6. Design, Construction and Cost Estimate

6-1 Design

6-1-1 Design Conditions

Based on the Master Plan, the port facilities are designed based on the following premises.

① Port facilities in the outer port and in the inner port are considered separately.

② In the construction plan for the outer port, the present facilities, wharves and quays, are utilized as much as possible.

③ In the construction plan for the inner port, the planned facilities are adapted to the present facilities as much as possible.

(1) Fundamental Conditions

The fundamental conditions for design of the facilities for the outer and inner ports are listed in Table VII-52.

Table VII-52 Fundamental Design Conditions

Items	Design Conditions	
	Outer Port	Inner Port
Tidal Level	H.W.L. +0.272 m L.W.L. -0.398 m	
Offshore Waves	S direction 10.0 sec Ho = 3.0 m SW direction 10.0 sec Ho = 1.5 m	
Wave Height	70 cm at coast	0 m
Cope Height of Wharves	*	+3.40 m
Seismic Coefficient	0.15 g	
Surcharge	*	4.0 t/m^2: General and agricultural and mineral bulk cargo wharf. 2.5 t/m^2: Container wharf (not including load of containers)
Lifetime	*	50 years

Note: *: There is no data for soil investigation, design and construction of several old facilities. Therefore, an inspection of parts of these facilities, especially aprons and foundations, will be necessary.

(2) Soil Conditions

The typical soil conditions in the inner port and the assumed soil conditions for design are shown in Fig. VII-31. As shown in Fig. VII-31, the upper layer of sot organic soil or clay is ignored in designing, and clayey sand or sandy clay which has an N-value less than 30 is also ignored. Only N-values greater than 30 are considered for design. Sand layers with N-values over 50 are considered as the bearing strata for foundations in designing.

In parts of the San Pedrito Lagoon, the sand layer can not be considered as a bearing stratum, because the layer is too thin and a soft complex layer underlies this sand layer.

The depths of the bearing strata and the layers that can be considered in designing are determined for each respective area. As the depth of these strata are uneven as shown by the 133 bores presented in Chapter III, Section 1-5, we can not generalize about the requisite depths.

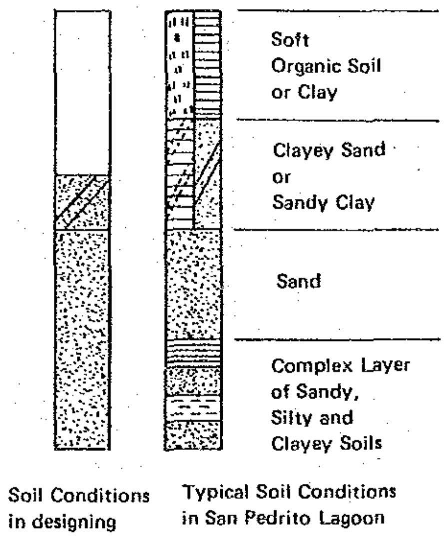


Fig. VII-31 Soil Conditions

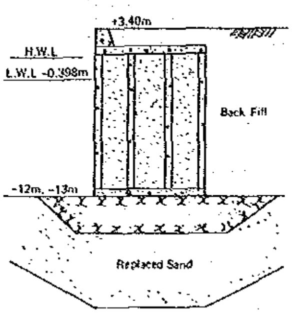
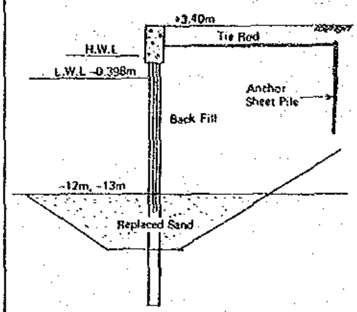
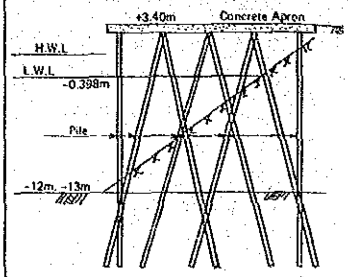
6-1-2 Main Port Facilities

For the berths in the inner port, three basic alternatives are compared, and shown in Table VII-53.

There are various structural types of berths, and three typical structures, gravity wall, sheet pile and pier type berths, are compared for the project.

From the comparison shown in Table VII-53, we see that the adoption of gravity wall or sheet pile type berths is difficult. For mineral bulk and grain, and for container berths, two kinds of pier type structures, that is reinforced concrete and steel pipe pile open type berths, are chosen and compared for the project.

Table VII-53 Structural Comparison of Berths

Type of Berth	Gravity Wall (Caisson) Type	Sheet Pile Type	Pier Type
Cross Section			
Lateral Resistance	Much replacement of soil is required ○	Water depth is large and steel pipe sheet pile is required ○	Good adaptability by diameter, length and numbers ◎
Bearing Capacity (Vertical)	○		◎
Workability at sea	A yard and ship or floating dock to fabricate concrete caissons is necessary Δ	Comparatively highly skilled labor is required ○	Easy ◎
Workload	Much Δ	Small ◎	Small ◎
Construction Speed	Not so fast Δ	Very Fast ◎	Very Fast ◎
Ease of Material Procurement	Can be built with domestic products ◎	Steel pipe sheet piles must be imported Δ	Concrete pile: ◎ Steel pipe pile: ○
Requirement of Corrosion Prevention	Not required ◎	Required Δ	Concrete pile: Not required ◎ Steel pipe pile: Required Δ

Note: Δ : Not Easy
○ : Level
◎ : Easy

(1) Mineral bulk and grain berths

For the mineral bulk and grain berths extending from the present berths, the following two alternatives are compared.

Alternative A: Reinforced concrete pile open type berth (Fig. VII-32)

Alternative B: Steel pipe pile open type berth (Fig. VII-33)

As shown in Fig. VII-32 and 33, one of the most important features is that the embedded length is short in comparison with the free length, and it seems to be unstable. For the stability of these structures, piles must be driven into a bearing stratum that is sand or an equivalent layer with an N-value more than 30. The required minimum embedded length of the concrete piles in Fig. VII-32 is 5 m and that of the steel pipe piles in Fig. VII-33 is 7 m.

(2) Container berth

For the container berth with a container crane, the rated load is 30.5 tons and the span is 20 m.

The options are:

Alternative C: Reinforced concrete pile open type berth (Fig. VII-34)

Alternative D: Steel pipe pile open type berth (Fig. VII-35)

As mentioned above, for the stability of these structures piles must be driven in to the required depth. The required minimum embedded length of the concrete piles for the container berth is 7 m and that of the steel pipe piles is 10 m.

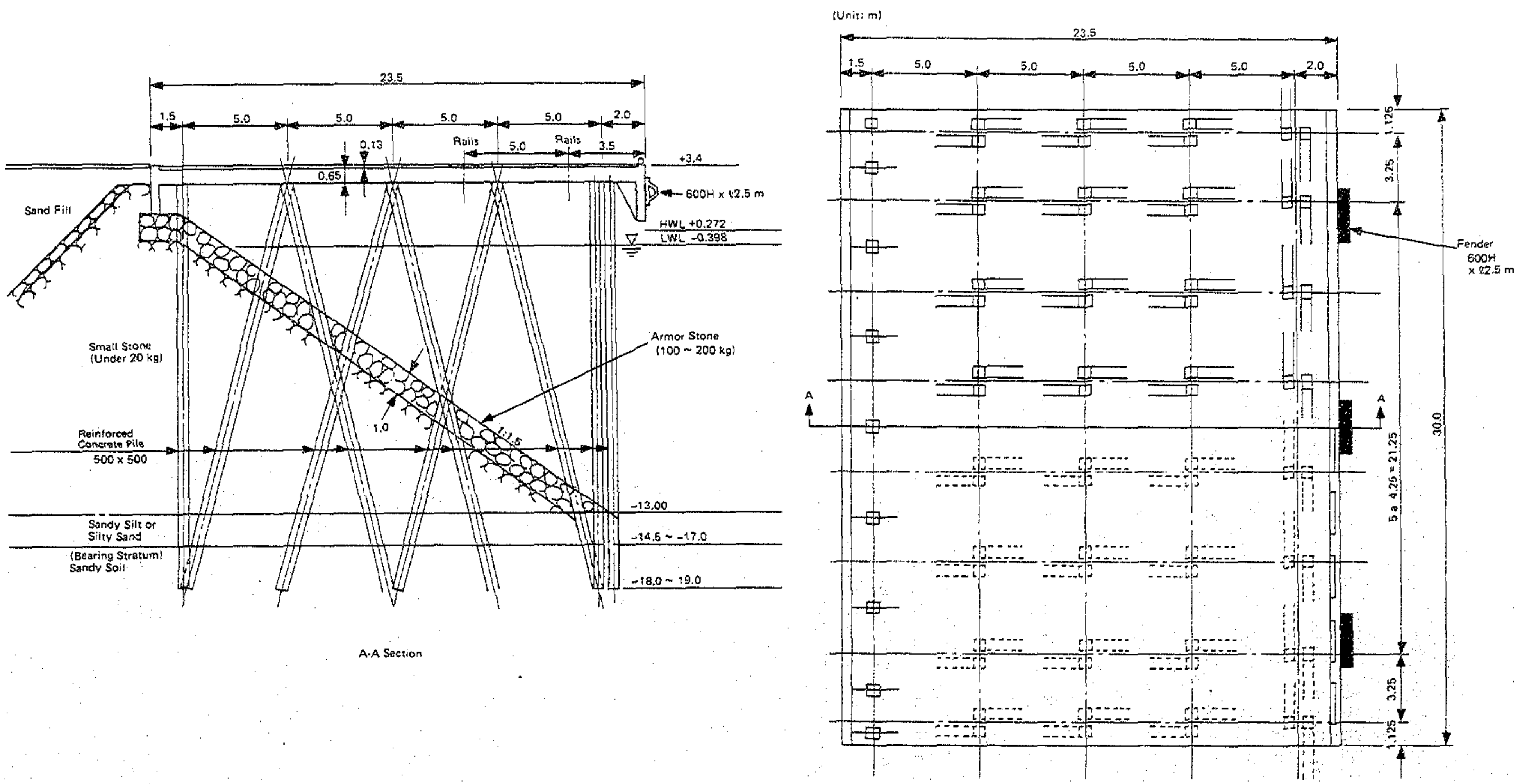


Fig. VII-32 Mineral Bulk and Grain Berth (Alternative A)

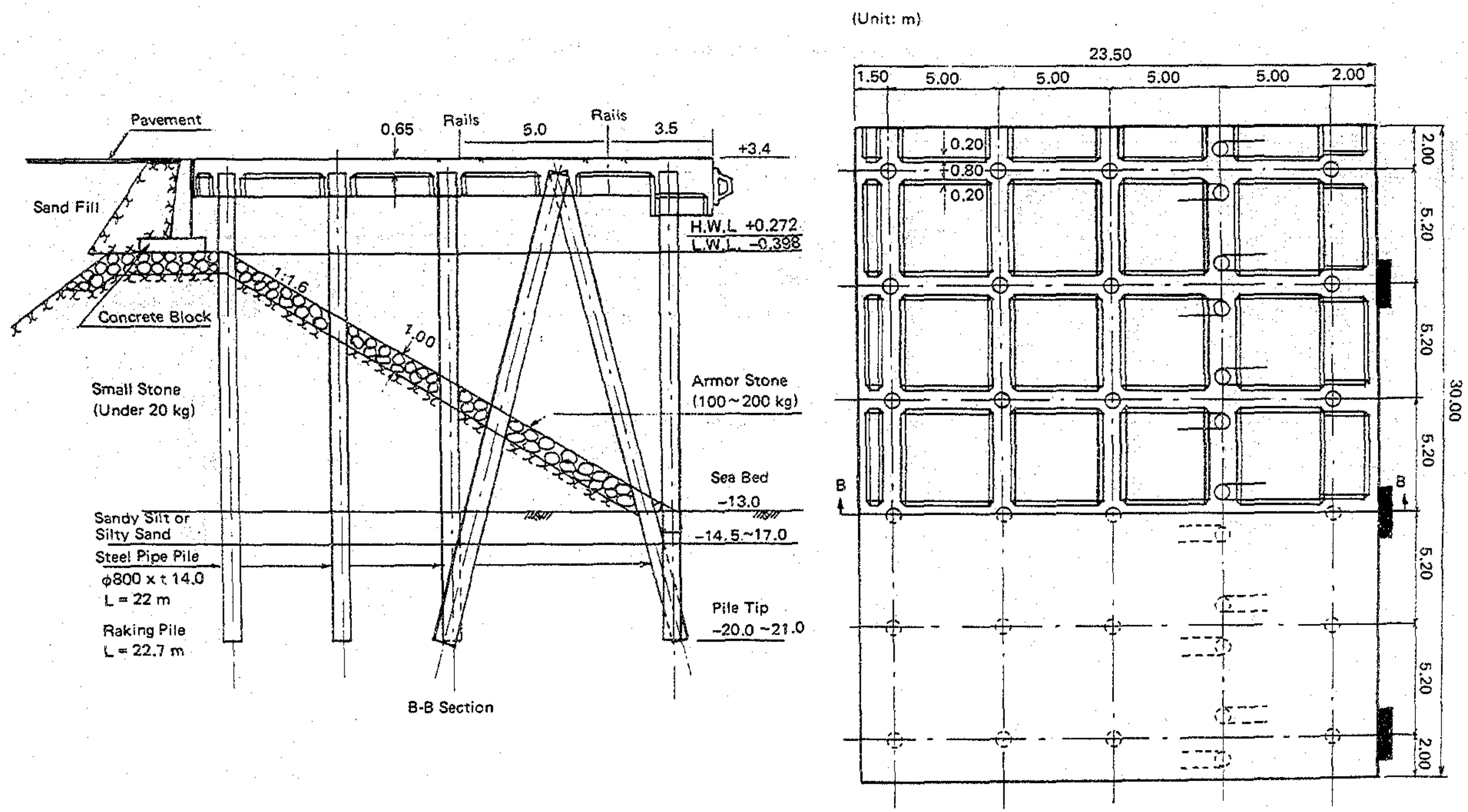


Fig. VII-33 Mineral Bulk and Grain Berth (Alternative B)

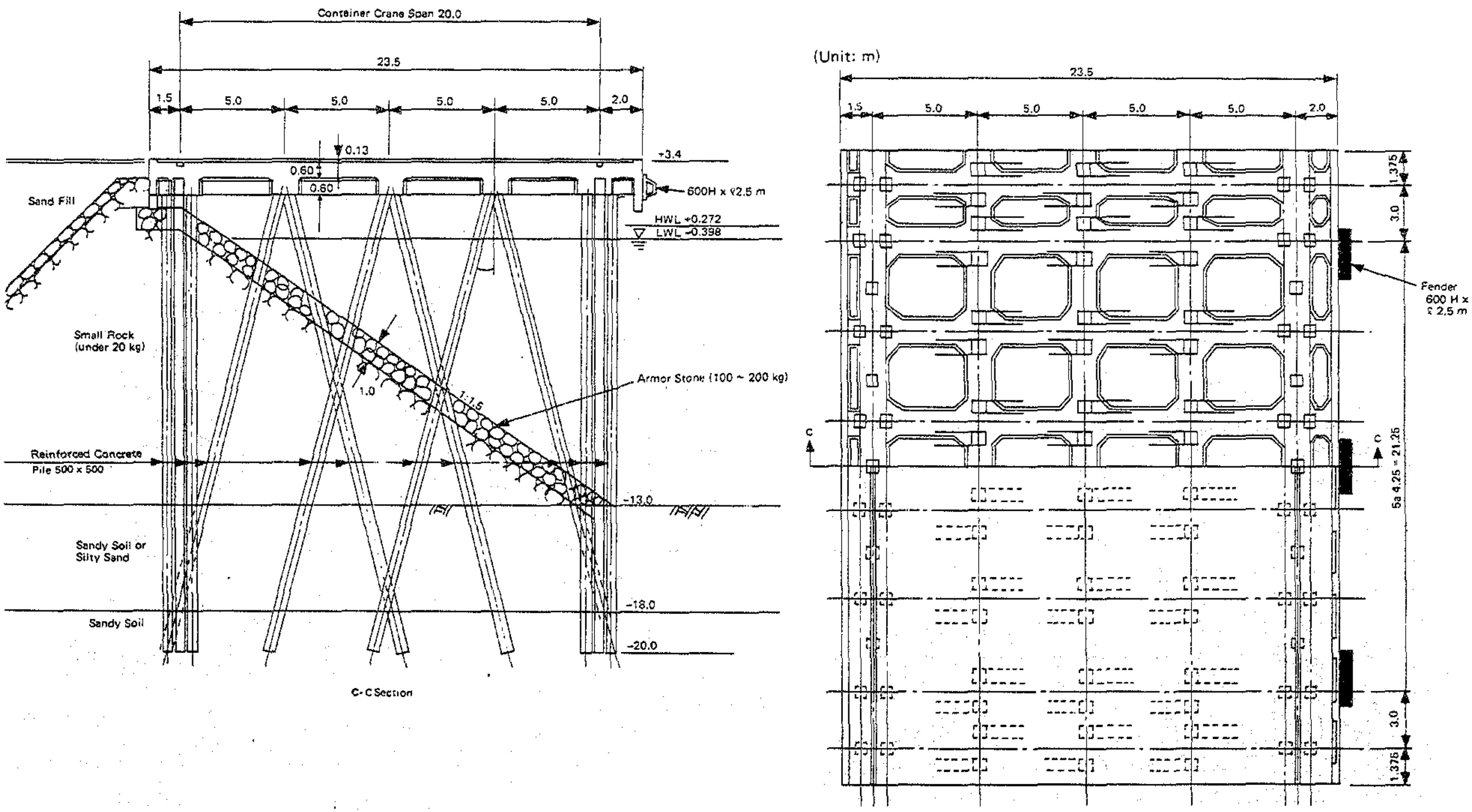


Fig. VII-34 Container Berth (Alternative C)

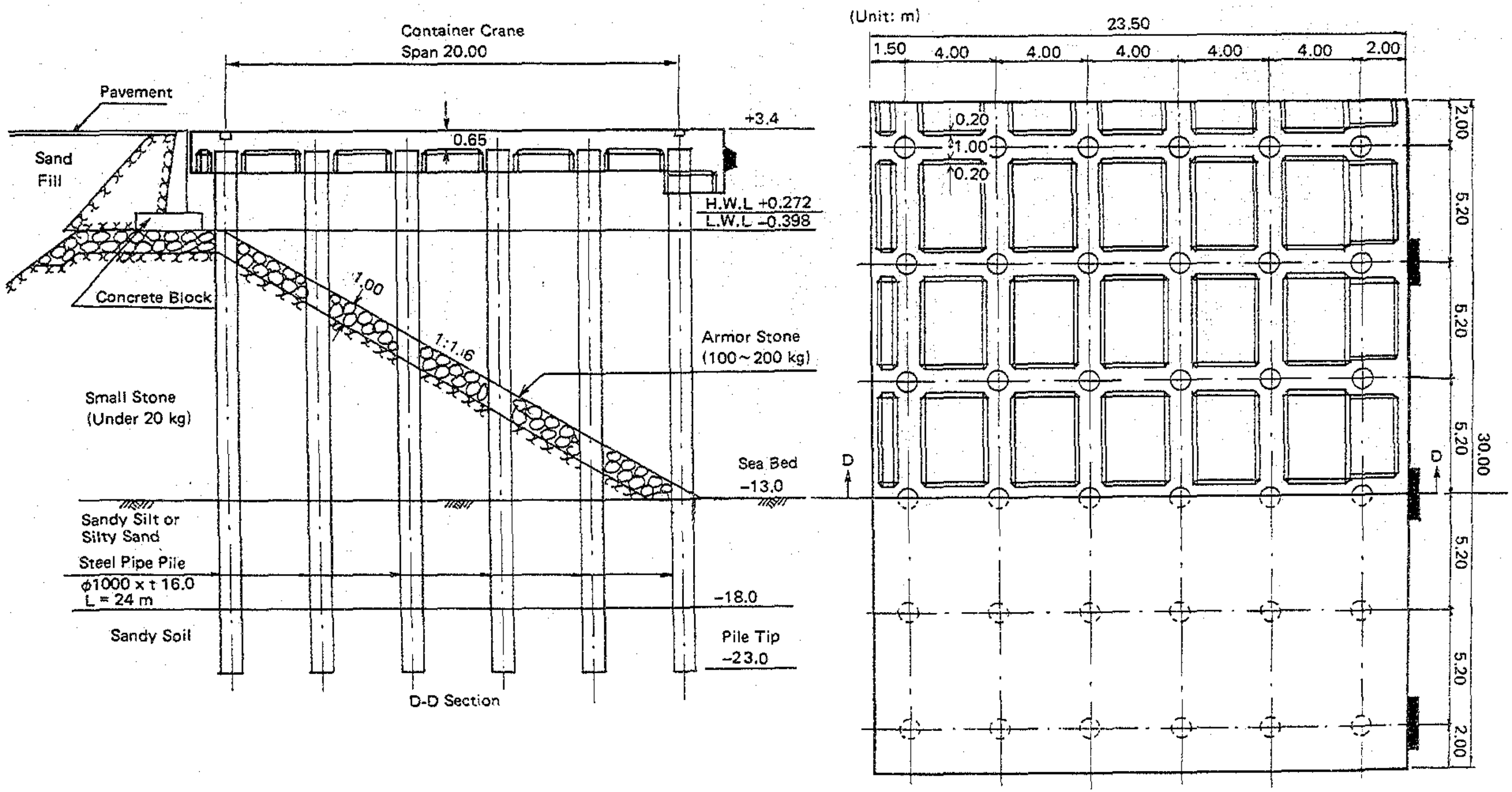


Fig. VII-35 Container Berth (Alternative D)

6-1-3 Other Facilities

The outlines of the design of the other port facilities which are shown in Fig. VII-25, Master Plan of the inner port, are described below.

