is required. So the Study Team would like to recommend preparation of a temporary passenger terminal at the Coastal Harbour.

The proposed site for the terminal is the southern part of the Coastal Harbour, which is 7.5 m in depth. The southern part of the Coastal Harbour can thus be used as a multi-purpose terminal for both cargo and passengers.

Considering a multipurpose terminal at 60% occupancy, 50 ~ 70 m equivalent in additional quay length is required.

The passenger terminal building, the bus terminal and a parking lot should be prepared behind the quaywall. These locations are shown in Fig. 4-6-14.

In order to obtain the space behind the quaywall, some part of the adjacent transit shed should be remodeled or demolished for the passenger terminal building. Furthermore, the parking space for automobiles should be located on the opposite side of the main road: this space would be available not only for terminal traffic but also for staffs and visitors to the government area.

The passenger terminal would include a cantenn and rest rooms.

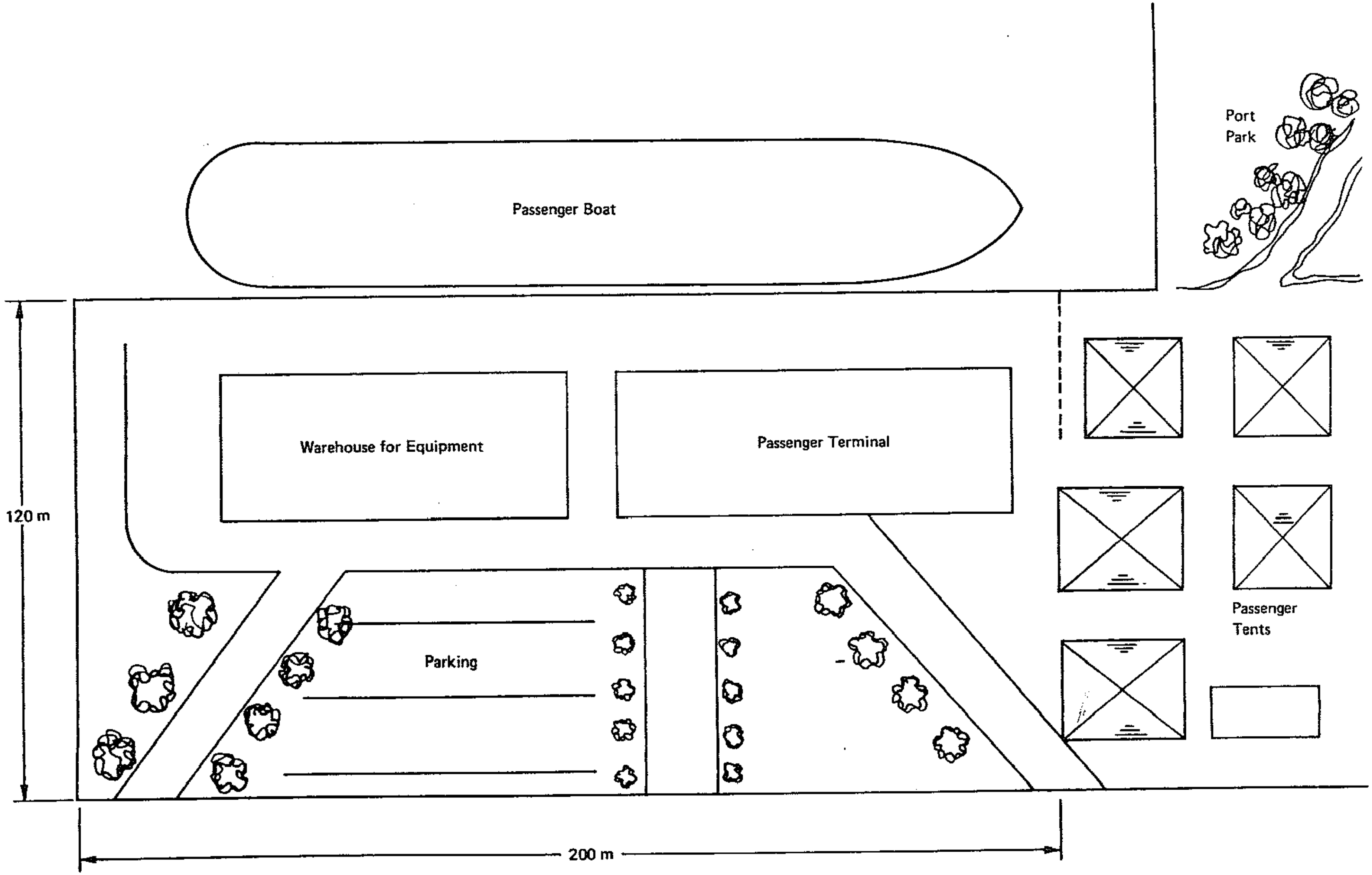


Fig. 4-6-13 Layout of Passenger Terminal

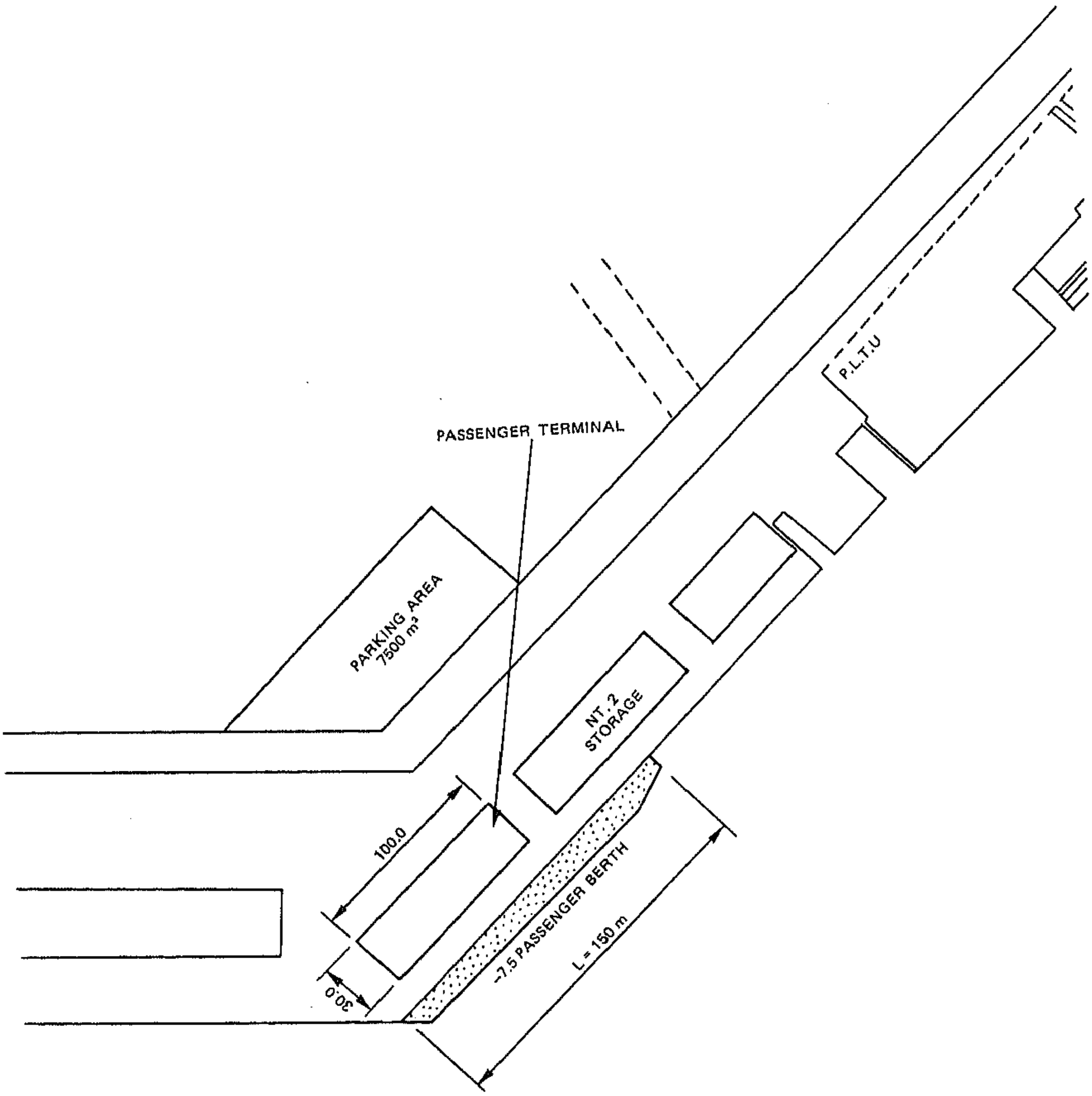


Fig. 4-6-14 Location of Temporary Passenger Terminal

4-6-10 Demolition and Construction of the West Breakwater

The existing West Breakwater is no longer useful as the foundation has broken down and the structure has settled. The Study Team proposes to rehabilitate this structure, as follows.

The north half of the breakwater should be demolished and a new breakwater constructed. Economically, it seems better to construct a new breakwater than to try and renovate this section of the old breakwater. Renovating the breakwater might prove expensive. A new breakwater would better protect the port.

The south half of the West Breakwater should be used as a revetment, that is, a retaining wall for the reclaimed land that will be used as an industrial area.

The layout of the proposed West Breakwater project is presented in Figure 4-6-15.

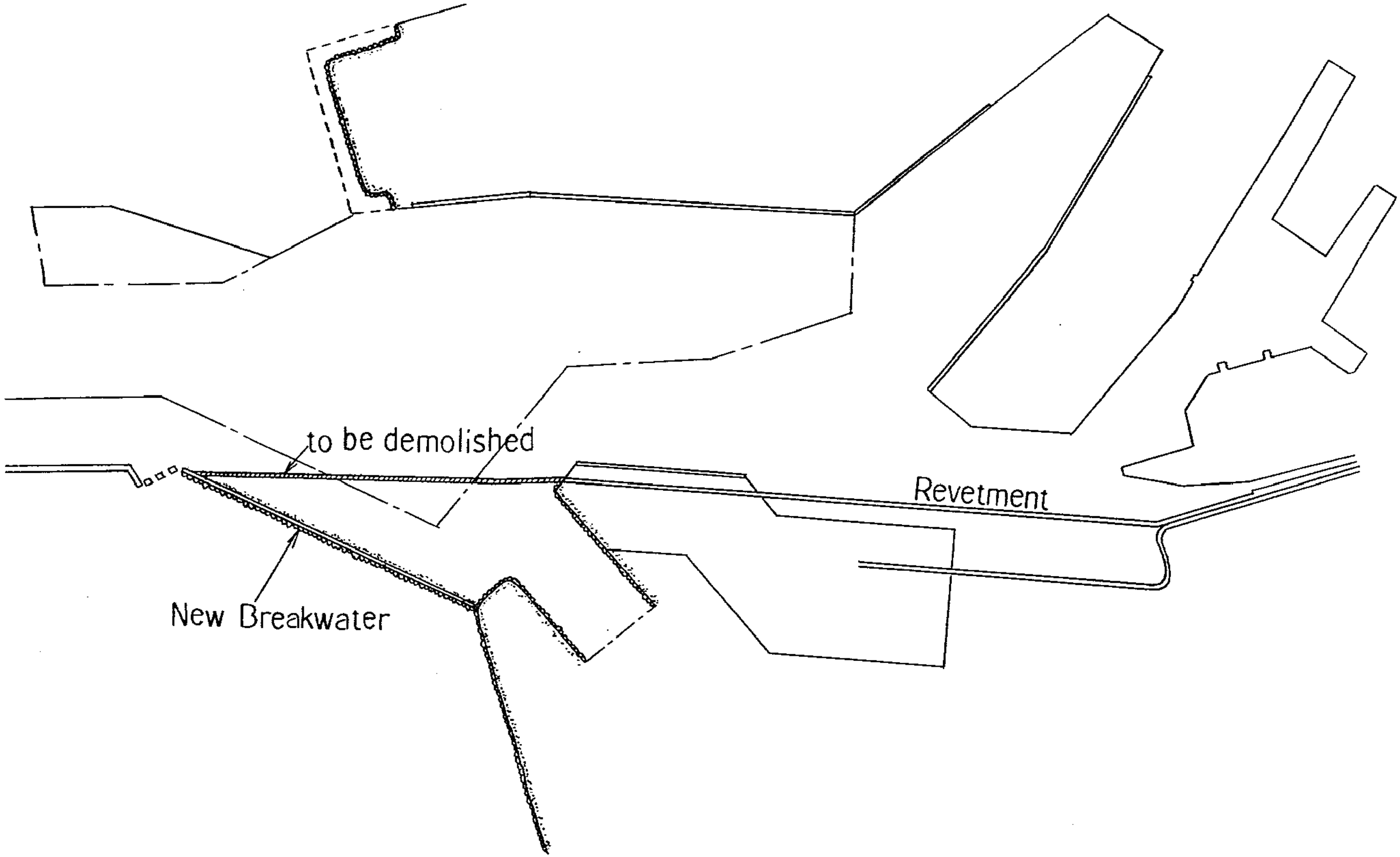


Fig. 4-6-15 Proposed West Breakwater Project

4-7 Prerequisite Works and Planning Constraints

There are various works which must be carried out before the overall Phase II construction can begin. Specifically, existing pipelines must be removed and Pertamina's bunker terminal, the fishermen's housing, the West Banjir Canal and PLTU's waterway must all be relocated.

