7.8 Handling Equipment

7.8.1 The Quantity of Machinery Necessary for Cargo Handling

54. Regarding the quantity of cargo handling machinery analyzed in respect of shipside, landside and grounded area operations, some can be reduced in respect of the entire terminal, since they should and can be operated comprehensively, supplementing each other. With this idea in mind, the quantities of machinery necessary for the terminal's operations in 1995 and 2000, respectively, is estimated as follows:

Table 7-8-1 Required Number of Cargo Handling Equipment

	Shipside operations		Landside operations	Number required
	Berths Nos.1-2	Berths Nos.4-5		
(1995)				
Container crane	2	2		4
Transfer crane	2	2	4	8
Tractor	12	8	3	23
Trailer	12	8	20	40
(2000)				
Container crane	2	2		4
Transfer crane	2	2	4	8
Tractor	14	10	3	27
Trailer	14	10	22	46

The main dimensions of required handling equipment are shown as follows;

(a) Container Crane

(1) Hoisting capacity under spreader		41 tonnes
(2) Outreach from centre line of water side rail		36 m
(3) Back reach from centre line of landside rail		11 m
(4) Span between centre lines of water side and landside rail		20 m
(5) Lifting height under spreader to top of crane rail		24 m
Lowering depth from top of rail		14 m
Total hoisting lift		28 m
(6) Approximate working speeds*		
i) Hoisting speed with 41tonne load	50m/min.	
ii) Hoisting speed with no load	120m/min.	
iii) Trolley traversing speed	150m/min.	
iv) Travel speed	45m/min.	

Note: The actual operating cycle of a container crane is 25 cycles per hour in actual loading/unloading work. The potentioal cycle is 35 times an hour, 102/103 seconds per cycle. Thus operating efficiency is 65% of potential efficiency.

(b) Tire Mounted Transfer Crane

(1) Hoisting capacity under spreader	30.5 (40) tonnes
(2) Span	23m 470mm
(3) Lift(9'6" containers 4 high)	14m 940mm
(4) Approximate working speeds	
i)Hoisting speed with 30.5tonnes load	17m/min.
ii)Trolly traversing speed	35m/min.
iii)Travelling speed	90m/min.

Note: If the cost of 40 tonnes RTG is not so high compared with that of 35 tonnes RTG, 40 tonnes RTG could be selected.

(c) Tractor-trailer

For 40 feet container

(d) A List of Equipments

Table 7-8-2 Specifications and Allotment of Equipment

Equipment	Dimension	Units	Remark
Container crane	Cap, 35t Span 30m	2	(Exist) Berths Nos.4 and 5
Container crane	Cap, 41t Span 20m	2	(New) Berths Nos.1 and 1A
Transfer crane	Cap, 30.5t(40t) One over 4high	8	(New) Berths for Nos.3 and 4: 5 units for Shutaify Bay Yard: 3 units
Tractor trailer	for 40 feet container	27	(New) for Berths Nos.3,4 and 5: 10units for Berths Nos.1 and 1A : 14units for CFS : 3units
Trailer	for 40 feet container	17	(New) for CFS
Folk lift (Heavy type)	Cap, over 25t	5	(Exist) for Shutaify Bay Yard for general cargo
Folk lift (Light type)	Cap, over 1t	45	(New)

7.9 Maintenance System

55. Mina Qaboos need many pieces of cargo handling equipment fore its expansion toward 1995. The efficiency of total cargo handling at the port is determined by the operating conditions of a given piece of equipments, not counting down time caused by sudden accidents. Many machines and other pieces of equipment must be maintained in good condition through daily servicing, weekly checks, monthly inspections or yearly tests. Parts should be replaced according to their specific maintenance schedules. The members of the engineering staff at Mina Qaboos have fine technical abilities and are able to keep the port's equipment in good working condition. They have been recording maintenance logs. Various kinds of spare parts are stored in a warehouse to cope with repairs or other servicing as needed. But the number of staff members in the engineering

department has to be increased at the same rate as the part's equipment is added.

1) Staff increase

	Engineers	Workers
Electrical	2	6
Mechanical	2	10
Other (including auto mobile drivers)		10
Total	30	

2) Working area

A new maintenance shop should be built in the entrance zone at Shutaify bay to handle repairs and ensure the safety and case of port operations. (see Fig.7-9-1)

	New	Former
Working area	10,800m^2	5,000m^2
Shop Building	1,300m^2	700m^2

In order to ensure profitability, it will become more important to carry out preventive maintenance as more modern handling equipment is used at the port. This preventive maintenance requires a lot of manpower, many spare parts and a large budget. Moreover, adequate preventive maintenance work requires the following items:

1) A preventive maintenance budget
2) A manual or checklist for preventive maintenance should be delivered to the staff after being translated from english or other languages, into arabic
3) Training and education to upgrade technical ability.

7.10 Training of Maintenance and Operational Staff Members

56. In proportion to the increase in cargo volume and the number of containers, the PSC will employ a large staff. Details of training new staff members are explained in detail in Chapter 9, "Operational Procedure", Section 9.6, "Training," in the CES report. This CES report has been reviewed by the JICA study team and has been found to be a reasonable proposal.

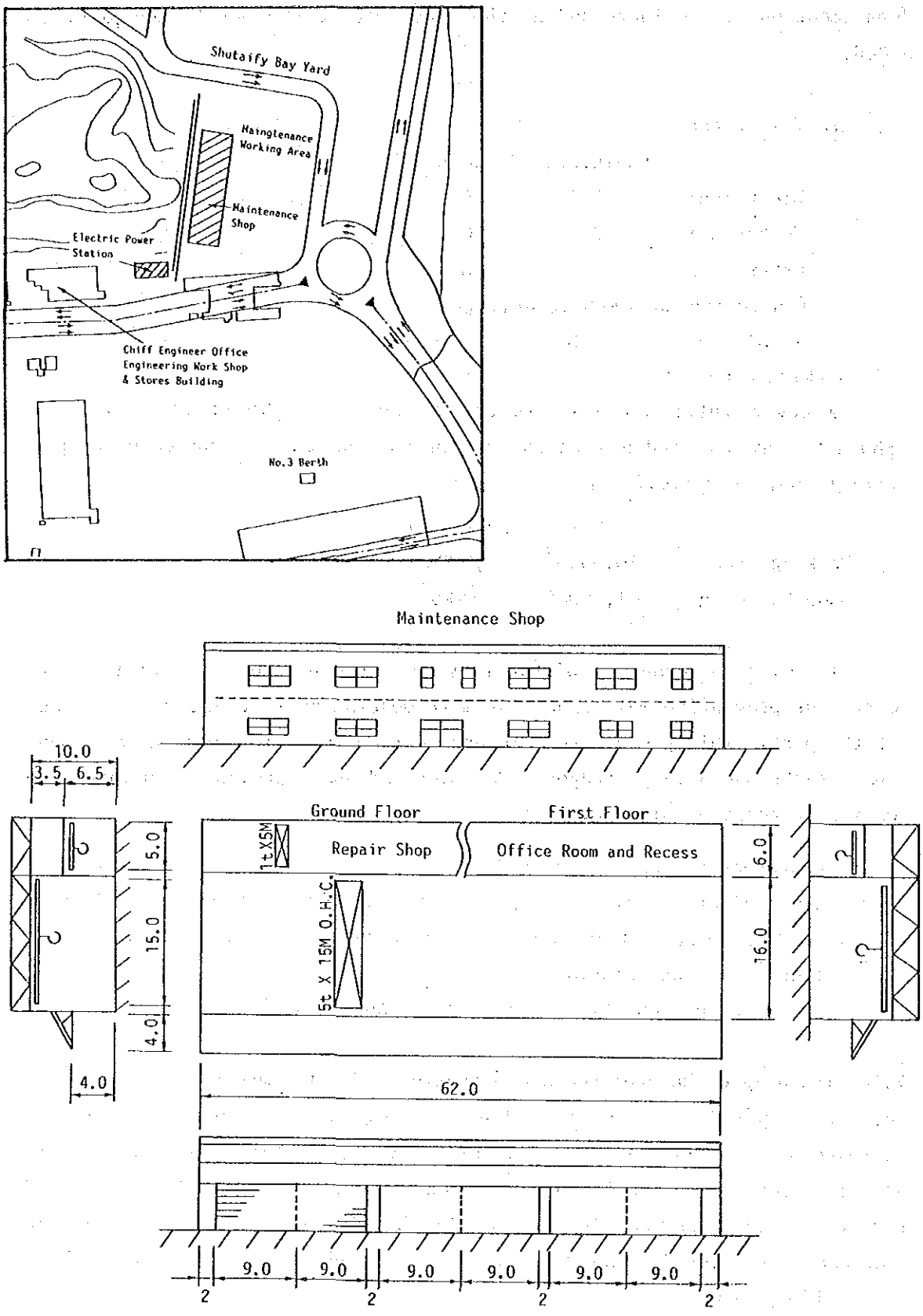


Fig. 7-9-1 Maintenance Working Area and Maintenance Shop

7.11 Design of Facilities

57. Desings of port facilities badsed on the future port planning are studied and shown as below.

(1) Berths

Berth No.12(A) is designed with a water depth of -8m, deep enough to accommodate 7,000t class ships. The water depth of berth No.12(B) is -4.0m, which can accommodate small craft such as tugboats and pilot boats.

The standard cross-section of the berths is shown in Fig. 7-11-1.

(2) Seawall

The Seawall for reclaimed land in Shutaify Bay is designed with an average water depth of -10m and a total length of 420m. (Fig. 7-11-2)

(3) Othe Facilities

1) Crane Foundation

Gantry cranes for container cargoes are planned at berths Nos.1A, 1 and 2. The railway foundation of the cranes is arranged as shown in Fig.7-11-3.

2) Pavement and Transfer Crane Tracks

The cross-section of the pavement and transfer crane tracks are shownn in Figs.7-11-4 and 7-11-5.