(1) Buildings

The warehouses, transit sheds and maintenance shop are steel frame structures. For the design of foundations, further soil borings of the reclaimed sand area will be required, because there is a possibility that the loose sand layer which is reclaimed by dredged sand may undergo liquefaction during an earthquake. Further detailed consideration may be required.

(2) Railways

The locations of the railways on the berths are shown in Fig. VII-25. Their track gauge is 1.435 m.

(3) Roads

The roads in the port are asphalt pavement and have 4 lanes which are 22 m wide. Furthermore, in principal, the port area including the berths is all asphalt pavement.

(4) Container and Marshalling Yards

The design of the container and marshalling yards, including location, required equipment, operation, administration and other factors, is quite complicated. Therefore, the design of these facilities should be carefully investigated as a separate, individual project.

6-2 Construction

6-2-1 Construction Quantities

(1) Facilities

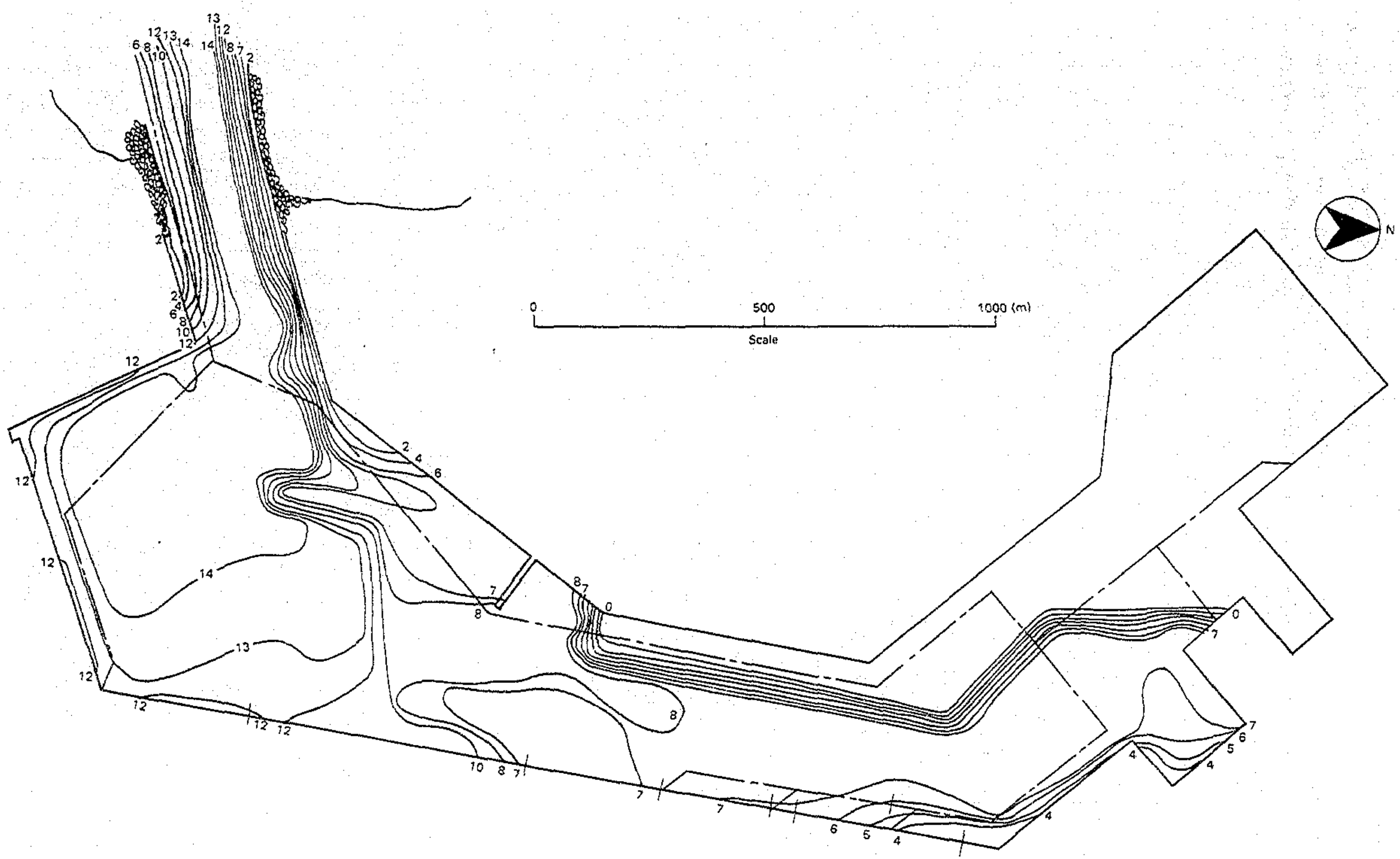
The construction quantities of the main commercial port facilities are presented in Table VII-54. The construction quantities of the fishery port and outer port facilities are listed in Appendix 2.

The dredging volumes in the table are calculated using the sounding at the end of 1984 as shown in Fig. VII-36.

Table VII-54 Port Facilities and Construction Quantities (Commercial Port)

Facility: Item	Facility: Sub Item	Unit	Quantity	Remarks
1. Dredging	(1) Channel (-14m)	m^3	465,000	200 m Width
	(2) Anchorage	m^3	4,600,000	
	(3) Industrial Lot	m^3	1,500,000	Dredging of the Organic Soil
2. Quays	(1) -13m Mineral Bulk Berth	m	300	Reinforced Concrete (RC) Pile Structure
	(2) The End of the Above	m	25	〃
	(3) -13m Grain Berth	m	300	〃
	(4) -13m Container Berth (Short-term Plan)	m	300	〃
	(5) -13m Container Berth (Master Plan)	m	300	〃
	(6) -12m General Cargo Berth	m	250	〃
	(7) The End of the Above	m	50	〃
	(8) -11m Domestic Trade Berth	m	200	〃
	(9) -9m Domestic Trade Berth	m	170	〃
	(10) The End of the Above	m	80	〃
	(11) Temporary Working Yard	m^2	40,000	
	(12) Water and Electric Supply for Construction Work	set	1	
	(13) Temporary Seawall	m	250	Seawall with Armor Stone
3. Railway and Road	(1) Railway	m	6,200	55 kg/m Rail
	(2) Road	m	4,100	22m Width, Asphalt Pavement
	(3) Fence and Gate	m	1,500	
4. Buildings, Transit Sheds and Warehouses	(1) Warehouse (No. 2)	m^2	6,400	40 x 160 (m)
	(2) Transit Shed (No. 3)	m^2	7,500	50 x 150 (m)
	(3) Transit Shed (No. 4)	m^2	7,500	50 x 150 (m)
	(4) Transit Shed (No. 5)	m^2	4,000	40 x 100 (m)
	(5) Silo for Grain	set	1	
	(6) Maintenance Shop	m^2	2,500	50 x 50 (m)
	(7) Warehouse (No. 3)	m^2	8,100	81 x 100 (m)
	(8) Warehouse (No. 4)	m^2	4,000	40 x 100 (m)
	(9) Office	m^2	10,000	100 x 100 (m) Building Coverage (0.6), Building Capacity Rate (1.8)
	(10) Communication Facilities	set	1	
	(11) Container Freight Station	m^2	5,500	Two Truck Scale Gate
5. Land	(1) Container Yard (Short-term Plan)	m^2	57,000	300 x 190 (m), Heavy Pavement
	(2) Container Yard (Master Plan)	m^2	99,000	300 x 330 (m), Heavy Pavement
	(3) Wharf Lot	m^2	265,000	Asphalt Pavement
	(4) Empty Van Pool	m^2	25,000	250 x 100 (m), Asphalt Pavement
	(5) Green Area	m^2	21,000	
	(6) Adjustable Area	m^2	35,000	Without Pavement
	(7) Industrial Lot	m^2	224,000	〃

Facility		Unit	Quantity	Remarks
Item	Sub Item			
6. Water and Electric Supply, and Drainage	(1) Water Supply	set	1	2,790 m (ϕ100), 7,680 m (ϕ200)
	(2) Drainage	set	1	Pipe (9,320 m)
	(3) Electric Substation	KVA	15,000	Including the Fishery Port
	(4) Electric Supply	set	1	Cable (10,000 m)
7. Aids to Navigation	(1) Lighted Spar Buoy	set	4	
	(2) Lighted Buoy	set	6	With Air Battery
	(3) Lighted Small Buoy	set	2	"
	(4) Leading Light	set	2	
8. Cargo Handling Equipment for Containers	(1) Gantry Crane (30.5 t)	set	2	
	(2) Forklift (33 t)	set	2	
	(3) Straddle Carrier (30.5 t)	set	6	
	(4) Trailer Head	set	2	
	(5) Container Chassis (20')	set	3	
	(6) Container Chassis (40')	set	2	
9. Cargo Handling Equipment for General Use	(1) Wheel Crane (15 t)	set	2	
	(2) Wheel Crane (9 t)	set	1	
	(3) Tractor	set	8	
	(4) Flat Chassis (10 t)	set	12	
	(5) Dump Truck (15 t)	set	5	
	(6) Pneumatic Unloader (200 t/hr)	set	4	With Tire Mount
	(7) Hopper (200 m^3)	set	3	
	(8) Hopper (50 m^3)	set	6	Movable
	(9) Belt Conveyer (440 (t/hr)	set	1	650 m x 2 Lane
	(10) Chain Conveyer (440 t/hr)	set	1	50 m x 2 Lane



Note: This figure is made based on the sounding results executed by DGOM until the end of 1984.

Fig. VII-36 Water Depth in the Inner Port

(2) Materials

The main materials needed for the construction are listed in Table VII-55. Water, fuel and electricity are not included in this table. As shown in the table, a great amount of materials are needed for the construction. Therefore, the supply method of the materials should be examined before construction.

Table VII-55 Main Construction Materials

Facilities		Main Materials					
Item	Sub Item	Steel (t)	Concrete (m^3)	Stone (m^3)	Gravel (m^3)	Asphalt (m^3)	Others
Commercial Port Facilities	1. Dredging	–	–	–	–	–	
	2. Quays	9,848	67,090	528,400	22,510	–	Rubber Fenders (124 sets) Bits (85 sets)
	3. Railway and Road	–	3,320	–	41,100	6,800	Ties (10,500 sets), Fence (1,500m) Lighting Poles and Lights (205 sets)
	4. Buildings, Transit Sheds and Warehouses	1,915	940	–	17,210	2,630	Truck Scales (2 sets)
	5. Land	–	172	–	255,500	37,900	Green Area (21,000 m^2)
	6. Water and Electric Supply, and Drainage	–	1,430	–	5,900	–	Tube (ϕ100, ϕ200), Valves, Pipe, Cable Lighting Poles, Lights, etc.
	7. Aids to Navigation	–	–	–	–	–	–
	8. Cargo Handling Equipment for Containers	–	–	–	–	–	–
	9. Cargo Handling Equipment for General Use	–	–	–	–	–	–
Fishery Port Facilities	1. Anchorage	–	–	–	–	–	–
	2. Quays	2,970	19,650	–	5,890	–	Rubber Fenders (394 sets) Bits (155 sets)
	3. Wharf Lot	–	–	–	34,000	6,000	–
	4. Road	–	1,200	–	11,600	2,140	–
	5. Fishery Industrial Lot	–	–	–	–	–	–
Outer Port Facilities	1. Terminal	–	350	–	–	–	Rubber Fenders (20 sets) Bits (15 sets)
	2. Touristic Facility	43	2,705	39,940	6,470	130	Green Area 16,560 m^2
	Total	14,776	96,857	568,340	400,180	55,600	–

6-2-2 Construction Procedure

(1) Basic concept

Dredging using a high capacity dredger, and construction work of wharves and other facilities have been executed at Manzanillo Port. The newly proposed facilities described above will be able to be constructed using the same methods as before. Equipment and labor for the construction work will be able to be obtained locally.

(2) Construction of each facility

Construction procedures of the main facilities are as follows:

1) Dredging of the channel and the anchorage

A high power dredger will be used as before. The organic soil distributed along the bottom surface of the inner part of the San Pedrito Lagoon will be dumped in the ocean 8 km away from the site. The sand will be used for the reclamation works.

2) Construction of the quay

The RC pile structure type quay is considered because this type structure has been constructed in Manzanillo Port. The comparison of the construction cost between the RC pile structure type and the steel pipe pile structure type is shown in Table VII-56.

Table VII-56 Construction Cost of the Typical Quay

(Unit: '000 pesos/m)

-13m Grain, Mineral Berth		-13m Container Berth	
RC Pile	Steel Pipe Pile	RC Pile	Steel Pipe Pile
1,503	1,902	1,720	2,285

The construction method of the RC pile type is as follows. Fig. VII-37 shows the construction procedure.

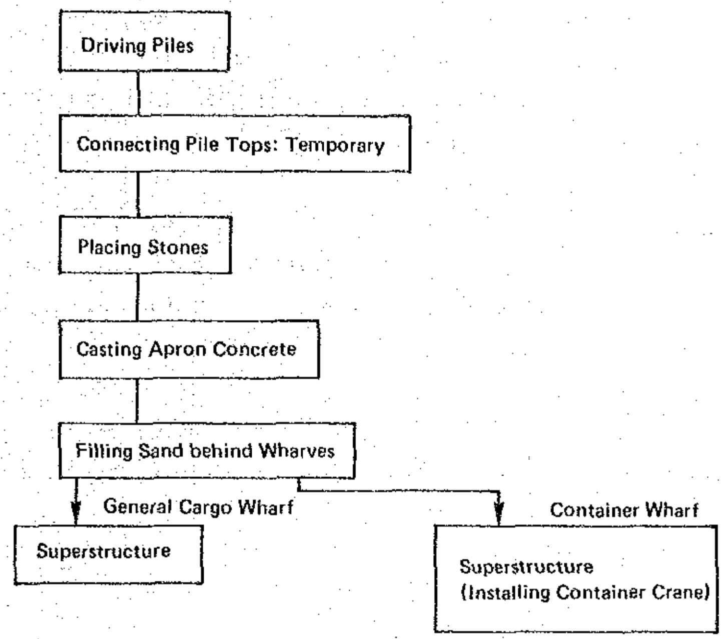


Fig. VII-37 Construction Procedure of the Quay

① Before driving piles, dredging must be carried out to the required water depth. Soft organic soil and clay are removed at this time.

② Piles must be driven into the required embedded depth using a diesel hammer of 3 ton ram weight or the equivalent. Sometimes the concrete piles can not be driven into the required embedded depth by hammer due to the existance of very stiff sand layer. At any rate, piles must be driven into the required depth. Auxiliary methods such as augering and jetting of water ware sometimes employed. These methods sometimes disturb the surrounding soil which must then be recovered by some treatment such as pouring cement milk.

③ Before placing stones, pile tops must be connected to protect them from the stones.

④ The unit length in the face line of wharf is currently 50 m. However, from the viewpoint of the thermal expansion of concrete the unit length should be 30 m or less.

3) Industrial area

The industrial area will be developed by reclaiming the Tapeixtles Lagoon. Organic soil is distributed along the bottom of the Lagoon with a thickness of 5 to 10 m. This organic soil has to be removed or improved. If it is removed using a small dredger, the soil will be dumped in the ocean 8 km away from the site. Then, the dredged sand in the inner port will be used for the reclamation of this Lagoon.

4) Quay structures at the fishery port

The quay structures at the fishery port will be of the RC pile type.

5) The wharf at the outer port

The old wharf at the outer port will be repaired for tourism. Data and informations such as the design and soil conditions of this old wharf could not be located. Therefore, the surveys listed below will be necessary.

① Overall inspection

The locations, dimensions and degree of damages of reinforced concrete piles, aprons and other facilities must be surveyed. Especially, the degree of damages, existence of cracks, lack of concrete piles and aprons, and exposure and corrosion of reinforced bars must be inspected in detaill

② Mechanical properties

The mechanical properties of concrete and reinforced bar sampled from the actual concrete piles and aprons must be investigated by the tension and compression test.

③ Soil investigation

Borings must be performed.

The required soil explorations include:

- Soil profile
- Standard penetration test (N-Value)
- Grain-size distribution

6) Sea wall at the outer port

The construction plan of the sea wall at the outer port should be decided carefully so as not to interfere with the daily operations in the immediate vicinity.

6-2-3 Construction Schedule

(1) Construction schedule

The construction schedule of the commercial port facilities is presented in Table VII-57. The construction schedules for the fishery port and the outer port are presented in Appendix 2.

Table VII-57 Construction Schedule

Item	Sub Item	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1. Dredging	(1) Channel (−14m)		—				—										
	(2) Anchorage		—	—	—		—	—	—	—	—	—	—				
	(3) Industrial Lot							—	—	—	—	—	—	—	—	—	
2. Quays	(1) −13m Mineral Bulk Berth	—	—														
	(2) The End of the Above	—	—														
	(3) −13m Grain Berth		—	—													
	(4) −13m Container Berth (Short-term Plan)			—	—												
	(5) −13m Container Berth (Master Plan)				—	—					—	—	—				
	(6) −12m General Cargo Berth											—	—	—	—		
	(7) The End of the Above													—	—		
	(8) −11m Domestic Trade Berth											—	—				
	(9) −9m Domestic Trade Berth												—	—			
	(10) The End of the Above													—	—		
	(11) Temporary Working Yard		—				—	—									
	(12) Water and Electric Supply for Construction Work		—				—	—									
	(13) Temporary Seawall					—											
3. Railway and Road	(1) Railway			—	—	—					—	—	—				
	(2) Road				—	—						—	—	—			
	(3) Fence and Gate				—	—								—			
4. Buildings, Transit Sheds and Warehouses	(1) Warehouse (No. 2)									—							
	(2) Transit Shed (No. 3)			—	—												
	(3) Transit Shed (No. 4)					—											
	(4) Transit Shed (No. 5)																—
	(5) Silo for Grain							—	—								
	(6) Maintenance Shop								—	—							
	(7) Warehouse (No. 3)																—
	(8) Warehouse (No. 4)																—
	(9) Office															—	—
	(10) Communication Facilities																—
	(11) Container Freight Station													—			

Facilitiy		Construction Year															
Item	Sub Item	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
5. Land	(1) Container Yard (Short-term Plan)					—											
	(2) Container Yard (Master Plan)													—			
	(3) Wharf Lot		—	—	—	—									—	—	
	(4) Empty Van Pool													—			
	(5) Green Area															—	—
	(6) Adjustable Area															—	—
	(7) Industrial Lot								—	—	—	—	—	—	—	—	—
6. Water and Electric Supply, and Drainage	(1) Water Supply		—	—	—	—											
	(2) Drainage		—	—	—	—											
	(3) Electric Substation					—											
	(4) Electric Supply					—											
7. Aids to Navigation	(1) Lighted Spar Buoy			—													
	(2) Lighted Buoy			—							—						
	(3) Lighted Small Buoy			—							—						
	(4) Leading Light			—													
8. Cargo Handling Equipment for Containers	(1) Gantry Crane (30.5 t)					—								—			
	(2) Forklift (33 t)					—								—			
	(3) Straddle Carrier (30.5 t)					—								—			
	(4) Trailer Head					—								—			
	(5) Container Chassis (20')					—								—			
	(6) Container Chassis (40')					—								—			
9. Cargo Handling Equipment for General Use	(1) Wheel Crane (15 t)					—						—					
	(2) Wheel Crane (9 t)								—								
	(3) Tractor				—	—			—								
	(4) Flat Chassis (10 t)				—	—							—				
	(5) Dump Truck (15 t)					—						—					
	(6) Pneumatic Unloader (200 t/hr)								—								
	(7) Hopper (200 m^3)								—								
	(8) Hopper (50 m^3)			—	—												
	(9) Belt Conveyer (440 t/hr)								—								
	(10) Chain Conveyer (440 t/hr)								—								

(2) Remarks

Concerning the construction schedule, please note the following items:

① The detailed construction schedule before 1990 (the Short-term Development Plan) is discussed in Chapter X.

② Silos for grain and related facilities will start operations before the middle of 1992.

③ The construction of the container berth will be finished before 1996. Within 1997, the container yard and equipment for the container operation will be arranged. The operation of the container station will start in 1998. This is separate from the container facility of the Short-term Plan.

④ The adjustment of the industrial area should be started from 1991 in order to be in time for the construction of the railway marshalling yard and some of the port facilities adjacent to the industrial area.

6-3 Cost Estimate

6-3-1 Estimate Conditions

(1) Estimation limit

Some limits for the estimation are as follows:

① The costs of the main port facilities in the Master Plan are estimated.

② Land rents, compensations and insurance costs are excluded from the estimation.

③ Existing port facilities are excluded from the estimation except for the −13 m berth which is under construction.

④ The cost of industrial lots only includes reclaiming and arrangement of the land. The construction cost of roads, water and electric supply, and drainage is excluded.

⑤ Dredging, quay construction, wharf and fishery industrial lots and road construction costs are only included for the estimation of the cost of fishery port facilities. These costs are estimated including existing fishery port facilities.

⑥ The repair cost for the wharf for cruising vessels, and the construction costs of the terminal, seawall, green area, parking area, mooring facilities and slipway for the launch are only included in the cost estimation for the touristic port facilities in the outer port.

⑦ Cost estimations for the fishery and the outer port facilities are presented in Appendix 2.

(2) Domestic and foreign portion

In general, the cost of the foreign portion includes the following:

① Articles and goods which have never been produced domestically

② Articles and goods which are seldom produced domestically

③ Articles and goods which cannot be supplied locally because of low domestic production and high domestic consumption

Based on the above criteria, the foreign portion comprises:

① Labor cost of the foreigners who work for foreign contractors, and the rental of equipment which belongs to foreign contractors

② Rails and attachments

③ Large size bits

④ Large size and special cargo handling equipment such as container handling equipment

⑤ Grain silos

⑥ Part of the electric supply facility, communication facilities, buildings and water supply and drainage facilities

⑦ Aids to navigation

⑧ Consulting fees for the detailed planning of the container handling facilities and railway marshalling facilities

Customs duties on the import goods are excluded in the cost estimation.

(3) Exchange rate

Eschange rate among U.S.$, Mexican Peso and Japanese Yen are as follows:

1 U.S.$ = 192 pesos = 240 Yen

Construction costs are estimated using the price at the end of 1984.