Furthermore, environmental problems associated with handling coal and the level of calmness in the harbor also limit the planning process.

The prerequisite works and planning constraints are considered below.

4-7-1 Removal of Existing Pipelines

There are currently three pipelines in the port area which carry petroleum products: one for Pertamina and two for PLTU's power plant. All three pipelines cross the eastern part of the access channel and must be removed before the Phase II works are carried out.

Whether these pipelines should be relocated or simply submerged at a greater depth at the same site is a purely technical matter. At any rate, the pipelines cannot remain at their current locations.

The removal of these pipelines must be discussed in detail with the relevant organizations at the earliest possible opportunity before the engineering work begins. It is important to complete the pipeline works as soon as possible in order to proceed with the other construction works.

4-7-2 Relocation of Pertamina's Bunker Terminal

As the port development project proceeds, demand for bunker fuel at the port will greatly increase. To meet this increased demand, Pertamina is planning to bring oil into the port utilizing 10,000 ~ 30,000 DWT class tankers. However, the current bunker terminal located in the Inner Harbour cannot accommodate such large vessels as the existing berths are only 3 ~ 4 meters deep.

Considering the current structural conditions of the existing terminal and the overall port plan, it would be preferable to construct a new facility, and to locate the new facility on the west side of the main access channel. The proposed relocation of the facilities is shown in Figure 4-7-1.

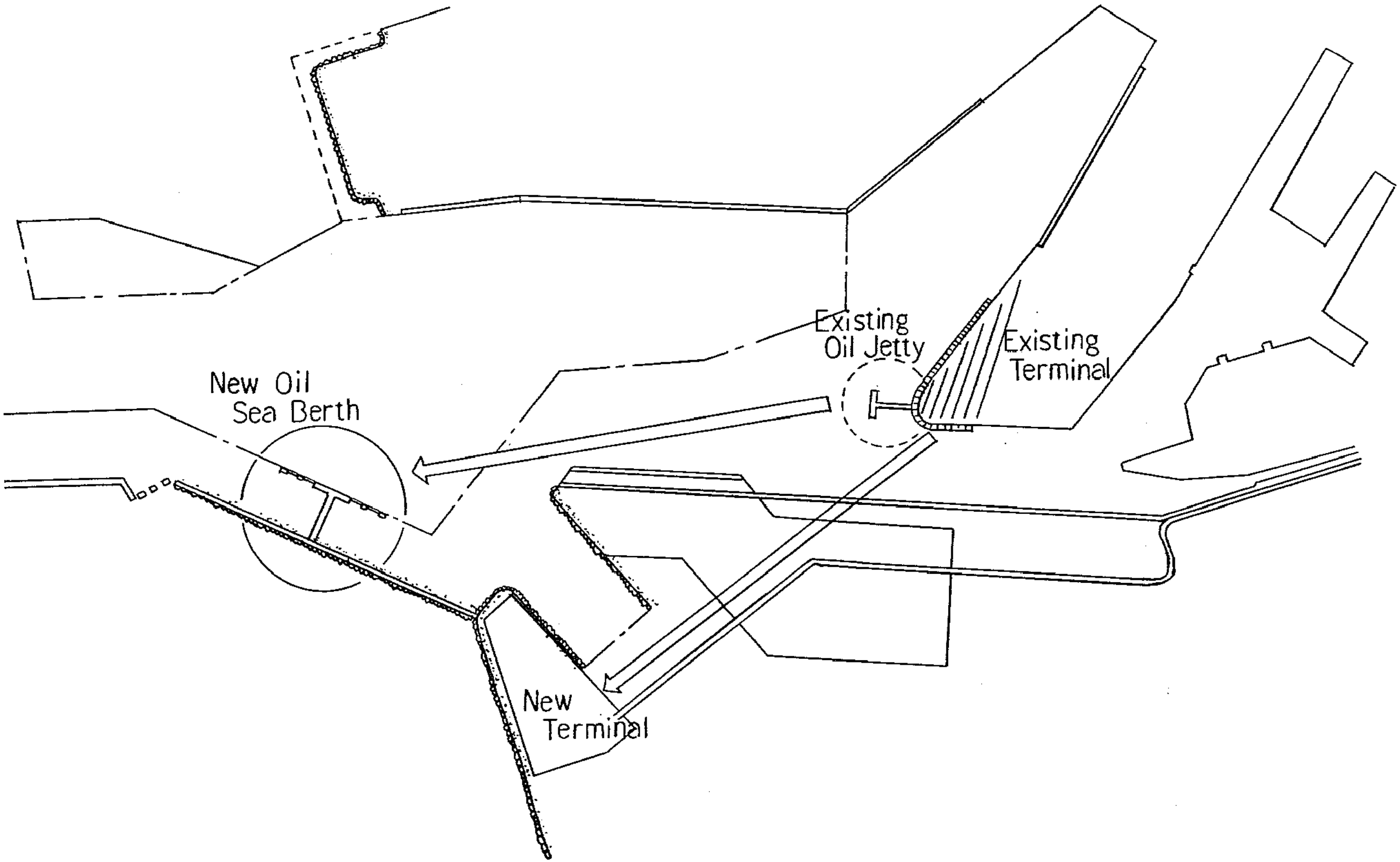


Fig. 4-7-1 Relocation of Oil Jetty Terminal

4-7-3 Relocation of the Fishermen's Housing

As a prerequisite to the Phase II construction works, the fishermen's housing located along the Banjir Canal must be removed.

Although these fishermen are technically squatters and may have no legal right to the land, an alternative housing site for the fishermen should be provided. Thus, we propose that the area behind the earth bank of the relocated canal be used for this purpose.

A variety of agencies including ADAPEL, DGSC, and the municipal government are all concerned with this issue, and the proposed plan should be discussed with all the parties concerned including the fishermen before the housing is destroyed.

The proposed relocation of the housing is presented in Figure 4-7-2. This relocation is a sensitive local political issue, and the Study Team is not in a position to comment on the relocation in detail. However, the Study Team would like to make the following recommendations:

- Using materials from the dredging works, the ground level at the site should be raised.

- Using waste materials from the development project, a few small fishery wharves should be constructed along the new canal.

- When the construction works begin, the branch office should employ these fishermen, who are the local residents of the port itself, as labourers on a preferential basis.