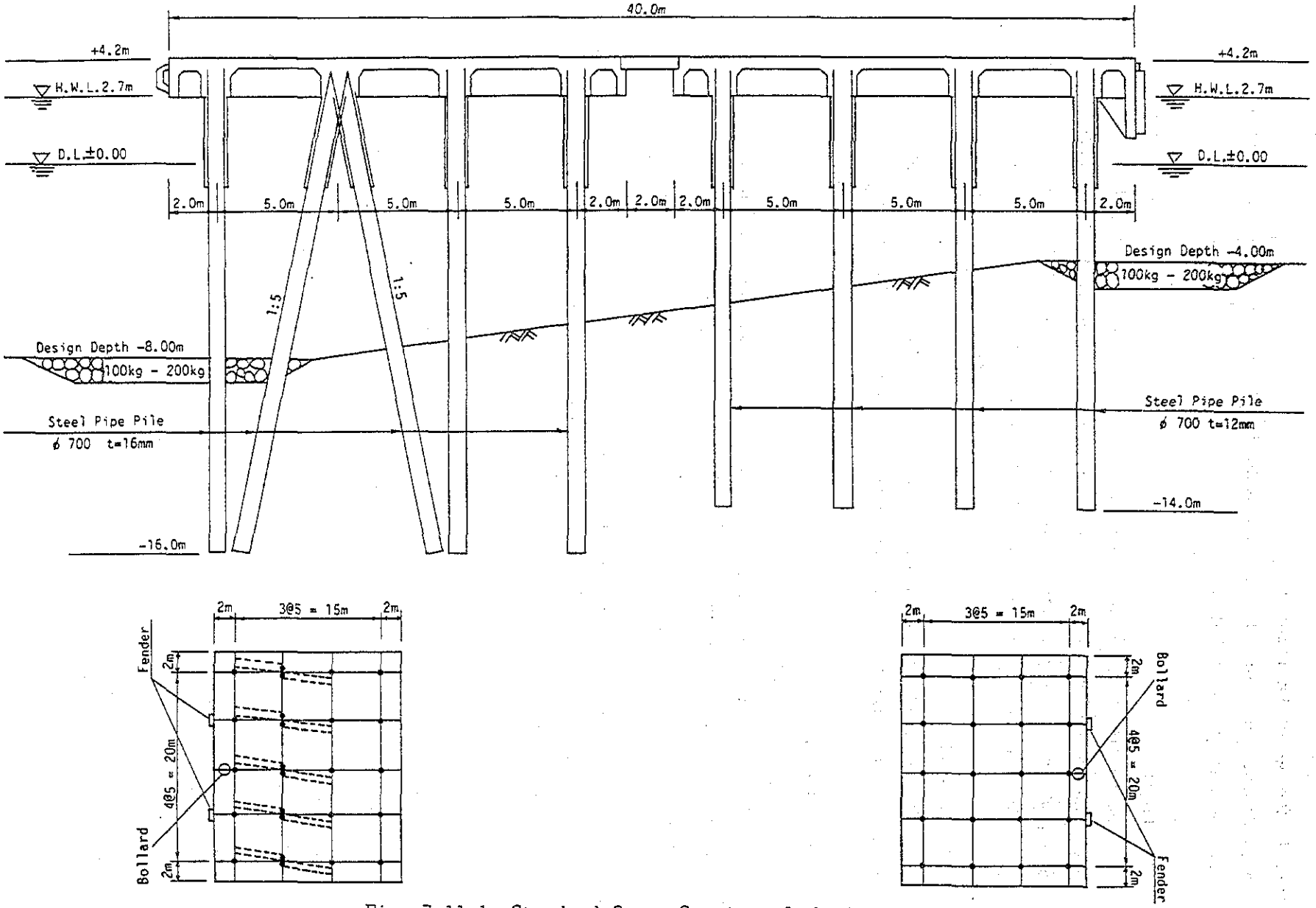


Fig. 7-11-1 Standard Cross Section of the Berths

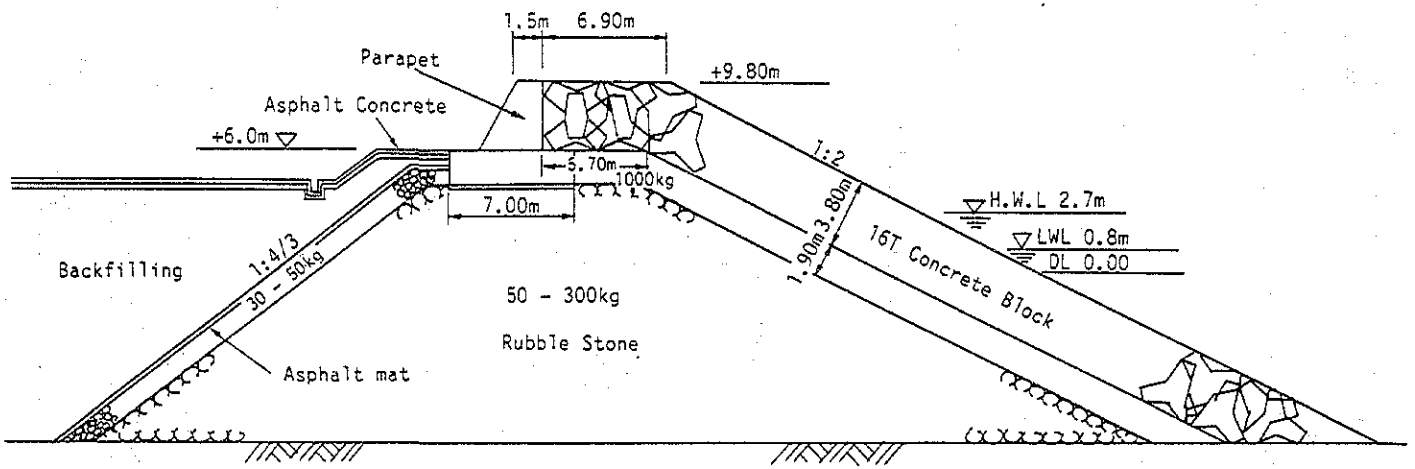


Fig. 7-11-2 Standard Cross Section of the Seawall

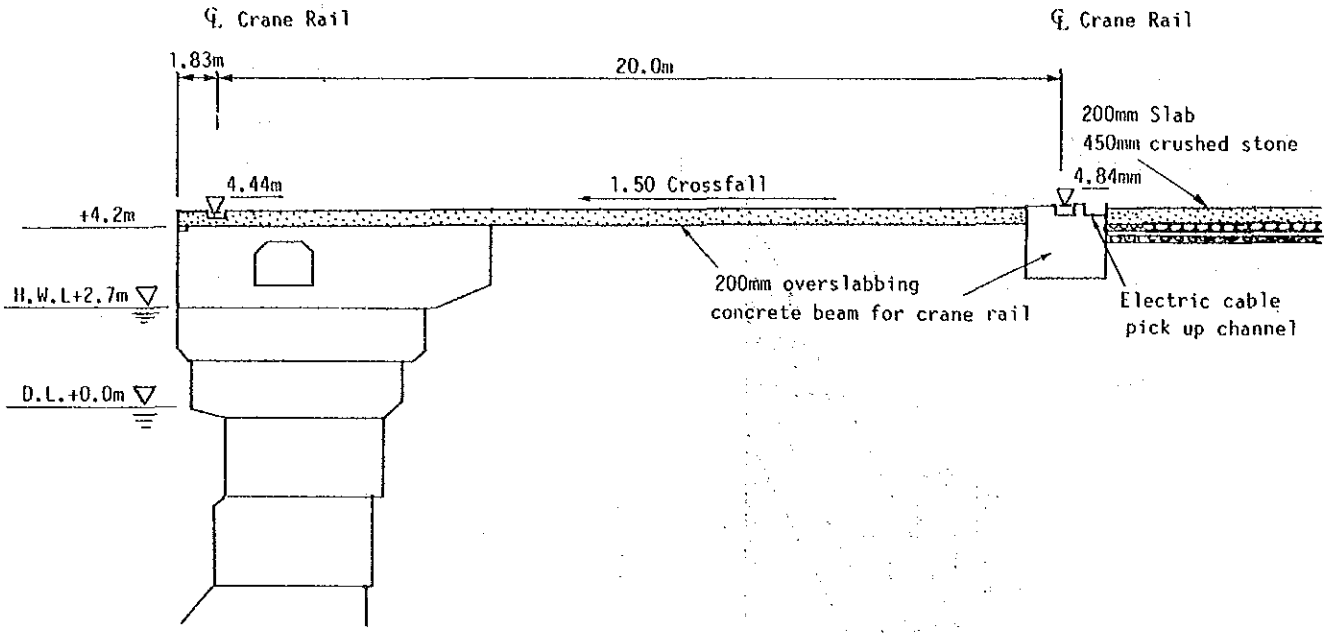


Fig. 7-11-3 Standard Cross Section of the Crane Foundation

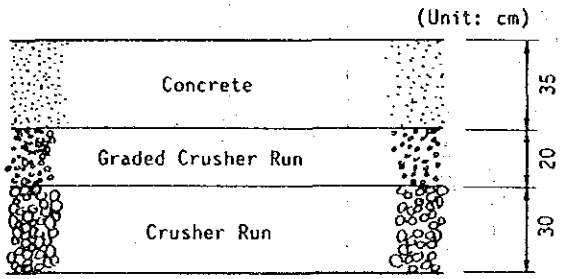


Fig. 7-11-4 Standard Cross Section of of Transfer Crane Track

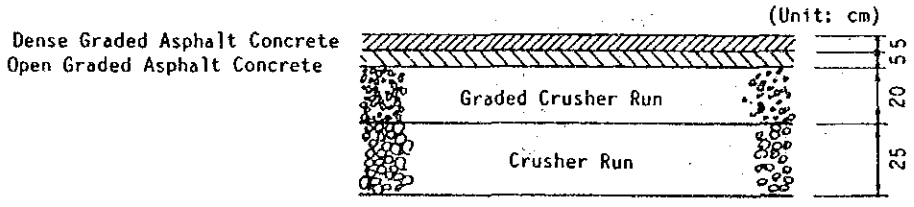


Fig. 7-11-5 Standard Cross Section of Pavement

7.12 Implementation Schedule of Port Construction

7.12.1 General

58. It is quite important to formulate a well designed construction program that will not obstruct the ongoing operations of Mina Qaboos, because it is a very busy port, with about one thousand ship calls a year. Given such conditions, how to dredge in front of the operational tub-basin is one of the key study points in terms of avoiding the most likely navigational obstructions to incoming and outgoing vessels.

59. The construction of the port facilities is to start in late 1990 and be completed by 1992. The project implementation schedule is briefly described below:

1) Blasting work at the quarry site at Jebel, and seawall construction will be executed, and reclamation and pavement work for the container yard will follow at Shutaify Bay.

2) In conjunction with the above work, the following work will be carried out on land; demolition of the sheds at Berths No.1 and 2; foundation-reinforcement work; and erection of container cranes, which will be installed at the container berths in due course.

3) Dredging work will be initiated at the -8m/-4m area, and the dredged materials will be used for reclamation at Shutaify Bay.

4) On completion of the dredging in the -8m/-4m area, dredging in the -13m area will start. The dredged materials therefrom will also be used for reclamation at Shutaify Bay.

5) Construction of Berth No.12 (A) (B) will start after completion of the dredging work.

6) The full package of the project is to be completed by the first half of 1992.

7.12.2 Amount of Construction Quantities

60. The construction quantities for each work component are shown in Table 7-12-1.

Table 7-12-1 Construction Quantities

Facility	Unit	Quantity
Land/Container Yard at Shutaify Bay	m^2	153,000
Land/Container yard at Mina Qaboos	Tracks for Container Crane, Container yard and road	
Dredging/Dumping (-13m, -8m, -4m)	m^3	1,186,800
Berths No.1 and 2	Concrete beam and rails for Container Crane	
Berth No.12 (A)(B)	m^2	6,400 (160m x 40m)
Buildings	m^2	15,600
Cargo Handling Equipment	No	56

7.12.3 Preliminary Study on Construction Procedure

(1) Blasting and Land Reclamation

61. The blasting operation is to be carried out at Jebel. The project area at Jebel forms a steep cliff, with no flat area, so the materials quarried from Jebel will initially be utilized to reclaim the adjacent sea area so that the reclaimed land can serve as a construction yard.

After building the construction yard, the materials quarried from Jebel will be utilized as rubble stone and armoured stone for the seawall. On completion of the seawall, the reclamation work will move into full gear.

(2) Dredging work

62. The required dredging volume is in the order of 383,300 m^3 in the -8m/-4m area, and 803,500m^3 in the -13m area. The dredged materials will be used for the reclamation at Shutaify Bay. The height of the land including the pavement will be approximately 5.0m above D.L.

According to the boring data, the type of soils at the proposed dredging area are judged to be as follows:

In the -8m/-4m area (between sea bed and -6.5m)... N = 20
(below that)..... N = 50

In the -13m area (between sea bed and -12m).... N = 20
(below that)..... N = 50

*N means N-value (Standard Penetration Test)

63. In the case of dredging hard-type ground, a grab dredger or pump dredger is considered suitable dredging equipment.

In grab dredging, a dredger is generally accompanied by two barges and two tugboats which are used to carry dredged materials to the dumping area. The grab dredger does not need as much space as a pump dredger. The quantity of dredging per hour by grab dredger, however, is much smaller than that of a pump dredger, resulting in longer working times and higher construction costs. Traffic congestion is usually caused by the barges and tugboats' frequent passage when carrying dredged material, hampering other vessels' navigation.

Addition to this, dumping of materials can be done up to an average depth 2m bellow the sea-level to allow for the draft of the barges. The remaining material should be carried and dumped at sites up to 3-4km away at sea.

In the case of pump dredging, on the other hand, other construction craft are not necessary, because the dredged material is carried through disposal pipelines. The dredging quantity per hour is three times as much as that of a grab dredger, which means construction will be completed in less time and more cheaply. However, the space occupied by a pump dredger is bigger than that by a grab dredger, and the disposal pipes which are placed on the surface of the water may hinder the passage of other vessels.

Moreover, the sea surface around the reclaimed land will become muddy, because of continuous disposal of muddy water.

Giving due consideration to these two methods, pump dredging is considered to be preferable, because the above-mentioned problems with the pump dredging method could be solved by applying appropriate countermeasures, while the problems with grab dredging cannot be solved technically at Mina Qaboos. The proposed countermeasures to solve the problems with pump dredging at Mina Qaboos are briefly described.

a) To divide the dredging area into various sections and to shorten the time spent by the dredger on each section, thus minimizing operational trouble to vessels passing nearby.

b) To place the disposal pipeline on the seabed in order not to hinder the passage of other vessels, especially in the area where the disposal pipelines may be a great obstacle.

c) To discharge the muddy water around the reclaimed land after letting the fine materials sink in the settling tank installed inside the seawall of the reclaimed land.

These countermeasures will help minimize the likely problems at Mina Qaboos.

(3) Construction of Berth No.12(A)(B)

64. On completion of dredging work at a water depth of -8m/-4m, the construction of Berth No.12(A)(B) is to start. The berth is of a steel pipe pile open type, including 12-degree batter piles. The stratum for pile-foundation at the new berth area is silty sand with N value of 50, so a diesel hammer of 7 ton ram weight is to be used. After the completion of pile-driving, the pile heads are to be rigidly fastened to the quay beams, and gravel is to be placed for the consolidation of pier foundations. At the last stage, the slab concrete is to be placed and paved on top.

As for the concrete material, ready-mixed concrete will be used.

7.12.4 Construction Schedule

1) Working Capacity

65. The working capacities of the major items which will be used most frequently in the Project have been compiled as follows:

Table 7-12-2 Working Capacity of Pump Dredging

Dredging (pump dredger 8,000 P.S.)	N=20	11,000m^3/day
	N=50	7,500m^3/day
Pile-driving		4 piles/day
Disposal of rubble stone		2,770m^3/day
Pavement		2,500m^2/day

2) Construction Schedule

66. The construction schedule at Mina Qaboos is shown in Table 7-12-3.

Table 7-12-3 Construction Schedule

Item	Sub-Item	1990					1991											1992											
		8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
Site Preparation																														
Land/Container Yard at Shutaify bay	Blasting Jebel																													
	SeaWall																													
	Reclamation/Surface Dressing																													
	Road/Yard Trucks of Crane																													
	Demolition																													
Land/Container Yard at Mina Qaboos	Demolition/Road Track of Crane																													
Dredging/Dumping	-8m/-4m Area																													
	-13m Area																													
Quay	No.1, No.2 Berth																													
	No.12(A)(B) Berth																													
Building	Office/C.F.S. etc.																													
Cargo Handling Equipment	Transfer Crane/ Container Crane etc.																													
Miscellanies	Access Road behind Shutaify Bay																													
	Mobilization																													

7.13 Cost Estimation

7.13.1 General

67. The cost of the development plan for Mina Qaboos has been estimated based upon the foregoing preliminary design, construction method and schedule.

The basic concept of cost estimation is briefly described below:

(1) Unit Rate for Labourers and Materials

These rates have been estimated using the average values obtained from various sources in Oman. If the rates were unavailable, they were estimated by comparison with other rates in Oman.

(2) Operating Cost of Equipment or Craft

(a) The cost of equipment or craft which are to be delivered from abroad have been calculated based on the standard used in Japan for calculating rental cost-that is the depreciation cost/maintenance cost per working days and operating hours.

(b) The cost of domestic equipment has been calculated from interviews with various sources. Wherever possible, these rates have been cross-checked.

(3) Unit Price

Unit price for each type of work, such as dredging, construction of quay and reclamation etc., are calculated as the sum of labourer, fuel, material, rental and other unit costs, and were checked by comparison with the corresponding unit prices in Oman and Japan.

7.13.2 Conditions for Cost Estimation

The main conditions for the cost estimation are as follows:

(a) Construction costs have been estimated using the prices and rates obtaining in December 1989 in principle.

(b) The inflation factor has been excluded from the estimation.

(c) The exchange rates of the U.S.$ against the Oman Rial (R.O.) and Japanese Yen (J¥) are as follows:

1U.S.$ = 0.385 R.O.

1U.S.$ = 144 J¥

(d) Rents or compensation for land and fishing activities have been excluded from the estimation.

(e) In general, the costs of the foreign portion include the following:

i) Materials, equipment, machinery and craft not produced in Oman.

ii) Materials available in Oman but which have been imported.

iii) Cost of foreign labourers.

(f) The construction cost of water and electric supply, drainage and communication facilities is excluded.

(g) Customs duties on the imported materials are fixed at 5% of their cost.

For construction equipment and craft mobilized outside Oman, custom duties are excluded in the cost estimation.

(h) Indirect costs except the above mobilization costs and administration costs are fixed at 23% of the direct cost.

(i) Physical contingencies are as follows:

0% Cargo-handling equipment

5% Dredging costs, costs of roads and land

10% Construction costs of quay, seawall, and buildings

(j) The consultation and technical cooperation fee is 5%.

Items of (g)(h)(i) and (j) are not included in direct cost.

7.13.3 Estimation Procedure

68. The estimation procedure has been carried out on the above conditions and the resulting of the unit prices and rates are as follows:

i) The unit prices for main materials

. Ready-mixed concrete	15 R.O./m^3
. Steel pipe pile	214 R.O./t
. Steel bar	152 R.O./t
. Armoured Stone (1,000kg)	2.6 R.O./m^3

ii) The day work for main labourer per day

. Skilled workers	10 R.O.
. Unskilled workers	8 R.O.
. Crew	10 R.O.

iii) The prices per unit quantity of main items

. Building	70 R.O./m^2
. Pavement	2.0 - 4.5 R.O./m^2
. Demolition	1.6 - 5.0 R.O./m^2
. Dredging	2.13 R.O./m^3
. Quay (Berth Nos.12(A)(B))	303.4 R.O./m^2
. Seawall	6,042.8 R.O./m

7.13.4 Result of Estimation

69. A summary of the estimation results is presented in Table 7-13-1.

On the basis of the construction schedule drawn up in Table 7-12-3, the yearly disbursement schedule has been estimated as shown in Table 7-13-2.

Table 7-13-1 Construction Cost for Each Item

Unit:1,000 R.O.

Facilities		Unit	Quantity	Unit Cost (R.O.)			Foreign Portion	Local Portion	Total
Item	Sub Item			Foreign Currency	Local Currency	Total			
1. Land/Container Yard at Shutaify Bay	(1) Blasting Jebel	m3	319,000	-	1.50	1.50	-	479	479
	(2) Seawall	m	420	405.05	5,637.30	6,042.80	170	2,368	2,538
	(3) Reclamation/Surface Dressing	m2	153,000	-	0.94	0.94	-	143	143
	(4) Road/Yard	m2	150,000	-	4.50	4.50	-	675	675
	(5) Tracks of Transfer Crane	m	2,900	-	7.00	7.00	-	203	203
	(6) Demolition	m2	13,200	-	5.00	5.00	-	66	66
	Sub-Total						170	3,934	4,104
2. Land/Container Yard at Mina Qaboos	(1) Demolition of Sheds	m2	22,100	-	1.60	1.60	-	35	35
	(2) Road	m	1,100	-	44.00	44.00	-	48	48
	(3) Tracks of Transfer Crane	m	4,820	-	7.00	7.00	-	34	34
	Sub-Total						-	117	117
3. Dredging/Dumping	(1) -8m/-4m Area	m3	383,300	1.82	0.31	2.13	697	118	815
	(2) -13m Area	m3	803,500	1.82	0.31	2.13	1,462	249	1,711
	Sub-Total		1,181,800				2,159	367	2,526
4. Quay	(1) Berhts No.1 and 2	m	970	14.76	155.79	170.55	14	151	165
	(2) Berth No.12(A)(B)	m2	6,400	113.2	190.20	303.40	725	1,217	1,942
	Sub-Total						739	1,368	2,107
5. Buildings	(1) Office/C.F.S. etc.	m2	15,600	4.84	65.16	70.00	76	1,016	1,092
	Sub-Total						76	1,016	1,092
6. Cargo Handling Equipment	(1) Transfer Crane/Container Crane etc.	No	56	-	-	-	8,380	-	8,380
	Sub-Total						8,380	-	8,380
7. Miscellanies	(1) Access Road behind Shutaify Bay	m	940	-	10.00	10.00	-	9	9
	(2) Mobilization	L.S.	3	-	-	-	600	-	600
	Sub-Total						600	9	609
8. Total							12,124	6,811	18,935
9. Indirect Cost	(1) Indirect Cost /Administration	L.S.	1				4,316	-	4,316
	(2) Consultation /Technical Cooperation	L.S.	1				1,154	-	1,154
	(3) Contingencies	L.S.	1				209	567	776
	(4) Customs Duties	L.S.	1				339	-	339
	Sub-Total						6,018	567	6,585
10. Grand Total							18,142	7,378	25,520

Table 7-13-2 Yearly Disbursement Schedule

Unit:1,000 R.O.