(4) Physical contingency

Estimated costs include physical contingency. Contingency rates are as follows:

0%	Imported cargo handling equipment
5%	Dredging cost, construction cost of roads and land Domestic cargo handling equipment
10%	Construction costs of the quays, seawall, buildings, transit sheds, warehouses, railway, water and electric supply facilities, drainage facilities and aids to navigation
15%	Communication facilities

6-3-2 Estimation Procedure

The estimation procedure is as follows:

① The prices of main materials using the cost estimation are listed below.

Concrete (pesos/m^3)	Stone (pesos/m^3)	Gravel (pesos/m^3)	Steel (pesos/kg)	Asphalt (pesos/m^3)
7,000 ~ 8,000	560	900	60	12,000

② Prices in Japan are used for the estimation of the costs of imported materials and goods.

③ If the prices are unavailable, they are estimated by comparing the prices of other goods both in Mexico and Japan.

④ An administration cost is fixed as 20% of the total construction cost at the site.

⑤ The additional tax rate on the materials is estimated as 15%.

6-3-3 Estimation Result

The summary of the construction cost estimate is presented in Table VII-58. The construction cost of each of the facilities is listed in Table VII-59.

The construction costs of the fishery port and the outer port facilities are included in Appendix 2.

Table VII-58 Construction Costs (Commercial Port)

Facility	Construction Cost ('000 pesos)		
	Total	Foreign Portion	Local Portion
1. Dredging	4,031,400	1,286,000	2,745,400
2. Quays	3,281,000	105,200	3,175,800
3. Railway and Road	573,000	274,000	299,000
4. Buildings, Transit Sheds, and Warehouses	4,971,000	2,611,000	2,360,000
5. Land	1,096,000	–	1,096,000
6. Water and Electric Supply, and Drainage	1,491,000	482,000	1,009,000
7. Aids to Navigation	89,000	78,500	10,500
8. Cargo Handling Equipment for Containers	2,126,000	2,126,000	–
9. Cargo Handling Equipment for General Use	1,316,200	1,198,000	118,200
Sub Total	18,974,600	8,160,700	10,813,900
Tax	887,395	–	887,395
Total	19,861,995	8,160,700	11,701,295

Table VII-59 Construction Cost of Each of the Facilities

Facility		Unit	Quantity	Construction Cost ('000 pesos)		
Item	Sub Item			Total	Foreign Portion	Local Portion
1. Dredging	(1) Channel (−14m)	m^3	465,000	297,900	100,000	197,900
	(2) Anchorage	m^3	4,600,000	2,946,000	988,000	1,957,000
	(3) Industrial Lot	m^3	1,500,000	787,500	197,000	590,500
2. Quays	(1) −13m Mineral Bulk Berth	m	300	496,000	21,000	475,000
	(2) The End of the Above	m	25	38,000	1,200	36,800
	(3) −13m Grain Berth	m	300	492,000	17,000	475,000
	(4) −13m Container Berth (Short-term Plan)	m	300	588,000	28,000	560,000
	(5) −13m Container Berth (Master Plan)	m	300	588,000	28,000	560,000
	(6) −12m General Cargo Berth	m	250	378,000	5,000	373,000
	(7) The End of the Above	m	50	70,000	−	70,000
	(8) −11m Domestic Trade Berth	m	200	270,000	3,000	267,000
	(9) −9m Domestic Trade Berth	m	170	213,000	−	213,000
	(10) The End of the Above	m	80	94,000	−	94,000
	(11) Temporary Working Yard	m^2	40,000	9,000	−	9,000
	(12) Water and Electric Supply for Construction Work	set	1	22,000	2,000	20,000
	(13) Temporary Seawall	m	250	23,000	−	23,000
3. Railway and Road	(1) Railway	m	6,200	284,000	194,000	90,000
	(2) Road	m	4,100	280,000	80,000	200,000
	(3) Fence and Gate	m	1,500	9,000	−	9,000
4. Buildings, Transit Sheds and Warehouses	(1) Warehouse (No. 2)	m^2	6,400	250,000	20,000	230,000
	(2) Transit Shed (No. 3)	m^2	7,500	305,000	25,000	280,000
	(3) Transit Shed (No. 4)	m^2	7,500	305,000	25,000	280,000
	(4) Transit Shed (No. 5)	m^2	4,000	163,000	14,000	149,000
	(5) Silo for Grain	set	1	1,980,000	1,800,000	180,000
	(6) Maintenance Shop	m^2	2,500	138,000	41,000	97,000
	(7) Warehouse (No. 3)	m^2	8,100	330,000	27,000	303,000
	(8) Warehouse (No. 4)	m^2	4,000	163,000	14,000	149,000
	(9) Office	m^2	10,000	1,000,000	550,000	450,000
	(10) Communication Facilities	set	1	100,000	70,000	30,000
	(11) Container Freight Station	m^2	5,500	237,000	25,000	212,000

Facility		Unit	Quantity	Construction Cost ('000 pesos)		
Item	Sub Item			Total	Foreign Portion	Local Portion
5. Land	(1) Container Yard (Short-term Plan)	m^2	57,000	153,000	–	153,000
	(2) Container Yard (Master Plan)	m^2	99,000	270,000	–	270,000
	(3) Wharf Lot	m^2	265,000	390,000	–	390,000
	(4) Empty Van Pool	m^2	25,000	69,000	–	69,000
	(5) Green Area	m^2	21,000	159,000	–	159,000
	(6) Adjustable Area	m^2	35,000	8,000	–	8,000
	(7) Industrial Lot	m^2	224,000	47,000	–	47,000
6. Water and Electric Supply, and Drainage	(1) Water Supply	set	1	183,000	14,000	169,000
	(2) Drainage	set	1	198,000	12,000	186,000
	(3) Electric Substation	KVA	15,000	330,000	66,000	264,000
	(4) Electric Supply	set	1	780,000	390,000	390,000
7. Aids to Navigation	(1) Lighted Spar Buoy	set	4	43,000	41,000	2,000
	(2) Lighted Buoy	set	6	20,000	19,000	1,000
	(3) Lighted Small Buoy	set	2	6,000	5,500	500
	(4) Leading Light	set	2	20,000	13,000	7,000
8. Cargo Handling Equipment for Containers	(1) Gantry Crane (30.5 t)	set	2	1,220,000	1,220,000	–
	(2) Forklift (33 t)	set	2	96,000	96,000	–
	(3) Straddle Carrier (30.5 t)	set	6	540,000	540,000	–
	(4) Trailer Head	set	2	152,000	152,000	–
	(5) Container Chassis (20')	set	3	66,000	66,000	–
	(6) Container Chassis (40')	set	2	52,000	52,000	–
9. Cargo Handling Equipment for General Use	(1) Wheel Crane (15 t)	set	2	40,000	–	40,000
	(2) Wheel Crane (9 t)	set	1	9,300	–	9,300
	(3) Tractor	set	8	528,000	528,000	–
	(4) Flat Chassis (10 t)	set	12	16,400	–	16,400
	(5) Dump Truck (15 t)	set	5	26,500	–	26,500
	(6) Pneumatic Unloader (200 t/hr)	set	4	160,000	160,000	–
	(7) Hopper (200 m^3)	set	3	126,000	120,000	6,000
	(8) Hopper (50 m^3)	set	6	63,000	60,000	3,000
	(9) Belt Conveyer (440 t/hr)	set	1	315,000	300,000	15,000
	(10) Chain Conveyer (440 t/hr)	set	1	32,000	30,000	2,000

Note: Costs in this table exclude additional tax.

CHAPTER VIII.
SHORT-TERM DEVELOPMENT PLAN

CHAPTER VIII SHORT-TERM DEVELOPMENT PLAN

1. Purpose of the Short-term Development Plan

1-1 Basic Policy

The Short-term Development Plan (hereinafter referred to as "Short-term Plan") for Manzanillo Port is a development plan for the target year 1990. Although the Master Plan determines the Port's overall future development course, the aim of the Short-term Plan is to concretely propose the improvement of port facilities which should take place by 1990.

The Short-term Plan is drawn up based on various technical, economic and financial evaluations.

The purpose of this chapter is:

① To prepare alternative options for the Short-term Plan through examining possible sites and the scale of the facilities which will be required.

② To evaluate and select the best development plan from the above alternative options.

The following items have to be considered in formulating the Short-term Plan.

① The Short-term Plan is a stage plan to realize the Master Plan.

② The proposed short-term port facilities should have enough capacity to handle the forecast cargo volume in the target year 1990.

③ Existing commercial port functions in the outer port excluding the PEMEX oil facility will be abolished by the target year 1990.

④ In preparing the Short-term Plan, the actual situation of the Port has to be fully considered.

1-2 Goals of the Short-term Plan

The major goals of the Short-term Plan are increasing the capacity of the Port in order to respond to increased demand, and improving operations.

Considering that port facilities are being constructed at present, it is clear that the capacity of the Port has to be increased. This can be accomplished through renovating existing facilities as well as by building new ones.

The improvement of operating procedures will not only increase efficiency at the Port, but will also effectively expand cargo handling capacity by enabling maximum utilization of port facilities. The improvement of operations in the commercial port is considered in detail in the next chapter.

2. Site Selection

Essentially, the site of the Short-term Plan is determined by the site of the Master Plan. As mentioned in Chapter VII, in the case of Manzanillo Port, the space for future development is extremely limited.

In drawing up both short- and long-term plans, various alternative sites are usually considered. Due to the space restrictions at Manzanillo Port, this is not possible here.

As in the Master Plan, for the Short-term Plan the new facilities for the commercial port will be located between the 600 m wharf currently under construction and the fishery port. As for the fishery port, new facilities will be located adjacent to existing wharves.

3. Scale of the Port Facilities

3-1 Commercial Port

3-1-1 Cargo Volume to be Handled in 1990

The demand forecast of cargo other than petroleum and its derivatives to be handled at the port of Manzanillo in 1990 is carried out in Chapter VI. Table VIII-1 shows the summary forecast cargo volume by each package type.

Table VIII-1 Summary of Cargo Movement in 1990

(Unit: '000t)

Package Type	Grand Total	Foreign Trade			Domestic Trade		
		Export	Import	Total	Out	In	Total
Agricultural Bulk	813	–	813	813	–	–	–
Mineral Bulk	477	180	154	334	36	107	143
Broken General Cargo	824	91	696	787	37	–	37
Container Cargo	190	66	124	190	–	–	–
Total	2,304	337	1,787	2,124	73	107	180

In order to formulate the Short-term Plan corresponding to this cargo volume, the necessary number of berths is estimated using two methods:

① the method considering the frequency of ship entry and handling capacity

② the method of simulation by queuing theory

3-1-2 Cargo Handling Efficiency in 1990

Table VIII-2 shows the cargo handling efficiency at Manzanillo Port in 1990. The cargo handling efficiency in 2000 and at present are described in Chapter VII. The value in 1990 is estimated referring to the value in 2000 and the present value.

Table VIII-2 Cargo Handling Efficiency in 1990

Package Type	Item	Efficiency
General Cargo	Average handling performance Working efficiency Working conditions	80 t/hour・ship 0.7 2 gangs/ship, ship gear
Container	Average handling performance Working efficiency Working conditions	30 TEU/hour・ship 0.7 1 container gantry crane + 1 truck crane
Agricultural Bulk	Average handling performance Working efficiency Working conditions	180 t/hour・ship 0.7 Ship gear with bucket, 50 m^3 capacity new hopper
Mineral Bulk	Average handling performance Working efficiency Working conditions	350 t/hour・ship (cement) 160 t/hour・ship (others) 0.7 (cement) 0.6 (others) Loading conveyor belt (cement) Ship gear with glove bucket (others)

3-1-3 Required Number of Berths by the Method Considering the Frequency of Ship Entry and Handling Capacity

(1) General cargo wharf

The volume of general cargoes in 1990 is estimated as 787 thousand tons in foreign trade, 37 thousand tons in domestic trade and 824 thousand tons in total, as shown in Table VIII-1.

Assuming that the foreign trade and domestic trade operations will not be completely separated by 1990, the berths required for general cargoes will have to cope with this cargo volume of 824 thousand tons. For calculating, the following conditions are assumed:

① The volume of general cargoes handled in 1990 excluding containerized cargoes is 824,000 tons.

② The average cargo handling performance is 80 tons/hour・ship, and working efficiency is 0.7, as shown in Table VIII-2.

③ The average per-ship loading/unloading volume is 2,300 tons. The 2,300 tons figure is forecast based on the actual average value and on the forecast value of 2,500 tons in 2000.

④ The number of days available for using berths is 330 days per year, and the number of hours that cargo is handled per day is 18 hours, the same as in the Master Plan.

⑤ Days necessary for purposes other than cargo handling are presumed to be 0.5 days per ship.

Based on the above assumptions, the berth occupancy ratio is determined by the number of berths in the same way as mentioned in Chapter VII, as shown in Table VIII-3.

Table VIII-3 Berth Occupancy Ratio by Number of Berths

Number of Berths	Berth Occupancy Ratio	Estimate
4	0.76	Δ
5	0.61	O
6	0.51	X

According to the above calculations, the number of berths required as general cargo berths is four or five.

By the way, as for the estimated volume of container cargoes of 190,000 tons to be handled in 1990, it is considered uneconomical to improve one berth for the exclusive use of container cargoes. The estimated volume of container cargoes in 1990 is too small to justify such an expense. So for the Short-term Plan, the number of berths required is estimated based on the assumption that container cargoes are handled together with general cargoes.

In this case, as the number of berths varies by the cargo handling efficiency of container cargoes, it is estimated for the following two cases.

Case A – Using 1 container gantry crane (efficiency: 30 TEU/hour·ship x 0.7)

Case B – Using the present handling system (efficiency: 12 TEU/hour·ship x 0.6)

For calculating the number of berths, the following conditions are assumed:

① The volume of container cargoes handled in 1990 is 190,000 tons.

② The per-container cargo volume is 14 tons.

③ It is assumed that the per-ship number of loaded containers that are loaded or unloaded is 250 TEU. The 250 TEU per ship figure is forecast based on the current handling patterns of loaded containers at the Port. It is said that an average of 200 to 250 TEU per ship is presently handled at Manzanillo Port. Since the import/export ratio for container cargo in 1990 is 65% for import and 35% for export, the ratio of empty containers to loaded containers is 30%. So, the per-ship number of containers to be handled is forecast as 325 TEU.

④ The number of days available for using berths is 330 days per year. The operating hours for the container cargoes are 18 hours a day.

⑤ Days necessary for purpose other than cargo handling are presumed to be 0.5 days per ship.

Based on the above assumptions, the total number of mooring days of container ships is calculated.

Accordingly, using this number, the berth occupancy ratio of general cargo wharves (including container cargo) is determined by the number of berths and the case, as shown in Table VIII-4.

Table VIII-4 Berth Occupancy Ratio by Case and Number of Berths

Case A			Case B		
Number of Berths	Berth Occupancy Ratio	Estimate	Number of Berths	Berth Occupancy Ratio	Estimate
4	0.82	X	4	0.89	X
5	0.66	O	5	0.71	Δ
6	0.55	Δ	6	0.59	Δ

Thus, by this method, the number of berths required as general and container cargo berths is five or six.

(2) Grain wharf

The estimated volume of grain cargoes in 1990 is 813,000 tons in total.

The number of berths to be required for grain cargoes is estimated in the same way as for the general cargoes, based on the following assumptions:

① The average cargo handling performance is 180 tons/hour·ship, and the working efficiency is 0.7, as shown in Table VIII-2.

② The average per-ship loading/unloading volume is 20,000 tons. The 20,000 tons is forecast based on the actual average value and the estimated value of 21,000 tons 2000.

③ The berths are available for use 330 days per year. The cargo handling hours per day are assumed to be 18 hours.

④ Days necessary for purposes other than cargo handling are presumed to be 1.0 day per ship.

Table VIII-5 shows the estimated berth occupancy ratio by the number of berths.

Table VIII-5 Berth Occupancy Ratio by Number of Berths

Nmber of Berths	Berth Occupancy Ratio	Estimate
1	1.22	X
2	0.61	O
3	0.41	X

So, considering the above results, the number of berths required as grain berths is two.

(3) Mineral bulk wharf

The number of berths required as mineral bulk berths is also estimated by the same method based on the premise that domestic and foreign trade operations will not be clearly separated in 1990.

For calculating, the following conditions are assumed:

① The volume of mineral bulk cargoes handled in 1990 is 477,000 tons in total.

② The average cargo handling performance is 350 tons/hour·ship for cement and 160 tons/hour·ship for other mineral bulk. The working efficiency is 0.7 for cement and 0.6 for other mineral bulk.

③ The average per-ship loading/unloading volume is 15,000 tons.

④ The berths are available for use 330 days per year. The cargo handling hours per day are assumed to be 18 hours.

⑤ Days necessary for purposes other than cargo handling are presumed to be 1.0 day per ship.

Based on these assumptions, the berth occupancy ratio is determined by the number of berths, as shown in Table VIII-6.

Table VIII-6 Berth Occupancy Ratio by Number of Berths

Number of Berths	Berth Occupancy Ratio	Estimated
1	0.59	O
2	0.30	X

Accordingly, the number of berths required as mineral bulk cargo berths is one.

3-1-4 Estimate of the Required Number of Berths Using the Method of Simulation by Queuing Theory

According to the method considering the frequency of ship entry and handling capacity, it is clear that the number of berths required as grain berths and mineral bulk berths in 1990 are two and one. However, this method alone should not be used to determine the appropriate number of berth required as general cargo berths (including container cargoes). So, the appropriate number of berths required in 1990 has to be examined using the simulation test.

(1) Simulation cases

Simulation tests are carried out for three cases as shown in Table VIII-7.

In case A, the number of berths to be improved by 1990 is 8 in total, and one container gantry crane is planned for container cargoes on the new wharf.

In case B, 9 berths are improved by 1990 instead of installing a container gantry crane.

Case C is only calculated for verification purposes. The aim of calculating this case is to verify that the construction of berths is economical. In this case, the number of berths in 1990 is 7.

Table VIII-7 Simulation Test Cases

Case Number	Number of Berths in the Commercial Port		
	Total Berths	New Berths	Existing Berths
Case A	8	3	5
Case B	9	4	5
Case C	7	2	5

(2) Premises for the simulation

The simulation tests for these cases are carried out under the same conditions as for the Master Plan except for the system of mooring. Specifically, for the Short-term Plan, simulation tests are carried out assuming that all different cargo type vessels can use any of the berths if these berths are unoccupied, from the viewpoint of efficiently using the limited number of berths.

Moreover, as mentioned before, it is assumed that the foreign trade and domestic trade operations will not be completely separated by 1990.

(3) Input data

Table VIII-8 shows the simulation test input data for each case by type of berth in 1990.

(4) Simulation test results

The results of simulation tests are shown in Table VIII-9.

As the exclusive use of berths is not considered in the Short-term Plan, all the output items are represented by average values.

Judging from the criteria for evaluating the results of simulation tests mentioned in Chapter VII, Case C will cause the greatest congestion of the port in 1990. On the other hand, Case B shows a very comfortable situation for port activity in 1990 compared with Case A.

However, Case B requires much more investment than Case A. In any case, the appropriate number of berths will be selected between Case A and Case B.

Table VIII-8 Simulation Test Input Data

Type of Berth	Rank of Ship Size ('000 DWT)	Number of Ships	Case A		Case B		Case C	
			Number of Berths	Serive Time (hours)	Number of Berths	Service Time (hours)	Number of Berths	Service Time (hours)
General Cargo	~ 10	52	8	36.0	9	36.0	7	36.0
	10 ~ 20	188		72.0		72.0		72.0
	20 ~ 30	96		72.0		72.0		72.0
	30 ~ 40	3		84.0		84.0		84.0
	40 ~	3		156.0		156.0		156.0
Agricultural Bulk	20 ~ 30	37		232.8		232.8		232.8
	30 ~ 40	4		247.2		247.2		247.2
Mineral Bulk	20 ~ 30	20		136.8		136.8		136.8
	30 ~ 40	2		182.4		182.4		182.4
Container	~ 10	23		30.0		48.0		48.0
	10 ~ 20	22		50.4		86.4		86.4
	20 ~ 30	5		68.4		122.4		122.4
General Cargo (Domestic)	~ 5	11		50.4		50.4		50.4
	5 ~ 10	4		96.0		96.0		96.0
	10 ~ 15	1		156.0		156.0		156.0
Mineral Bulk (Domestic)	5 ~ 10	4		134.4		134.4		134.4
	10 ~ 15	1		163.2		163.2		163.2
	20 ~	5		328.8		328.8		328.8

Table VIII-9 Simulation Test Results by Case

Items of Output	Results of Calculation		
	Case A	Case B	Case C
1. Average Berth Occupancy Ratio	0.55	0.50	0.65
2. Ship Waiting Ratio (%)			
2-1 Ratio of Waiting Ships to Ship Entry (%)	20.0	7.3	41.4
2-2 Ratio of Waiting Time to Mooring Time (%)	7.1	1.6	20.9
3. Per Ship Waiting Time (hours)	6.0	1.5	18.5

3-1-5 Cargo Handling and Storage Facilities in 1990

The movement of various cargoes at Manzanillo Port in 1990 is forecast using the same method as in Chapter VII.

Table VIII-10 shows the cargo volume passing through storage facilities and storeyards in 1990 by package type.

Table VIII-10 Volume of Cargoes Passing through Storage Facilities and Storeyards in 1990

(Unit: '000 t)

Package Type		Total Cargo Volume	Direct Cargo	Indirect Cargo		
				Storeyards	Storage Facilities	Sub-total
General Cargo excluding Scrap Iron	Foreign	727	163	356	208	564
	Domestic	37	15	14	8	22
	Sub-total	764	178	370	216	586
Scrap Iron	Foreign	60	6	54	–	54
Container Cargo	Foreign	190	57	133	–	133
Mineral Bulk Cargo	Foreign	334	154	–	180	180
	Domestic	143	107	–	36	36
	Sub-Total	477	261	–	216	216
Total		1,491	502	557	432	989

Accordingly, from the above table, the necessary area of storage facilities and storeyards in 1990 can be estimated each for general cargoes and mineral bulk cargoes.