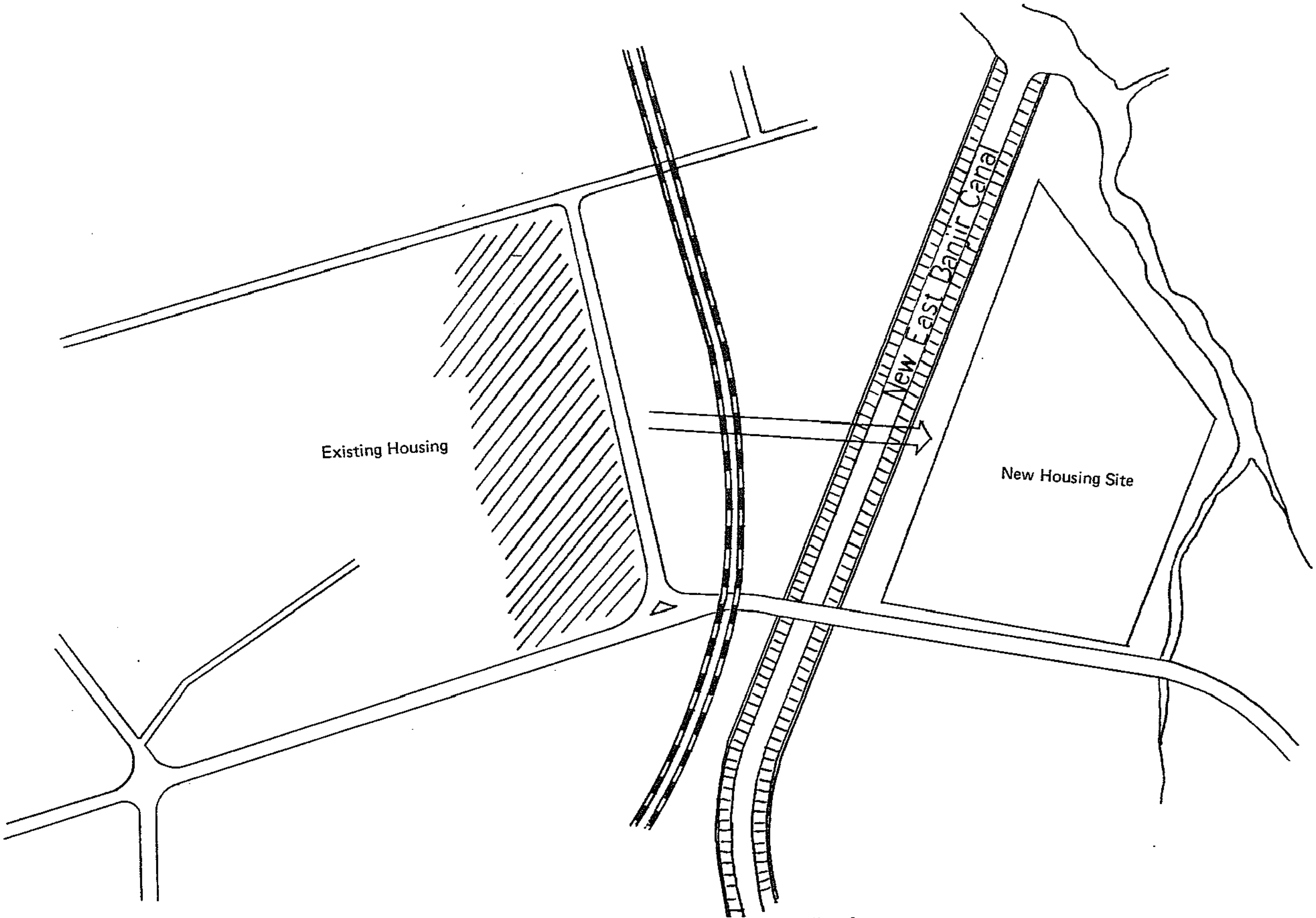


Fig. 4-7-2 Relocation of Fishermen's Housing

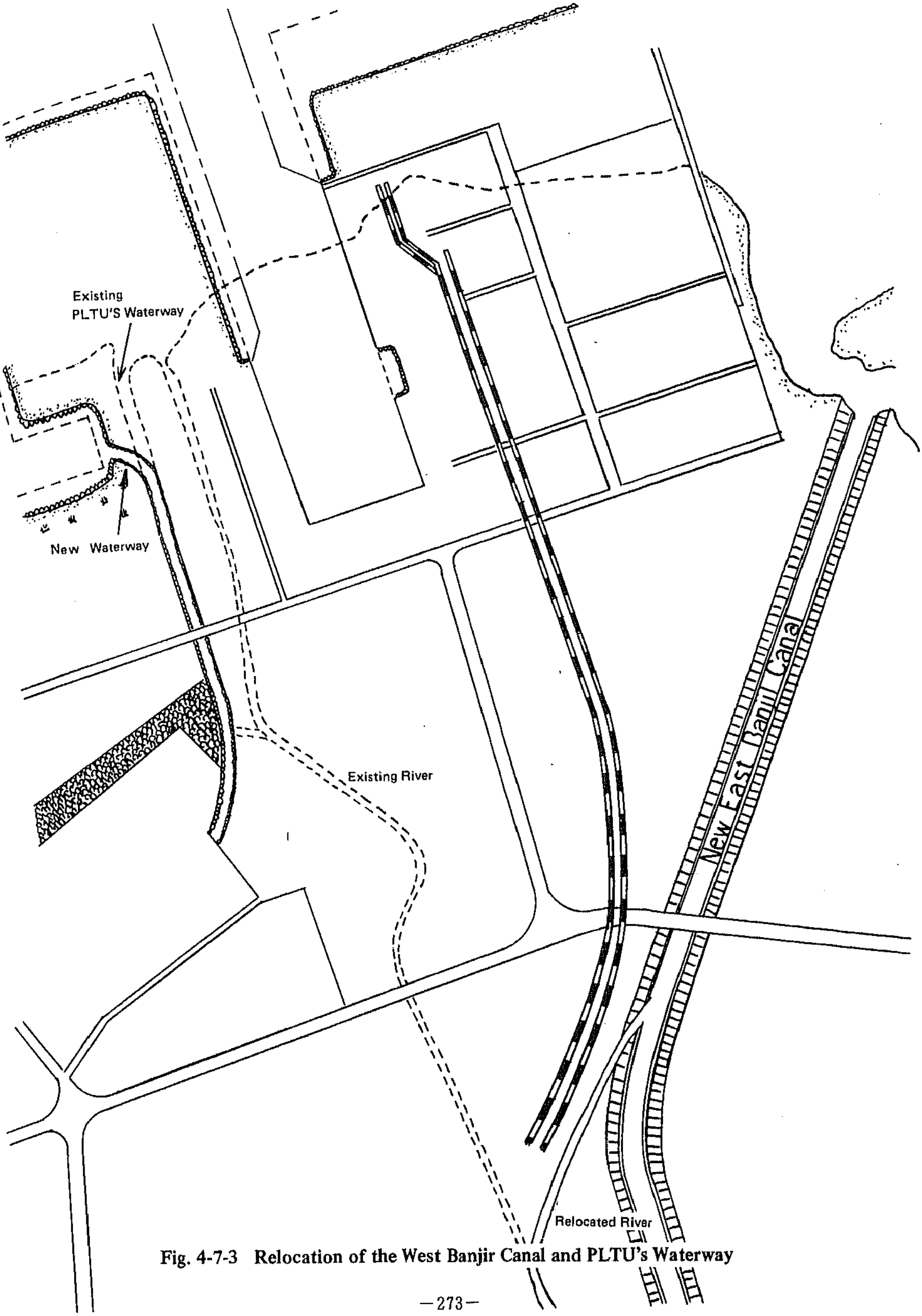


Fig. 4-7-3 Relocation of the West Banjir Canal and PLTU's Waterway

4-7-4 Relocation of the West Banjir Canal and PLTU's Waterway

Before the construction work begins, the West Banjir Canal and PLTU's waterway must be relocated. The relocation plans are presented as Figure 4-7-3.

4-7-5 Environmental Problems at the Coal Terminal

There are various environmental problems associated with the handling of coal. Coal dust tends to scatter, and the coal and dust may create a fire hazard. There are also environmental problems associated with the burning of coal. Pollutants such as sulfer oxides and nitrogen oxides are released into the atmosphere, and the treatment of odours and residual ash is problematic. The problems, in the port, however, are only dust and fire hazard.

By applying state of the art anti-pollution technology including various mechanical, electrical and chemical devices, these problems can be minimized. The coal terminal is designed and located in such a way as to minimize the fire hazard and the dust problem.

4-7-6 Calmness in the Harbour

The relation between berth productivity and wave height is a crucial factor in planning facilities and operating systems for ports. Container vessels and small ships such as local vessels and rakyat are especially limited by wave conditions.

In Japan, container cargo handling operations generally stop when wind velocity is over 15 m/s and the height of waves which strikes moored vessels broadside is more than 0.5 m. Applying similar criteria to Semarang Port, the Study Team tried to predict the number of days when such handling operations will have to be stopped due to inclement weather. Although the empirical data is not sufficient for an exact study, the team analyzed the situation based on a simple wave penetration analysis.

Based on the SPJV wave observation survey, the frequency of occurrence of different incident wave heights in the northwest moonsoon season is shown in Table 2-28. Waves over one meter in height at the top of the breakwater occur 12.1 percent of the time during this season.

The most critical Wave direction affecting calmness in the harbour is from NW to NE. Based on eye observation data, it seems that such north waves occur 72 percent of the time during the northwest monsoon season.

So, the frequency of incident waves over one meter in height coming from the NW to NE during the northwest monsoon season is 0.12 x 0.72, or roughly 9 percent. The number of days such waves occur is 137 days (the length of the northwest monsoon season) x 0.09, or approximately 12 days.

The calmness within the harbour was estimated using a computer model which simulated irregular wave disturbance phenomena. Three simulations were conducted for three different incident wave directions: N35°W, N2°W and N25°30'E. The results of these simulations are shown in Figures 4-7-4, 4-7-5 and 4-7-6, respectively.

From the figures we can see that when the incident wave height is over one meter, the height of waves which strike moored vessels broadside is between 40 and 60 centimeters.

Based on the empirical data and our simple calculations, our conclusions are as follows:

(1) When waves which are about 50 centimeters or higher strike the pierhead at a right angle, container handling between container vessels and the berths using a container crane may be impossible.

The height of the waves which strike the berths of the old port in the Inner Harbour which face the ocean is also critical. When the incident waves at the top of the breakwater are around one meter in height (and the waves striking the container terminal are about 50 cm), the waves striking these berths in the Inner Harbour may be 30 or 40 cm high. As the vessels which use these berths are relatively small boats such as rakyat and local vessels, waves of this height will affect the cargo handling. Incidentally, this section of the old port will be rehabilitated as part of the overall port development plan.

(2) Assuming that container handling between container vessels and the berths will only be discontinued due to inclement weather during the northwest monsoon season, the number of days such handling will be impossible is approximately 12 days per year.

These conclusions are based on data from short-term wave observations; therefore, they are only tentative conclusions. If the container terminal is to be located as recommended in the port plan, further investigations concerning the wave height must be carried out.

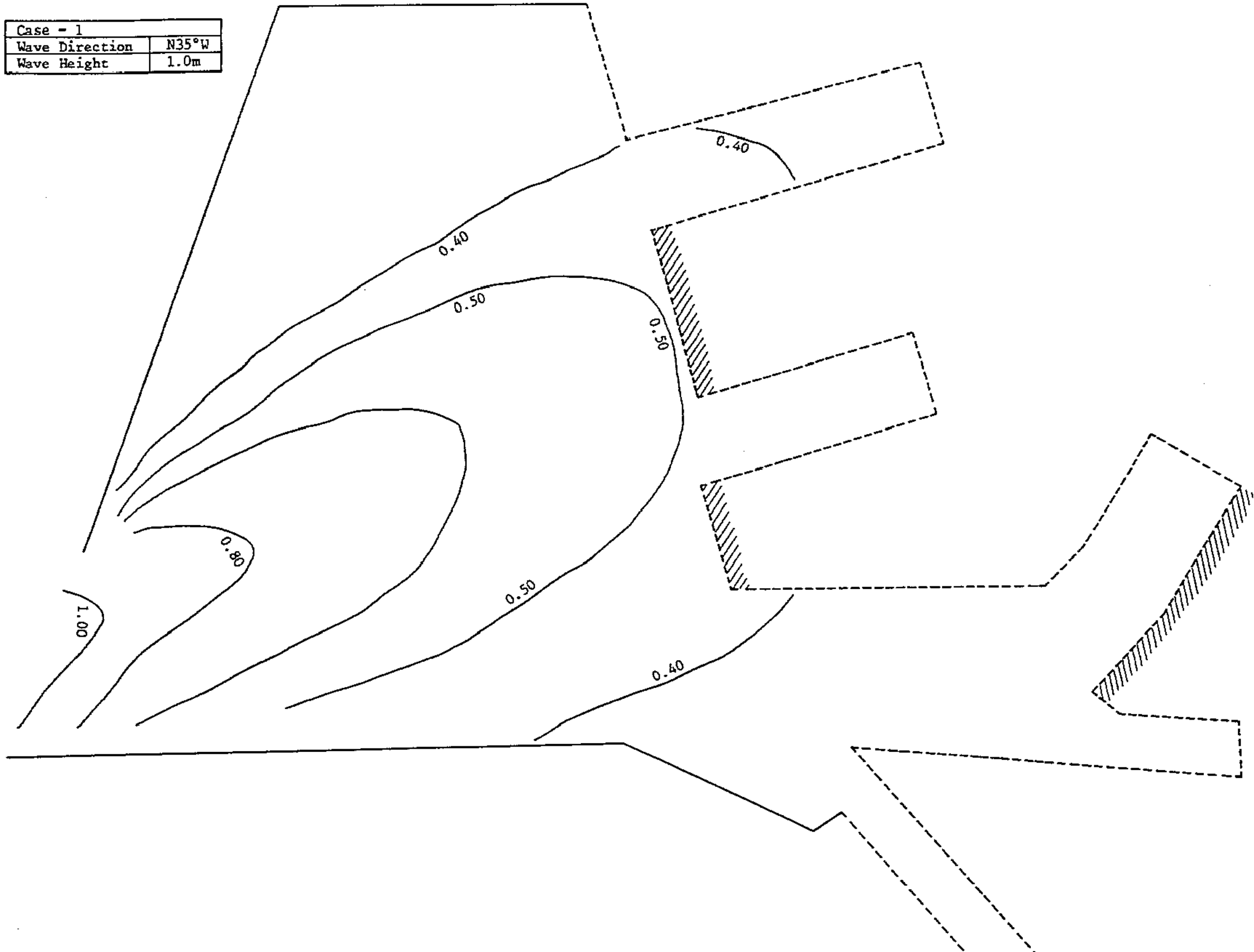


Fig. 4-7-4 Wave Disturbance (N35°W)

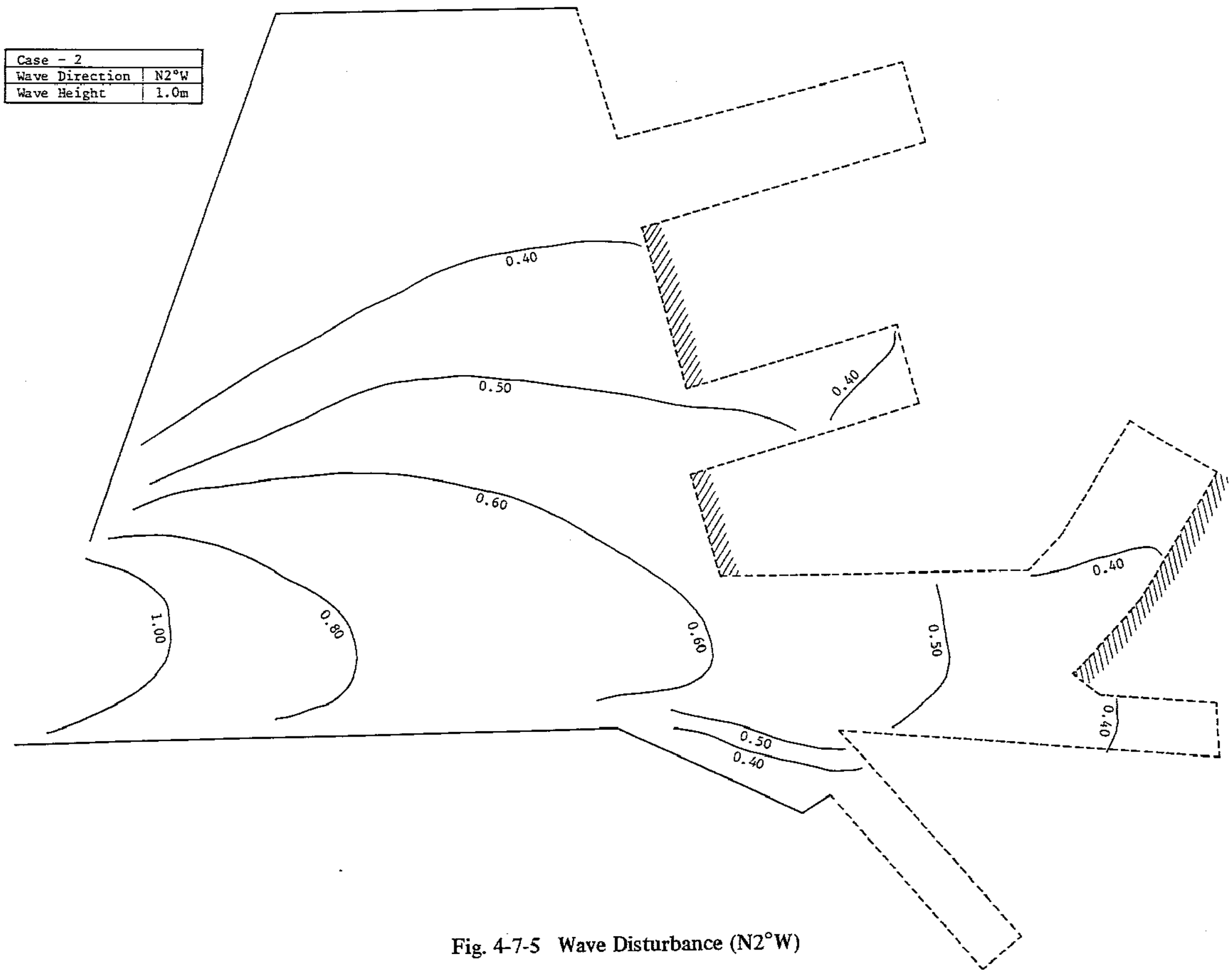


Fig. 4-7-5 Wave Disturbance (N2°W)