No.	Item	Total		1990		1991		1992	
		Foreign Portion	Local Portion	Foreign Portion	Local Portion	Foreign Portion	Local Portion	Foreign Portion	Local Portion
1.	Land/Container Yard at Shutaify Bay	170	3,934	57	1,158	113	2,776	-	-
2.	Land/Container Yard at Mina Qaboos	-	117	-	117	-	-	-	-
3.	Dredging/Dumping	2,159	367	-	-	2,159	367	-	-
4.	Quay	739	1,368	-	-	460	900	279	468
5.	Buildings	76	1,016	25	339	34	452	17	225
6.	Cargo Handling Equipment	8,380	-	3,020	-	5,360	-	-	-
7.	Miscellanies	600	9	400	-	200	9	-	-
8.	Total	12,124	6,811	3,482	1,614	8,346	4,504	296	693
9.	Indirect Cost	6,018	567	1,820	129	3,662	309	536	129
10.	Grand Total	18,142	7,378	5,302	1,743	12,008	4,813	832	822

Chapter 8 FORMULATION OF THE MASTER PLAN OF THE NEW PORT

8.1 Planning Premises

8.1.1 Cargo Volume in the Future

1. The future cargo volume in the New Port is summarized in the following table:

Table 8-1-1 Future Cargo Volume in the New Port

Items	2000	2010	2015
1. Total Container Cargo	102,354TEUs	296,482TEUs	432,080TEUs
	747,894tons	2,176,154tons	3,181,258tons
2. Bulk Grains	-	123,400tons	153.600tons
3. Total General Cargo	336,600tons	711,500tons	972,000tons
(Iron and Steel)	(141,200tons)	(370,700tons)	(535,400tons)
(Timber)	(54,000tons)	(81,000tons)	(96,800tons)
(Other General Cargo)	(141,400tons)	(259,700tons)	(339,800tons)
4. Vehicles	-	51,100tons	87,000tons
5. Livestock	-	8,400tons	13,810tons
Total	1,084,494tons	3,080,494tons	4,423,194tons

The functions that should be taken into consideration to develop in and around the New Port are as follows:

(1) Import Cargo Handling Function
(2) Export Cargo Handling Function
(3) Transshipment Cargo Handling Function
(4) Industrial Port Function
(5) Free Trade Zone Function
(6) Fishery Port Function
(7) Other Functions

2. In forecasting the future cargoes, the Free Trade Zone function was not taken into consideration, so the cargoes generating from a free trade zone may be added to the above cargo volume. But the possible industries in the free-trade zone are distribution centers and export promoting industries, and cannot be clearly identified at present. So, in the formulation of a Master Plan of the new port, we exclude the cargoes from the Free Trade Zone.

In forecasting the future cargoes, some parts of industrialization were already envisaged. The development of the Sohar Industrial Estate was taken into consideration, but the petrochemical products that were studied by Shell Corporation were not included because the expected export cargo volume was over 1 million tons and the total forecast export cargoes were only about 400,000tons, even in 2015. So we will take into consideration the following cargo volumes in formulating the Master Plan:

1) Ammonia ; 57,000tons(Export)
2) Urea ;174,000tons(Export)
3) Methanol ;500,000tons(Export)
4) MTBE ;100,000tons(Export)
5) SMDS ;500,000tons(Export)

In forecasting the future cargoes, exports of processed fish cargo were taken into consideration, but the volume of unloaded fishes was not included. The volume of unloaded fishes was 8,600 tons in 2000 and 16,000 tons in 2015, analyzed in Appendix 4-3-8. We intend to use this analysis only as the maximum estimates in formulating fishery port plans.

8.1.2 Vessel Size and Berth Dimensions

3. Sizes and berth dimensions of the various vessels used for the plan are as follows:

(1) General Cargo Vessels

Te objective vessel sizes are as follows:

a. Maximum Vessel Size;

Overall Length : 198m
Breadth : 28.2m
Full Load Draft : 11.7m

b. Objective Vessel Size for Continuous Berths;

Overall Length : 175m
Breadth : 24.4m

The required berth dimensions are as follows:

a. Single Berth : Length : 250m ; Depth : -13,0m
b. Continuous Berth : Length : 220m ; Depth : -13.0m

(2) Container Vessels

The objective vessel sizes are as follows :

a. Maximum Mother Vessel Size;

Overall Length : 290m

Breadth : 32.2m

Full Load Draft : 12.7m

b. Maximum Feeder Vessel Size;

Overall Length : 175m

The berth dimensions are as follows:

a. Minimum Length : 320 + 160 = 480m ; Depth : -14.0m

b. Standard Length : 320m ; Depth : -14.0m

(3) Other Special Vessels

a. Bulk Grain Carriers

The maximum vessel size and berth dimensions are as follows:

i) Maximum Vessel Size : 50,000DWT

(L, B, Dr) = (208.0m, 32.2m, 11.2m)

ii) Required Single Berth Dimensions :

Length = 250m, Depth = -13.0m

iii) Required Dimensions of Continuous Berths :

Length = 220m, Depth = -13.0m

b. Ro-Ro Vessels

The maximum vessel size and berth dimensions are as follows :

i) Maximum Vessel Size : 30,000DWT

(L, B, Dr) = (200m, 32.2m, 10.0m)

ii) Required Single Berth Dimensions :

Length = 240m, Depth = -11.0m

iii) Required Dimensions of Continuous Berths :

Length = 220m; Depth = -11.0m

c. Livestock Carriers

The maximum vessel size and berth dimensions are as follows :

Maximum Livestock Carriers : 34,000 GRT

Length : 195.0m

Full-load Draft : 10.7m

Required Berth Dimensions : Length : 220m

Depth : -12.0m

Ro-Ro vessels and livestock carriers use general cargo berths, so the actual berth depth will be -13.0m.

d. Petrochemical product carriers

The vessel size and berth dimensions are as follows:

Vessel Size

i) Ammonia ; 5,000GRT Chemical Tankers
(L, B, Dr) = (123.0m, 8.3m, 7.8m)

ii) Urea ; 25,000DWT General Cargo Vessels
(L, B, Dr) = (174m, 24.4m, 10.9m)

iii) Methanol, MTBE and SMDS ; 50,000DWT Product Tankers
(L, B, Dr) = (170.7m, 32.2m, 11.3m)

Required Berth Dimensions :

i) Ammonia Tankers : Length : 135m; Depth: -8.6m

ii) Urea : Length : 200m; Depth : -12.0m

iii) Products Tankers : Length : 200m, Depth : -12.5m

Actually, ammonia tankers will use the existing jetty. And urea vessels use the general cargo berths, so the depth will be -13.0m. Considering the frequency of product tankers, one berth should be allocated to oil products tankers along the breakwater.

e. Fishery Boats and Vessels

The vessel sizes and required berth dimensions are as follows:

Vessel Size:

	(L, B, Dr)
1-2GT Boats	: (7.0m, 2.0m, 0.7m)
30GT Dhows	: (20.0m, 4.2m, 2.3m)
Trawling Vessels	: (30.0m, 8.0m, 4.0m)

Number of Vessels

	in 2000	in 2015
1-2GT Boats :	34	-
30GT Dhows :	8	13
Trawling Vessels :	7	14

Required Berth Dimensions :

In 2000	Depth	Unloading	Preparation	Sub-total	Laying	Total
1-2GT Boats	:-1.5m	24.5m	16.5m	41.0m	102.0m	143.0m
30GT Dhows	:-3.0m	23.0m	23.0m	46.0m	50.4m	96.4m
Trawling Vessels	:-5.5m	34.5m	34.5m	69.0m	84.0m	153.0m
Total	:	82.0m	74.0m	156.0m	236.4m	392.4m
In 2015						
30GT Dhows	:-3.0m	23.0m	23.0m	46.0m	82.0m	128.0m
Trawling Vessels	:-5.5m	92.0m	92.0m	184.0m	168.0m	352.0m
		115.0m	115.0m	230.0m	250.0m	480.0m

8.2 Alternative Formulation Plans

4. Before formulating a Master Plan, reclamation plans and excavation plans should be compared considering future expansion beyond 2015.

8.2.1 Reclamation Plan Alternatives

5. Fig.8-2-1 shows various alternative plans. Taking into consideration the soil volume balance, the alternative plans are formulated. The required quay length in 2015 is assumed to be about 3km, and the final quay length is assumed to be about 10km beyond 2015. The concepts of the alternative formulations are as follows:

Alternative 1 : This plan is formulated by considering the development of the westernmost area, where there is a huge open space. But the Ministry of the Environment intends to designate this area as a natural reservation area (NRA)[1]. In this plan, the port area would intrude into NRA by 3.7km in the long run. The distance from the existing jetty to the densely populated area of Majis is only 2km. So the right side of the port should be used for "clean" industries such as a FTZ and light industry.

Alternative 2 : This plan is formulated by considering the utilization of the existing jetty. In this plan, the distance of intrusion to NRA would be reduced to 2.7km.

---

1) We visited the poposed site of NRA, but was not be able to recognize any mangroves there.

Alternative 3 : This plan is formulated by considering the east side development of the existing jetty. In this plan, the distance of intrusion to NRA would be reduced to 1.7km.

8.2.2 Excavation Plan Alternative

6. If it is not necessary to reclaim the sea area, breakwaters must be constructed to shelter the turning basin. Two alternatives are worth considering. One is on the west side of the existing jetty, the other is on its east side. But the latter plan is not suitable, because the outer channel will cross the existing jetty. So the former plan is the only feasible alternative. The concept of the alternative formulation is as follows.

Alternative 4 : A breakwater of insufficient length would not be effective in decreasing wave height, so we planned the main breakwater to be 600m long. To obtain 290m width in the entrance channel, the distance between two breakwaters should be 860m. In order to utilize the open space, the inner channel veers to the east side. From this plan the intrusion distance will be 2.3km in the long term.

8.2.3 Selection of Suitable Alternative

7. In order to reduce the intrusion to NRA, alternatives 3 and 4 seem to be preferable. The excavation plan is cheaper than the reclamation plan. So we have selected Alternative 4.

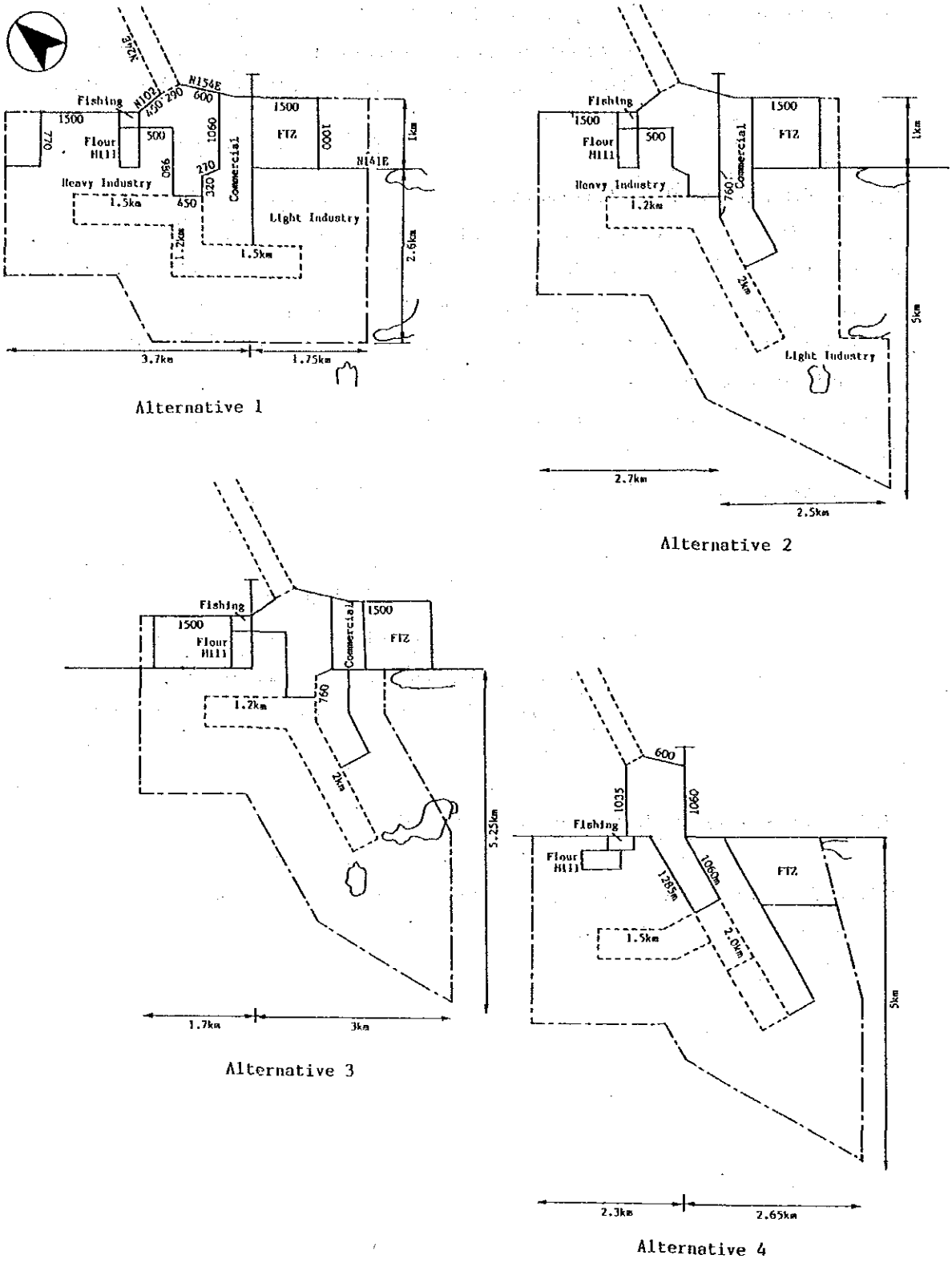


Fig. 8-2-1 Alternatives of Reclamation Plans

8.3 Required Scale of Port Facilities

8.3.1 Container Berths

8. The volume of container cargoes will be 432,080 TEUs in 2015. The average cargo handling volume per container vessel calling at Mina Qaboos was 368 TEUs in 1988. If the volume does not change in the future, the number of the calling container vessels would be 1,174. The number of vessels arriving per day will be 3.2168 vessels/day. The cargo handling productivity is assumed to be 25 units/hour/gang, and the service time for one vessel is assumed to be 0.33 day. The berth occupancy rate and the average waiting time can be calculated as follows:

Number of Berths	Berth Occupancy Rate	Average Waiting Time
2	0.5308	3.15 hr
3	0.3538	0.43 hr

If we adopt 3 berths, the average waiting time would be reduced to less than 1 hour. Comparing the service time (7.92hrs) with the average waiting time, we would recommend the adoption of 3 berths.

The volume of container cargoes will be 102,458 TEUs in 2000. The number of the calling container vessels will be 278.4. The number of vessels arriving per day will be 0.7628 vessels/day. The berth occupancy rate and the average waiting time can be calculated as follows:

Number of Berths	Berth Occupancy Rate	Average Waiting Time
1	0.2517	2.7 hr

The number of berths required is only one, but since we envisage transshipment, the minimum number required is 2 berths for a mother vessel and a feeder vessel. Judging from the overall lenght of both vessels, 1.5 standard container berths will be required in 2000.

8.3.2 General Cargo Berth

9. We have planned multi-purpose berths which can be used for general cargo vessels, Ro-Ro vessels and livestock carriers. In 2015, the cargo volumes of iron and steel, timber, vehicles, livestock and other general cargoes will be 535,400 tons, 96,800 tons, 87,000 tons, 13,800 tons and 339,800 tons, respectively. Assuming that the cargo volume per vessel for these cargoes are 2,420 tons/vessel, 2,080 tons/vessel, 300 tons/vessel, 460 tons/vessel and 950 tons/vessel, respectively, the numbers of calling vessels will be 221.2, 46.5, 290, 30 and 538.4, respectively. Accordingly, the arrival rates per day are 0.6061, 0.1275, 0.7945, 0.0822 and 1.4751, respectively. The combined arrival rate can be calculated as 3.0852. On the other hand, the service times per vessel for these cargoes are assumed to be 0.9926, 1.0630, 0.2645, 0.4142 and 0.6278 day/vessel respectvely. The combined service time can be calculated as 0.6176. The berth occupancy rate and the average waiting time can be calculated as follows:

Number of Berths	Berth Occupancy Rate	Average Waiting Time
3	0.635	5.5 hr
4	0.476	1.1 hr

The number of multi-purpose berths required will be 4 in 2015.

10. In 2000, the cargo volumes of iron and steel, timber and other general cargoes will be 141,200 tons, 54,000 tons and 141,400 tons respectively. Taking the same procedure in 2015, the berth occupany rate and the average waiting time can be calculated as follows:

		N [1]	λ [2]	$1/\mu$ [3]
1) Iron and Steel	:	58.3	0.1599	0.9926
2) Timber	:	26.0	0.07113	1.0630
3) Other General Cargoes	:	148.8	0.4078	0.6278
Combined		233.1	0.6386	0.7745

Number of Berths	Berth Occupancy Rate	Average Waiting Time
1	0.4946	18.2 hr
2	0.2473	1.2 hr

The number of multi-purpose berths required will be 2 in 2000.