(1) Size of storage facilities for general cargoes

Necessary area of storage facilities is calculated as follows:

$$\frac{216,000}{20 \times 0.5 \times 1.5} = 14,400 \text{ m}^2$$

Judging from the net area of existing facilities of about 7,500 m^2, the net area of storage facilities that have to be newly constructed by 1990 is 6,900 m^2.

So, the required total area of new storage facilities is estimated, as follows:

Required total area = 6,900/0.6 = 11,500 m^2

The 0.6 figure is assumed based on the relation between the net area and total area of existing storage facilities.

Table VIII-11 shows the calculated required scale in 1990 and the proposed scale in the Short-term Plan for the storage facilities to be newly constructed.

Table VIII-11 Scale of Storage Facilities to be Newly Constructed

(Unit: m^2)

Package Type	Calculated Required Scale in 1990	Proposed Scale in the Short-term Plan
General Cargo	11,500	15,000

(2) Size of storage facilities for mineral bulk cargoes

The only mineral bulk cargo that will have to be stored is cement. Cement is generally stored in a silo. As we hear that the construction of a silo is already scheduled by a private company in the existing port area, we do not include any additional storage facilities for mineral bulk cargoes in the Short-term Plan.

3-2 *Fishery Port*

3-2-1 Volume to be Handled

As described in Chapter VI, the estimated fish catch to be handled at Manzanillo Port in 1990 is 70,000 tons.

3-2-2 Required Scale of the Basic Facilities

As for the fishery port, the required scale of the basic facilities in 1990 is calculated in the same way as for the Master Plan in Chapter VII. Accordingly, a detailed explanation for this calculation is omitted in this section.

(1) Projected use of the fishery port in 1990

By assuming a ratio of annual landing volume to standard landing volume of 150, the standard landing volume in 1990 is estimated as 467 tons.

The ratio of different tonnage-class fishing boats at Manzanillo Port in 1990 is estimated as in Table VIII-12 from the 1981 ratio and the 2000 prediction.

Table VIII-12 Estimated Ship Size

Year	Item	Ship Size (G/T)						Total
		~5	5~20	20~50	50~100	100~500	500~	
1981	Number of Boats	160	23	7	58	14	–	262
	Share (%)	61	9	3	22	5	–	100
1990	Share (%)	△3% 58	+1% 10	+1% 4	22	5	+1% 1	100
2000	Share (%)	△6% 55	+1% 10	+2% 5	22	5	+3% 3	100

From the relation between the number of boats and landing volume as shown in Table VII-34, the number of fishing boats and landing volume in 1990 is forecast as shown in Table VIII-13.

Table VIII-13 Number of Fishing Boats and Landing Volume in 1990

Item	Sign	Ship Size (G/T)						
		~5	5~20	20~50	50~100	100~500	500~	Total
Number of Fishing Boats per Year (boats)	A	244	42	17	92	21	4	420
Average Landing Volume (t)	B	0.6	3	12	24	60	150	
Voyage Days (days)	C	1	3	5	10	30	60	
Number of Boats per Standard Day	D=A/C	*195	*11	3	9	1	1	220
Landing Volume (t)	E=DxB	117	33	36	216	60	150	612

Note: * Boats less than 20 G/T are presumed to be at port 80% of the time.

(2) Calculation of the scale of fishery wharves

1) Landing wharf

The landing wharf is calculated as shown in Table VIII-14.

Table VIII-14 Landing Wharf Caluclation

Water Depth (m)	Ship Size (G/T)	Standard Ship Size ① (G/T)	Maximum Draft (m)	Ship Length (m)	Berth Length ② (m)	Number of Boats ③ (boats)	Assumed Time Available for Fish Landing ④ (hours)	Landing Time per Boat ⑤ (hours)	Turnover ⑥=④/⑤	Proposed Number of Berths ⑦=③/⑥	Total Length of Berth ⑧=②×⑦ (m)
below -2.0	~ 5	2	0.7	9	3	195	2	0.3	6	33	99
-2.0~-3.0	5~ 20	10	1.6	16	20	11	6	1.0	6	2	40
-3.0~-4.0	20~ 50	40	2.5	22	30	3	6	2.0	3	1	30
-4.0~-5.0	50~100	80	3.1	29	35	9	6	3.0	2	5	175
-5.0~-6.0	100~500	200	3.6	40	45	1	6	6.0	1	1	45
over -6.0	500~	500	4.9	56	60	1	6	11.0	0.55	2	120
											509

2) Preparatory wharf

The preparatory wharf is calculated as shown in Table VIII-15.

Table VIII-15 Preparatory Wharf Calculation

Water Depth (m)	Ship Size (G/T)	Standard Ship Size ① (G/T)	Maximum Draft (m)	Ship Length (m)	Berth Length ② (m)	Number of Boats ③ (boats)	Assumed Time Available for Preparatory ④ (hours)	Preparatory Time per Boat ⑤ (hours)	Turnover ⑥=④/⑤	Proposed Number of Berths ⑦=③/⑥	Total Length of Berth ⑧=②×⑦ (m)
below -2.0	~ 5	–	–	–	–	–	–	–	–	–	–
-2.0 ~ -3.0	5 ~ 20	10	1.6	16	20	11	8	1	8	2	40
-3.0 ~ -4.0	20 ~ 50	40	2.5	22	30	3	8	2	4	1	30
-4.0 ~ -5.0	50 ~ 100	80	3.1	29	35	9	8	2	4	3	105
-5.0 ~ -6.0	100 ~ 500	200	3.6	40	45	1	8	4	2	1	45
over -6.0	500 ~	500	4.9	56	60	1	8	4	2	1	60
Total											280

3) Rest wharf

The rest wharf is calculated as shown in Table VIII-16.

Table VIII-16 Rest Wharf Calculation

Water Depth (m)	Ship Size (G/T)	Standard Ship Size ① (G/T)	Maximum Draft (m)	Ship Width (m)	Ship Width + Allowance ② (m)	Number of Boats ③	Required Length of Wharf ④=②×③ (m)
below -2.0	~5	2	0.7	2.3	3.0	33	99
-2.0 ~ -3.0	5 ~ 20	10	1.6	3.5	4.0	11	44
-3.0 ~ -4.0	20 ~ 50	40	2.5	5.1	6.0	3	18
-4.0 ~ -5.0	50 ~ 100	80	3.1	6.1	7.0	9	63
-5.0 ~ -6.0	100 ~ 500	200	3.6	7.6	8.5	1	8.5 (10m)
Over -6.0	500 ~	500	4.9	9.4	10.5	1	10.5 (20m)
Total							254

Note: Figures in parentheses represent a proposed length for the Short-term Plan.

(3) Proposed scale of the fishery wharf

The total length of wharves to be improved by the target year in 1990 is shown in Table VIII-17.

Table VIII-17 Fishery Wharf

(Unit: m)

Type of Wharf	Length of Wharf				Proposed Total Length
	Landing Wharf		Preparatory and Rest Wharf		
	Calculated	Proposed	Calculated	Proposed	
-4m	169	170	231	130	300
-7m	340	340	303	280	620

Although the proposed length for preparatory and rest functions is shorter than the calculated length, this should present no problem because the wharf will be utilized cooperatively.

3-2-3 Required Scale of the Functional Facilities

The required scale of the major facilities is also calculated in the same way as in the Master Plan.

Table VIII-18 shows the results of calculation and proposed scale for the Short-term Plan.

Table VIII-18 Proposed Functional Facilities for the Fishery Port

(Unit: m^2)

Facility	Calculated Area	Proposed Area
Fish Handling Shed	8,160	10,900
Ice Making and Ice Storage Facility	700	4,900
Cold Storage Facility	2,160	
Parking Lot	9,922	Utilize vacant land

4. Alternative Options for the Short-term Plan

In formulating the Short-term Plan, factors to be considered include:

① Efficient handling of various cargoes and fishes

② Minimizing the investment

③ Ensuring a smooth shift to the next plan

As mentioned in "Site Selection", judging from the shape of the Master Plan and the present situation, it is not only economical but also convenient for the use of port facilities to locate the new berths from the base of the existing 600 m wharf.

Further, the shape of the fishery port also cannot be changed freely because a new wharf of about 670 m has been developed.

Accordingly, in preparing alternative options for the Short-term Plan of Manzanillo Port, the variable factors are the number of berths and the location of each of the berths in the commercial port.

The alternative options are prepared as shown in Fig. VIII-1 to VIII-3.

Under Plan A, the total number of berths in the target year is 8, and the three new berths are located straight from the base of existing wharves. On the deepest wharf, one container gantry crane is installed for realizing the efficient handling of container cargoes and the quick dispatch of ships. However, this wharf is not a permanent facility for handling container cargoes.

In Plan B, instead of installing a container crane, one more berth is improved as compared with Plan A. So, the total of berths in the target year is 9, and the four new berths are located straight from the base of existing wharves.

In Plan C, the total number ob berths in the target year is 8, the same as in Plan A. However, the location of the facility where container cargoes are mainly handled differs from Plan A. The wharf on which a container crane is installed in Plan C is the container terminal in the Master Plan.

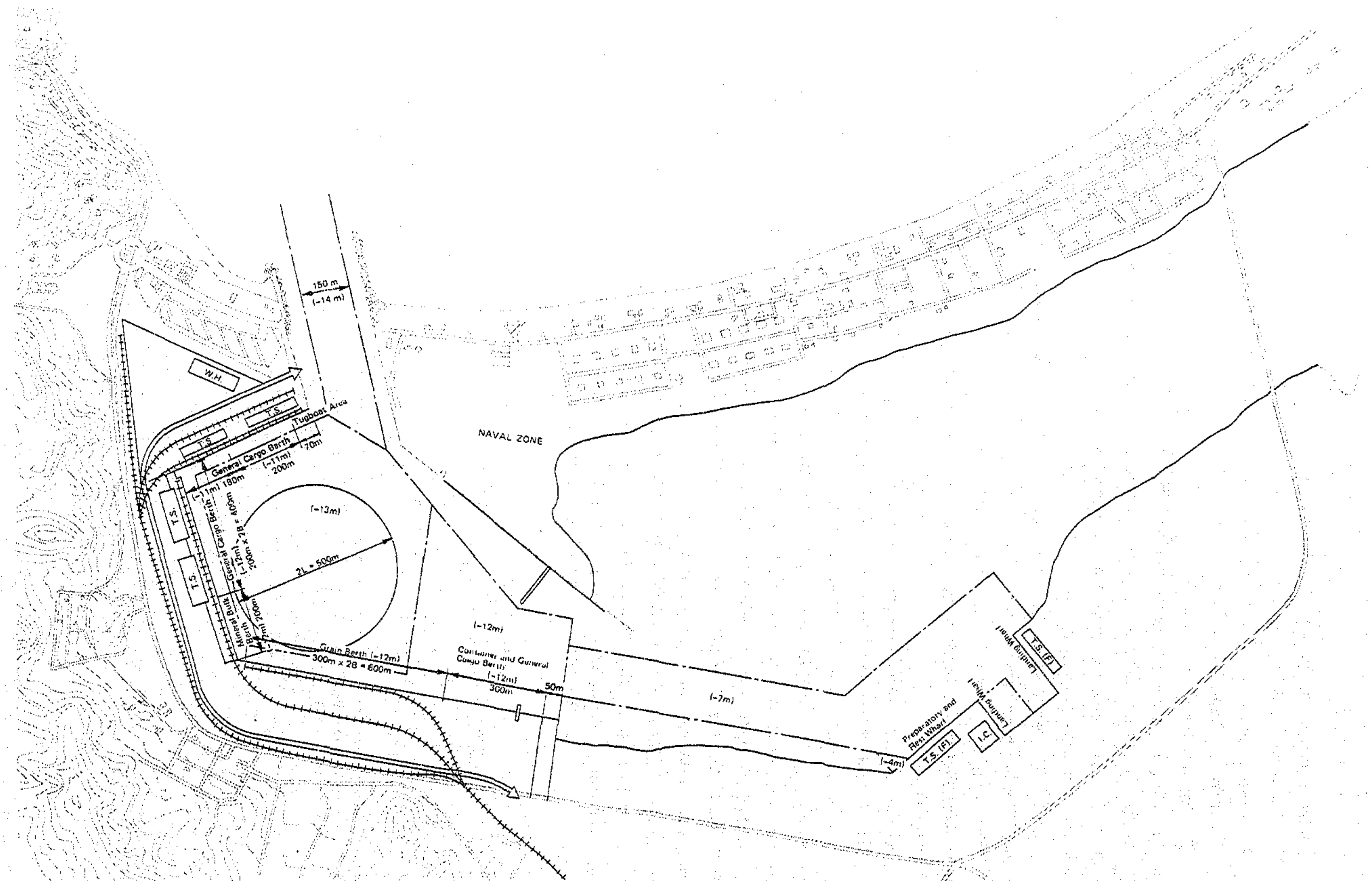


Fig. VIII-1 Alternative Short-term Plan A

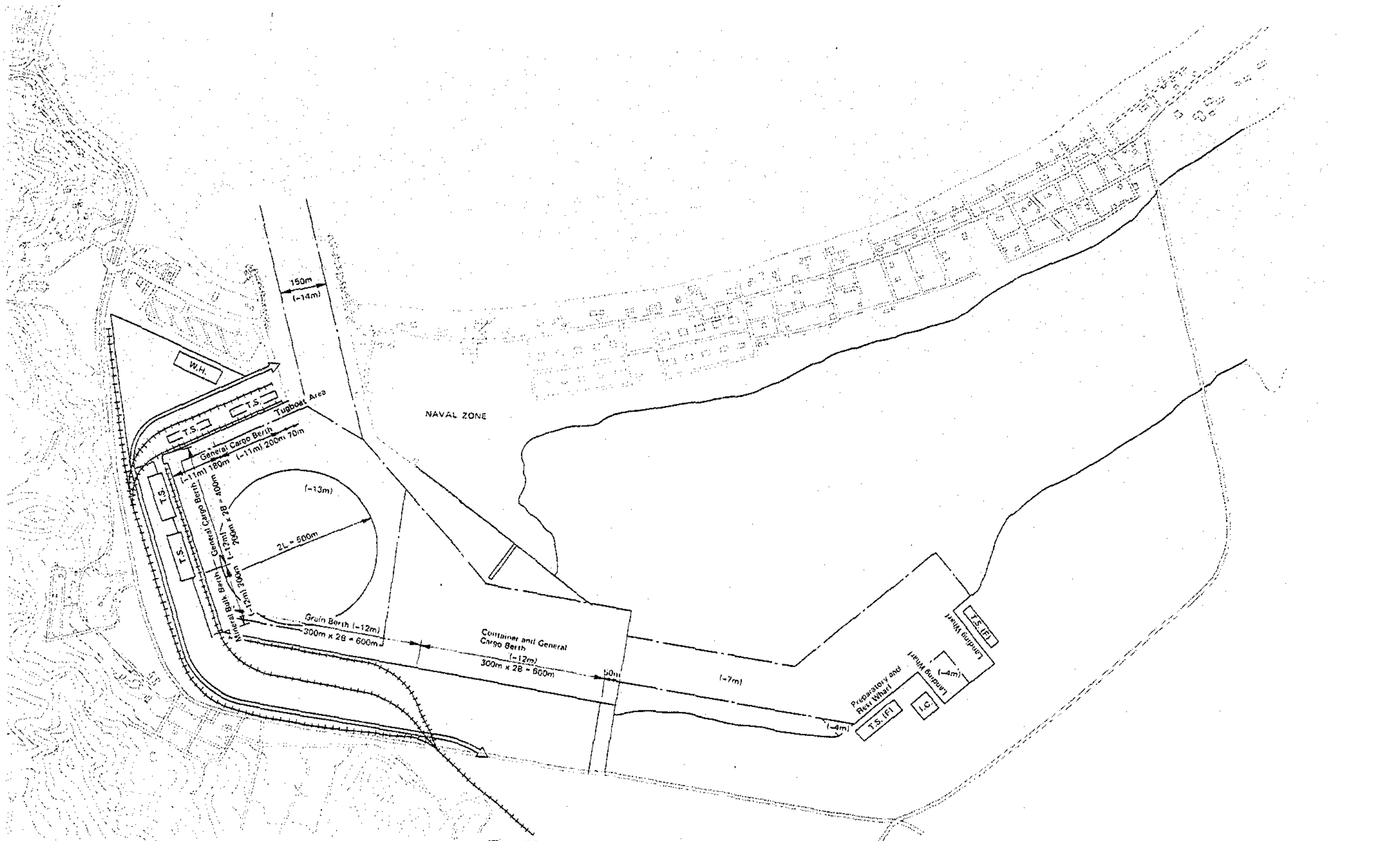


Fig. VIII-2 Alternative Short-term Plan B

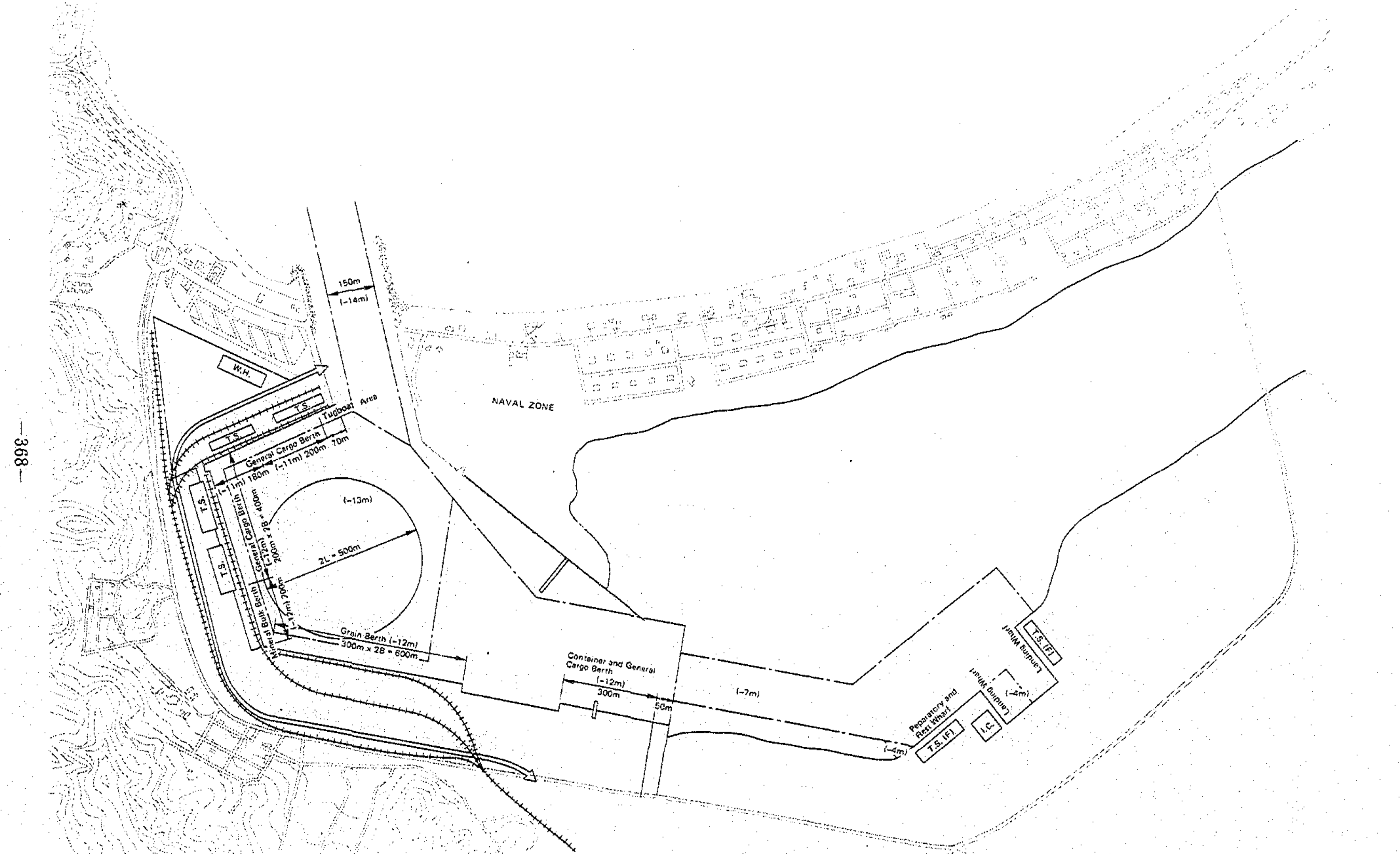


Fig. VIII-3 Alternative Short-term Plan C

As for the fishery port, the face line is already determined by the Master Plan. So, as the Short-term Plan for the fishery port, the design shown in Fig. VIII-4 is proposed from the viewpoint of minimizing investment.