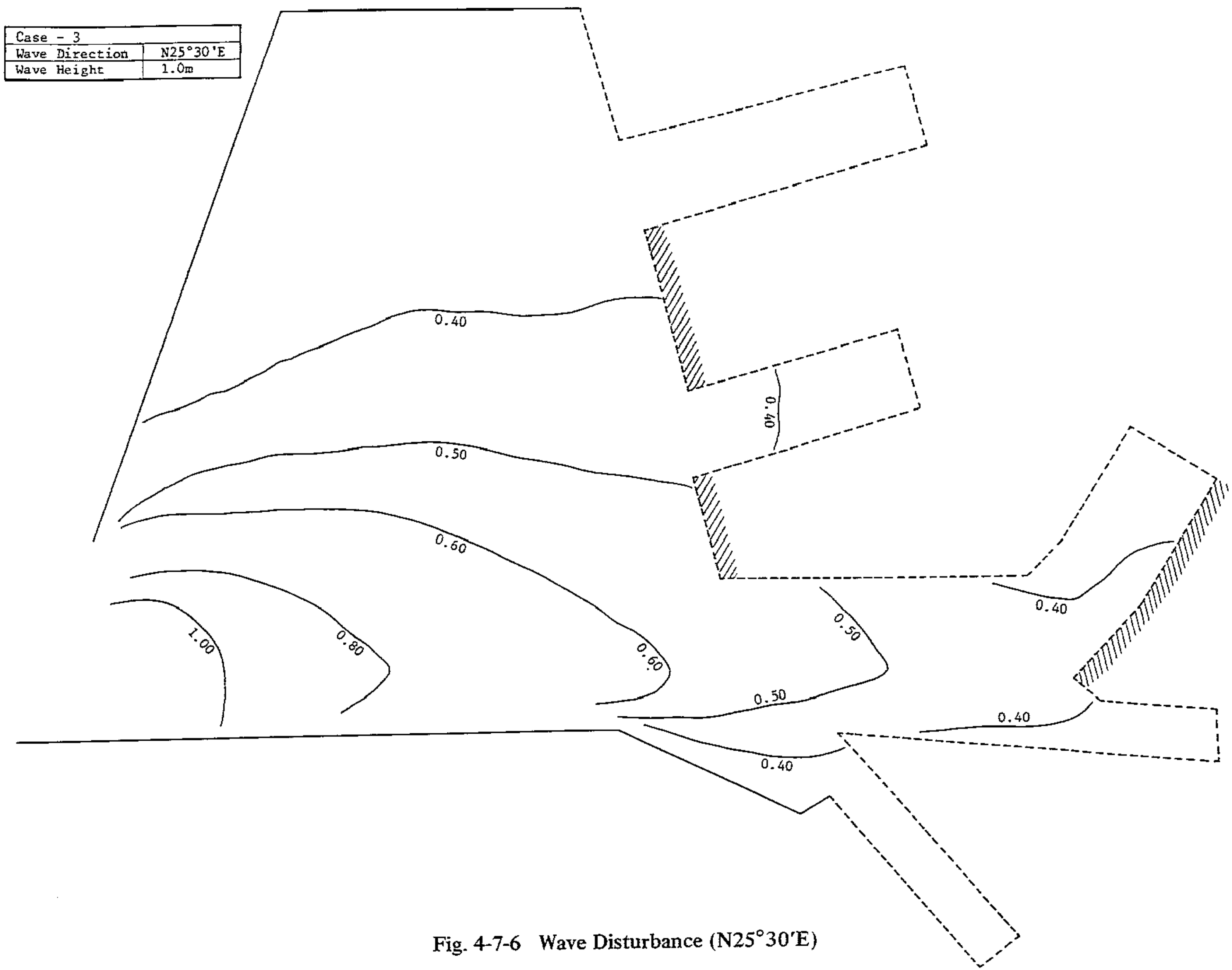


Fig. 4-7-6 Wave Disturbance (N25°30'E)

4-8 Land Use and Overall Layout

4-8-1 Land Use Plan

The land use in 1995 and 2005 is classified as shown in Table 4-8-1.

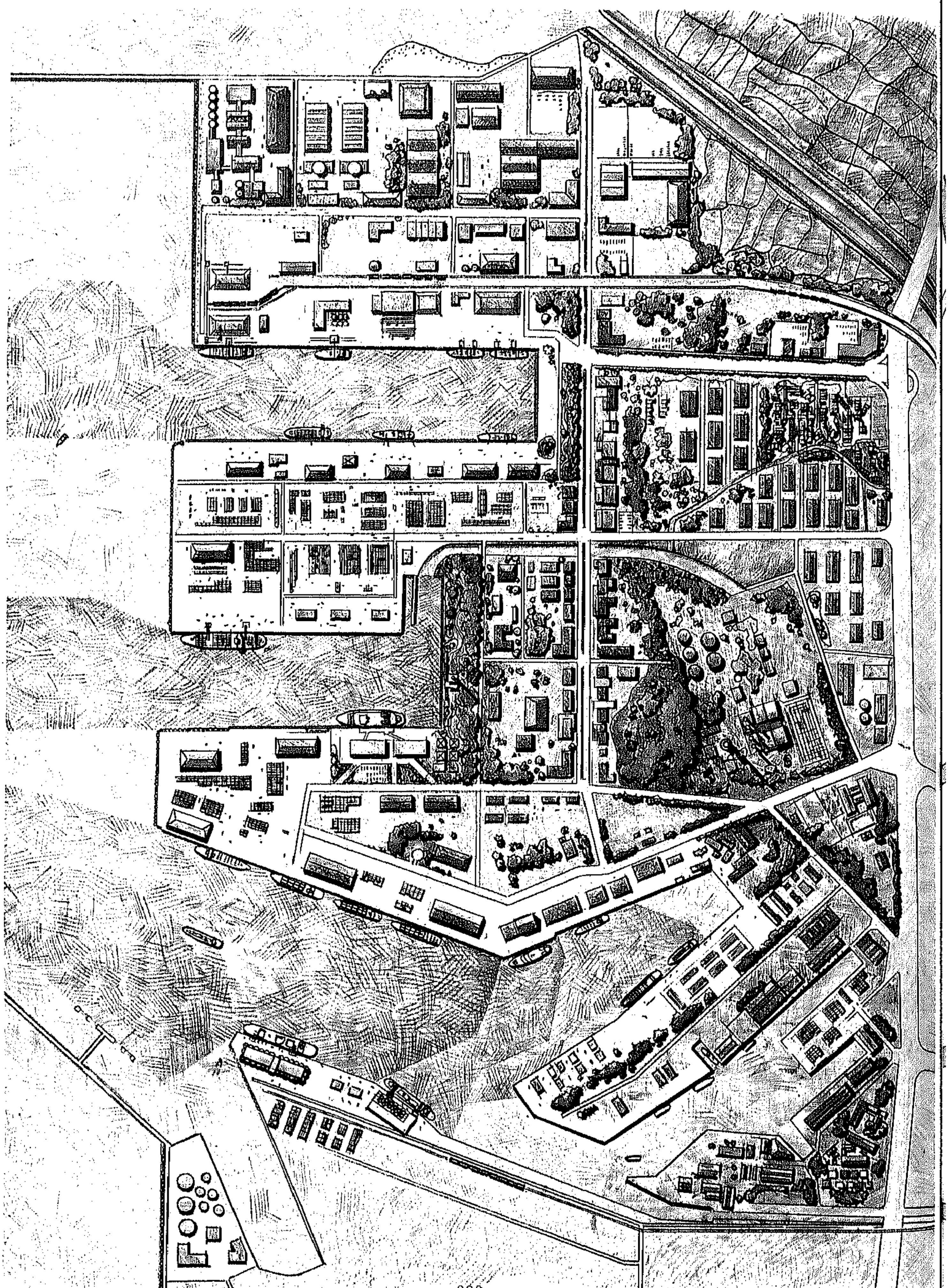
Table 4-8-1 Land Use

Unit: ha

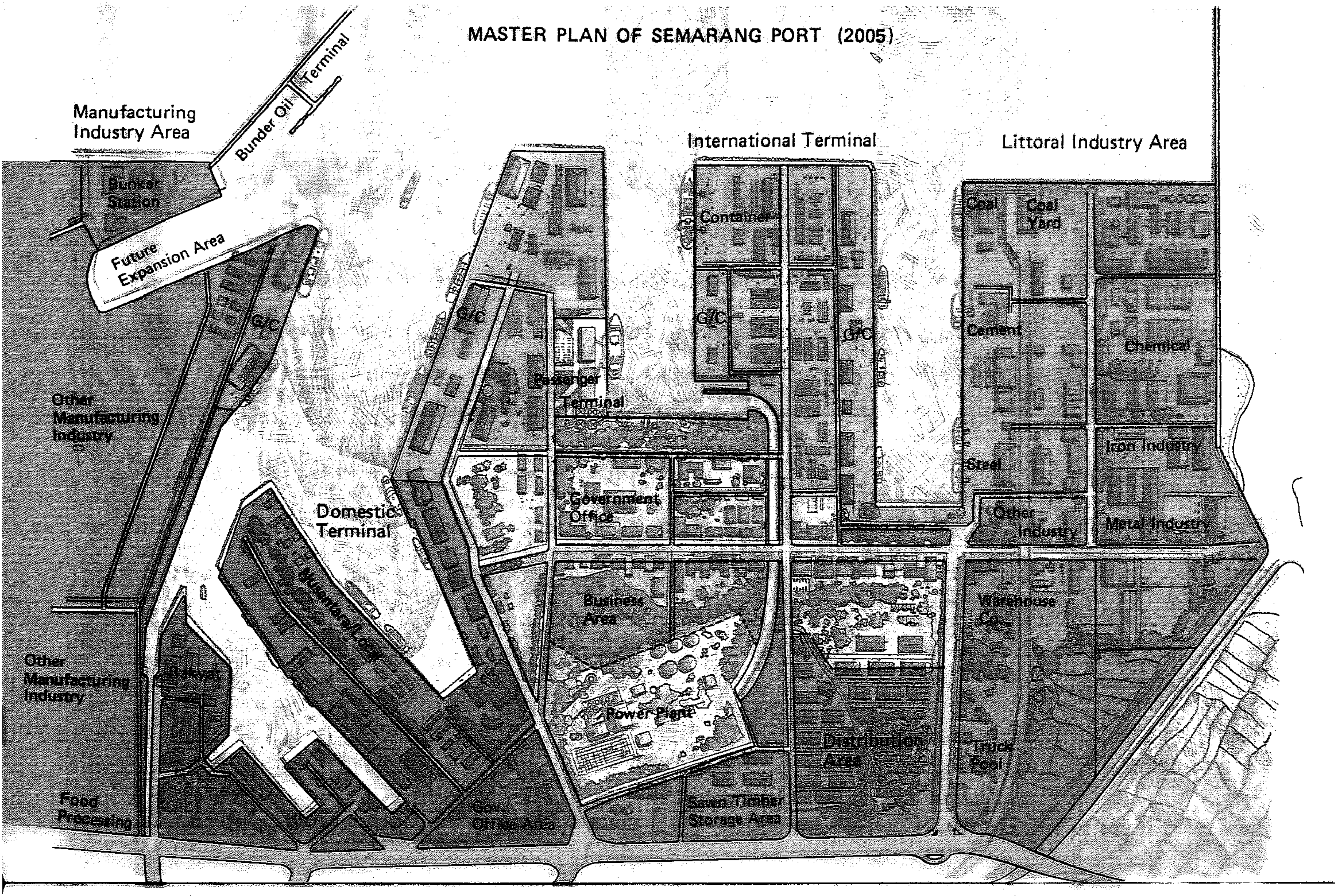
Zone \ Year	1995	2005	Remarks
International Terminal	27.4	57.2	General cargo, containers,
Government Area	15.8	26.6	Government office, quarantine
Business Area	29.5	37.6	Shipping agents, trucking agents
Distribution Area	23.6	55.4	Vanpool & car parking, open storage
Domestic Terminal	64.8	64.8	Nusantara, Khusus, Rakyat
Industry	95.3	272.3	
West	42.3	169.1	Shipping, food, automobiles, etc.
East	53.0	73.2	Heavy industry,chemicals,coal,cement
New Road	9.6	50.4	
New Rail	4.0	4.0	
Total	323.0	538.3	