---

1) N : the number of calling vessels

2) λ : the arrival rates of the vessels per day

3) $1/\mu$:the average service time per vessel

8.3.3 Bulk Grain Berths

11. In 2015, Mina Qaboos will not be able to handle the total forecast amount of bulk grains. So we plan one berth for bulk grain carriers in 2015.

8.3.4 Petrochemical Berths

12. As described in 8.1.2, if this project is adopted by the government of Oman, one liquid petrochemical berth will be necessary. The location of this berth will be at the main breakwater. The berth for chemical tankers carrying ammonia will be at the existing jetty.

8.3.5 Other Berths

13. The required berth length for the fishery port is described in 8.1.2. We did not plan berths exclusively used for the Royal Fleet. But it is possible to berth His Majesty's Vessels the general cargo berths, considering the projected berth occupancy rates for 2000 and 2015.

A bunkering berth should be constructed at the breakwater.

The selected development plans are shown in Figs.8-3-1 and 8-3-2.

Fig.8-3-3 shows the degree of calmness in the port area.

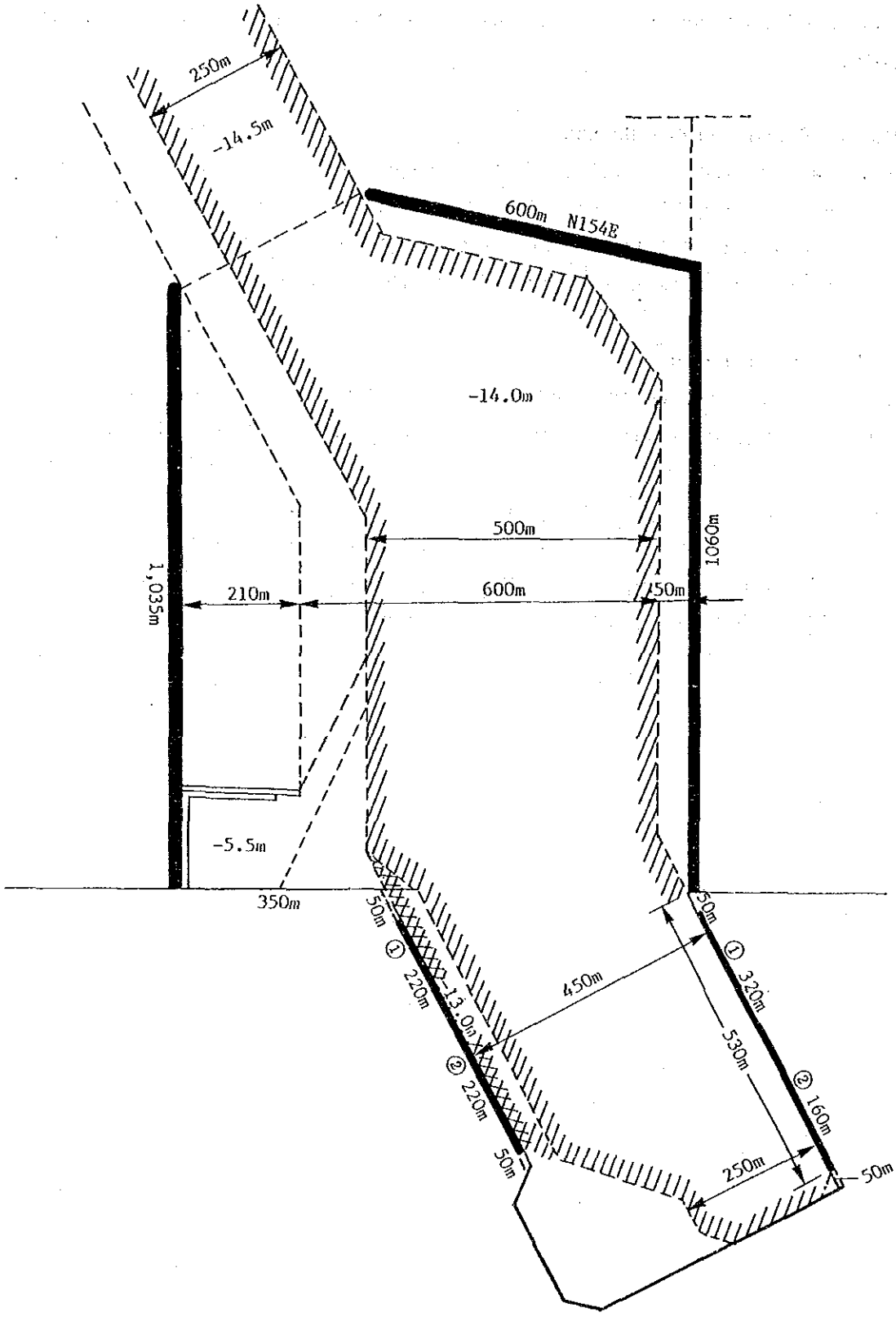


Fig. 8-3-1 Selected Plan in 2000

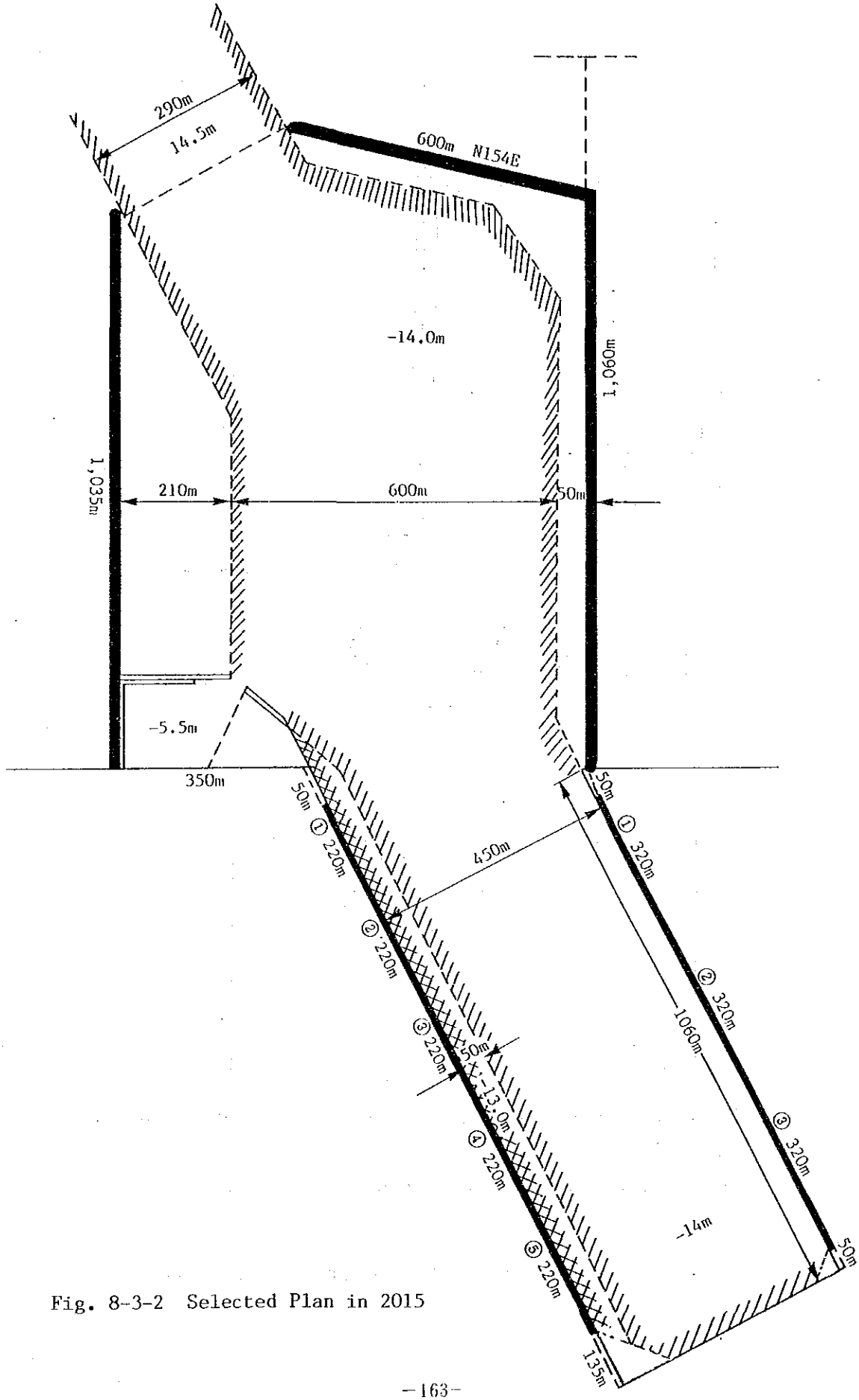
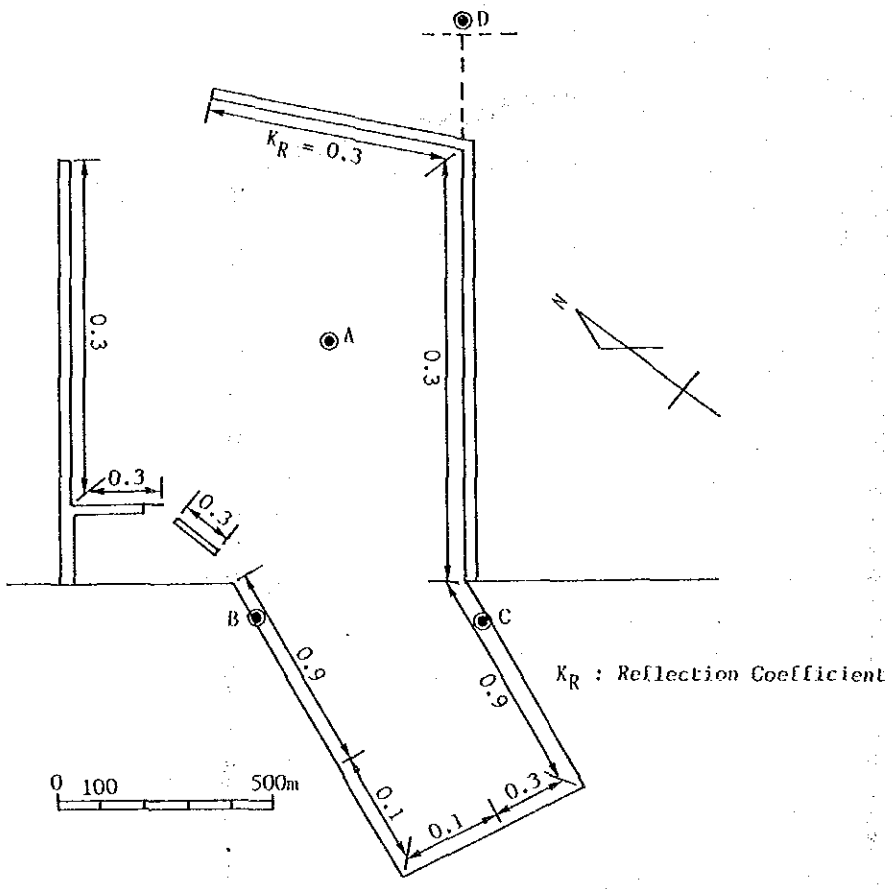


Fig. 8-3-2 Selected Plan in 2015



(%)

Point	Unexceeding Probability (lines of wave height : 0.5m)
A	96.9
B	98.5
C	98.7
D	67.7

Note : The figures were calculated based on observation wave record from 1986 to 1989.
The point D is in front of the existing jetty.

Fig. 8-3-3 Degrees of Calmness in the Port Area

8.4 Required Scale of Cargo Handling Equipment

8.4.1 Handling Systems for the New Port

(1) Break bulk cargo

14. Loading and unloading of break bulk cargo will be done by ship's gear, and fork-lifts will be used between the apron and the shed. Generally, fork-lifts operate within a 150m driving distance. Between the apron and the outside open storage area, transportation will be carried out by trucks or tractor-trailers. The expected layout of the general cargo berth is as shown below;

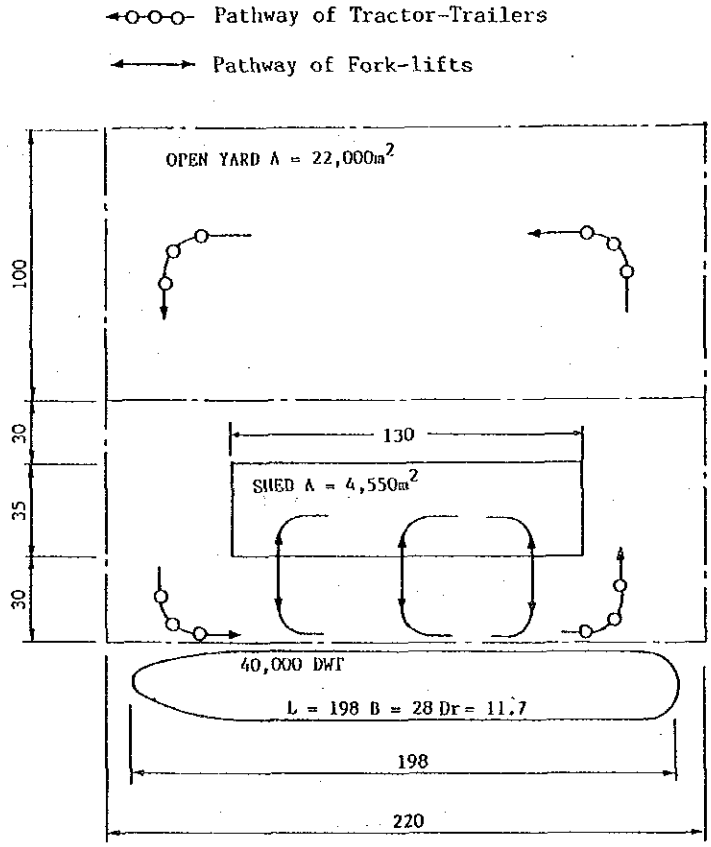


Fig. 8-4-1 Layout of General Cargo Berth

(2) Container Cargo

15.(a) There are two different approaches to container handling when loading and discharging, one is roll-on, roll-off, and the other is lift-on, lift-off. Roll-on, roll-off, however will only be used in special cases. At the new port, the lift-on, lift-off system by container crane on a quay will be used.

(b) At terminal

There are many handling systems; transfer crane, straddle carrier, chassis system, and others at the terminal. The handling system recommended by the team for Mina Qaboos is the transfer crane system. Similarly, at the new port, a transfer crane system is recommended.

(3) Vehicles and livestock

16. These cargoes are transported from vessels to quay sides by using a ramp or passage way.

(4) Grain and others

17. Handling of grains will be carried out by a pneumatic unloader system and conveyer from the ship to the silo. A pump and pipeline system will be used in future for Petroleum Products and Chemicals.

8.4.2 Required Numbers of Handling Equipment

(1) General cargo berth

18.(a) Break bulk (bagged, palletized, others)

Fork-Lifts

One gang	2 units
Three gangs per ship(2units x 3)	6 units
for back yard work	2 units
for spare	2 units
total number per berth.....	10 units

(b) Dry bulk (Steel, timber, etc.)