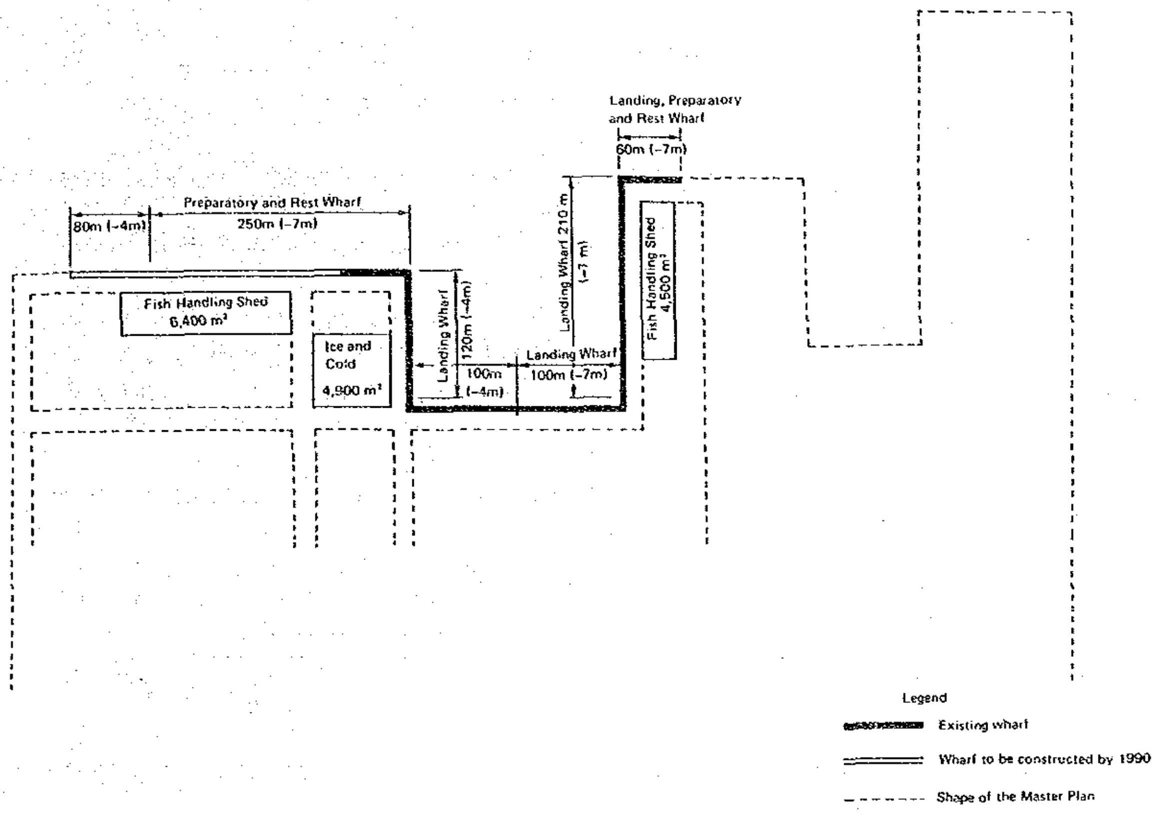


Fig. VIII-4 Fishery Port Facilities Layout in 1990

5. Short-term Development Plan

The alternatives, Plan A, Plan B and Plan C, are evaluated from the following viewpoints as shown in Table VIII-19.

Table VIII-19 Items and Viewpoints of Evaluation

Items of Evaluation	Viewpoints of Evaluation
(1) Efficient Use and Operation of Facilities	Can the efficient use and operation of port facilities be realized by the layout of facilities?
(2) Containerization	Is it possible to cope with containerization soon and completely?
(3) Continuity to the Master Plan	Can facilities provided under the Short-term Plan be readily shifted for use under the Master Plan?
(4) Relation to Existing Wharves	Can the plan fully satisfy scale and functional requirements without having a harmful influence on the existing wharves?
(5) Possibility of Early Utilization	Is there any factor which would greatly hamper early use?
(6) Amount of Investment	What is the amount of investment? Will the money invested and put into the construction prove to have been spent wisely?

The results of the assessment of the three alternative plans using the above criteria are tabulated in the below Table VIII-20.

Table VIII-20 Evaluation of Alternative Plans

Items of Evaluation	Evaluation		
	Plan A	Plan B	Plan C
(1) Efficient Use and Operation	◎	○	△
(2) Containerization	◎	△	◎
(3) Continuity to the Master Plan	○	◎	◎
(4) Relation to Existing Wharves	◎	◎	◎
(5) Possibility of Early Utilization	◎	○	○
(6) Investment			
• Amount of Investment (Unit: '000,000 pesos)	5,975	6,054	6,213
• Investment Efficiency	○	◎	△

Note: Ranking of evaluation ◎ Excellent ○ Ordinary △ Some problems

In Plan A, as the wharf that handles container cargoes with a container crane is not a container terminal in the Master Plan, the berth will have to be modified when shifting to the Master Plan.

Plan B has a defect in that it would be difficult to cope with the future development of containerization under the plan because of the lack of a container crane.

Plan C has two main problems:

① The temporary revetment would interrupt port activities between the two wharves on both sides of this zone to some extent, and the temporary revetment would not be used in the future.

② The amount of investment is the greatest among the three alternative options.

Thus, the Short-term Plan has to be selected between Plan A and Plan B. Compared with Plan B, Plan A is not only economical, but also has an advantage in handling containerized cargo.

Accordingly, Alternative Plan A is selected as the most appropriate Short-term Development Plan as shown in Fig. VIII-5.

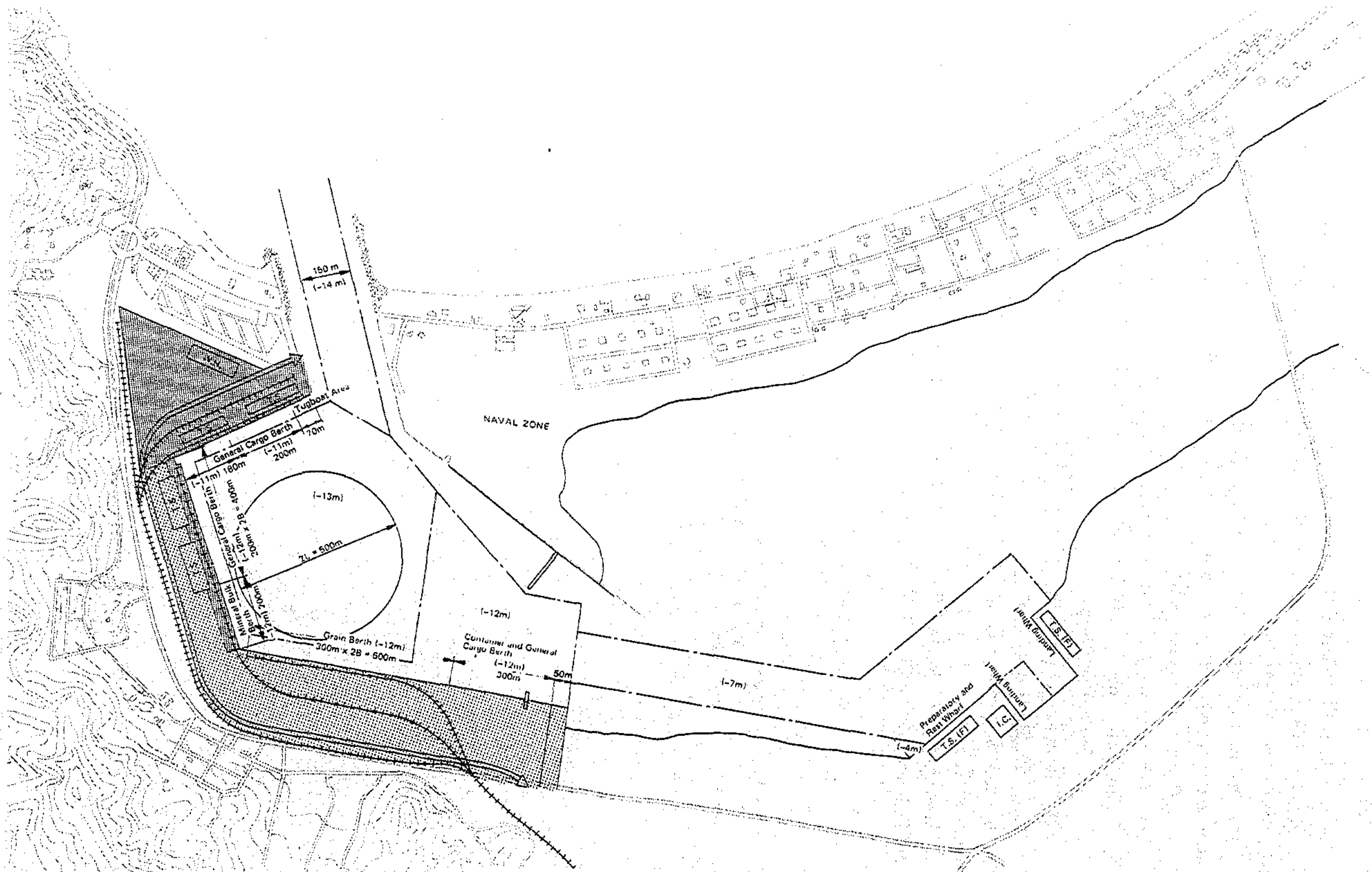


Fig. VIII-5 Short-term Development Plan

CHAPTER IX.

ADMINISTRATION AND OPERATION

CHAPTER IX ADMINISTRATION AND OPERATION

1. General

Port administration and operation systems throughout the world vary greatly from country to country and from port to port. Furthermore, administrative and operating systems at individual ports change over time in response to changing circumstances.

The main elements of port management and operation systems consist of an appropriate form and structure of the port administrative body, efficient port operations, a sound financial system using modern accounting methods, a reasonable level of port dues, accurate port statistics, skillful promotion and publicity, development of the port city and of auxiliary commercial services, and regional cooperation with neighboring ports.

This chapter first describes the present conditions of the administration and operation systems at Manzanillo Port based on analyses of the collected data. The current administrative and operational problems are considered, and appropriate responses are suggested. Finally, considering the current problems at the Port and the trends in worldwide maritime transportation, an administration and operation system for the port of Manzanillo is proposed.

2. Present Situation and Problems

2-1 Present Situation

A general description of the present administrative system and of the agencies concerned is presented in Chapter III, Section 5. A more detailed analysis of the current operations is presented below based on statistical data. This data, which is of great importance for efficient management of the Port, is collected and processed by the local office of DGODP.

2-1-1 Turn-around of Vessels

Statistics on the turn-around of vessels including the average duration of stay within the port, the average waiting time for a berth, and the average time occupying a berth, are the touchstone of a port's efficiency. The time spent waiting for berths is a complete loss to vessels, and indicates the shortage of berthing facilities within the port. The berth occupancy ratio also indicates the efficiency of a port, and the shortage of berthing facilities.

Table IX-1 presents these indicators for the port of Manzanillo. As shown in the table, the average waiting time and the average duration of stay within the Port have been decreasing each year. The average time that vessels occupy berths has also been decreasing.

Table IX-1 Turn-around of Vessels

Year	Average Time Ships Spend in Port (hours)	Average Waiting Time for Berths (hours)	Average Time Ships Occupy a Berth (hours)	Berth Occupancy Rate (%)
1981	279	109	170	73
1982	255	51	146	44
1983	177	37	129	34

Note: Berth occupancy is calculated as follows:

$$\text{Berth occupancy} = \frac{\text{Total time ships occupy berths}}{\text{24 hours} \times 365 \times \text{number of berths}}$$

Number of berths: 1981, 1982 – 7 berths, 1983 – 9 berths

Source: DGODP "Sistema Estadístico Operacional Indicadores de Rendimiento"

As for berth occupancy, in 1981 when 237 vessels called at the Port and 1,425 thousand tons of cargo were handled, the ratio was 73%. This figure dropped to 34% in 1983 when 175 vessels called at the Port and 1,091 thousand tons of cargo were handled.

2-1-2 Time Lost due to Unnecessary Interruptions

Time lost due to unnecessary interruptions such as equipment failure, delayed arrival of vehicles to carry cargo, and labor trouble is a sign of weakness in the administrative and operational organization.

Table IX-2 shows the time lost due to unnecessary interruptions for each type of cargo at Manzanillo Port, and Table IX-3 presents the average values of these figures at major Mexican ports. The time lost at Manzanillo is much higher than the average value, and the ratio of time lost to total operation time is 2 ~ 3 times higher than the average at major Mexican ports.

2-1-3 Working Efficiency

Table IX-4 presents the working efficiency by each type of cargo at Manzanillo Port, and Table IX-5 presents the average value of these figures at major Mexican ports.

At Manzanillo Port, the efficiency of handling general cargo has been increasing, but the efficiency of handling agriculural bulk cargo has not changed significantly. In general, the efficiency of handling all types of cargo at Manzanillo is higher than the average at major Mexican ports.

2-1-4 Causes of Time Loss

DGODP divides the causes of time loss into the following four categories:

① Inadequate preparation including failure to properly arrange for handling equipment, other machines, and labor

② Delay during operations caused by a lack of transfer vehicles and inadequate storage capacity

③ Ship-side trouble, such as trouble with ship gear

④ Natural conditions

The amount of time loss attributed to each of these categories at Manzanillo in 1983 is presented in Table IX-6 by type of cargo.

Table IX-2 Time Lost due to Unnecessary Interruptions (Minzanillo)

Year	Broken General Cargo			Unitized General Cargo			Mineral Bulk			Agricultural Bulk		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
1981	46.9	39.3	0.46	35.0	19.9	0.36	108.1	196.9	0.65	143.5	139.9	0.49
1982	27.3	36.1	0.57	38.3	37.4	0.49	150.7	197.1	0.57	143.3	116.7	0.45
1983	11.3	15.1	0.57	20.5	31.3	0.60	88.1	163.2	0.65	121.0	133.2	0.65

Note: (1) Average real operation time per ship, unit: hours
(2) Average lost time per ship during operation time, unit: hours
(3) Ratio of lost time to total operation time (3) = (2)/ [(1) + (2)]
Source: DGODP, "Sistema Estadístico Operacional Indicadores de Rendimiento"

Table IX-3 Time Lost due to Unnecessary Interruptions (Average of major Maxican ports)

Year	Broken General Cargo			Unitized General Cargo			Mineral Bulk			Agricultural Bulk		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
1981	43.3	17.6	0.29	52.1	18.6	0.26	131.6	86.9	0.40	128.7	59.2	0.32
1982	27.9	10.9	0.28	33.1	14.4	0.30	110.3	77.5	0.41	109.8	62.4	0.36
1983	35.3	10.0	0.22	35.1	9.7	0.22	68.0	36.0	0.35	70.2	27.6	0.28

Note: (1), (2), (3) same as in Table IX-2
Source: DGODP,,"Sistema Estadístico Operacional Indicadores de Rendimiento"

Table IX-4 Working Efficiency (Manzanillo)

Year	Broken General Cargo			Unitized General Cargo			Mineral Bulk			Agricultural Bulk		
	Ton/hr·W	Ton/hr·G	Ton/hr·S	Ton/hr·W	Ton/hr·G	Ton/hr·S	Ton/hr·W	Ton/hr·G	Ton/hr·S	Ton/hr·W	Ton/hr·G	Ton/hr·S
1981	2.2	25.3	54.0	6.2	58.5	77.4	11.5	37.8	125.7	14.9	41.5	149.3
1982	2.4	28.4	58.1	3.4	36.3	80.9	13.6	43.3	126.7	11.2	35.4	140.6
1983	3.1	32.7	60.3	4.3	44.8	91.4	26.2	70.2	153.9	14.6	42.1	145.8

Note: 1) Ton/hr·W: Tonnage per worker-hour
2) Ton/hr·G: Tonnage per gang-hour
3) Ton/hr·S: Tonnage per ship-hour
4) These figures indicate the working efficiency during real operational time.

Source: DGODP, "Sistema Estadístico Operacional Indicadores de Rendimiento"

Table IX-5 Working Efficiency (Average of major Mexican ports)

Year	Broken General Cargo			Unitized General Cargo			Mineral Bulk			Agricultural Bulk		
	Ton/hr·W	Ton/hr·G	Ton/hr·S	Ton/hr·W	Ton/hr·G	Ton/hr·S	Ton/hr·W	Ton/hr·G	Ton/hr·S	Ton/hr·W	Ton/hr·G	Ton/hr·S
1981	1.4	16.3	32.6	3.8	40.3	59.7	10.8	67.0	153.8	7.6	53.2	113.0
1982	2.1	22.2	38.9	4.7	46.9	72.3	12.8	100.9	160.9	8.2	56.6	125.7
1983	2.1	23.7	36.4	6.9	80.3	110.6	11.8	90.1*	149.8	7.3	36.9	134.9

Note: Ton/hr·W, Ton/hr·G, Ton/hr·S same as in Table IX-4
* This figure indicates the cargo tonnage handled per hatch-hour.

Source: DGODP, "Sistema Estadístico Operacional Indicadores de Rendimiento"

Table IX-6 Causes of Time Lost at Manzanillo (1983)

(Unit: hours)

Item	Broken General Cargo		Unitized General Cargo		Mineral Bulk		Agricultural Bulk		Total	
	Amount of time	%	Amount of time	%	Amount of time	%	Amount of time	%	Amount of time	%
Inadequate Preparation	1,566		961		2,323		6,959		11,809	48.2
Delay during Operations	1,086		2,133		2,190		2,450		7,859	32.0
Ship-side Trouble	168		310		239		945		1,662	6.8
Natural Conditions	235		967		333		1,654		3,189	13.0
Total	3,055	12.5	4,371	17.8	5,085	20.7	12,008	49.0	24,519	100.0

Source: DGODP, "Sistema Estadístico Operacional Indicadores de Rendimiento"

About half of all the time lost at Manzanillo Port occurred during handling of agricultural bulk cargoes. The main causes of time loss seem to be inadequate preparation and delay during operations caused by a lack of transfer vehicles. As bulk cargoes are discharged directly from ships to transfer vehicles, that is trucks or railway wagons, a lack of timely transfer vehicles directly increases the amount of time loss.

2-2 Present Administrative and Operational Problems

The present administrative and operational problems which cause time loss and other waste presented below are based on site surveys, analysis of data, and interviews with port officials and port users. The problems fall into two main categories, as follows:

- Form and structure of the port administrative body
  - ① There are many organizations related to the administration of the Port, and the relationships among these organizations is complicated.
  - ② There is no timely information system, so the preparation for cargo handling and the proper arrangement of transfer vehicles is difficult.
  - ③ The complicated administrative procedures and customs formalities delay the flow of cargo through the port.
  - ④ There is no particular cargo handling tariff for container cargoes.
  - ⑤ There are some cargoes which are left in transit sheds for an inordinately long period of time. Transit sheds should be used for sorting loading/discharging cargoes, not for long-term storage.

- Port facilities and operations

  ① There is a lack of berthing facilities and equipment for handling special cargoes.

  ② There is a lack of equipment to handle containers, and the container yard is too small.

  ③ The frequency of vessels calling at the Port is low, and there is no non-stop route linking Manzanillo with the west coast of U.S.A.

  ④ There is too much time lost during cargo handling due to unnecessary interruptions, particularly during handling of bulk cargoes.

3. Administrative Recommendations

In fiscal year 1983 ~ 84, CNCP carried out two important studies on the administrative and financial systems of ports: "Programa de Modernizacion de la Administracion Portuaria" and "Analysis del Sistema de Ingresos y Egresos de los Puertos".

Based on these studies, the Government of Mexico is now improving port administration and operations.

The goals of the current execution program are as follows:

① To decentralize port administration

② To create local autonomy and financial responsibility at each port

③ To provide efficient and certain service at a reasonable cost

④ To promote regional development

⑤ To encourage the participation of local governments

Reorganization of administrative bodies, introduction of new businesses, improvement of equipment and establishment of computer systems are now taking place to achieve these goals.

These reform measures will help improve port administration at Manzanillo Port. In addition to these reform measures, the following items are proposed judging from our analyses of the present situation and problems.

① Development of a timely information system

Judging from analyses of the cause of time loss, inadequate preparation due to a lack of timely information seems to be one of the main causes. A timely information system including adequate ship to shore radio communications would provide considerable assistance for preparation of cargo handling, and would help reduce time loss. The key station of this communications system should be established in the administration body.

Relevant information should be communicated to the appropriate offices throughout the system in a timely manner.

② Simplification of formalities and administrative procedures

To expedite the clearance of cargoes, the port administration body should make an effort to simplify the formalities and procedures in close cooperation with customs officials.

The standardization of document format may be central to the simplification process.

③ Improvement of regulation and tariff for containers

Judging from the trend of worldwide maritime transportation, containerization will continue to increase, and it seems that this will affect Mexico in the very near future. Container transportation is a very useful method to realize secure and efficient cargo handling.

The present port tariff for container works seems to be a tariff revised from that for general cargo. That is, the conventional tariff for general cargo handling work is adopted for the container with different rate schedules. A more simplified tariff for containers, in conformity with the actual work performed at the container terminal, must be prepared.

Improving and establishing regulations to simplify the tariffs and various procedures for customs clearance, etc. related to containers is recommended. The merit of container transport as an efficient means of cargo transport can be fully utilized only by implementation of efficient regulations.

④ Improvement of relations with persons and organizations concerned with port development

To promote port activities, the port administration body should keep close contacts with governmental officials, local entrepreneurs, transportation companies, local inhabitants, and other individuals and groups concerned with the development of the port.

Periodic meetings should be held with all the parties concerned. This will make the port more responsive to the needs of its users, and help promote the growth of the port.

4. Proposed Operation System

As mentioned above, the time lost due to unnecessary interruptions of cargo handling at the port of Manzanillo is significant.

To improve the productivity of the port operation, the most effective measure is to reduce the time lost.

4-1 Bulk Cargo Operation

Currently, the majority of import bulk cargo is discharged directly from incoming vessels. The agricultural bulk cargo is discharged directly from ship to truck on the quaywall apron using a glove bucket. The mineral bulk cargo is also discharged directly from the ship using a glove bucket, but is placed directly into railway wagons.

The direct delivery system is not ideal. Whenever there is any delay in the timely arrival of transfer vehicles or in the transfer operation itself, the ocean vessels are forced to wait and time is lost. Under the Master Plan this situation will be remedied through introduction of pneumatic unloaders and silos.

Unfortunately, these facilities can not be constructed as part of the Short-term Plan. In order to reduce the time lost in the short-term, larger hoppers with a capacity of 50 m^3 will be introduced. These hoppers will expedite the transfer system and help to reduce the time loss.

Table IX-7 shows the required cargo handling equipment for the Short-term Plan.

Table IX-7 Cargo Handling Equipment for Bulk Cargo

Equipment	Capacity	Number of Machines	Remarks
Truck Crane	70 t	1	Setting for hopper
Wheel Crane	15 t	2	
Shovel Loader	3.5 m^3	6	Timming work in ship hold
Forklift	2.7 t	4	
Hopper	50 m^3	6	To be newly purchased

4-2 Container Cargo Operation

4-2-1 Container Operation Method

When handling a large number of containers and full container ships, the best management of container terminals is performed by a single organization which has enough skillful officers and workers to be able to supply full service to customers (shipping companies, shippers/ consignees) from receiving containers to loading them onboard ship, or from discharging containers to delivery to the consignee.