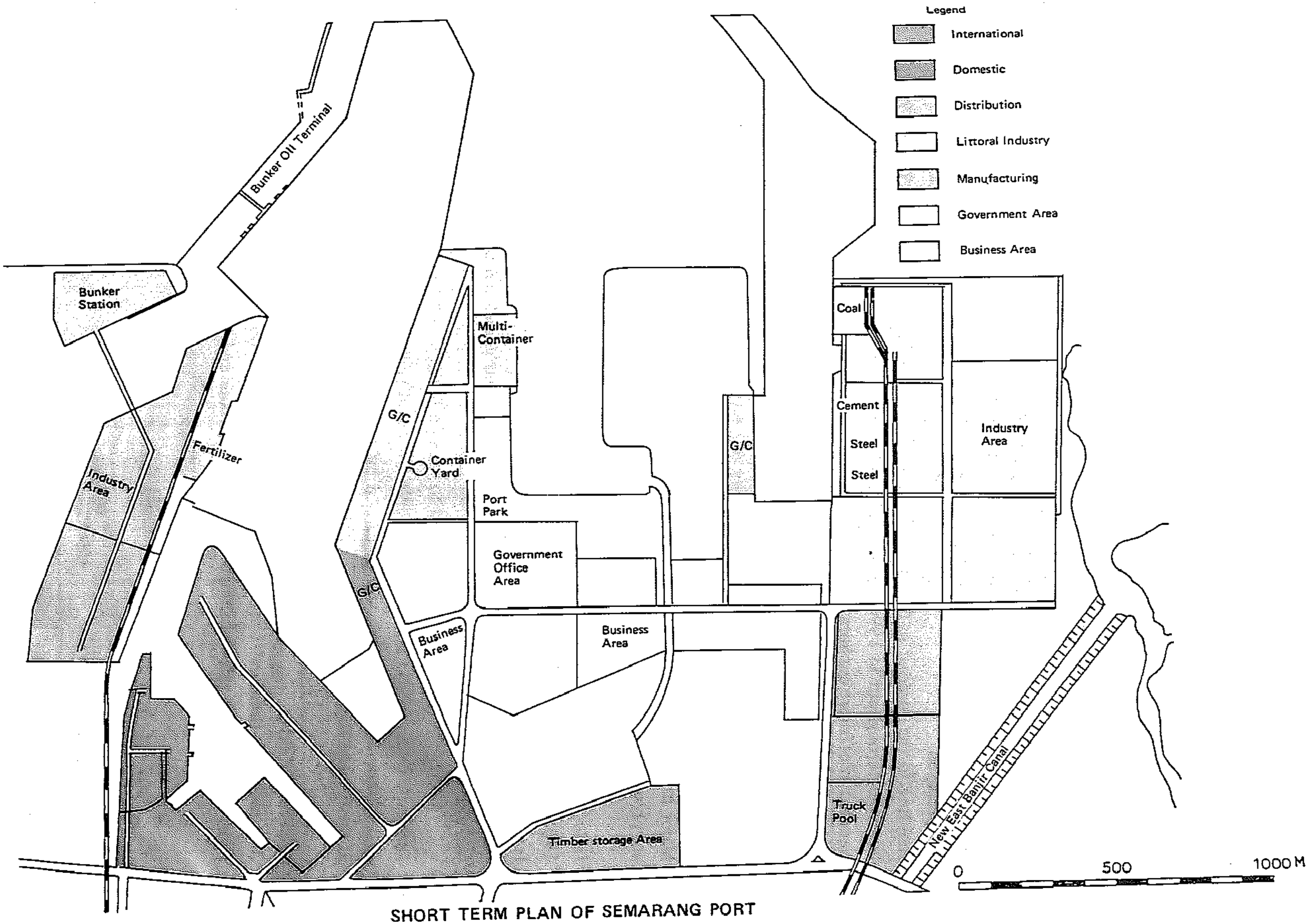
4-8-2 Overall Layout

The Master Plan for 2005 and the Short-term Development Plan for 1995 are presented in Figs. 4-8-1 and 4-8-2, respectively.



MASTER PLAN OF SEMARANG PORT (2005)





SHORT TERM PLAN OF SEMARANG PORT

4-9 Urgent Development Plan

4-9-1 Necessity of an Urgent Plan

An urgent development plan toward 1990 was prepared at the request of the Indonesian Government to cope with the new demand for industrialization and economic development. That is to say, since the completion of the Phase I project, many industries wish to acquire new sites behind the port; sawn timber, fertilizer, chemical and coal industries are major clients.

Especially, a coal terminal would be in line with the Government policy which is aiming at the replacement of petroleum with coal as an energy resource.

Furthermore, the international terminal which was constructed in 1985 is already fully occupied, so in order to cope with the demand for the time being, some additional facilities will have to be prepared.

According to the forecast in Chapter 3, cargo demand is estimated as shown in Table 4-9-1. The total cargo throughput in 1990 will be 2.74 million tons excluding Kayu Lapis' logs which will be handled at offshore anchorages.

The cargoes by terminal are as follows.

- Conventional and Container Cargo
  1,200 thousand tons of cargo is projected, and about 10% of cargoes are containerized. Major import cargoes are general cargo, wheat and iron/steel and the main export cargoes are plywood and agricultural products.

- Industrial Cargo
  190 thousand tons of scrap, 150 thousand tons of coal and 680 thousand tons of fertilizer are expected as major cargoes.
  Although the demand will not be so great, asphalt, sand/gravel and raw pottery material will also be handled.

- Domestic (Nusantara) Cargo
  210 thousand tons of cargo will be carried by nusantara. These cargoes will be handled at the Coastal Harbour.

- Local and Rakyat
  260 and 310 thousand tons of cargoes will be carried by local vessels and rakyat, respectively. These will be handled at the Inner Harbour and Kali Baru.

Table 4-9-1 Urgent Plan for 1990

Facility	Cargo Throughput	Wharf Productivity	Required Quay Length	Existing Quay Length	Phase II Quay Length/Number	
	(,000 tons)	(tons/m/year)	(m)	(m)	(m)	
Foreign	1,230					
12,000DWT	1,080	1,200*	900	555	345	2.3
4,000DWT	150	1,000	150	0	150	1.5
Nusantara	210					
3,500DWT	70	1,000	70	0	70	0.7
1,000DWT	140	800	175	320	(155)**	(2.2)
Local/Rakyat	570					
200DWT	570	800	710	1,865	(1,155)***	(33)
Industrial	1,020					
Coal	150		150	0	150	1.0
Fertilizer	680		150	0	150	1.0
Iron/Scrap	190	1,700	110	0	110	1.1
Passenger	50	-	150	0	150	1.0

Note: * Includes Containers
** 150m is used as a temporary passenger terminal
*** Multi-use with cargo for Nusantara.
These wharves will be used for offshore transhipment cargo as in the past.

4-9-2 Required Number of Berths and Length

Actually, the temporary passenger terminal occupancy rate is about 14 percent, assuming a total occupancy including cargo throughput as 60 percent, the remaining 46 percent is for nusantara and oceangoing vessels up to 7.5 m in quaywall draft.

The capacity for these cargoes is 155 thousand tons. This is equivalent to 1.2 berths.

As for –7.5 m wharves, 2.2 berths will be required; however, 1.2 berths are covered at the passenger terminal, so the required number of berths is 1 berth for the time being.

Overall, the required quay length and the number of berths in Phase II are as follows:

Table 4-9-2 Required Number and Length of Berths in the Urgent Plan

	Length (m)	Draft (m)	Number of Berths
12,000 DWT	345	10 m (*11.5 m)	2.3
4,000 DWT	100	7.5 m	1.0
Coal	150	7.5	1.0
Fertilizer	150	7.5	1.0
Iron/Steel	100	7.5	1.0
Passenger (Rehabilitation)	150	7.5	1.0

Note: * The Draft of wharves which is determined considering future third generation container vessels.

4-9-3 Other Facilities

Roads including one bridge, revetments, land reclamation and relocation of the West Breakwater should be considered as minimum necessary infrastructural investments.

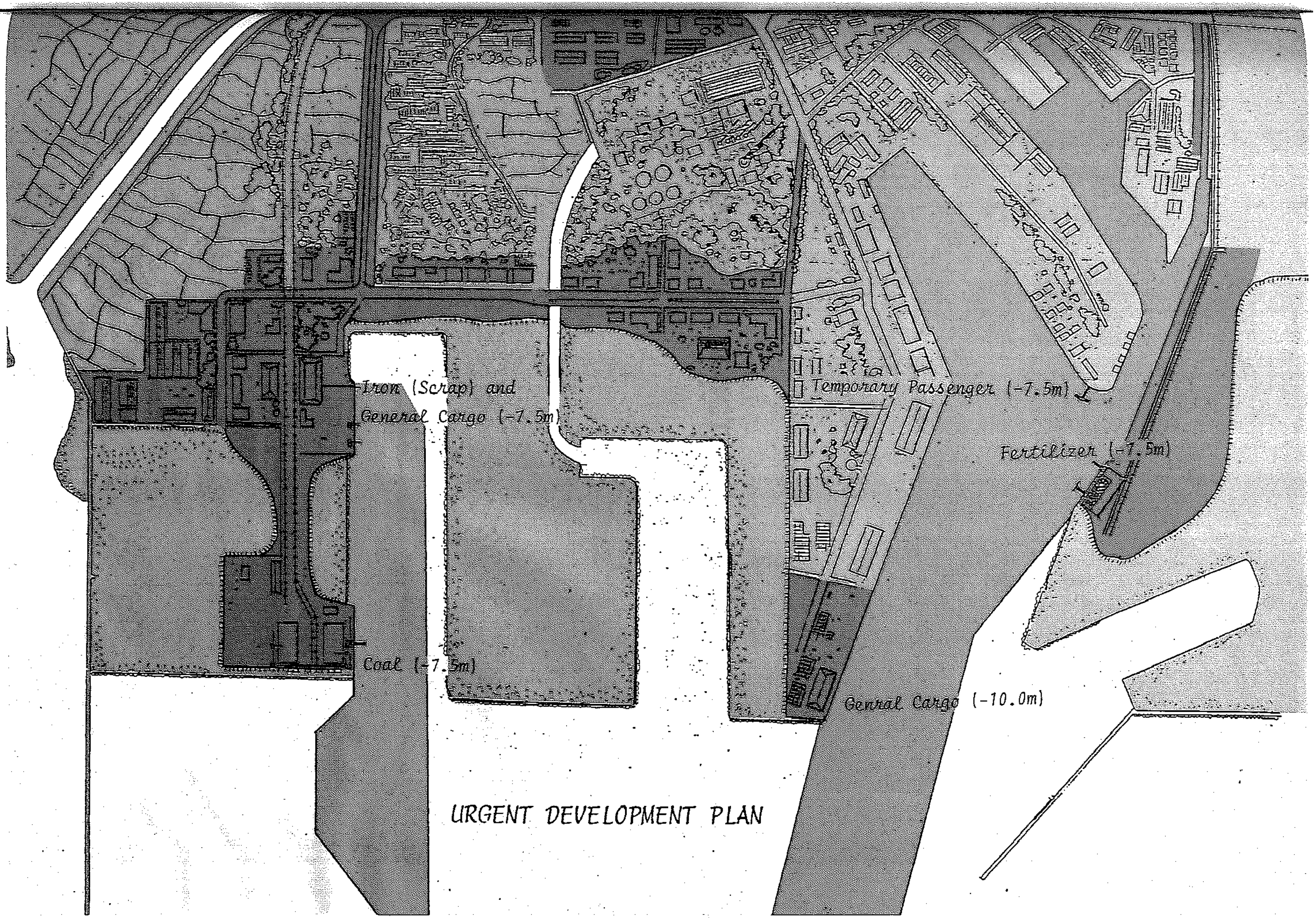
These are listed in the Table 4-9-3.