1) Tractor-trailers (Truck)

One gang	2 units
Two gangs per ship (2units x 2)..	4 units

2) Mobile-cranes

Two units per berth.....	2 units

(2) Container Cargo berth

19. 1) Container Cranes (Fig.8-4-2)

Items	2000	2015
Containers to be Handled (TEU)	102,354	431,294
Number of Berths Available	1.5	3
Number of Container Cranes	3 units	6 units
Reference: Handling Capacity per annum (TEU)	225,000	450,000

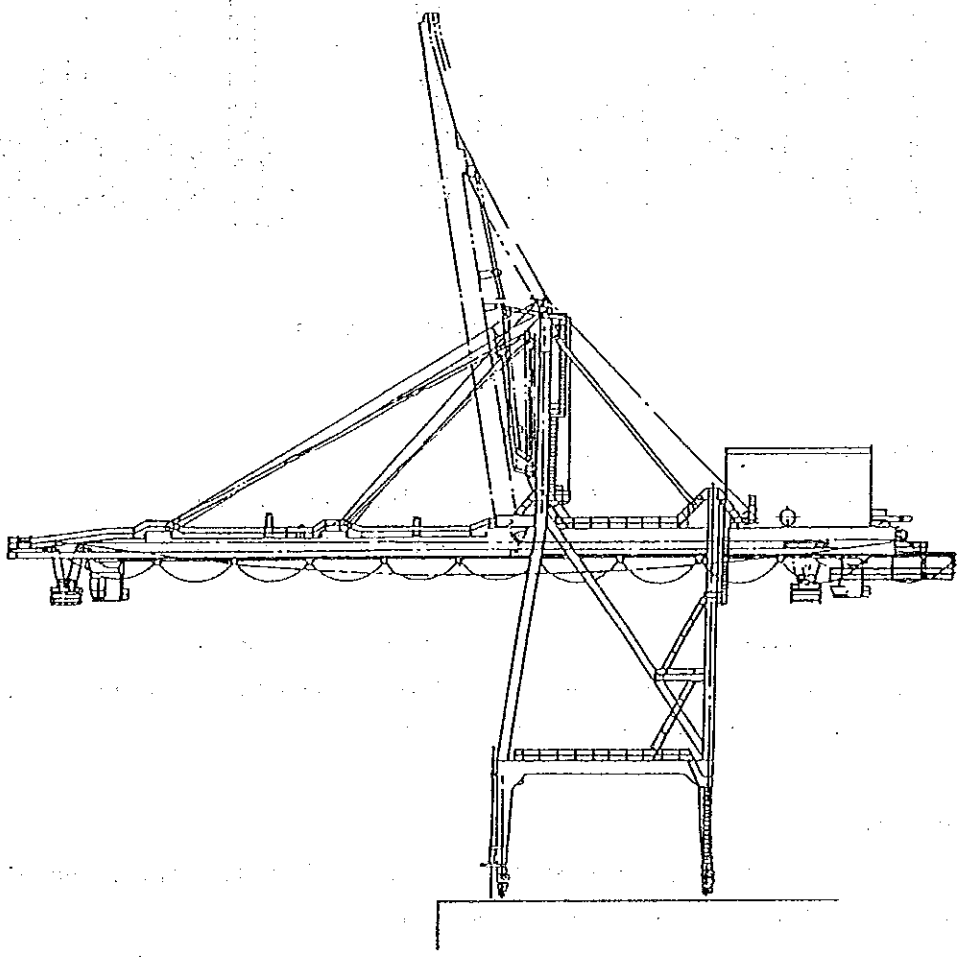


Fig. 8-4-2 Container Cranes

2) Transfer Cranes (Fig. 8-4-3)

There should be eight Transfer Cranes in the Container Yard.

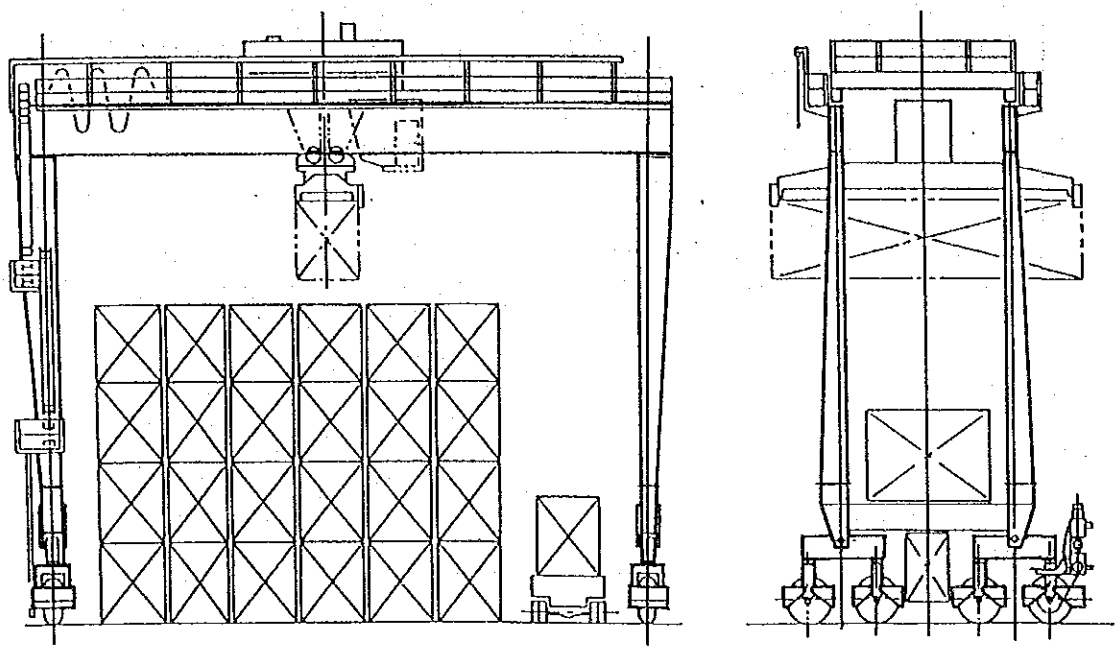


Fig. 8-4-3 Transfer Cranes

3) *Tractor-trailer chassis at the yard*

The required number of tractor-trailer chassis for transportation between the aprons and the container yards is determined at 18 units.

4) Tractor-trailers at the Container Fright Station (C.F.S.)

The required number of tractor-trailer at the C.F.S. will be five(5) tractor-trailer sets and twenty(20) trailers (chassis).

(3) Bulk Grain

20. Comparison of handling equipment is listed in Tables 8.4.1 and 8.4.2. (number of Pneumatic unloaders and capacity)

Table 8-4-1 Comparison Table of Berthing Hours

	PLAN A	PLAN B
1) Number of Pneumatic unloaders and capacity	400ton/hr x 2 sets 800 ton/hr	400ton/hr x 1 set 400 ton/hr
2) Unloading hours 50,000ton/ 1)	62.5hr	125hr
3) Berthing hours 2) + 10 hr	72.5hr	135hr

Table 8-4-2 Cost Comparison

unit: x 1000 R.O

	PLAN A	PLAN B
4) Pneumatic unloader	2,000	1,000
5) Conveyer system	1,500	800
6) Dust collector	750	750
7) Electric Equipment	750	750
8) Subtotal	5,000	3,300
9) SILOS	3,500	3,500
10) Buildings	2,000	2,000
11) Subtotal	5,500	5,500
12) Total 8)+11)	10,500	8,800
13) Economic life	25 years	
14) Annual cost 12)/13)	420	352
15) Ship cost per day	3.75/day	0.156/hr
16) Ship cost in Port 15)x3)	11.31	21.06
17) Ship cost per year 16)x3	33.93	63.18
18) Total annual cost 14)+17)	453.93	415.18
19) Difference, A-B	+41.75	

Conclusion: The annual cost of PLAN B (Pneumatic unloader 400ton/hr x 1 set) is less than that of PLAN A by 41,750 RIAL.
Therefore PLAN B in recommended by the JICA TEAM.

(4) Total numbers of equipment

21. A list of the cargo handling equipment required for the new port is listed below in Table 8-4-3.

Table 8-4-3 Cargo Handling Equipment

DISCRIPTION	2000	2015
Container Cranes	3	3
Transfer Cranes	8	7
Tractor-Trailers	27	20
Trailers	20	-
Mobil Cranes	2	2
Fork Lifts	30	10
Truck Scales	1	1
Tug Boats	2	1

8.5 Required Scale of Storage Facilities

8.5.1 Estimation of Area Required for General Cargo

(1) Required area by storage mode

22. The required areas are summarized in Table 8-5-1.

Table 8-5-1 Required Area by Storage Mode

Open area

year (2000)	throughput (ton)	dwell time (day)	working days/year	stacking density (t/m^2)	peak factor	allowance	required area(m^2)
timber	54000	8.05	300	2.5	1.6	1.4	1298
steel	141200	7.00	300	1.3	1.6	1.4	5677
vehicles (unit)	0	5.30	300	0.0625	1.8	1.2	0
others	81918	12.80	300	0.75	1.6	1.4	10439
sum	277118						

Stacking density of vehicles: 1/16 ($16m^2$/unit)

Covered

year (2000)	throughput (ton)	dwell time (day)	working days/year	stacking density (t/m^2)	peak factor	allowance	required area(m^2)
rice*5	7090	10	300	2.5	1.5	1.4	199
sugar*5	2615	12.8	300	2.5	1.5	1.4	94
cement*5	580	12.8	300	2.5	1.5	1.4	21
others	28682	12.8	300	0.75	1.5	1.4	3427
sum	38967						3740

Open area

year (2015)	throughput (ton)	dwell time (day)	working days/year	stacking density (t/m^2)	peak factor	allowance	required area(m^2)
timber	96800	8.05	300	2.5	1.6	1.4	2327
steel	535400	7.00	300	1.3	1.6	1.4	21526
vehicle							
(unit)	43500	5.30	300	0.0625	1.8	1.2	26559
others	182402	12.80	300	0.75	1.6	1.4	23244
sum	858102						73656

stacking density of vehicle: 1/16 (16m2/unit)

Covered

year (2015)	throughput (ton)	dwell time (day)	working days/year	stacking density (t/m^2)	peak factor	allowance	required area(m^2)
rice*.5	20295	10	300	2.5	1.5	1.4	568
sugar*.5	9045	12.8	300	2.5	1.5	1.4	324
cement*.5	1225	12.8	300	2.5	1.5	1.4	44
others	69658	12.8	300	0.75	1.5	1.4	8322
sum	100223						9258

Amount directly delivered 30565

(2) Relationship between required area and available area.

23. The required areas and available areas are summarized in Tables 8-5-2 and 8-5-3.

Table 8-5-2 Required Area and Available Area (Open Area)

Unit: m^2

	2000	2015
Required Area	17,414	73,656
Available Area		
No.1 Berth	47,000	47,000
No.2 Berth	22,000	22,000
No.3 Berth		22,000
No.4 Berth		15,000
No.5 Berth		47,000
Sum	69,000	153,000
Balance	51,586	79,344

Table 8-5-3 Required Area and Available Area (Covered)

Unit: m^2

	2000	2015
Required Area	3,740	9,258
Available Area		
No.2 Berth	4,550	4,550
No.3 Berth		4,550
Sum	4,550	9,100
Balance	810	-158

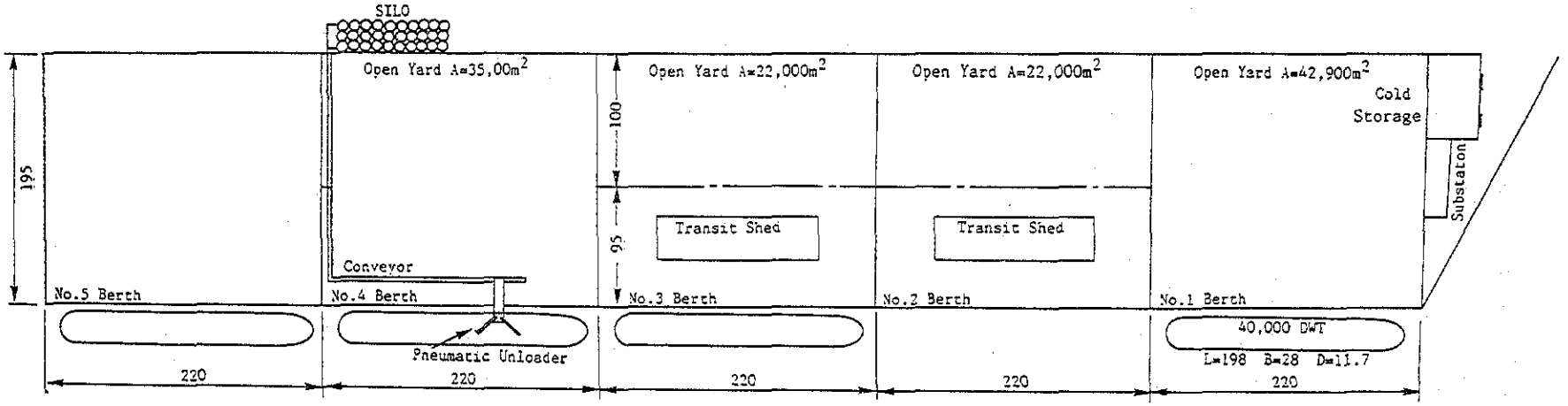


Fig. 8-5-1 Layout of General Cargo Berth

8.5.2 Estimation of Area Required for Container Cargo

24.(1) The number of ground spots required for each container mode is estimated as out-lined is the tables below:

Table 8-5-4 The Number of Ground Spots (For the Year 2000)

		g.spot	dwell time	stack height	efficiency	peak fact.	serv.day (day)	throughput
(a)	export(1)	114	7.0	4.0	0.80	1.3	365.0	14632
(b)	transship		6.9	4.0	0.80	1.3	365.0	0
(c)	import	228	8.6	3.0	0.75	1.3	365.0	16748
(d)	export(e)	198	21.0	4.0	0.80	1.3	365.0	8471
(e)	export(e)	300	21.0	4.0	0.80	1.3	365.0	12835
(f)	export(e)	228	21.0	4.0	0.80	1.3	365.0	12322
(g)	export(e)		21.0	4.0	0.80	1.3	365.0	16748
(h)	import(r)	276	6.9	4.0	0.80	1.3	365.0	35938
(i)	import		21.0	4.0	0.80	1.3	365.0	0
(j)	transship	276	6.9	4.0	0.80	1.3	365.0	35938
(a)	export(e)		21.0	4.0	0.80	1.3	365.0	0
(g)	import		8.6	3.0	0.75	1.3	365.0	0
(d)	transship	264	6.9	4.0	0.80	1.3	365.0	34376
sum		2112						161168

Table 8-5-5 The Number of Ground Spots (Based on the Year 2000)

summary	storage cap.(TEUs)	required slot 2000	balance 2000	additional g.spots
import(r)	9097	3949	5148	122
import	33496	18648	14848	202
export(1)	14632	2793	11839	92
export(e)	33628	16665	16963	396
transship	70314	30150	40164	308
sum	161168	72205		1122

Table 8-5-6 The Number of Ground Spots (For the Year 2010)

		g.spot	dwell time	stack height	efficiency	peak fact.	serv.day (day)	throughput
(a)	export(1)	114	7.0	4.0	0.70	1.3	365.0	12803
(b)	transship	618	6.9	4.0	0.70	1.3	365.0	70412
(c)	import	684	8.6	3.0	0.60	1.3	365.0	40196
(d)	export(e)	426	21.0	4.0	0.70	1.3	365.0	15948
(e)	export(e)	642	21.0	4.0	0.70	1.3	365.0	24034
(f)	export(e)	630	21.0	4.0	0.70	1.3	365.0	23585
(g)	export(e)		21.0	4.0	0.70	1.3	365.0	0
(h)	import(r)	540	10.0	2.0	0.60	1.3	365.0	18194
(i)	import	570	8.6	3.0	0.60	1.3	365.0	33496
(j)	transship	606	6.9	4.0	0.70	1.3	365.0	69045
(a)	export(e)		21.0	4.0	0.70	1.3	365.0	0
(g)	import		8.6	3.0	0.60	1.3	365.0	0
(d)	transship		6.9	4.0	0.70	1.3	365.0	0
sum		4830						307712

Table 8-5-7 The Number of Ground Spots (Based on the Year 2010)

summary	storage cap.(TEUs)	required slot 2000	balance 2000	additional g.spots
import(r)	18194	11979	6215	184
import	73692	49968	23724	404
export(1)	12803	7162	5641	50
export(e)	63566	44329	19237	514
transship	139457	91291	48166	423
sum	307712	204729		1575

Table 8-5-8 The Number of Ground Spots (For the Year 2015)

		g.spot	dwell time	stack height	efficiency	peak fact.	serv.day (day)	throughput
(a)	export(1)	342	7.0	4.0	0.80	1.3	365.0	43896
(b)	transship	618	6.9	4.0	0.80	1.3	365.0	80471
(c)	import	570	8.6	3.0	0.75	1.3	365.0	41871
(d)	export(e)	312	21.0	4.0	0.80	1.3	365.0	13349
(e)	export(e)	642	21.0	4.0	0.80	1.3	365.0	27467
(f)	export(e)	630	21.0	4.0	0.80	1.3	365.0	26957
(g)	export(e)		21.0	4.0	0.80	1.3	365.0	0
(h)	import(r)	540	10.0	2.0	0.75	1.3	365.0	22742
(i)	import	570	8.6	3.0	0.75	1.3	365.0	41871
(j)	transship	606	6.9	4.0	0.80	1.3	365.0	78908
(a)	export(e)		21.0	4.0	0.80	1.3	365.0	0
(g)	import		8.6	3.0	0.75	1.3	365.0	0
(d)	transship		6.9	4.0	0.80	1.3	365.0	0
sum		4830						377529

Table 8-5-9 The Number of Ground Spots (Based on the Year 2015)

summary	storage cap.(TEUs)	required slot 2015	balance 2015	additional g.spot
import(r)	22742	17937	4805	114
import	83741	70011	13730	187
export(1)	43896	9852	34044	265
export(e)	67770	61785	5985	140
transship	159370	135854	23525	181
sum	377529	295439		887

(2) For the year 2000

25. The container berth configuration shown in Fig.8-5-2 was planned with the data given above and three (3) cranes to be installed.