However, if the number of containers is still small, it is not necessary to establish a separate management system. In the case of the port of Manzanillo, the total volume of container cargo in 1990 is estimated at 190,000 tons. Judging from this volume, no particular organization or management system will be necessary.

Efficiency of operation and quality of the terminal service are governed by the selection of the container handling method and the kinds and numbers of equipment assembled at the container terminal.

Container handling methods in general use are classified by handling equipment used such as the chassis system, the straddle carrier system and the transfer crane system. In the chassis system, each container is placed on a chassis and stored in the container yard. In the two other systems, containers are stacked in the container yard in layers, 3 layers maximum using a straddle carrier, and normally 5 layers with a transfer crane, which enables the efficient use of land area.

There are some other stacking machines for containers such as forklifts and side loaders (side forklifts), but they are mostly used as auxiliary equipment for terminal container handling.

The chassis system requires a large terminal land area, a large number of chassies and a lot of initial investment since containers are stored in a single layer.

The straddle carrier system is an excellent operational system because of its high cargo handling capability and flexibility in handling a large volume of cargo in a short period of time.

Since the container terminal in the port of Manzanillo will be utilized by various users, a system capable of meeting the various demands of different users, that is, one which is flexible will be required. In addition, the container terminal for the Short-term Plan is a temporary facility. It will change its location to a neighboring place under the Master Plan.

Considering the requirements of the port of Manzanillo, the straddle carrier system is adopted.

4-2-2 Flow of Containers in the Terminal

The operation of the container terminal is outlined below with respect to export containers, and the reverse operation is applicable to import containers.

The flow of containers mentioned below is for the case of a full-scale container terminal. As the container terminal for the Short-term Plan is a temporary one, and the volume of container cargo is not so large, some of the handling work described below will be able to be carried out outside of the terminal.

① Export containers brought to the terminal gate by truck are inspected for appearance, damage, and the seal on the container door, and their weights are measured. Detailed information about the container (name of shipping company, name of ship, destination, container number, kind of cargo, particularly the presence of dangerous cargo, etc.) as well as weight are given to the control office. This inspection at the gate will constitute the formal hand-over of the containers from the shipper to the terminal and the responsibility of the container terminal for the container begins at this point, so the necessary check must be performed carefully and the results shall be recorded.

② The control office decides the location where the container is to be stored in the container yard based upon the information received from the gate. The storing location of the container is given to the truck and straddle carrier drivers. The determination of the storing location of containers in the yard is based upon the arrival schedule of export-import containers and plans for loading ships. If container yard planning is not made well, the efficiency of terminal work will drop due to a shortage of yard space and increased handling of containers in the yard.

③ The driver of the straddle carrier will receive the container at the transfer point from the truck, carry it to the instructed location, and store it as directed by the control office. Guidelines are drawn on the yard surface for identifying locations.
These guidelines are helpful for effective use of yard space, useful for safe operation by designating the passage of the straddle carriers, and indispensable for stock control of containers within the yard.

④ At the time of loading onto the ship, a container stored in the yard is carried to the spot directly below the container crane by the straddle carrier in accordance with the container ship plan, and it is then loaded onto the ship by the container crane.

⑤ Small lots of export cargo (namely, LCL cargo) which are insufficient to full one container are carried by truck into the container freight station (CFS). There, they are loaded into a container (LCL container) together with other LCL cargo having the same destination in accordance with the container loading plan, based upon the destination and kind/quantity of cargo. The LCL container is then carried into the yard and stored for loading.

The flow of containers is presented graphically in Fig. IX-1.

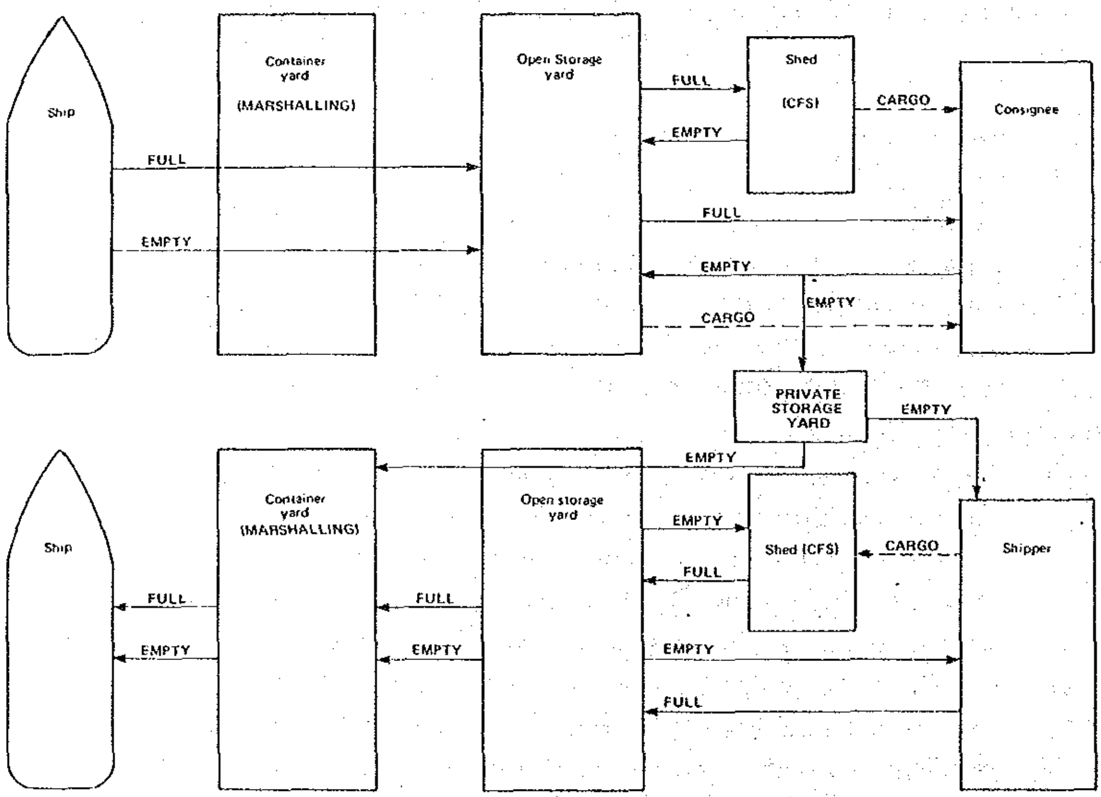


Fig. IX-1 Container Flow

4-2-3 Management of the Terminal

The number and functions of workers which will be required to effectively perform the container terminal operations depend on various factors such as regulations related to labor, employment agreement between labor and employers, and work schedule as well as the ability of each worker at the port of Manzanillo. It is difficult to predict the number of workers required, and therefore the type of workers required. Thus their roles in container terminals in Japan are described below for reference.

① Operation management department

Ship planner: Preparation and execution of ship loading/unloading plan

Yard planner: Preparation and execution of container yard plan

Radio operator: Communicating and giving instructions for work to be performed to drivers of container handling equipment in accordance with the container yard plan and ship plan

Gate clerk: Receiving and delivering of containers at the gate and necessary documentation work

Documentation/accounting clerk:
Preparation and issuing of necessary documents, and receiving of payment for work done

Maintenance engineer:
Inspection, maintenance and repair of containers and handling equipment.

② Operation department

Operators of container crane, straddle carrier, yard tractor, etc.

Gate checker: Inspection of containers upon receiving or delivery at the gate

Worker on ship: Lashing and unlashing of containers on ship

③ Container freight station (CFS) department

Clerk: Preparing and issuing of documents for cargo receiving and delivery, and preparation of plans for loading cargo to containers

Worker and forklift operator:
Stuffing/unstuffing cargo to/from containers, or receiving cargo from and delivering cargo to trucks

Tallying man: Tallying and checking during cargo stuffing and unstuffing and during cargo receiving and delivery

4-2-4 Container Equipment

Various kinds of container handling equipment must be functionally combined in order to effectively carry out the terminal work of loading/unloading, storing and receiving/delivering a large number of containers. Kinds and numbers of equipment must be selected and determined in reasonable consideration of the specifications, working efficiency and capacity of each piece of equipment. The quantity of required equipment is shown in Table IX-8.

Table IX-8 Cargo Handling Equipment for Container Cargo

Equipment	Capacity	Number of Machines	Remarks
Gantry Crane	30.5 t	1	To be newly purchased
Truck Crane	70 t	1	
Straddle Carrier		3	To be newly purchased
Forklift	33 t	1	〃
〃	7 t	1	
〃	3.6 t	1	
〃	2.7 t	1	
Container Chassis	20'	2	To be newly purchased
〃	40'	2	〃
Trailer Head		2	〃

4-3 Conventional General Cargo

According to Table IX-2, time lost due to unnecessary interruption of general cargo has been increasing in recent years.

This means to occur because the required cargo is not brought to the ship's side apron when required and because preparing in advance the work schedule required for achieving efficient loading work is difficult. In other words, the direct delivery method does not provide efficient cargo handling since the buffer function of transit sheds is not effectively utilized. The buffer function is capable of adjusting the two types of cargo transport, between ship and shed and between shed and shipper (consignee), by means of temporary storing of cargo.

Higher efficiency can be expected for general cargo handling by the improvement of a timely information system and the introduction of adequate overtime charges for cargoes which exceed the free time period.

Based on the cargo forecast, the volume of heavy cargo including iron and steel, scrap iron and some machines will increase.

Considering this trend and the existing equipment working in the port, the following equipment will be required to handle conventional general cargo.

Table IX-9 Cargo Handling Equipment for General Cargo in the Short-term Plan

Equipment	Capacity	Number of Machines	Remarks
Truck Crane	70 t	1	For handling heavy cargo
Wheel Crane	15 t	2	For handling scrap iron
〃	9 t	2	
Forklift	7 t	20	
〃	3.6 t	8	
〃	2.7 t	12	
Tractor		5	To be newly purchased
Flat Chassis	10 t	10	〃
Dump Truck	15 t	3	For handling scrap iron
Shovel Loader	6 m^3	1	To be newly purchased

4-4 Maintenance

A reduction in the number of handling machines due to mechanical troubles will directly reduce working capacity, resulting in lower efficiency of overall operating work. Thus, maintenance and repair work must be sufficient. In particular, inspection and maintenance work for preventing trouble in advance should be conducted; maintenance inspections should take place regularly. For this purpose, it is necessary to maintain a sufficient mechanical staff, to establish a mechanics training program, to ensure proper supplies and to arrange facilities for the orderly storage of mechanical parts.

CHAPTER X.

DESIGN, CONSTRUCTION AND COST ESTIMATE

CHAPTER X DESIGN, CONSTRUCTION AND COST ESTIMATE

1. Design

1-1 Basic Premises

Based on the Chapter VIII, the port facilities are designed based on the following premises.

① Only the commercial port facilities in the inner port are considered.

② The port facilities are designed in accordance with layout plan of the Short-term Plan for the target year 1990, which is shown in Fig. VIII-5.
Furthermore, these facilities also conform with the Master Plan for the target 2000, which is shown in Fig. VII-25.

③ The design makes the greatest possible use of the present facilities

1-2 Design Conditions

1-2-1 Facilities

Two grain berths and a container and general cargo berth are main facilities.

1-2-2 Basic Conditions

The basic conditions for design are shown in Table X-1.

Table X-1 Basic Conditions

Item	Grain Berth	Container and General Cargo Berth
Water Depth	-12 m (-13 m)	-12 m (-13 m)
Object Vessel	20,000 DWT Bulk Carrier (40,000 DWT)	20,000 DWT (40,000 DWT)
Cope Height	+3.4 m	
Number of Berths and Berth Length	2 Berths: 600 m (A 300 m Mineral Bulk Berth and a 300 m Grain Berth)	1 Berth: 300 m (A Grain Berth)
Surcharge	4.0 t/m²	4.0 t/m² But that is 2.5 t/m² during operation of the container grantry crane.
Container Gantry Crane		Dead Load: 610 t Rated Load: 30.5 t Span: 20 m
Lifetime	50 years	

Note: The conditions in parentheses are those of the Master Plan.

1-2-3 Natural Conditions

The natural conditions are shown as follows:

① Tidal Level: H.W.L. +0.272 m
L.W.L. −0.398 m

② Soil: The typical soil conditions in the San Pedrito Lagoon and the assumed soil conditions are shown in Fig. X-1.

From the ground surface, the subsoils consist of soft organic soil or clay that is ignored in designing, clayey sand or sandy clay that has an N-value less than 30 and is also ignored, sandy soil, and a complex layer of sandy, silty and clayey soils.

The employed thickness of clayey sand or sandy clay in designing are shown in Fig. X-2 and Fig. X-3, which are determined crosssectional figures of the grain and container and general cargo berths.

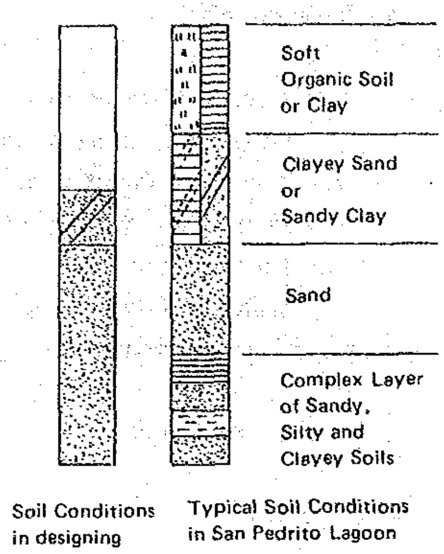


Fig. X-1 Soil Conditions

1-2-4 Other Conditions

The other conditions are described as follows:

① Seismic Coefficient: 0.15

② Berthing Velocity: 0.15 m/sec

③ Construction Materials

o Concrete

ⓐ Reinforced Concrete Pile:
Standard Design Strength: $\sigma c = 250\ kg/cm^2$
Elastic Modulus: $Es = 2.1 \times 10^5\ kg/cm^2$

ⓑ Reinforced Concrete:
Standard Design Strength: $\sigma c = 200\ kg/cm^2$
Elastic Modulus: $Ec = 1.8 \times 10^5\ kg/cm^2$

o Steel

ⓐ Steel Bar for Concrete Reinforcement:
Yield Strength: $\sigma y = 2{,}400\ kg/cm^2$
Elastic Modulus: $Ey = 2.1 \times 10^6\ kg/cm^2$

1-3 Design of Main Port Facilities

As for the main port facilities, berths are designed as follows:

① Reinforced concrete open type berths are adopted.

② Various load conditions are investigated including ordinary condition, conditions during berthing and operating, and during storms and earthquakes. The design is performed to accommodate severe conditions.

③ The calculation are performed based on the theory of elasticity. Further, the working load on each pile is calculated assuming that the piles are rigidly connected to a rigid beam or slab.

④ Design conditions in both the Short-term Plan and the Master Plan are considered.

⑤ The mineral bulk berth, the grain berth and the container and general cargo berth are designed as −13 m berths. Thus these berth will not have to be remolded to accommodated large vessels under the Master Plan.

1-3-1 Grain Berth

The Grain Berths are shown in Fig. X-2. These berths are utilized as a mineral bulk berth and grain berth in the Master Plan.

1-3-2 Container and General Cargo Berth

The design of the container and general cargo berth is shown in Fix. X-3. In this figure, rails for a container gantry crane are shown. This berth is utilized as a grain berth in the Master Plan.

1-3-3 Comments

As shown in Fig. X-2 and X-3, these berths have certain specific features. The following items will have to be carefully considered in the detailed design and construction of these berths.

① Ensuring the embedded length of pile

As shown in Fig. X-2 and X-3, the embedded length of piles is short in comparison with the free length. For the stability of these structures, piles must be driven into the bearing stratum, or into an equivalent layer with an N-value more than 30, to a sufficient depth. In these designs, the required minimum embedded lengths of piles are 5 m for the grain berth and 7 m for the container and general cargo berth.

② Determination of pile length

As shown in Chapter III, Section 1-5, and in Appendix 1, the transversal distributions of soil profiles including the bearing stratum or an equivalent layer show complicated figures.

Therefore, it is rather difficult to determine the length of each pile, so a special method for the driving of piles will be required. As one possible effective method, the controlled minimum embedded length method may be considered. In this method, the pile must be driven to the minimum embedded length, that is 5 m into the bearing stratum or an equivalent layer, after the set of pile per blow reaches a constant value that can be determined by the driving test and the soil surveys, or by prior experience.

③ Connection between pile tops and concrete beam or slab

The connection between pile tops and a concrete beam or slab is one of the most important points for the stability of these pier structures.

As this area has a high possibility of earthquakes, a connection that can sufficiently transfer the load from a beam or slab to the pile tops and from the pile tops to a beam or slab is required.

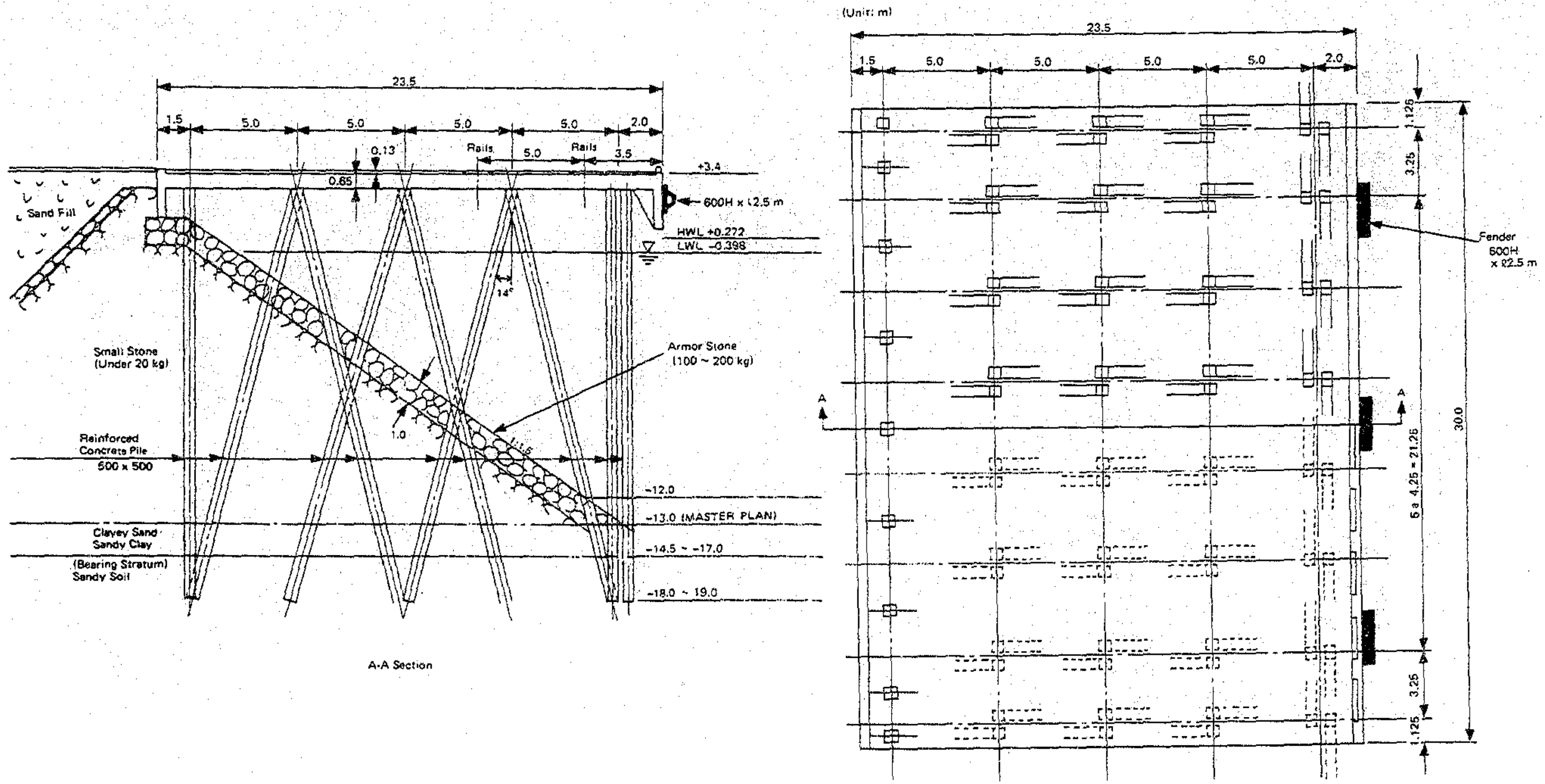
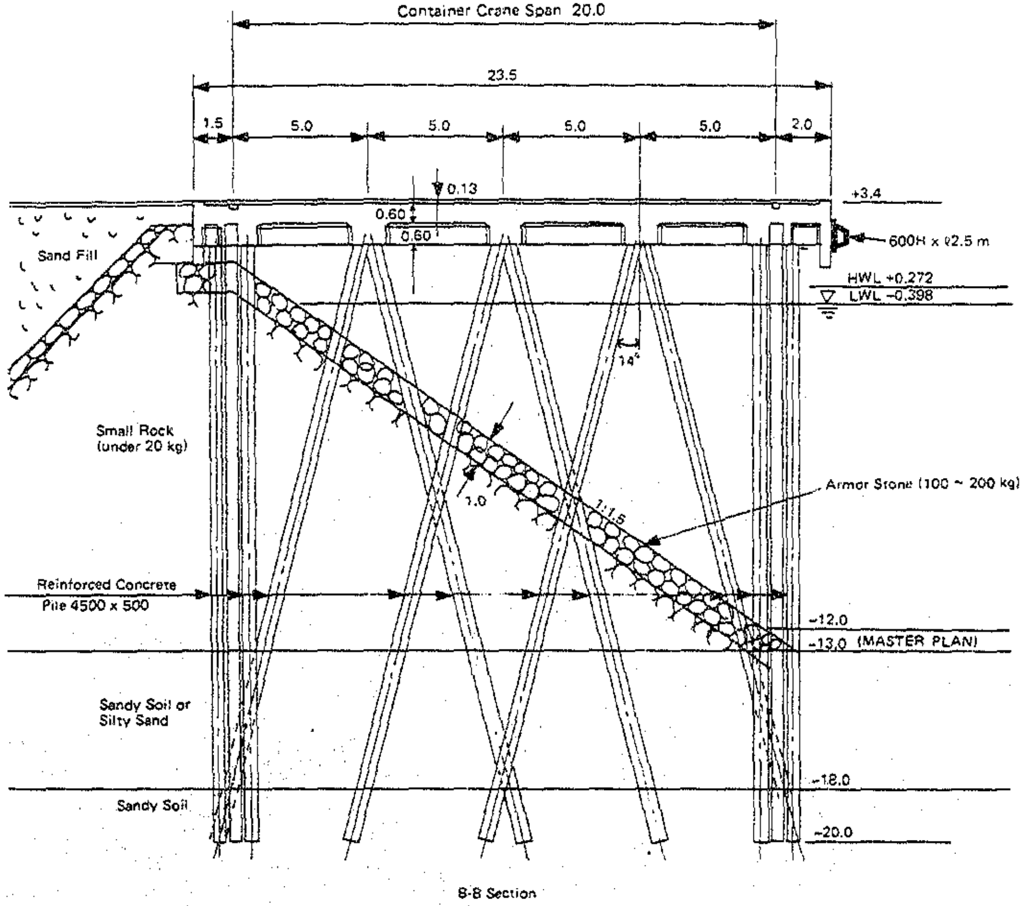