Table 4-9-3 Other Facilities

Roads	95,600 m^2
Bridge	100 m span
Revetments	7,800 m
West Breakwater	600 m
Reclamation	1,100,000 m^2

4-9-4 Overall Layout

The Urgent Plan for 1990 is presented in the following figure.



URGENT DEVELOPMENT PLAN

CHAPTER 5

DESIGN, CONSTRUCTION AND COST ESTIMATE

CHAPTER 5 DESIGN, CONSTRUCTION AND COST ESTIMATE

5-1 Design Conditions

The design conditions of the structure for the Urgent Plan in 1990 are considered in this Chapter.

5-1-1 Design Conditions of Berths

Vessels to be accommodated and design conditions of each berth, such as length, depth, apron elevation, surcharge, berthing velocity, seismic coefficient and lifetime are shown in Table 5-1-1.

Table 5-1-1 Design Conditions of Berths

No.	Name of Berth	Length 1 Berth (m)	Vessel Size (DWT)	Water Depth (m)	Apron Elev. (m)	Surcharge at Wharf* (t/m^2)	Berthing Velocity (m/s)	Seismic Coef. (KH)	Life-time (years)
1	General Cargo	150	15,000	-10.0	+2.2	3.0(1.5)	0.15	0.07	25
2	General Cargo	100	5,000	-7.5	+2.2	2.0(1.0)	0.15	0.07	25
3	Steel & Bulk	100	8,000	-7.5	+2.2	Unloader 2.0(1.0)	0.15	0.07	25
4	Fertilizer	150	6,000	-7.5	+2.2	Unloader 2.0(1.0)	0.15	0.07	25
5	Temporary** Passenger and G/C	150	5,000	-7.5	+2.2	2.0(1.0)	0.15	0.07	25
6	Coal	150	6,000	-7.5	+2.2	Unloader 2.0(1.0)	0.15	0.07	25

Note: *Figures in parentheses are surcharge in case of earthquakes.
**Rehabilitation

5-1-2 Tidal Range

H.W.L. = C.D.L. + 1.00 m
M.S.L. = C.D.L. + 0.60 m
L.W.L. = C.D.L. ± 0.00 m

Note: C.D.L. = Cardinal Datum Level.

5-1-3 Wave Force

Wave force is not considered because these structures are sheltered by the breakwaters.

5-1-4 Fender System

Rubber fenders will be installed at all of the berths.

5-1-5 Corrosion Prevention Measures

Corrosion prevention measures such as coating, increasing steel thickness and cathodic protection will be carried out.

5-1-6 Soil Conditions

1) Shearing stress in the existing ground:

At the international berths : $\pm 0.0 \sim -25.0$ m $C=0.4+0.12\ Z$ ton/m² (Zo = ±0.0 m)
under –25.0 m mean N-20

At the inner berths : $\pm 0.0 \sim -25.0$ m $C=0.9+0.11\ Z$ ton/m²
under –25.0 m mean N-25

2) Weight per unit volume under water: $\gamma_t = 0.55$ ton/m²

5-1-7 Allowable Stress

Allowable compression stress of reinforced concrete : 80 kg/cm²
Allowable tension stress of steel : 1,400 kg/cm²

Note: These values are multiplied by 1.5 for seismic conditions.

5-1-8 Safety Factors

Safety factors are shown in Table 5-1-2.

Table 5-1-2 Safety Factors

Conditions	Ordinary	Particular
Circular Slide	1.2	1.0
Sliding	1.2	1.0
Over-turning	1.2	1.0
Bearing of Pile	2.5	2.0
Penetration Length of SPP	1.5	1.2

5-2 Design of Main Wharves

First of all, the Study Team compares various structural designs for the quaywalls for medium size draft vessels (−5.5 ~ −7.5 m)

The following 4 structural types are considered:

Type A	Steel Sheet Pile	(Fig. 5-2-1)
Type B	L-shaped Concrete Block	(Fig. 5-2-2)
Type C	Steel Pipe Pile Pier	(Fig. 5-2-3)
Type D	P.C. Pile Pier Type	(Fig. 5-2-4)

The 4 types are compared in Table 5-2-1.

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

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

Table 5-2-1 Technical Comparison of 4 Alternative Quaywalls

Alternative / Item	A Steel Sheet Pile	B L-Shape Concrete Block	C Steel Pipe pile	D P.C. Pile (Pre-stress Concrete)
Main Construction Craft	Piling & S.C.P. Pontoon, Deck Barge	S.C.P. & Lifting Pontoon Deck Barge	Piling Pontoon Deck Barge	Piling Pontoon Deck Barge
Workability	Not so easy for S.C.P. ○	Not so easy for S.C.P. ○	Very easy ◎	Easy ○
Construction Control	Not so easy △	Not so easy △	Very easy ◎	Easy ○
Working Energy	Fairly much ○	Fairly much ○	Usual ◎	Usual ◎
Construction Period	Long △	Long △	Usual ◎	Usual ◎
Corrosion Protection	Required △	Not required ◎	Required △	Not required ◎
Construction Cost Ratio (Type D=1)	2.1	1.9	1.05	1.0

Note: S.C.P.: Sand Compaction Pile

◎ Very good ○ Good

△ Poor

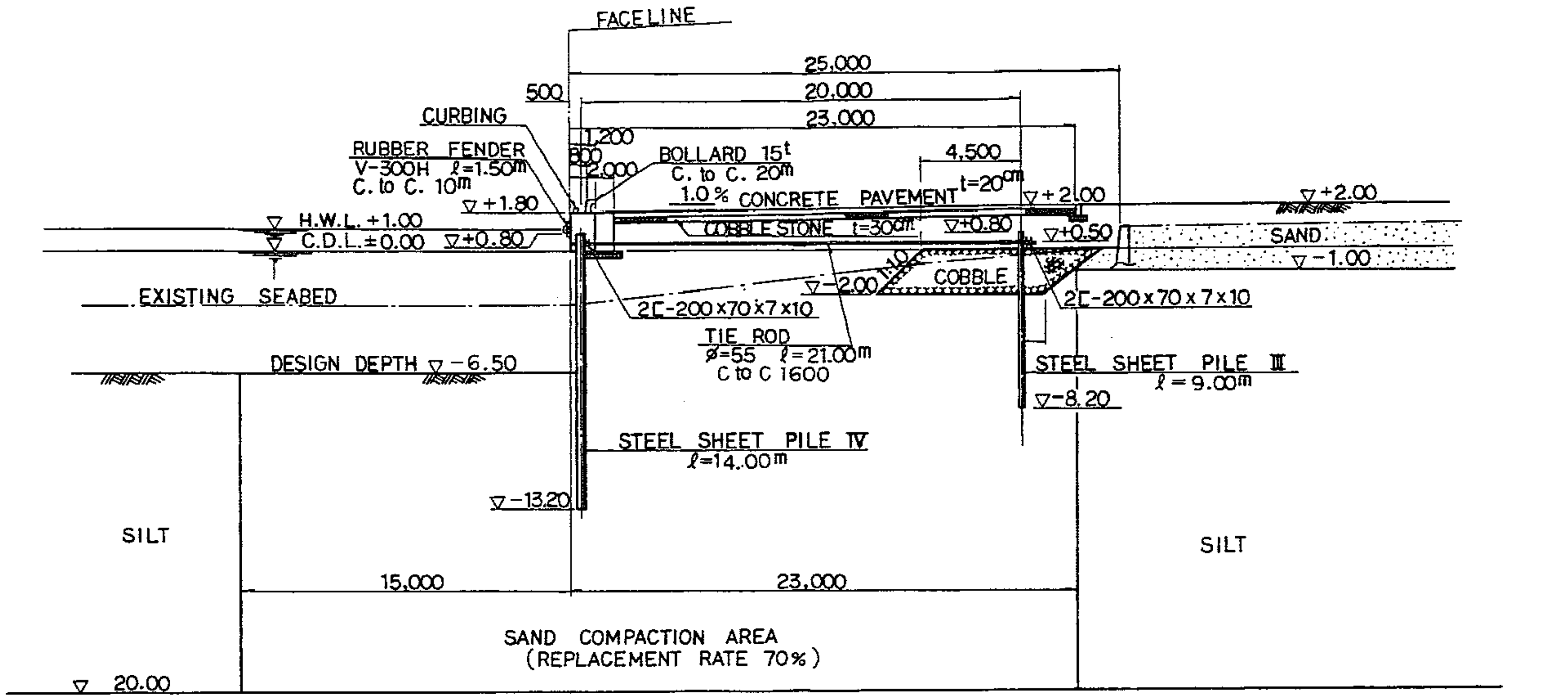


Fig. 5-2-1 Design of Type-A (Steel Sheet Pile)

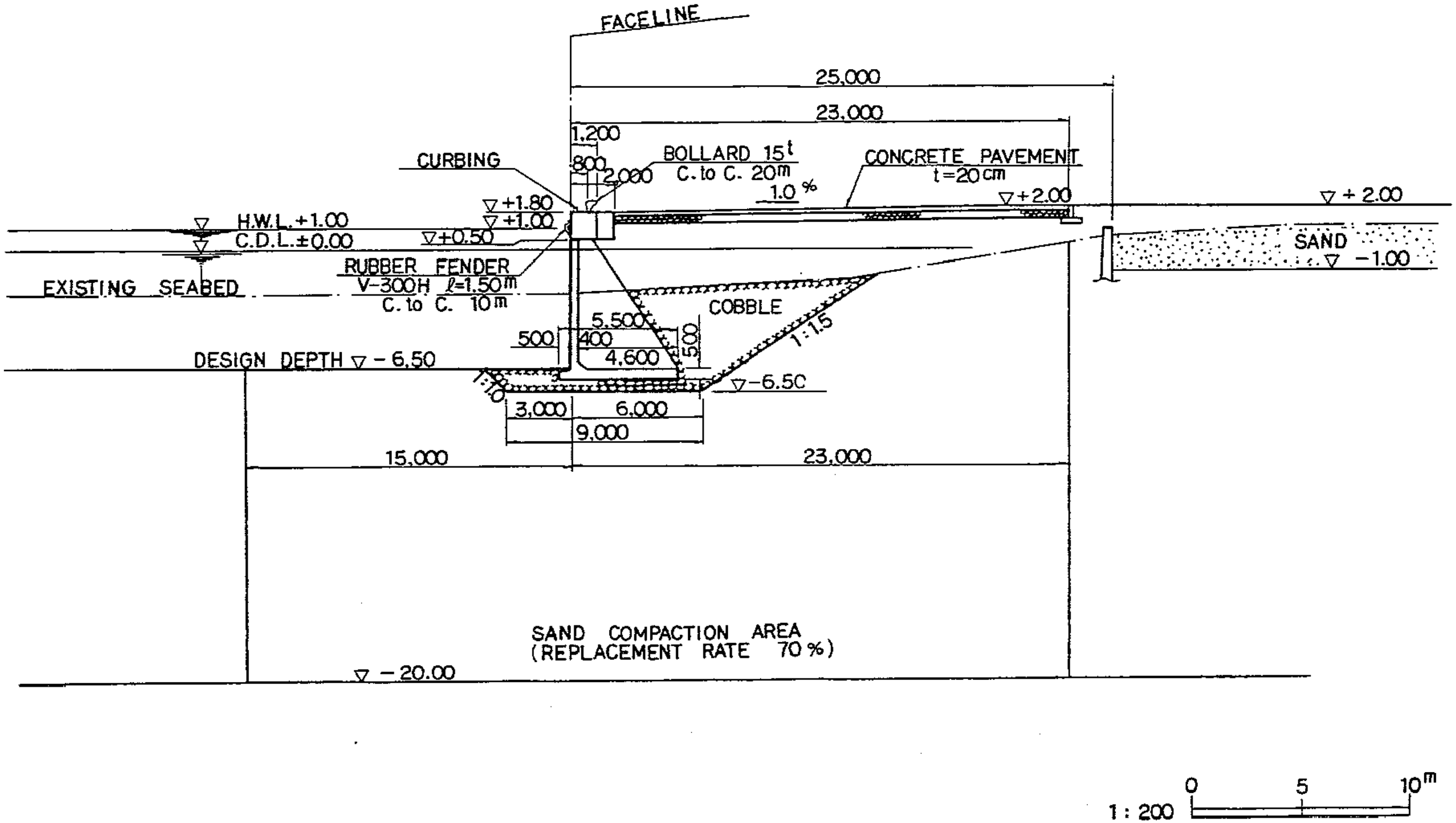


Fig. 5-2-2 Design of Type-B (L-shaped Concrete Block)