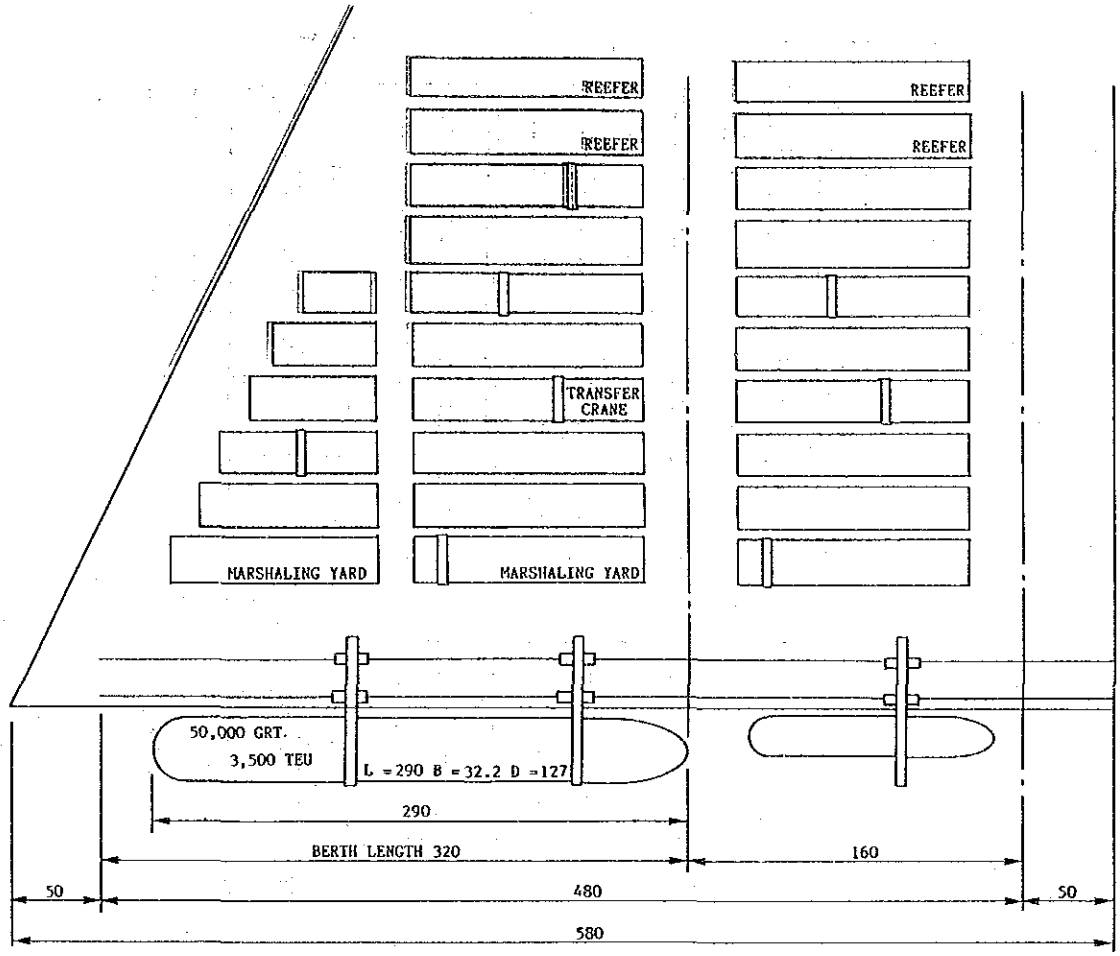


Fig. 8-5-2 Container Berth Layout in the Year 2000

(3) For the year 2015

26. The layout of the final three container berths in the year 2015 is shown in Fig.8-5-3.

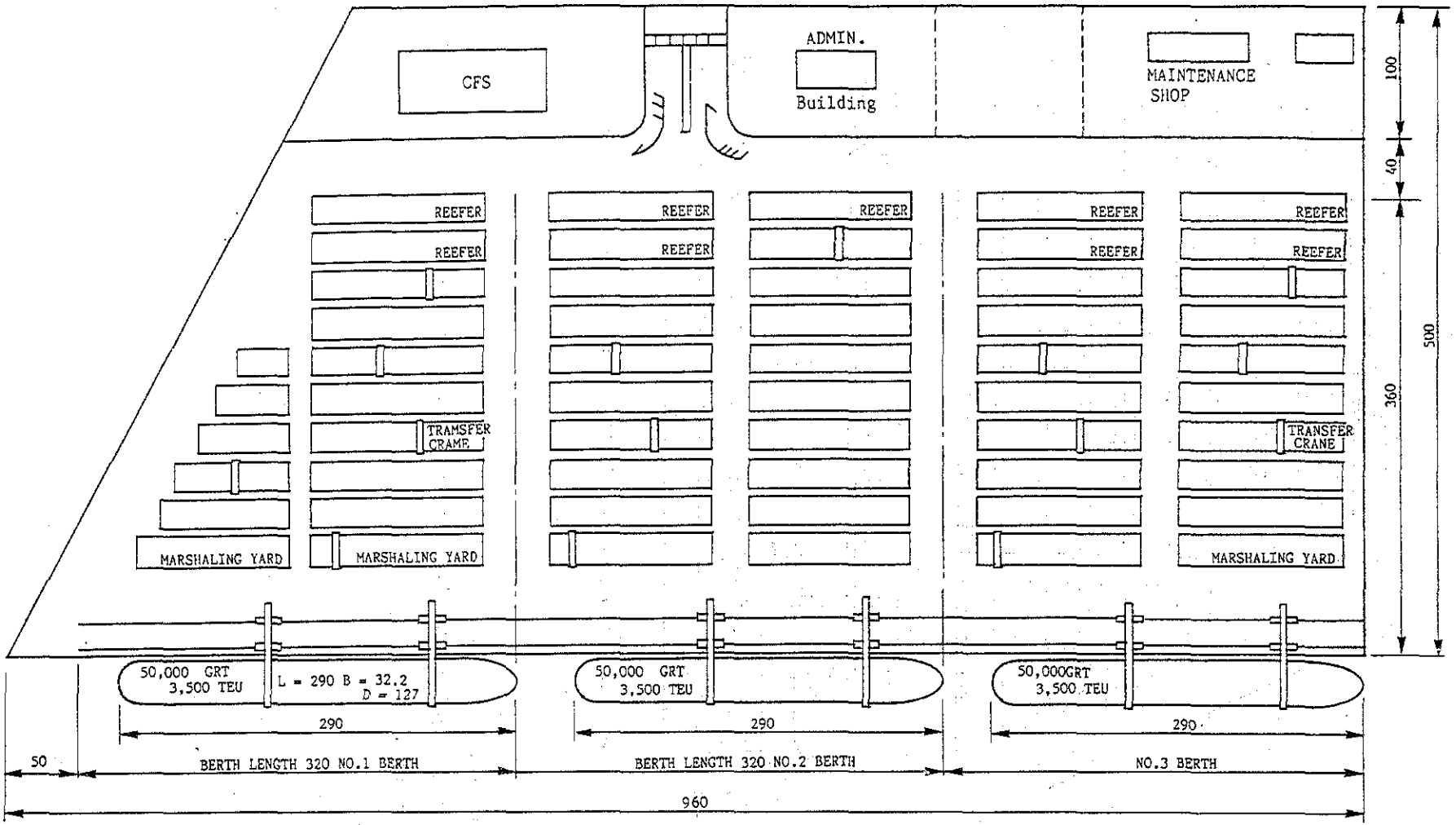


Fig. 8-5-3 Final Layout of Container Berth in the Year 2015

8.5.3 Other Facilities

(1) C.F.S.

a) Expected number of containers

27. The expected number of containers and cargo tonnage throughput at C.F.S. are: 10% of loaded import containers and 25% of loaded export containers in the year 2015. These numbers are shown in Table 8-5-10.

Table 8-5-10 Container and Cargo Throughput

	Container(TEU)	Cargo (ton)
Import	7,000	82,612
Export	2,460	27,100
Sum	9,460	109,712

b) Area of C.F.S.

The area required for the C.F.S. is 5,170m^2.

The dimension of the C.F.S. is 50m in width and 110m of frontage.

(2) Container berth administration building

28. An administration building will be required to control the container operations. This building will have three stories; on the ground floor will be the canteen and rest room; on the first floor are offices; and on the second floor will be the operations control room and the computer room. The building will be 800m^2 in area, 20m width and 40m.

(3) Maintenance shop

29. A maintenance shop for repair and maintenance work on the handling equipment or damaged containers is required at the container berth.

The required shop area will be 1,700m^2 (1200m^2 for maintenance, plus 500m^2 for damaged containers) with a width of 25m and a length of 70m.

An overhead crane, steam cleaners, press machines, wheel dollies and other repair tools as well as a store of spare parts will be provided in the maintenance shop.

A further 3,000m^2 or so of open working and storage area will be needed for damaged containers, handling equipment etc.

8.6 Other Facilities

8.6.1 Electric Transfomer Substation

30. Two electric transformer substation will be needed at the new port facility. One will be required beside the container berth to serve as a power source for the cranes, reefer containers, yard lighting and other facilities. Another substation will be needed at the general cargo berth for yard lighting, the silos and other facilities.

8.6.2 Cold Storage

31. The annual amount of imported chilled and frozen food stuffs will reach 89,000tons by 2015.

A cold storage facility will be required at the general cargo berth near the fishery port and No.1 berth in the new port. The area of cold storage will be 1,860m^2 (40m x 50m).

8.6.3 Grain Silos

32. Grain silos with a capacity of 60,000 tons will be built behind No.4 general cargo berth. Handling of grain from ship to silo will require a pneumatic unloader and a belt conveyer of 400t/hr capacity.

The layout of No.4 berth including silos, unloader and conveyer are shown below.

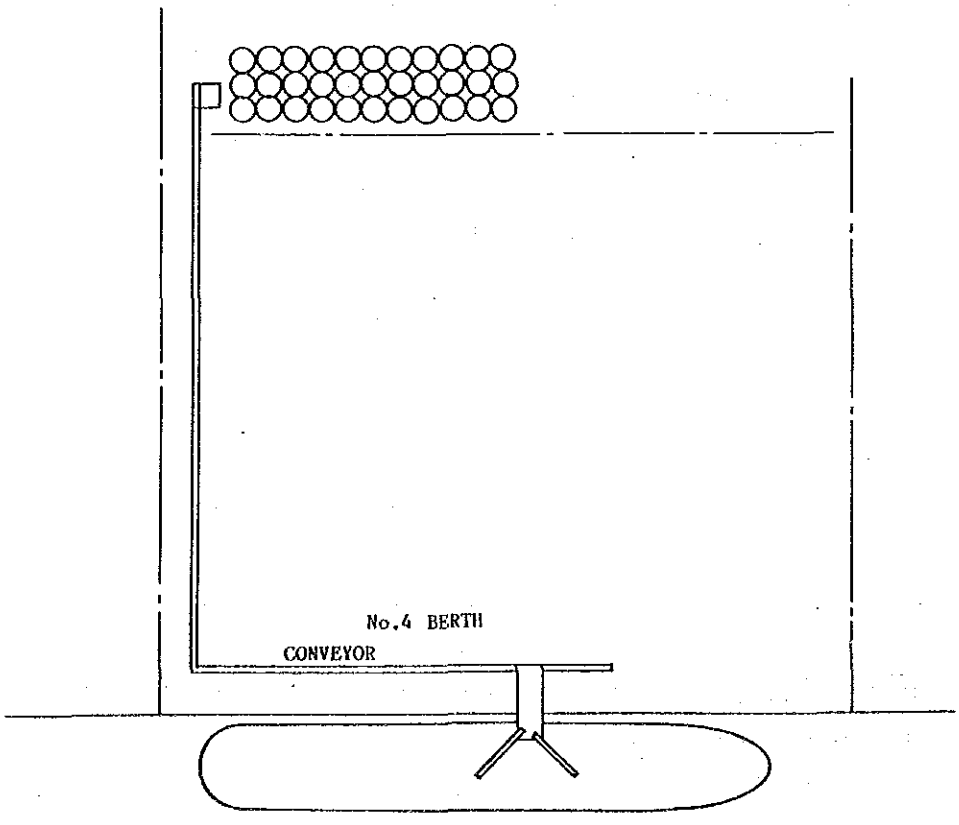


Fig. 8-5-4 Layout of No.4 Berth

8.7 Proposed Land Use Plan

33. As described in 8.2.1, the east side of the port should be developed for the FTZ and light industry. According to the Sohar Structure Plan, the government of Oman intends to formulate a new district center at Falaj al Qabail. The government also intends to develop a major local center in the vicinity of the existing Majis town. The development of a new major road to connect these two centers is also planned.

In 2015, both side terminals will be used for commercial cargoes. But in the long term beyond 2015, the east terminal should be used for commercial cargoes and the west terminal should be used for industrial cargoes.

In the Master Plan for 2015, two main roads, of which one wil be behind the container berths and another behind the general cargo berths, should be connected to the existing road. The entrance to the port should be located at the crossing of the existing trunk road and the existing branch road. The proposed land use plan is illustrated in Figs.8-7-1 and 8-7-2. We described in 8.2.1 that the total quay length in the long term would be about 10km, but the reservation of such a huge land area seems to be unnecessary considering the required berth length in 2015. The expansion of the west channel may not be necessary. So in the land use plan for 2015, we exclude the west channel and reduce the heavy industrial area to the area surrounded by the boundary, that is, 1,250m from the quay line.

In the Sohar Structure Plan, the desalination/power plant is planned at the container terminal of our plan. The demand for electricity is estimated to be about 75MW by 2005. In our plan the desalination/power plant should be located in the heavy industrial area.