Fig. X-2 Grain Berth



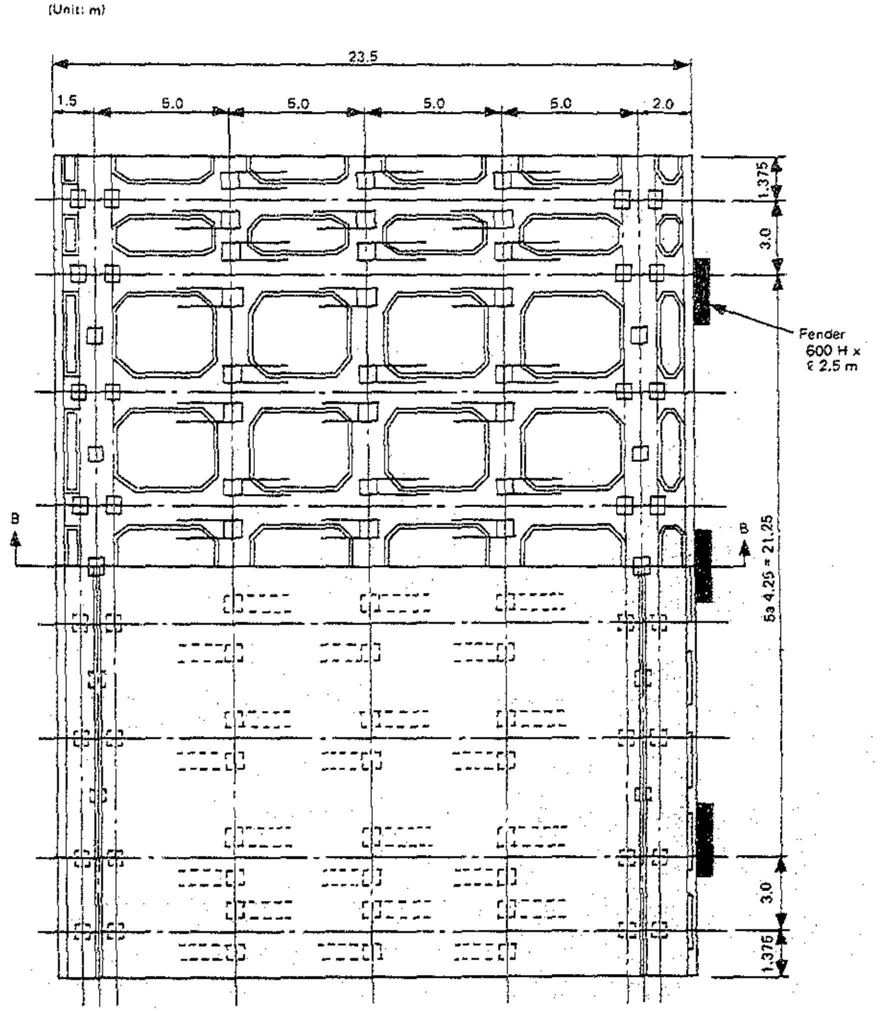


Fig. X-3 Container and General Cargo Berth

2. Construction

2-1 Construction Quantities

Construction quantities in the Short-term Plan are shown in Table X-2. The main construction materials are listed in Table X-3. Water, fuel and electricity are not included in this table.

2-2 Construction Procedure

The newly proposed facilities described in the table will be constructed using the same methods as in the past. Equipment and labor for the construction work will be able to be obtained locally.

2-2-1 Construction Schedule

The construction schedule for the commercial port facilities is shown in Table X-4.

2-2-2 Remarks

Concerning the construction, please note the following items:

① A high power dredger will be used as before. The dredged sand will be used for the reclamation works. The width of the entrance channel of −14 m depth has to be expanded from 100 m to 150 m.
There is a shoal in the anchorage as shown in Fig. VII-36. This shoal has to be removed immediately because it will obstruct ship operations.

② To start the container operations from 1990, each berth has to be constructed according to the following schedule:
Construction of the −12 m Mineral Bulk Berth: 1985 ~ 1986
Construction of the −12 m Grain Berth: 1986 ~ 1987
Construction of the −12 m Container and General Cargo Berth: 1987 ~ 1988

③ Roads in the port are 12.5 m wide including two lanes, a paved shoulder and a sidewalk An easy and economical way for the expansion of these roads after 1990 will have to be prepared.

④ Construction quantities and the construction schedule for the fishery port are presented in Appendix 3.

Table X-2 Port Facilities and Construction Quantities (Commercial Port)

Facility		Unit	Quantity	Remarks
Item	Sub Item			
1. Dredging	(1) Channel (–14m)	m^3	275,000	150m Width
	(2) Anchorage	m^3	905,000	
2. Quays	(1) –12m Mineral Bulk Berth	m	300	RC Pile Structure
	(2) The End of the Above	m	25	RC Pile Structure
	(3) –12m Grain Berth	m	300	RC Pile Structure
	(4) –12m Container and General Cargo Berth	m	300	RC Pile Structure
	(5) Temporary Working Yard	m^2	20,000	
	(6) Water and Electric Supply for Construction Work	set	1	
	(7) The End of the –12m Container and General Cargo Berth	m	50	
	(8) Temporary Seawall	m	250	Seawall with Armor Stores
3. Railway and Road	(1) Railway	m	1,500	55 kg/m Rail
	(2) Road	m	7,500	12.5m Width, Asphalt Pavement
	(3) Fence and Gate	m	400	
4. Transit Sheds	(1) Transit Shed (No. 3)	m^2	7,500	50 x 150 (m)
	(2) Transit Shed (No. 4)	m^2	7,500	50 x 150 (m)
5. Land	(1) Container Yard	m^2	57,000	300 x 190 (m), Heavy Pavement
	(2) Wharf Lot	m^2	103,000	Asphalt Pavement
	(3) Wharf Lot	m^2	68,000	Without Pavement
6. Water and Electric Supply, and Drainage	(1) Water Supply	set	1	2,790 m (ϕ100), 3,720 m (ϕ200)
	(2) Drainage	set	1	Pipe (6,000 m)
	(3) Electric Substation	KVA	5,500	Including the Fishery Port
	(4) Electric Supply	set	1	Cable (5,820 m)
7. Aids to Navigation	(1) Lighted Spar Buoy	set	4	
	(2) Lighted Buoy	set	3	
	(3) Lighted Small Buoy	set	1	
	(4) Leading Light	set	2	
8. Cargo Handling Equipment for Containers	(1) Gantry Crane (30.5 t)	set	1	
	(2) Forklift (33 t)	set	1	
	(3) Straddle Carrier (30.5 t)	set	3	
	(4) Trailer Head for Container	set	2	
	(5) Container Chassis (20')	set	2	
	(6) Container Chassis (40')	set	2	
9. Cargo Handling Equipment for General Use	(1) Wheel Crane (15 t)	set	1	
	(2) Tractor	set	5	
	(3) Flat Chassis (10 t)	set	10	
	(4) Dump Truck (15 t)	set	3	
	(5) Hopper (50 m^3)	set	6	Movable

Table X-3 Main Construction Materials

Facilities		Main Materials					
Item	Sub Item	Steel (t)	Concrete (m^3)	Stone (m^3)	Gravel (m^3)	Asphalt (m^3)	Others
Commercial Port Facilities	(1) Dredging	–	–	–	–	–	–
	(2) Quays	5,883	39,840	342,700	13,650	–	Rubber Fenders (72 sets) Bits (48 sets)
	(3) Railway and Road	–	–	–	8,620	1,380	Ties (2,500 sets), Fence (400 m)
	(4) Buildings, Transit Sheds and Warehouses	600	–	–	5,260	1,130	–
	(5) Land	–	–	–	87,000	13,330	–
	(6) Water and Electric Supply, and Drainage	–	880	–	3,500	–	Tube (ϕ100, ϕ200), Valves, Pipes Cables, Lighting Poles, Lights, etc.
	(7) Aids to Navigation	–	–	–	–	–	–
	(8) Cargo Handling Equipment for Containers	–	–	–	–	–	–
	(9) Cargo Handling Equipment for General Use	–	–	–	–	–	–
Fishery Port Facilities	(1) Anchorage	–	–	–	–	–	–
	(2) Quay	1,620	10,750	–	3,690	–	Rubber Fenders (200 sets) Bits (86 sets)
	(3) Wharf Lot	–	–	–	17,000	3,000	–
	(4) Road	–	–	–	5,000	1,000	Lighting Poles (35 sets) Lights (70 sets)
Total		8,103	51,470	342,700	143,720	19,840	

Table X-4 Construction Schedule

Facility: Item	Facility: Sub Item	Unit	Quantity	Construction Year: 1985	1986	1987	1988	1989	1990
1. Dredging	(1) Channel (−14m)	m^3	275,000		—				
	(2) Anchorage	m^3	905,000		—	—	—		
2. Quays	(1) −12m Mineral Bulk Berth	m	300	—	—				
	(2) The End of the Above	m	25	—	—				
	(3) −12m Grain Berth	m	300		—	—			
	(4) −12m Container and General Cargo Berth	m	300			—	—		
	(5) Temporary Working Yard	m^2	20,000		—				
	(6) Water and Electric Supply for Construction Work	set	1		—				
	(7) The End of the −12m Container and General Cargo Berth	m	50				—	—	
	(8) Temporary Seawall	m	250					—	
3. Railway and Road	(1) Railway	m	1,500			—	—	—	
	(2) Road	m	2,100				—	—	
	(3) Fence and Gate	m	400				—	—	
4. Transit Sheds	(1) Transit Shed (No. 3)	m^2	7,500			—	—		
	(2) Transit Shed (No. 4)	m^2	7,500					—	
5. Land	(1) Container Yard	m^2	57,000					—	
	(2) Wharf Lot	m^2	103,000		—	—			
	(3) Wharf Lot	m^2	68,000		—	—	—	—	
6. Water and Electric Supply, and Drainage	(1) Water Supply	set	1		—	—	—	—	
	(2) Drainage	set	1		—	—	—	—	
	(3) Electric Substration	KVA	5,500					—	
	(4) Electric Supply	set	1					—	
7. Aids to Navigation	(1) Lighted Spar Buoy	set	4			—			
	(2) Lighted Buoy	set	3			—			
	(3) Lighted Small Buoy	set	1			—			
	(4) Leading Light	set	2			—			
8. Cargo Handling Equipment for Containers	(1) Gantry Crane (30.5t)	set	1					—	
	(2) Forklift (33t)	set	1					—	
	(3) Straddle Carrier (30.5t)	set	3					—	
	(4) Trainer Head for Container	set	2					—	
	(5) Container Chassis (20')	set	2					—	
	(6) Container Chassis (40')	set	2					—	
9. Cargo Handling Equipment for General Use	(1) Wheel Crane (15t)	set	1					—	
	(2) Tractor	set	5				—	—	
	(3) Flat Chassis (10t)	set	10				—	—	
	(4) Dump Truck (15t)	set	3					—	
	(5) Hopper (50m³)	set	6			—	—		

3. Cost Estimate

3-1 Estimation Limit

Some limits for the estimation are as follows:

① The cost of the main port facilities in the Short-term Plan is estimated.

② Estimation limits in the Master Plan described in Chapter VII are also applied in this chapter.

③ Cost estimation results of the fishery port facilities are presented in Appendix 3.

3-2 Estimation Result

A summary of the estimated construction cost is presented in Table X-5. The construction costs of each of the facilities are listed in Table X-6. And Table X-7 shows the annual investment at the commercial port.

Table X-5 Construction Costs (Commercial Port)

Facilities	Construction Cost ('000 pesos)		
	Total	Foreign Portion	Local Portion
1. Dredging	756,000	251,000	505,000
2. Quays	1,744,700	70,000	1,674,000
3. Railway and Road	117,400	60,000	57,400
4. Transit Sheds	610,000	50,000	560,000
5. Land	319,000	–	319,000
6. Water and Electric Supply, and Drainage	733,000	228,000	505,000
7. Aids to Navigation	76,000	66,100	9,900
8. Cargo Handling Equipment for Containers	1,176,000	1,176,000	–
9. Cargo Handling Equipment for General Use	442,500	390,000	52,500
Sub Total	5,974,600	2,291,100	3,683,500
Tax	328,605	–	328,605
Total	6,303,205	2,291,100	4,012,105

Table X-6 Construction Cost of Each of the Facilities

Facility		Unit	Quantity	Construction Cost ('000 pesos)		
Item	Sub Item			Total	Foreign Portion	Local Portion
1. Dredging	(1) Channel (–14m)	m^3	275,000	176,000	59,000	117,000
	(2) Anchorage	m^3	905,000	580,000	192,000	388,000
	Sub Total			(756,000)	(251,000)	(505,000)
2. Quays	(1) –12m Mineral Bulk Berth	m	300	496,000	21,000	475,000
	(2) The End of the Above	m	25	38,000	1,200	36,800
	(3) –12m Grain Berth	m	300	492,000	17,000	475,000
	(4) –12m Container and General Cargo Berth	m	300	588,000	28,000	560,000
	(5) Temporary Working Yard	m^2	20,000	4,400	–	4,400
	(6) Water and Electric Supply for Construction Work	set	1	8,300	800	7,500
	(7) The End of the –12m Container and General Cargo Berth	m	50	95,000	2,000	93,000
	(8) Temporary Seawall	m	250	23,000	–	23,000
	Sub Total			(1,744,700)	(70,000)	(1,674,700)
3. Railway and Road	(1) Railway	m	1,500	84,000	60,000	24,000
	(2) Road	m	2,100	31,000	–	31,000
	(3) Fence and Gate	m	400	2,400	–	2,400
	Sub Total			(117,400)	(60,000)	(57,400)
4. Transit Sheds	(1) Transit Shed (No. 3)	m^2	7,500	305,000	25,000	280,000
	(2) Transit Shed (No. 4)	m^2	7,500	305,000	25,000	280,000
	Sub Total			(610,000)	(50,000)	(560,000)
5. Land	(1) Container Yard	m^2	57,000	153,000	–	153,000
	(2) Wharf Lot	m^2	103,000	151,000	–	151,000
	(3) Wharf Lot	m^2	68,000	15,000	–	15,000
	Sub Total			(319,000)	(–)	(319,000)
6. Water and Electric Supply, and Drainage	(1) Water Supply	set	1	112,000	9,000	103,000
	(2) Drainage	set	1	128,000	8,000	120,000
	(3) Electric Substation	KVA	5,500	121,000	25,000	96,000
	(4) Electric Supply	set	1	372,000	186,000	186,000
	Sub Total			(733,000)	(228,000)	(505,000)

Facility		Unit	Quantity	Construction Cost ('000 pesos)		
Item	Sub Item			Total	Foreign Portion	Local Portion
7. Aids to Navigation	(1) Lighted Spar Buoy	set	4	43,000	41,000	2,000
	(2) Lighted Buoy	set	3	10,000	9,300	700
	(3) Lighted Small Buoy	set	1	3,000	2,800	200
	(4) Leading Light	set	2	20,000	13,000	7,000
	Sub Total			(76,000)	(66,100)	(9,900)
8. Cargo Handling Equipment for Containers	(1) Gantry Crane (30.5 t)	set	1	610,000	610,000	–
	(2) Forklift (33 t)	set	1	48,000	48,000	–
	(3) Straddle Carrier (30.5 t)	set	3	270,000	270,000	–
	(4) Trailer Head for Container	set	2	152,000	152,000	–
	(5) Container Chassis (20')	set	2	44,000	44,000	–
	(6) Container Chassis (40')	set	2	52,000	52,000	–
	Sub Total			(1,176,000)	(1,176,000)	(–)
9. Cargo Handling Equipment for General Use	(1) Wheel Crane (15 t)	set	1	20,000	–	20,000
	(2) Tractor	set	5	330,000	330,000	–
	(3) Flat Chassis (10 t)	set	10	13,700	–	13,700
	(4) Dump Truck (15 t)	set	3	15,800	–	15,800
	(5) Hopper (50 m^3)	set	6	63,000	60,000	3,000
	Sub Total			(442,500)	(390,000)	(52,500)
Total				5,974,600	2,291,100	3,683,500
Tax				328,605	–	328,605
Grand Total				6,302,605	2,291,100	4,012,105

Table X-7 Annual Investment at the Commercial Port

(Unit: '000,000 pesos)

Facility: Item	Facility: Sub Item	Unit	Quantity	1985 F/C	1985 L/C	1985 Total	1986 F/C	1986 L/C	1986 Total	1987 F/C	1987 L/C	1987 Total	1988 F/C	1988 L/C	1988 Total	1989 F/C	1989 L/C	1989 Total	TOTAL F/C	TOTAL L/C	TOTAL Total
1. Dredging	(1) Channel (-14m)	m^3	275,000				59	117	176										59	117	176
	(2) Anchorage	m^3	905,000				115.2	232.8	348	57.6	116.4	174	19.7	38.8	58				192	388	580
	Sub Total						(174.2)	(349.8)	(524)	(57.6)	(116.4)	(174)	(19.2)	(38.8)	(58)				(251)	(505)	(756)
2. Quays	(1) -12m Mineral Bulk Berth	m	300	6.3	142.5	148.8	14.7	332.5	347.2										21	475	496
	(2) The End of the Above	m	25	0.96	29.44	30.4	0.24	7.36	7.6										1.2	36.8	38
	(3) -12m Grain Berth	m	300				8.5	237.5	246	8.5	237.5	246							17	475	492
	(4) -12m Container and General Cargo Berth	m	300							8.4	168	176.4	19.6	392	411.6				28	560	588
	(5) Temporary Working Yard	m^2	20,000				0	4.4	4.4										0	4.4	4.4
	(6) Water and Electric supply for Construction Work	set	1				0.8	7.5	8.3										0.8	7.5	8.3
	(7) The End of the -12m Container and General Cargo Berth	m	50										1	46.5	47.5	1	46.5	47.5	2	93	95
	(8) Temporary Seawall	m	250													0	23	23	0	23	23
	Sub Total			(7.26)	(171.94)	(179.2)	(24.24)	(589.26)	(613.5)	(16.9)	(405.5)	(422.4)	(20.6)	(438.5)	(459.1)	(1)	(69.5)	(70.5)	(70)	(1,674.7)	(1,744.7)
3. Railway and Road	(1) Railway	m	1,500							6	2.4	8.4	30	12	42	24	9.6	33.6	60	24	84
	(2) Road	m	2,100										0	15.5	15.5	0	15.5	15.5	0	31	31
	(3) Fence and Gate	m	400										0	1.2	1.2	0	1.2	1.2	0	2.4	2.4
	Sub Total									(6)	(2.4)	(8.4)	(30)	(28.7)	(58.7)	(24)	(26.3)	(50.3)	(60)	(57.4)	(117.4)
4. Transit Sheds	(1) Transit Shed (No. 3)	m^2	7,500							12.5	140	152.5	12.5	140	152.5				25	280	305
	(2) Transit Shed (No. 4)	m^2	7,500													25	280	305	25	280	305
	Sub Total									(12.5)	(140)	(152.5)	(12.5)	(140)	(152.5)	(25)	(280)	(305)	(50)	(560)	(610)
5. Land	(1) Container Yard	m^2	57,000													0	153	153	0	153	153
	(2) Wharf Lot	m^2	103,000				0	30.2	30.2	0	120.8	120.8							0	151	151
	(3) Wharf Lot	m^2	68,000				0	3	3	0	4.5	4.5	0	4.5	4.5	0	3	3	0	15	15
	Sub Total						(0)	(33.2)	(33.2)	(0)	(125.3)	(125.3)	(0)	(4.5)	(4.5)	(0)	(156)	(156)	(0)	(319)	(319)
6. Water and Electric Supply, and Drainage	(1) Water Supply	set	1				3.6	41.2	44.8	1.8	20.6	22.4	1.8	20.6	22.4	1.8	20.6	22.4	9	103	112
	(2) Drainage	set	1				2.4	36	38.4	2.4	36	38.4	1.6	24	25.6	1.6	24	25.6	8	120	128
	(3) Electric Substation	KVA	5,500													25	96	121	25	96	121
	(4) Electric Supply	set	1													186	186	372	186	186	372
	Sub Total						(6.0)	(77.2)	(83.2)	(4.2)	(56.6)	(60.8)	(3.4)	(44.6)	(48)	(214.4)	(326.6)	(541)	(228)	(505)	(733)
7. Aids to Navigation	(1) Lighted Spar Buoy	set	4							41	2	43							41	2	43
	(2) Lighted Buoy	set	3							9.3	0.7	10							9.3	0.7	10
	(3) Lighted Small Buoy	set	1							2.8	0.2	3							2.8	0.2	3
	(4) Leading Light	set	2							13	7	20							13	7	20
	Sub Total									(66.1)	(9.9)	(76)							(66.1)	(9.9)	(76)
8. Cargo Handling Equipment for Container	(1) Gantry Crane (30.5 t)	set	1													610	0	610	610	0	610
	(2) Forklift (33 t)	set	1													48	0	48	48	0	48
	(3) Straddle carrier (30.5 t)	set	3													270	0	270	270	0	270
	(4) Trailer Head for Container	set	2													152	0	152	152	0	152
	(5) Container Chassis (20')	set	2													44	0	44	44	0	44
	(6) Container Chassis (40')	set	2													52	0	52	52	0	52
	Sub Total															(1176)	(0)	(1176)	(1176)	(0)	(1176)
9. Cargo Handling Equipment for General Use	(1) Wheel Crane (15 t)	set	1													0	20	20	0	20	20
	(2) Tractor	set	5										132	0	132	198	0	198	330	0	330
	(3) Flat Chassis (10 t)	set	10										0	6.9	6.9	0	6.8	6.8	0	13.7	13.7
	(4) Dump Truck (15 t)	set	3													0	15.8	15.8	0	15.8	15.8
	(5) Hopper (50 m^3)	set	6							30	1.5	31.5	30	1.5	31.5				60	3	63
	Sub Total									(30)	(1.5)	(31.5)	(162)	(8.4)	(170.4)	(198)	(42.6)	(240.6)	(390)	(52.5)	(442.5)
Total				7.26	171.94	179.3	204.44	1,049.46	1,253.9	193.3	857.6	1,050.9	247.7	703.5	951.2	1,638.4	901.0	2,539.4	2,291.1	3,683.5	5,974.6
Tax				-	15.7	15.7	-	81.2	81.2	-	77.9	77.9	-	64.9	64.9	-	88.9	88.9	-	328.6	328.6
Grand Total				7.26	187.64	194.9	204.44	1,130.66	1,335.1	193.3	935.5	1,128.8	247.7	768.4	1,016.1	1,638.4	989.9	2,628.3	2,291.1	4,012.1	6,302.2

CHAPTER XI. ECONOMIC ANALYSIS

CHAPTER XI ECONOMIC ANALYSIS

1. Purpose and Methodology of Economic Analysis

1-1 Purpose

The purpose of this chapter is to appraise the economic feasibility of the Short-term Development Plan presented in Chapter VIII. The evaluation of a project should show whether the project is justifiable from the economic point of view by assessing its contribution to the national economy. Thus, the basic purpose of this chapter is to investigate the economic benefits as well as the economic costs which will arise from the project, and to evaluate whether the net benefits exceed those which could be derived from other investment opportunities (the opportunity cost of capital).