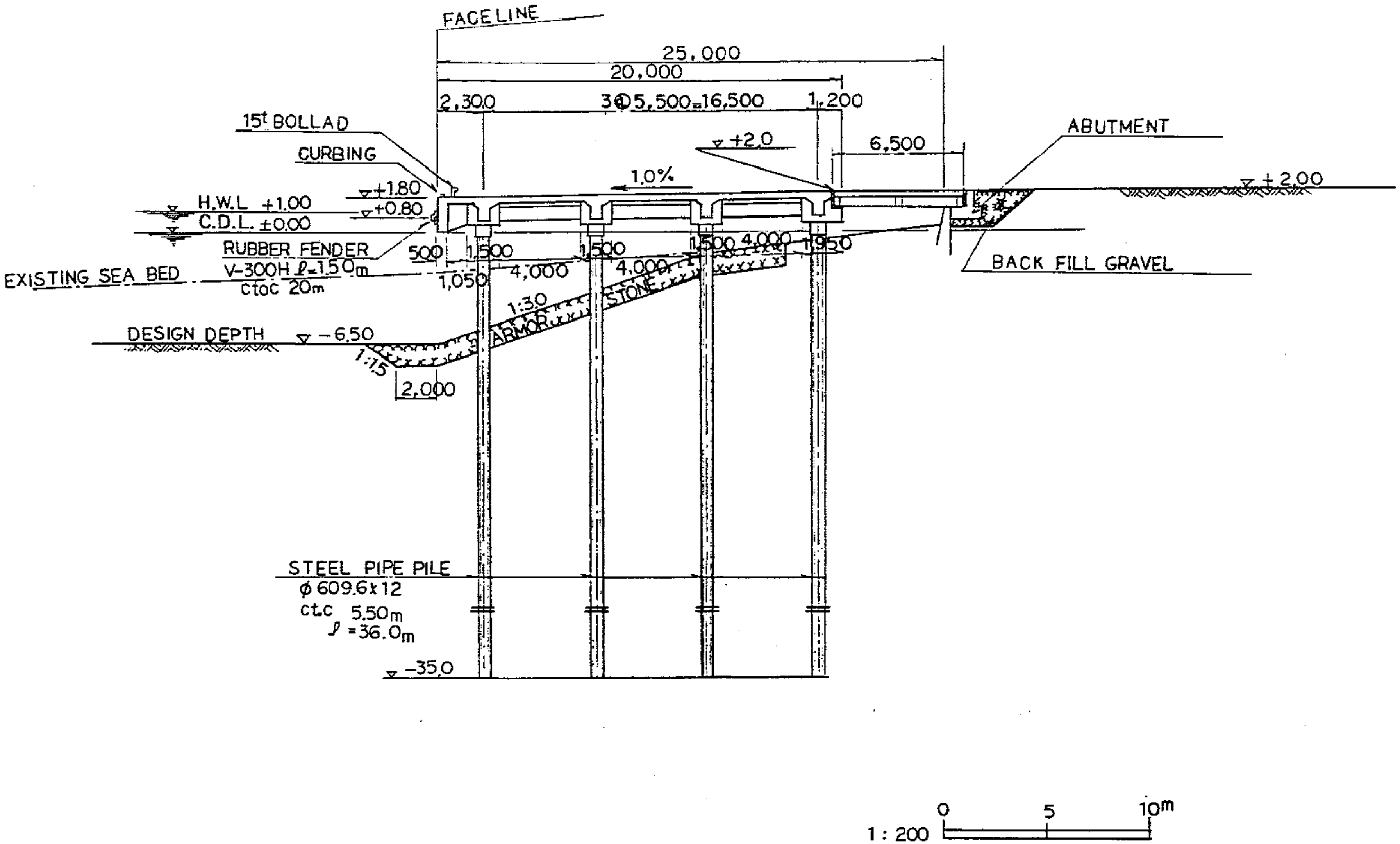


Fig. 5-2-3 Design of Type-C (Steel Pipe Pile)

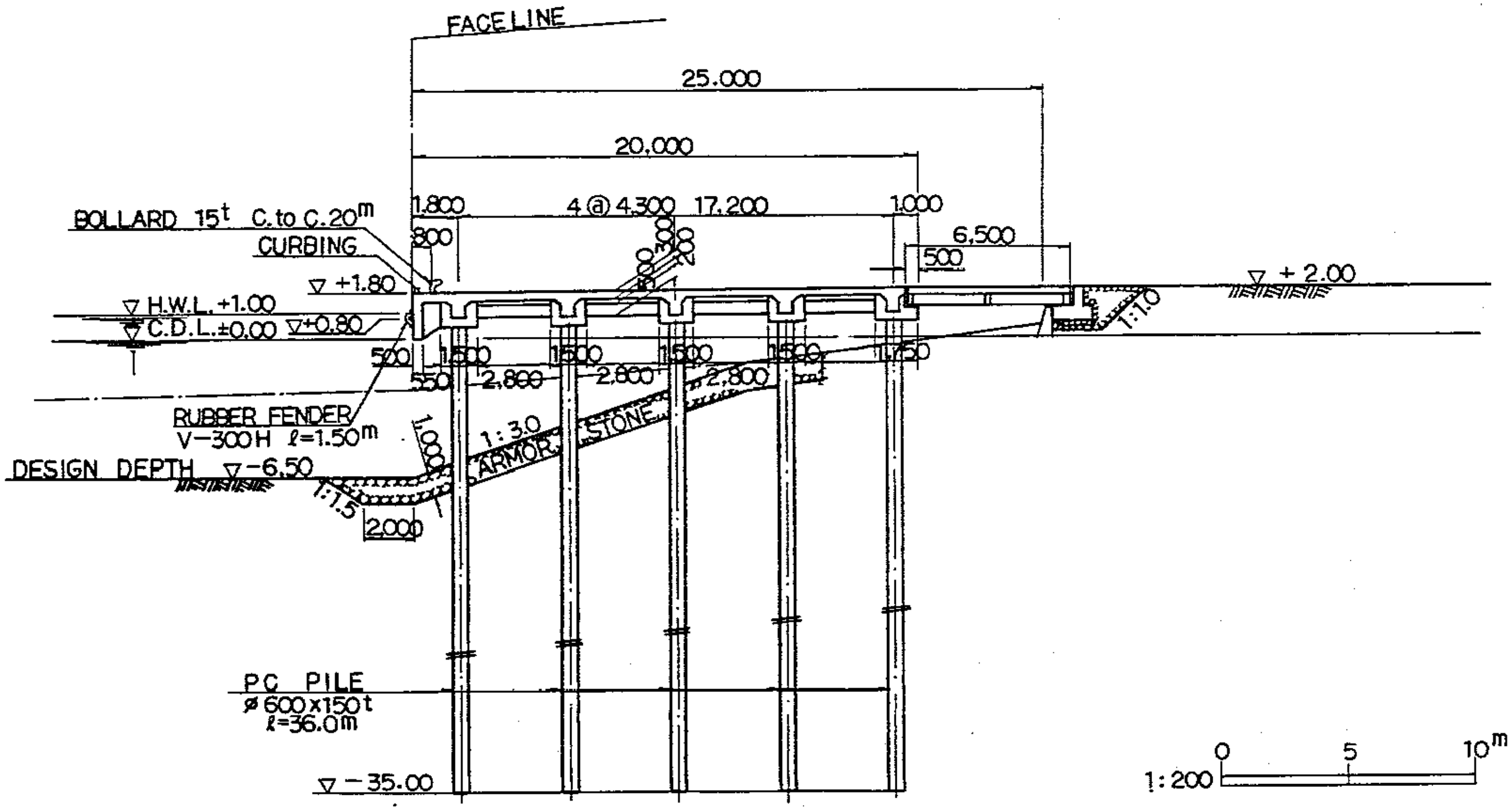


Fig. 5-2-4 Design of Type-D (P.C. Pile)

As shown in Table 5-2-1, the steel sheet pile type (Type A) and the L-shaped concrete block type (Type B) are not economical due to the high construction cost, so the steel pipe pile type (Type C) and the P.C. pile type (Type D) are potential types for design and construction.

Although the total construction cost is almost the same between Types C and D, Type C is superior on the points of workability, construction control, piling and construction schedule.

Therefore, the Team recommends Type C.

As for the deep sea wharf over –9 m in depth, the Study Team would like to recommend the same type of structure as the already constructed Phase I wharf.

Details by wharf are shown below.

1. –10 m Berth for General Cargo

   As shown in the Phase I project, it can be said that Type C is the best. A typical cross section is shown as Fig. 5-2-5.

2. –7.5 m Berth for General Cargo

   Based on the above comparison, Type C is preferable for the –7.5 m berth because the cost is 5 percent less than that of Type D.

   Fig. 5-2-6 shows a standard cross section of this type of structure.

   The existing breakwater or L-shaped revetment to be used as an abutment for the pier should be reinforced.

3. –7.5 m Berth for Coal, Fertilizer and Iron Scrap.

   Although these cargoes each require different cargo handling equipment, a typical cross section is shown as Fig. 5-2-7.

4. –7.5 m Multipurpose Temporary Passenger Terminal

   This berth will be located at the Coastal Harbour, the existing –5.5 m berth will be remodeled to –7.5 m.

   The cross section is shown as Fig. 5-2-8.

   The northern end of the warehouse should be remodeled as a passenger terminal building.