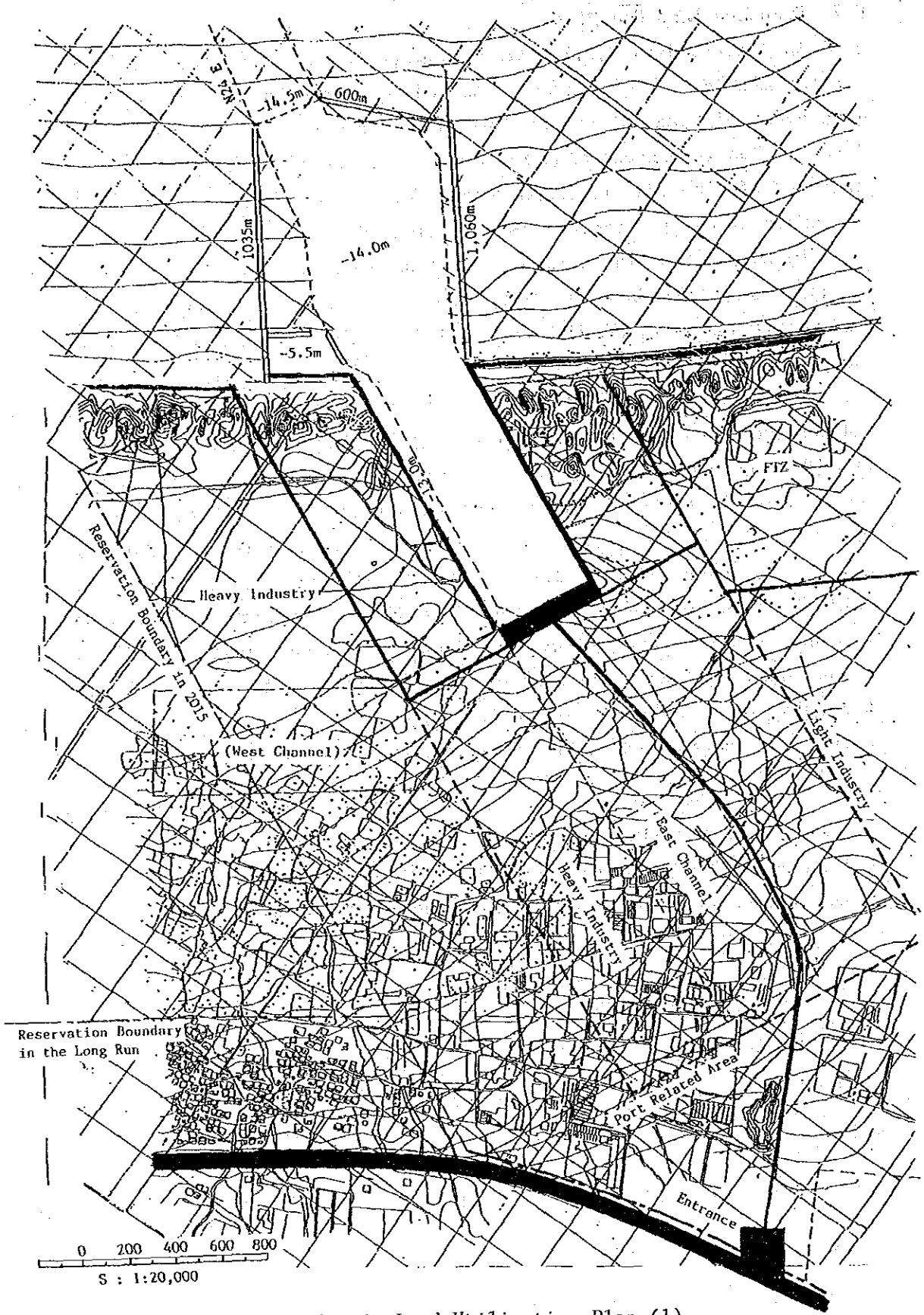
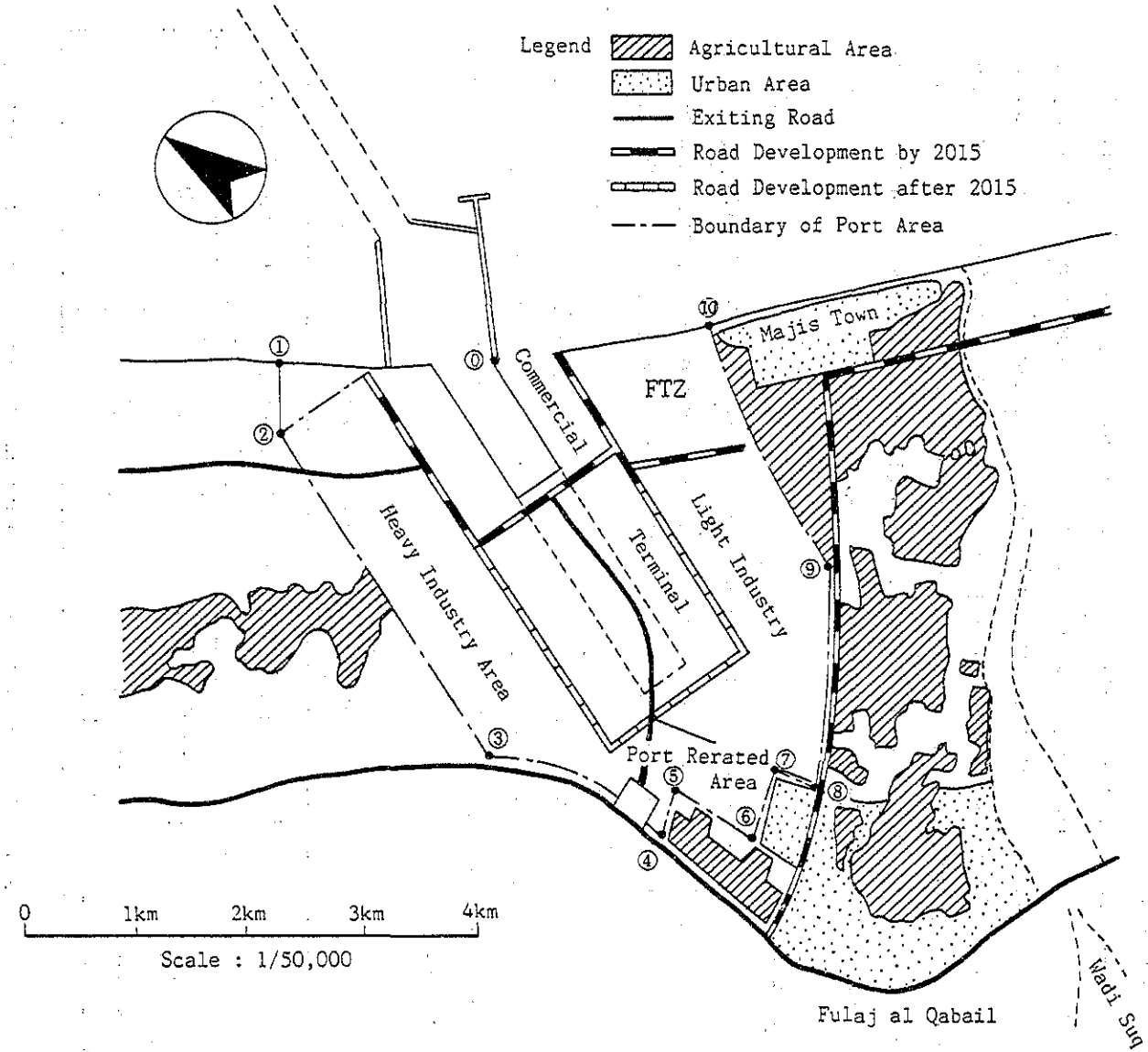


Fig. 8-7-1 Land Utilization Plan (1)



Point Coordinate

Point	East	North
⓪	56°38'02"	24°28'41"
①	56°37'25"	24°29'31"
②	56°37'06"	24°29'20"
③	56°36'18"	24°27'40"
④	56°36'24"	24°26'49"
⑤	56°36'39"	24°26'53"
⑥	56°36'39"	24°26'28"
⑦	56°37'01"	24°26'33"
⑧	56°37'03"	24°26'21"
⑨	56°38'27"	24°26'52"
⑩	56°38'45"	24°27'56"

Fig. 8-7-2 Land Utilization Plan (2)

Chapter 9 PRELIMINARY DESIGN AND COST ESTIMATE FOR THE NEW PORT

1. The port facilities needed to meet the future traffic demand were discussed in the previous chapter. In this chapter their structural designs and cost estimates are summarized.

9.1 Preliminary Design

2. The location of the port facilities designed is shown in Fig. 9-1-1.

9.1.1 Breakwaters

3. Breakwaters with a total length of 3,045m are planned from the shore line to a point with a depth of -7.5m offshore. These breakwaters are to prevent the channel from shoring, and serve to secure the calmness needed for ship activities with regard to ordinary sea condition or storms. Furthermore, another breakwaters are planned in the inner port area. These breakwaters will make a water basin for small vessels. The standard cross sections of the breakwater are shown in Fig. 9-1-2.

9.1.2 Berths

4. The container berth is designed with a water depth of -14m, and the general cargo berth is designed with a water depth of -13m, deep enough to accommodate 50,000 DWT ships, 40,000 DWT ship respectively. The water depth of berths in the inner port is -5.5m, which can accommodate small size ship such as fishing boats. The loading and preparation quay and the lying quay with a depth of -5.5m is planned taking the trawling vessels into account. The apoposed cross-sectons of the berths are shown in Fig. 9-1-3 - 4.

Table 9-1-1 Fishing Port

Item / Quay	Structural Type	Depth(m)	Apron Width(m)
Loading and Preparation Quay	Concrete Block Type	-5.5	10
Lying Quay (1)	Open Type	-5.5	11
Lying Quay (2)	Open Type	-5.5	11

The standard cross-sections of the various quaies are shown in Fig. 9-1-5 and 6.

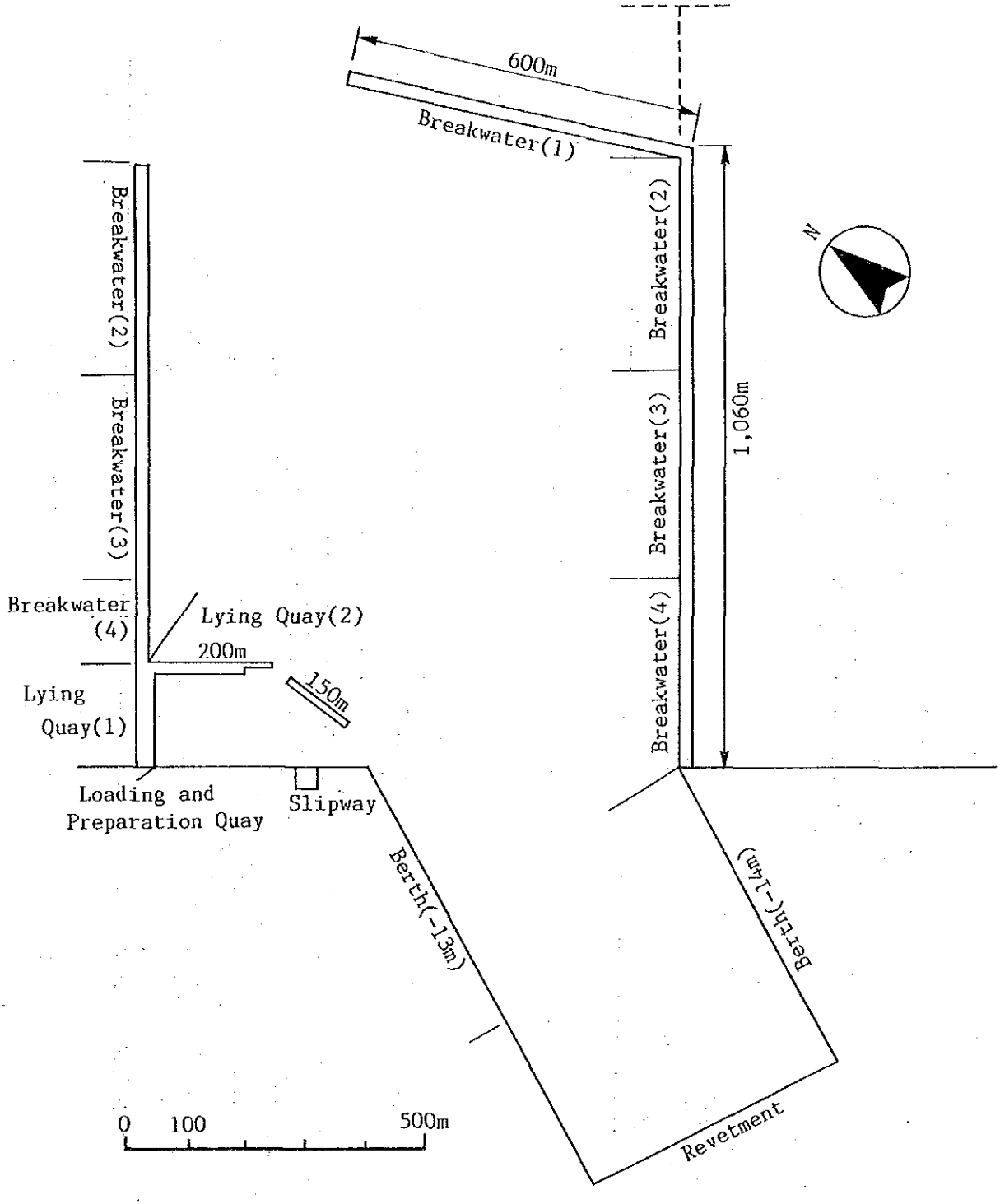


Fig. 9-1-1 Location of Facilities

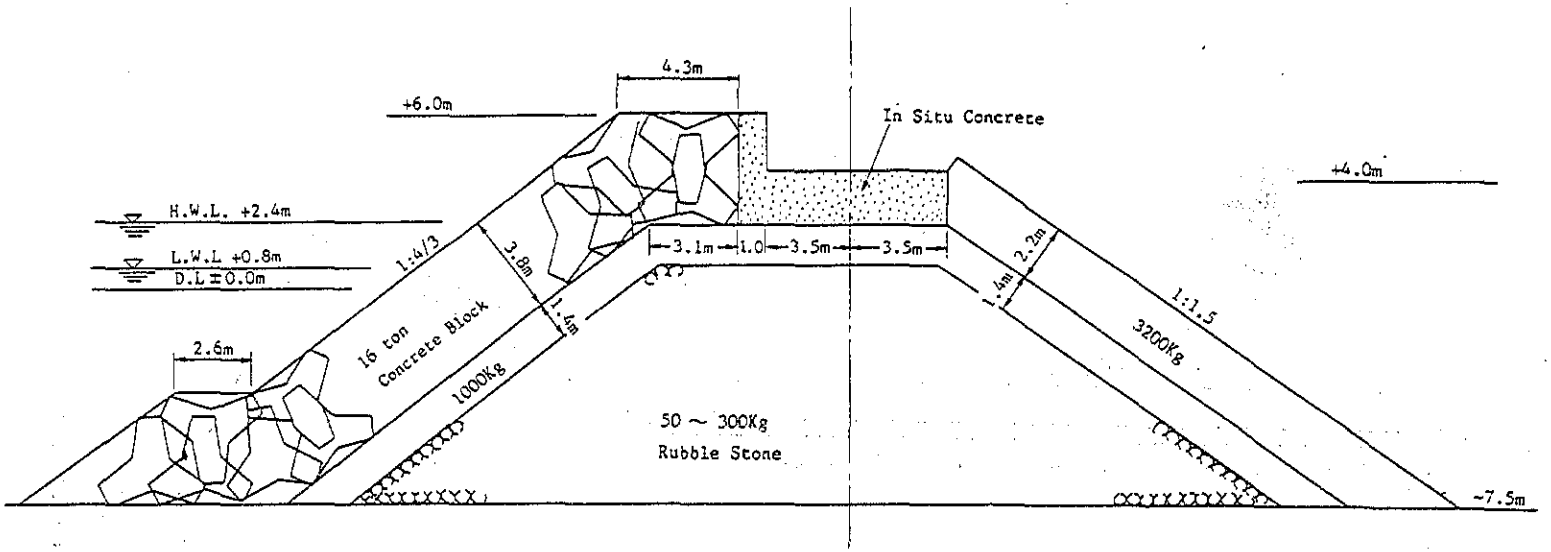


Fig. 9-1-2(1) Standard Cross Section of the Breakwater (1)

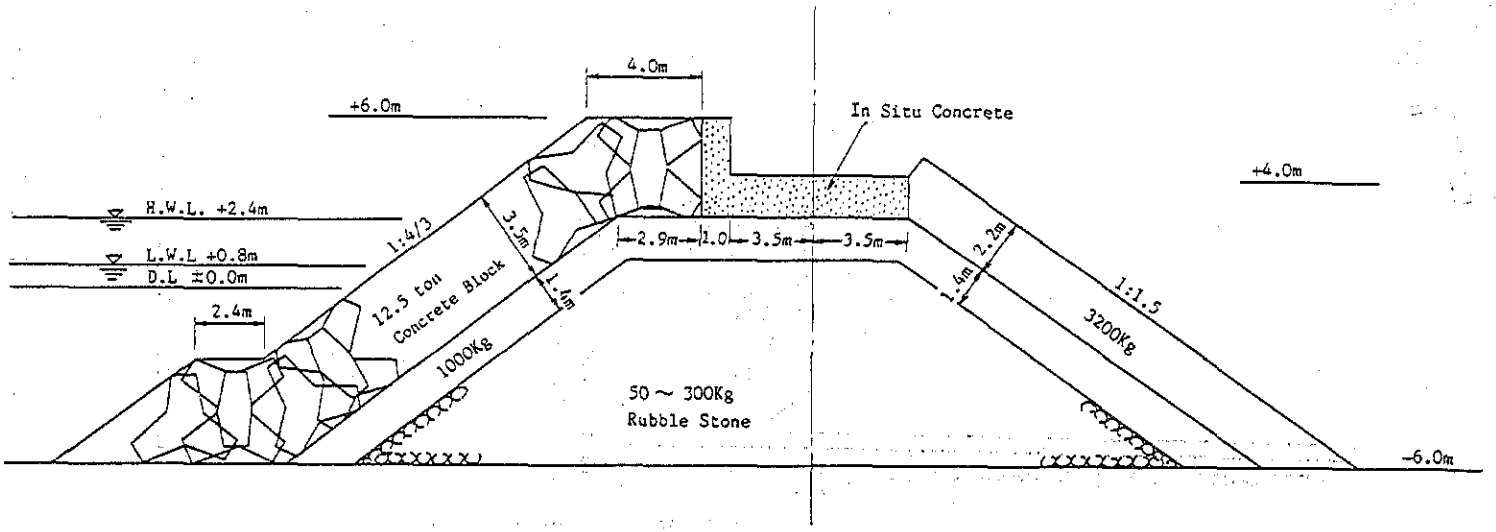


Fig. 9-1-2(2) Standard Cross Section of the Breakwater (2)