1-2 Methodology

For this project, costs have been calculated based upon international prices. Sufficient statistical data were not always available, so rough estimates were sometimes used.

There are several different viewpoints concerning the evaluation of economic returns. Here, however, the economic return is evaluated in terms of the Internal Rate of Return (IRR) based on cost benefit analysis using the Discount Cash Flow Method. The IRR is a discount rate which makes the costs and benefits of a project equal.

1-3 Alternative Case

Ultimately, the economic viability of a project is determined by comparing the return on the project with the return which could come from other investments. This is the opportunity cost of capital.

In order to determine the return on the project, we conduct a cost-benefit analysis. That is, we subtract the costs which will be incurred from carrying out the proejct from the benefits which will be gained.

To calculate the benefits of the project in economic terms, we use an alternative case. We compare the case when an investment is made, the "with" case, and the case when no investment is made, the "without" case. This is the only sensible way to evaluate the benefits.

Thus, determining the "without" case is central to the analysis. In this study, the following conditions are adopted as the "without" case:

① The existing commercial port functions in the outer port are abolished.

② No investment is made.

③ The 600 m wharf under construction is considered as one of the existing facilities.

1-4 Prerequisites for the Economic Analysis

The following prerequisites are assumed for the analysis.

① Only the commercial port functions in the inner port are analyzed. The fishery port, the touristic port, and the industrial zone are excluded.

② The costs of the construction of infrastructures which are closely related to this project such as railways, roads, industrial water works, water drainage, and power supply are excluded. However, the costs within the port area are included.

③ As for the cargo volume to be handled at the port in 1990 and 2000, the estimates presented in Chapter VI are adopted. The estimated cargo volume is the same for both the "with" and "without" cases.

④ The useful lifetimes of the main facilities such as the wharf and the warehouse are 40 years and 25 years, respectively. So, the period of economic calculation (project life) is assumed as 30 years.

⑤ The foreign currency exchange rate (Dec. 1984) used in this study is:

1 U.S. dollar = 192 pesos

2. Benefits

2-1 Benefit Items

As benefits brought about by the development project of the port of Manzanillo, the following are considered:

① Contribution to the national economic development through modernization of the Port
② Reduction of staying costs for berth-waiting and for loading/unloading cargo through upgrading port services
③ Reduction of cargo handling costs by raising cargo handling productivity through mechanization and containerization
④ Reduction of damage to cargo through containerization and mechanization
⑤ Reduction of the transport period (time cost) through increasing the efficiency of port activities
⑥ Prompt control of accurate information through introduction of a computer system and standardization of forms and procedures
⑦ Promotion of regional economic development through development of port related industries
⑧ Increased employment opportunities and incomes
⑨ Improvement of cargo handling safety

To realize these benefits, increasing the cargo handling capacity of the port and meeting the demand for container transportation are indispensable. These improvements will lead to the improvement of the nation's economic situation and of the nation's international status.

Many of the expected benefits cannot be evaluated in strictly monetary terms. However, three benefits which can be evaluated monetarily are considered in the analysis:

① Reduction in staying costs
② Reduction in cargo handling costs
③ Reduction in time costs

The following three benefits are intangible, so only a qualitative analysis is undertaken:

① Development of port related industries
② Increase in employment opportunities
③ Improvement of cargo handling safety

2-2 Reduction in Ship's Staying Cost

The volume of cargo handled at the port of Manzanillo is increasing. If the increased volume of cargo were to be handled only by the existing facilities, then the number of ships waiting for berth space would increase to the point where port congestion would become a serious problem.

Implementing the project will avert this problem. Investment in improved port facilities will reduce the waiting time for berth space and the time for loading and unloading cargo. The staying time of ships will be reduced, and this cost reduction is a benefit of the project. Benefits that will accrue to Mexico from the improved facilities can be calculated by comparing the case where investment is carried out against the case where it isn't – the "with" case vs the "without" case. This is calculated by multiplying three factors.

Reduction in Ship's Staying Costs (Benefit)	=	Difference in Ship's Staying Time	x	Staying Costs (per Unit Time)	x	Share of Benefits Accruing to Mexico

2-2-1 Difference in Staying Time

The average waiting period is estimated by the results of a simulation in accordance with Queuing Theory. In order to avoid misestimation of staying time, it is assumed that both the distribution of ships' arrival and the distribution of cargo handling periods are random distributions.

The difference of the total staying period including the cargo handling period in 1990 between the "without" case and the "with" case is shown in Table XI-1.

Table XI-2 also breaks down the difference of staying period for domestic and foreign trade for each year after 1987. This distinction is necessary to calculate the amount of this benefit of staying period reduction which will accrue to Mexico.

Table XI-1 Total Staying Period (1990)

(Unit: days)

Package Type	Waiting Period			Handling Period			Total Staying Period		
	Without	With	Difference	Without	With	Difference	Without	With	Difference
General Cargo	745	43	702	1,158	1,018	140	1,903	1,061	842
Agricultural Bulk	57	5	52	528	392	136	585	397	188
Mineral Bulk	36	3	33	311	237	74	347	240	107
Container	108	6	102	150	71	79	258	77	181
Total	946	57	889	2,147	1,718	429	3,093	1,775	1,318

Note: Handling period includes days necessary for purposes other than cargo handling.

Table XI-2 Reduction in Staying Period

(Unit: days)

Year	Total	Foreign Trade	Domestic Trade
1987	329	303	26
1988	658	605	53
1989	988	908	80
1990	1,318	1,211	107
1991	↓	↓	↓
⋮			

2-2-2 Calculation of Staying Costs

"Staying Costs" are those costs incurred while a vessel is within the port. One method of calculating staying costs involves determining the cost per day of each individual item such as labor, depreciation costs, fuel, etc., and adding all of these costs together. Another method is simply to add the charterage cost per day and the cost of the fuel that is consumed each day the vessel is in the harbour. The latter method is adopted here.

Staying costs are significant, and are closely related to the availability of facilities at each port.

The time charterage of dry cargo vessels is shown in Table XI-3. The average time charterage is shown graphically in Fig. XI-1. Average tonnage of vessels calling at the port of Manzanillo is estimated at about 14,500 DWT for dry cargo vessels based on the actual records from 1983. Then the average charterage of vessels of this size is about 7.5 US$/DWT·Month as shown in Fig. XI-1.

Table XI-3 Time Charterage of Dry Cargo Vessels

(Unit: US$/DWT·Month)

Year	12,000 ~ 19,999 DWT	20,000 ~ 34,999 DWT	35,000 ~ 49,999 DWT	50,000 ~ 84,999 DWT	85,000 ~ DWT
1982					
Jan. ~ Mar.	7.18	4.87	4.22	2.66	1.30
Apr. ~ Jun.	7.39	5.78	5.85	2.80	1.24
Jul. ~ Sep.	6.17	3.23	4.41	1.48	1.19
Oct. ~ Dec.	6.89	3.63	2.72	1.66	0.99
1983					
Jan. ~ Mar.	6.60	4.43	2.67	2.07	1.13
Apr. ~ Jun.	7.95	4.39	3.16	2.34	1.28
Jul. ~ Sep.	6.64	3.48	2.89	2.12	1.65
Oct. ~ Dec.	7.91	3.73	3.15	2.26	1.64
1984					
Jan. ~ Mar.	8.09	4.14	2.88	2.46	1.77
Apr. ~ Jun.	6.91	4.29	2.29	2.81	2.15
Jul. ~ Sep.	5.56	4.20	3.12	2.83	1.96
Oct. ~ Dec.	7.50	4.40	3.99	3.06	1.86

Source: GCBS

Fuel consumption during ships' staying is assumed to be 3.3 tons/day for 15,000 DWT vessels based on the actual records of Japanese vessels. Diesel-Oil cost is assumed to be US$254/ton based on the prices in the port of Oakland and in the port of Los Angeles. From the above estimates, US$4,588/vessel·day is adopted as the average staying cost for vessels calling at the port of Manzanillo.

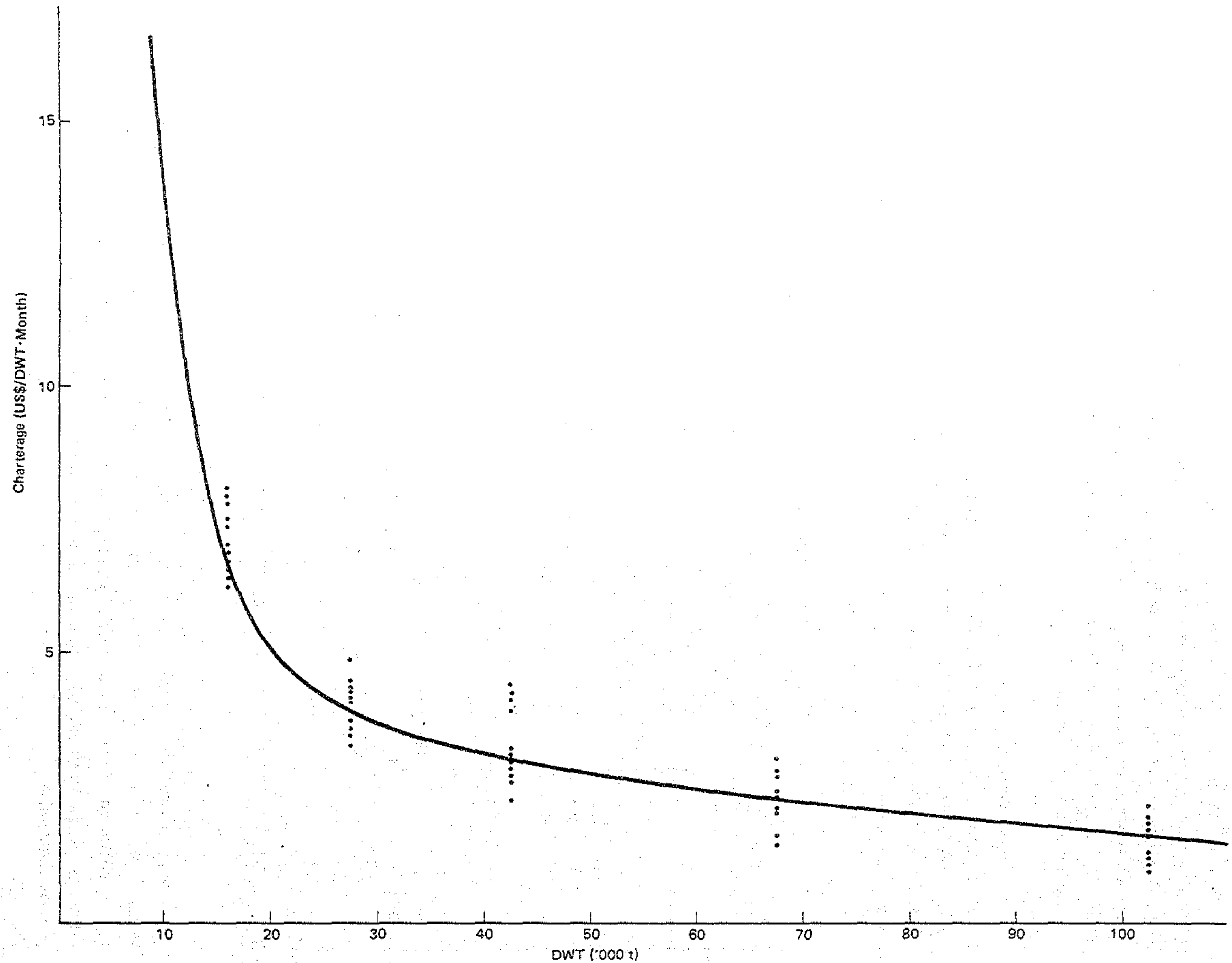


Fig. XI-1 Average Time Charterage of Dry Cargo Vessels

2-2-3 Attribution of the Benefit of Reduced Staying Costs

Reducing staying costs for vessels calling at the port of Manzanillo will clearly benefit the overall world economy. However, this reduction of costs may primarily benefit ship operators. The percentage of the reduction of staying costs which can be attributed to Mexico is discussed below.

The direct benefits to the Mexican economy will come through Mexican vessels. Table XI-4 shows the Mexican share in dry cargo by commodity for all those vessels calling at Mexican ports. The Mexican share for domestic trade is high, around 80 per cent. However, the share for foreign trade is currently very low.

On the other hand, we expect the percent of foreign trade cargo carried by Mexican vessels to increase significantly for several reasons:

① The goal of the Port and Harbor Bureau of SCT is for Mexican vessels to carry 30% of the foreign trade cargo by 1988.

② The administrative regulations of the Transportation Ministry state that Mexican vessels will carry 50% of all general cargo and bulk cargo for both import and export.

③ According to the Code of Conduct for Liner Conference adopted at UNCTAD in 1974, the trading country's share is 40%.

Thus, we estimate the Mexican share for foreign trade as about 30% until 1990 and as about 40% from 1991. Also, assuming a slight increase in the percentage of domestic cargo handled by Mexican carriers, we estimate the Mexican share of domestic cargo at about 90%.

Table XI-4 Mexican Share in Dry Cargo by Commodity
(Excluding petroleum and its related products)

(Unit: '000 t, %)

Item	1981			1982			1983		
	Total	Native	Ratio	Total	Native	Ratio	Total	Native	Ratio
General Cargo	5,867	290	5	3,830	336	9	3,469	394	11
Agricultural Bulk	5,491	205	4	3,241	20	1	6,551	114	2
Mineral Bulk	11,643	152	1	9,820	414	4	9,955	420	4
Others	1,624	6	–	1,710	22	1	1,127	32	3
Foreign Trade Total	24,625	653	3	18,601	792	4	21,102	960	5
Domestic Trade Total	10,951	8,867	81	10,581	7,914	75	11,526	9,431	82
Grand Total	35,576	9,520	27	29,182	8,706	30	32,628	10,391	32

Source: DGODP, "Estadísticas del Movimiento Portuario Nacional de Carga y Buque", 1981, 1982, 1983

Reduction of staying costs for foreign vessels will also benefit the Mexican economy indirectly over the 30 year project life time. Of course, attributing a percentage of these benefits to the Mexican economy is somewhat nebulous.

① Raise in port tariffs

At the same time that staying costs are reduced due to improved facilities and handling procedures, the port management body may opt to increase the port tariffs. In this case, it may be said that all or a part of the benefit that would have accrued to foreign ship operators is transferred to the Mexican economy by means of the increased tariff. Increased tariffs usually result in an increase in the local price of imported goods and a drop in the competitive position of exports. But in this case, the increase would be limited to the amount of the reduced costs from reducing staying time. Thus local prices of imported goods would not rise above, and the competitive position of exports would not fall below, their current levels.

② Feedback through economic activities

We can assume that some of the benefit attributed to foreign ship operators will return to Mexico over time through the market mechanisms of world shipping and of the entire world economy. However, as the world shipping and international trade systems are complex, it is virtually impossible to measure this feedback effect precisely.

Overall, we assume that 50% of the benefits attributed to foreign ship operators will be transferred to the Mexican economy. Of course, the actual amount of this benefit which will be returned to the Mexican economy will depend on the policy of the management body of the port of Manzanillo and on various other factors.

2-2-4 Total Benefit to the Mexican Economy from Reduced Staying Costs

In conclusion, the total benefit to the Mexican economy from reduced staying costs is the sum of the direct benefits from Mexican vessels and the indirect benefits from foreign vessels for domestic and foreign trade.

As mentioned above, Mexican vessels will carry 90% of domestic cargo. Thus if "D" equals the reduced staying costs for domestic trade, the benefit to Mexico from domestic trade equals .9D (the percent carried by Mexican vessels) plus 50% (the percent of benefits to foreign ship operators that will be returned to Mexico) times .1D (the percent carried by foreign vessels). In short, for domestic trade,

Benefit to Mexico = .9D + (.5 x .1D) = .95D.

Similarly, if "F" equals the reduced staying costs for foreign trade,

Benefit to Mexico = .3F + (.5 x .7F) = .65F

through 1990. And from 1991,

Benefit to Mexico = .4F + (.5 x .6F) = .70F.

Thus, the total benefits to the Mexican economy from reduced staying costs equal .95D + .65F through 1990 and .95D + .70F from 1991. The reduction in staying cost and benefit to the Mexican economy from the reduction in staying cost are all presented in Table XI-5.

Table XI-5 Benefit to the Mexican Economy from Reduction in Ships' Staying Cost

(Unit: '000,000 pesos)

Year	Reduction in Staying Cost			Benefit to the Mexican Economy		
	Foreign Trade	Domestic Trade	Total	Foreign Trade	Domestic Trade	Total
1987	266	23	289	173	22	195
1988	533	47	580	347	44	391
1989	800	70	870	520	67	587
1990	1,067	94	1,161	693	90	783
1991	1,067	94	1,161	745	90	835
↓	↓	↓	↓	↓	↓	↓

2-3 Reduction in Cargo Handling Costs

Another benefit of the project will be the reduction in handling costs due to improved handling efficiency from mechanization and rationalization of cargo handling procedures. We do not expect that there will be any appreciable change in the administrative costs of cargo handling. Thus the only factor we consider here are the direct costs of cargo handling which consist of:

① Labor costs

② Operational and Maintenance costs (repairs, fuel, electricity, water, etc.)

In the "with" case, labor costs will be reduced substantially. The savings in labor costs will be partially offset by increased operational and maintenance costs. Depreciation costs are not considered in this analysis.

In this section, estimates of cargo volume and the number of vessels are the same as in Section 2-2.

2-3-1 Labor Costs

Workers engaged in stevedoring at the port of Manzanillo belong to "Union de Estibadores y Jornaleros del Pacifico". The union is paid a lump sum equal to approximately 32.6% of the tariff collected by "Servicios Portuarios de Manzanillo, S.A. de C.V."

Thus labor is currently paid a certain amount for each ton of cargo handled. If the project is carried out, the volume of cargo which the stevedores handle per hour will increase significantly. The payment system will have to be adjusted so that the labor cost per unit of cargo drops in accordance with the increased handling efficiency from the improvement of port facilities.

For this analysis, we consider the reduced labor costs as one of the benefits of the project.

2-3-2 Operational and Maintenance Costs

For calculation purposes, fuel and electricity costs are determined by summing up the additional expenses for all of the facilities. Annual maintenance costs are estimated by multiplying the purchase price of handling facilities by a fixed percentage (2% for structures, 5% for machines).

2-3-3 Net Reduction in Cargo Handling Costs

Based on the above assumptions, the reduction in cargo handling costs for each fiscal year is presented in Table XI-6.

Table XI-6 Reduction in Cargo Handling Costs

(Unit: '000,000 pesos)

Year	Reduction in Labor Cost	Additional Costs			Net Reduction in Handling Costs
		Maintenance	Operation	Total	
1987	29	–	–	–	29
1988	56	–	–	–	56
1989	86	–	–	–	86
1990	147	59	12	71	76
1991	↓	↓	↓	↓	↓
⋮					

2-4 Reduction in Time Costs

The reduction of staying period due to the implementation of the project brings about a remarkable reduction in the time required for import and export. This will bring about a reduction in the usance interest as goods will be put onto ships faster. If the reduced time is converted into monetary terms, it can be estimated using the following equation:

$$RTC = Q/365 \times D \times V \times I/365 \quad \cdots\cdots (XI\text{-}1)$$

where,
- Q: Transport cargo volume (ton/year)
- D: Reduction in export ships' staying period (days)
- V: Average cargo value (US$/ton)
- I: Usance interest (%/year)