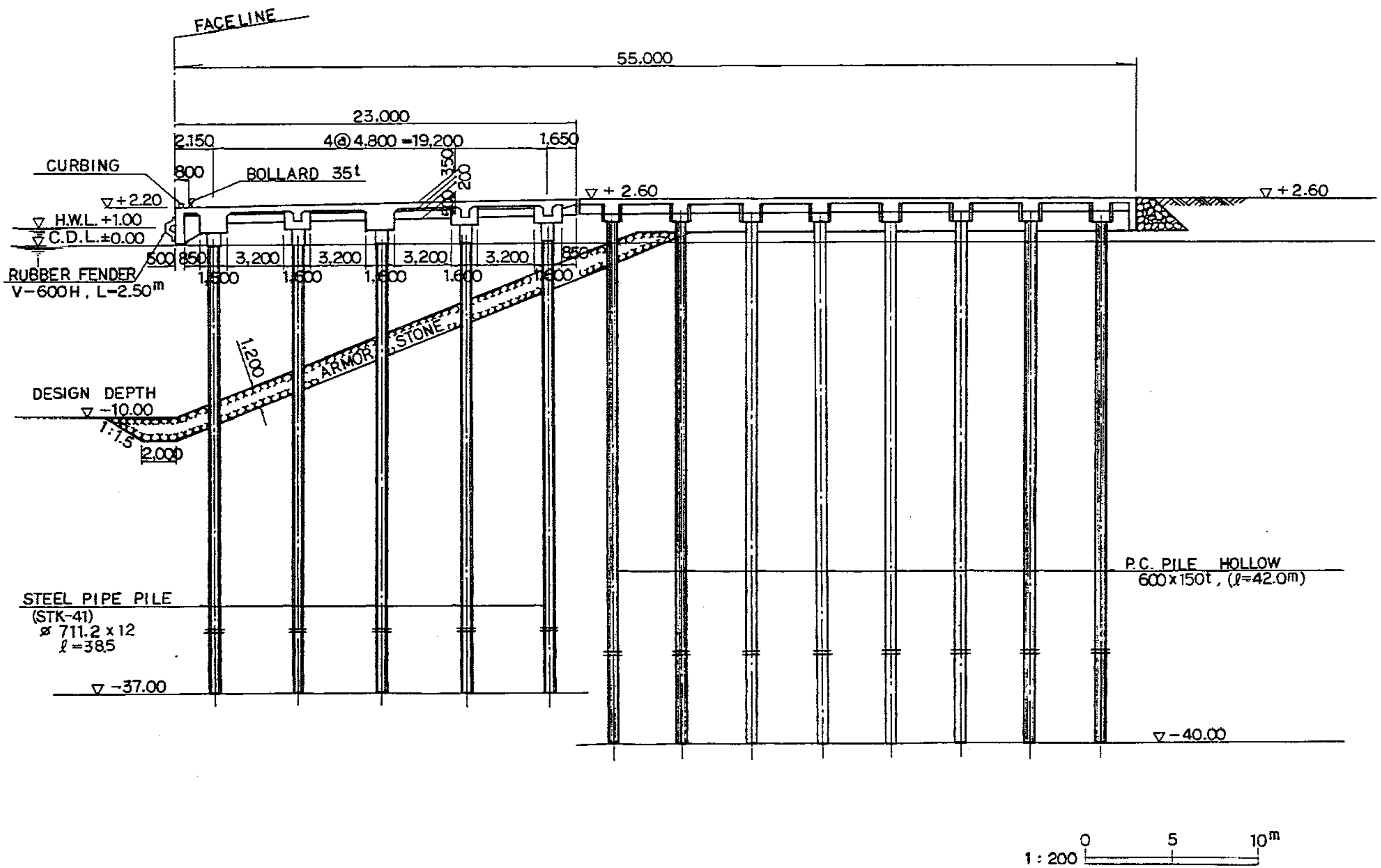


Fig. 5-2-5 -10 m General Cargo Berth

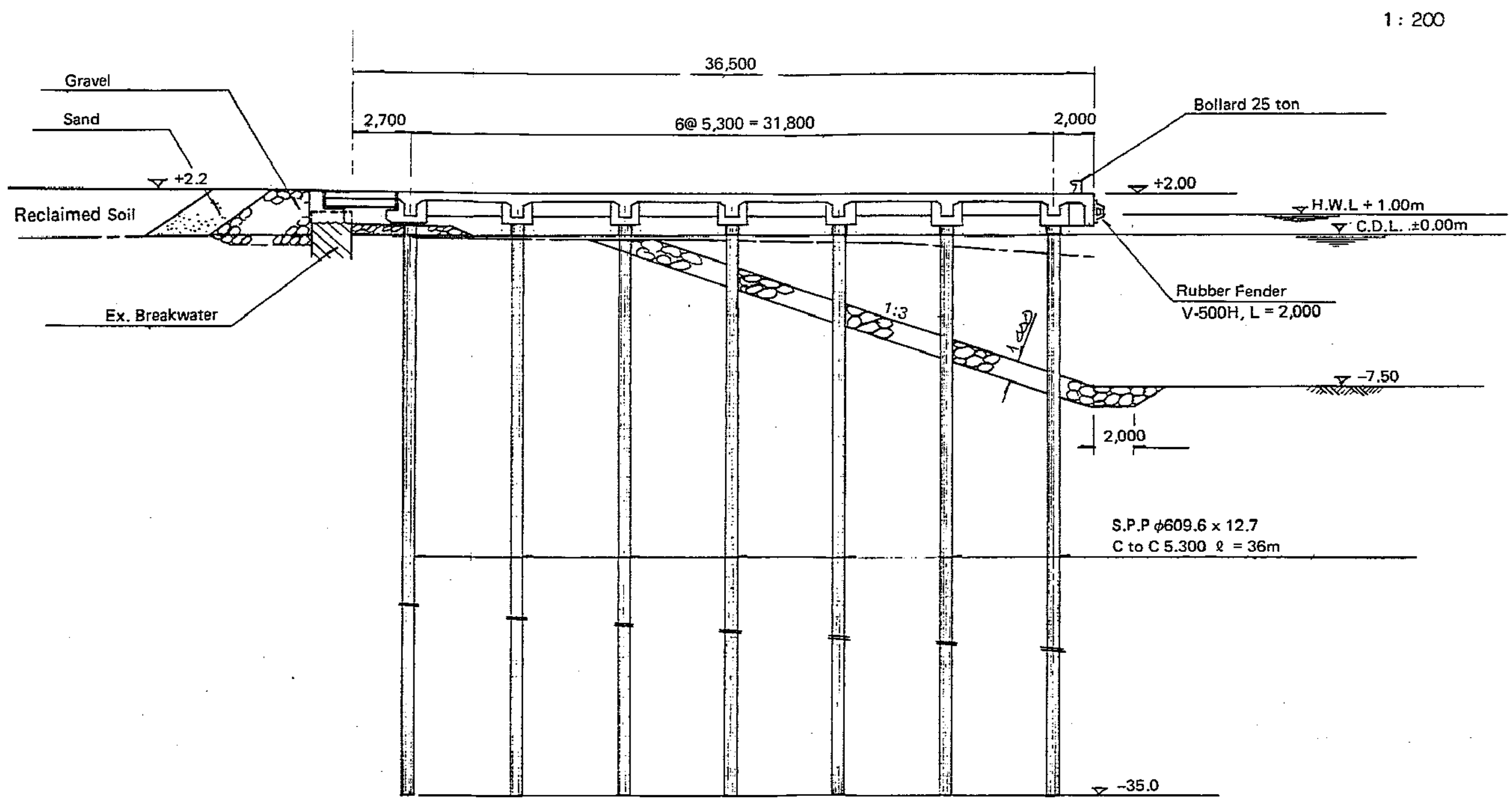


Fig. 5-2-6 –7.5 m General Cargo Berth

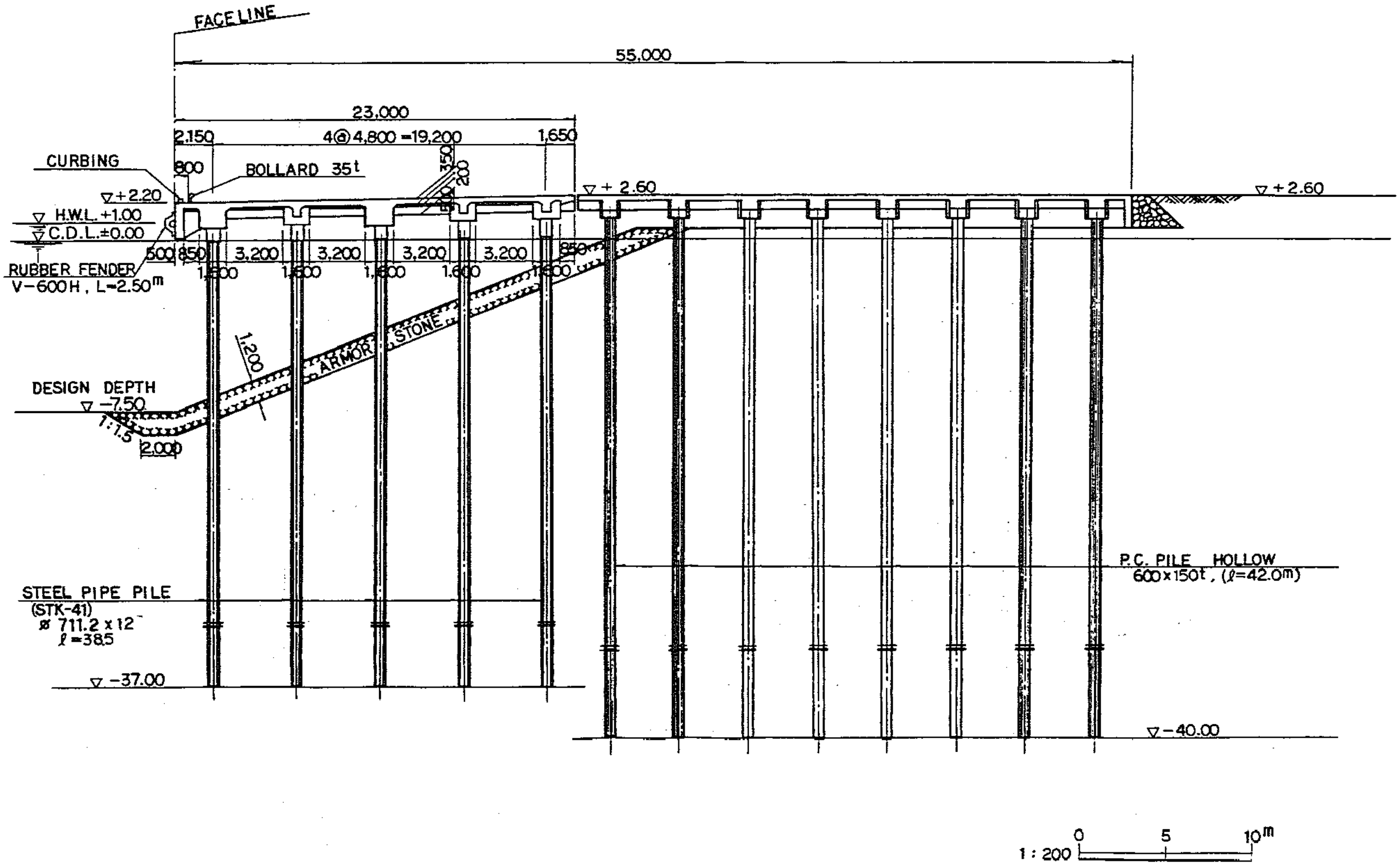
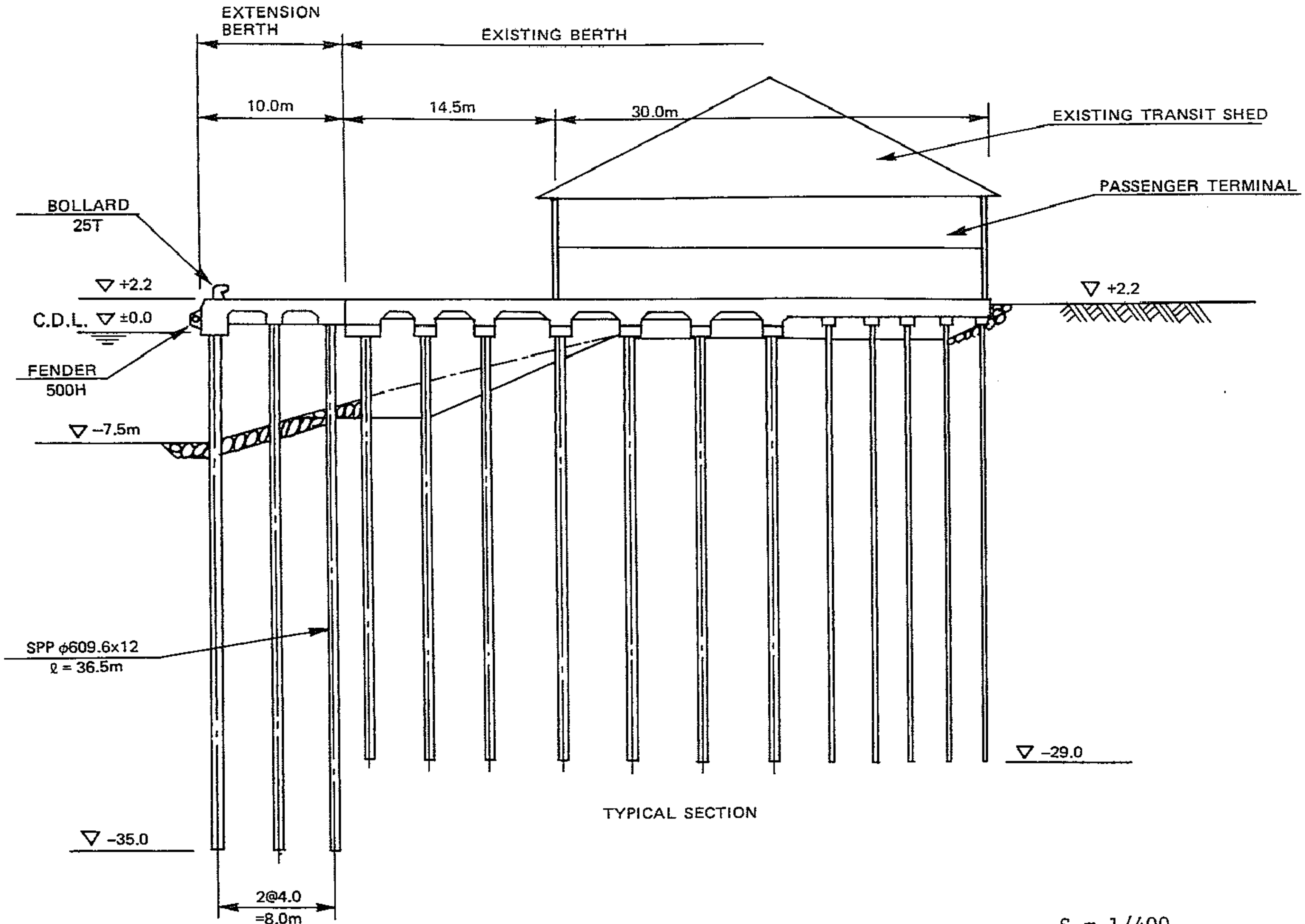


Fig. 5-2-7 −7.5 m Coal, Fertilizer, and Iron and Scrap Berth



S ≒ 1/400

Fig. 5-2-8 Temporary Passenger Berth