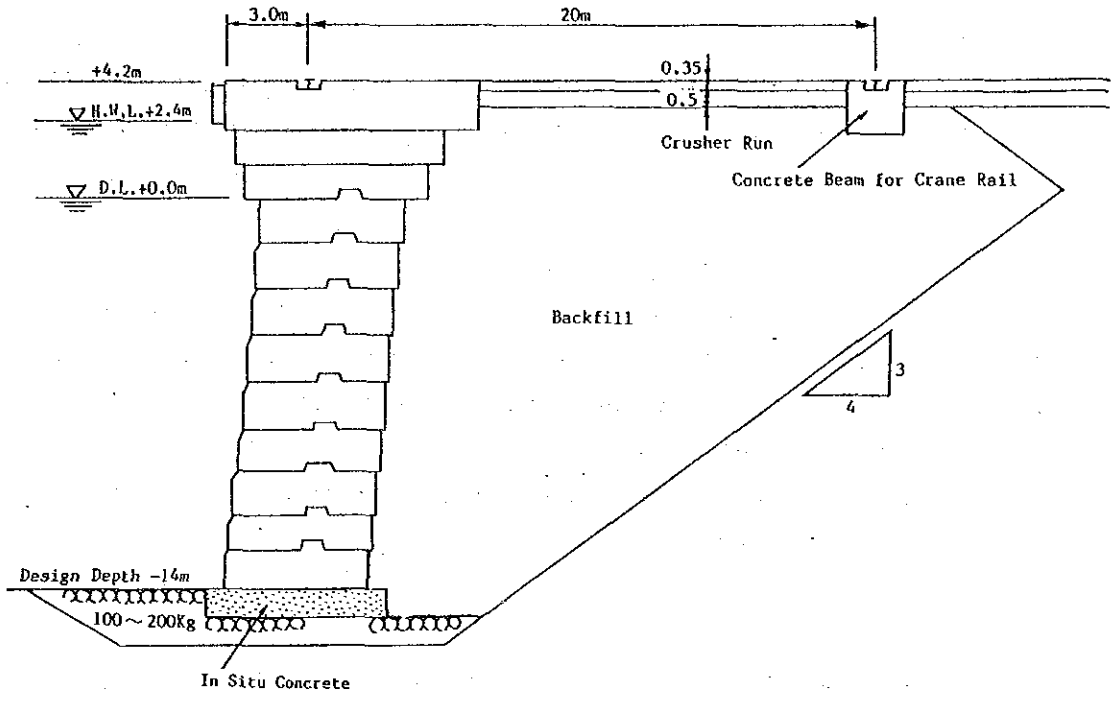


Fig. 9-1-3 Proposed Cross Section of the Bank (-14m)

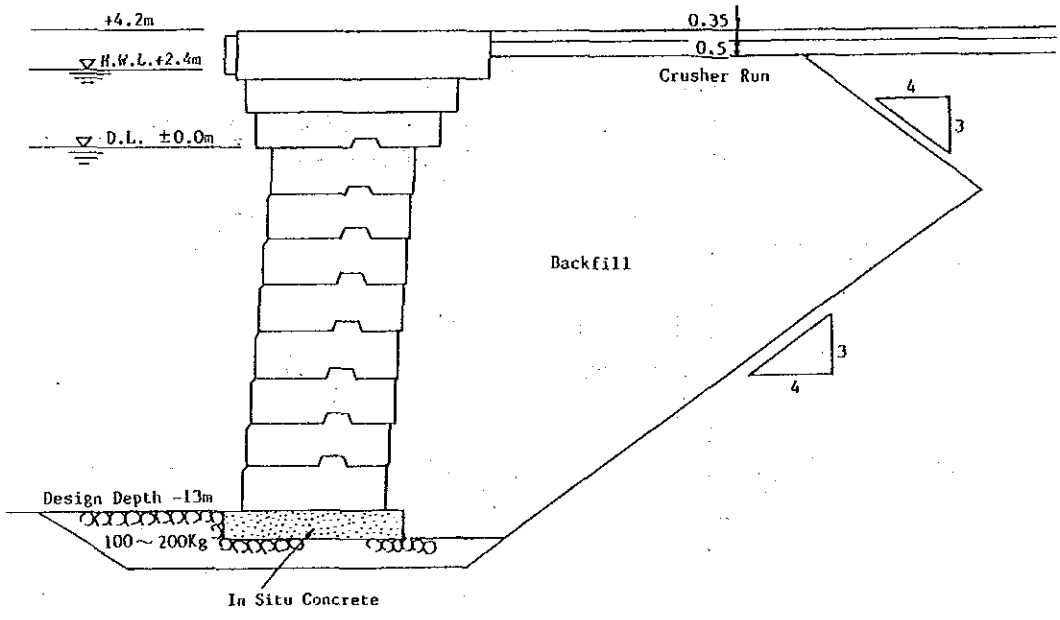


Fig. 9-1-4 Proposed Cross Section of the Bank (-13m)

9.1.3 Other Facilities

(1) Revetment

5. At the end of the channel, a revetment is planned. This revetment will absorb the invading wave energy and also protect the channel from slope failure. (Fig. 9-1-7)

(2) Pavement and Transfer Crane Tracks

Considering construction and maintenance costs, all the pavement work will be bituminous except for the transfer crane tracks, and the standard cross-section will be as per the required strength owing to the cargo handling vehicles and equipment.

The cross-sections of the pavements and transfer crane tracks are shown in Fig. 9-1-8, 9-1-9.

(3) Slipway

A slipway is planned in the inner port area. This slipway is needed to accommodate for repairs of ships up to 300 GWT. The standard cross section of the slipway is shown in Fig. 9-1-10.

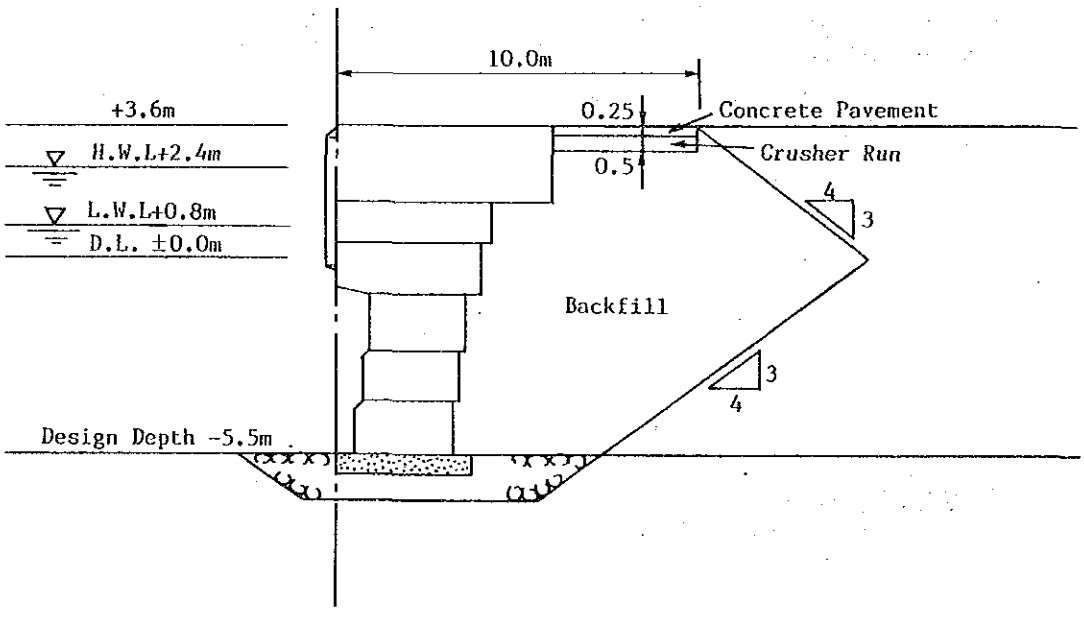


Fig. 9-1-5 Standard Cross Section of the Loading and Preparation Quay

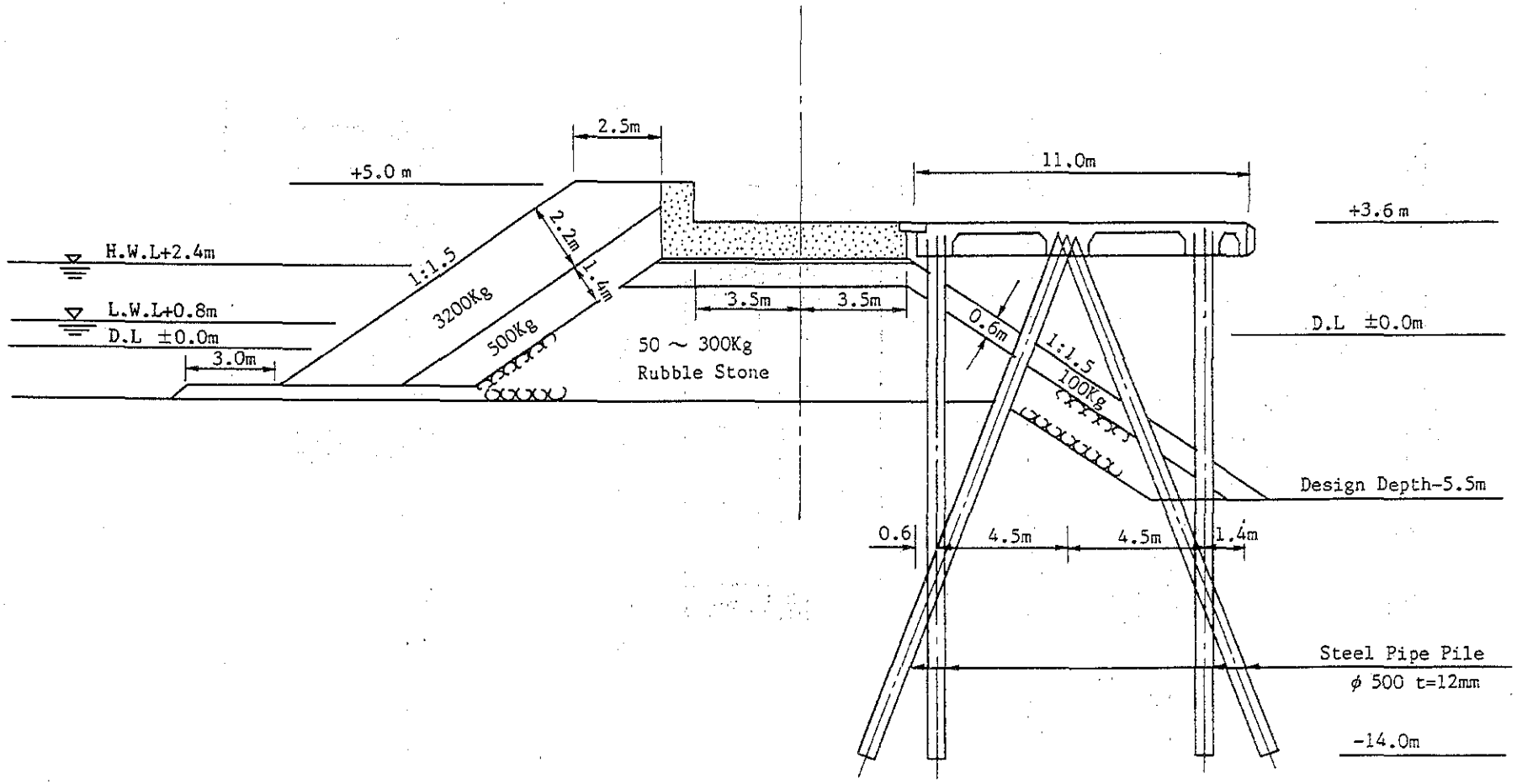


Fig. 9-1-6 Standard Cross Section of the Lying Quay (1)

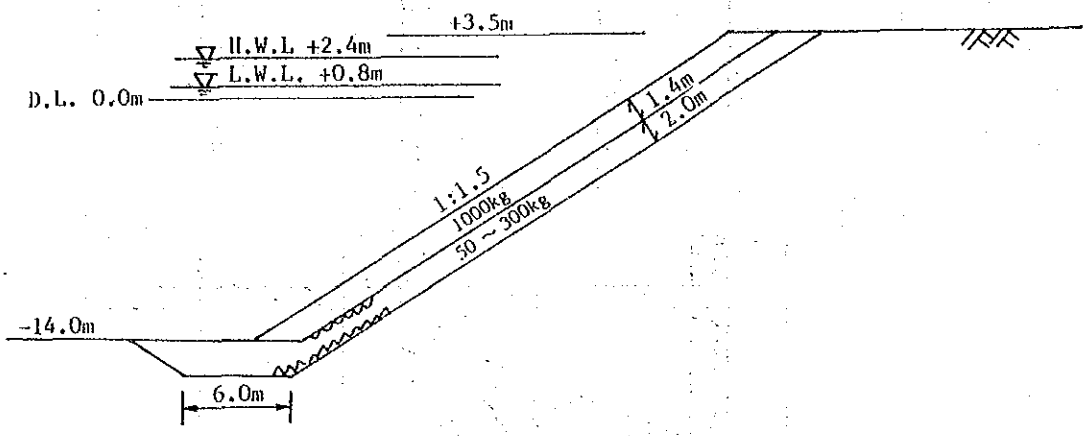


Fig. 9-1-7 Standard Cross Section of the Revetment

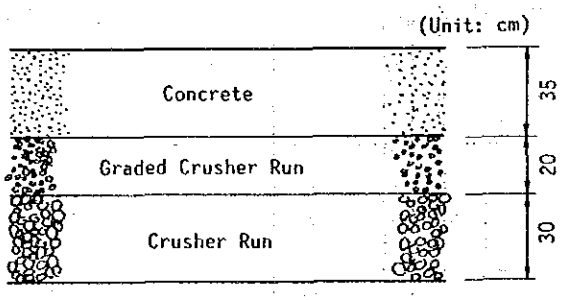


Fig. 9-1-8 Standard Cross Section of Transfer Crane Track

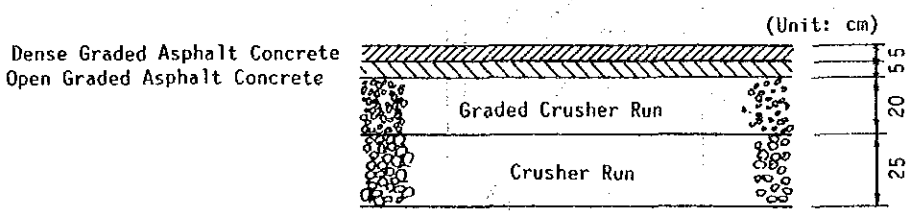


Fig. 9-1-9 Standard Cross Section of Pavetment

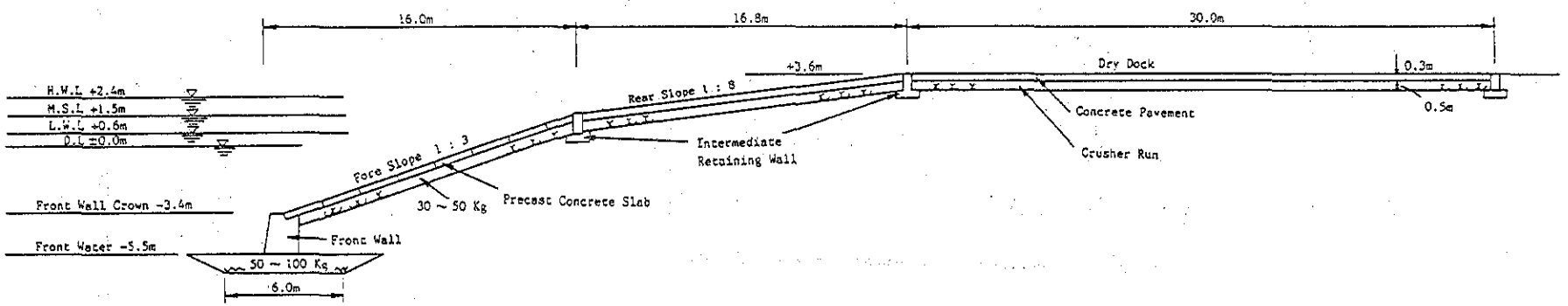


Fig. 9-1-10 Standard Cross Section of the Slipway

9.2 Implementation Schedule of Port Construction

9.2.1 General

6. The construction quantities for each facility in this project up to the beginning of the year 2,000 are shown in Table 9-2-1 and Fig.9-2-1. To complete the project within four years, the implementation of construction and the supply of construction equipment and materials should be carefully planned.

Table 9-2-1 Construction Quantities

Description	Unit	Quantities
Dredging / Land Excavation		
Channel	m^3	1,586,000
Basin (A)	m^3	6,434,000
(B)	m^3	3,842,000
Land Excavation	m^3	596,000
Quay		
-14m	m	580
-13m	m	540
-5.5m (A)	m	340
-5.5m (B)	m	156
Breakwater		
East	m	600
South	m	1,060
West	m	1,035
East Inner	m	200
Yard Pavement		
Container Yard	m^2	148,000
Open Yard	m^2	100,000
Road	m	3,500
Buildings	m^2	12,950
Cargo Handling Equipment and Tug-Boat	NO	61

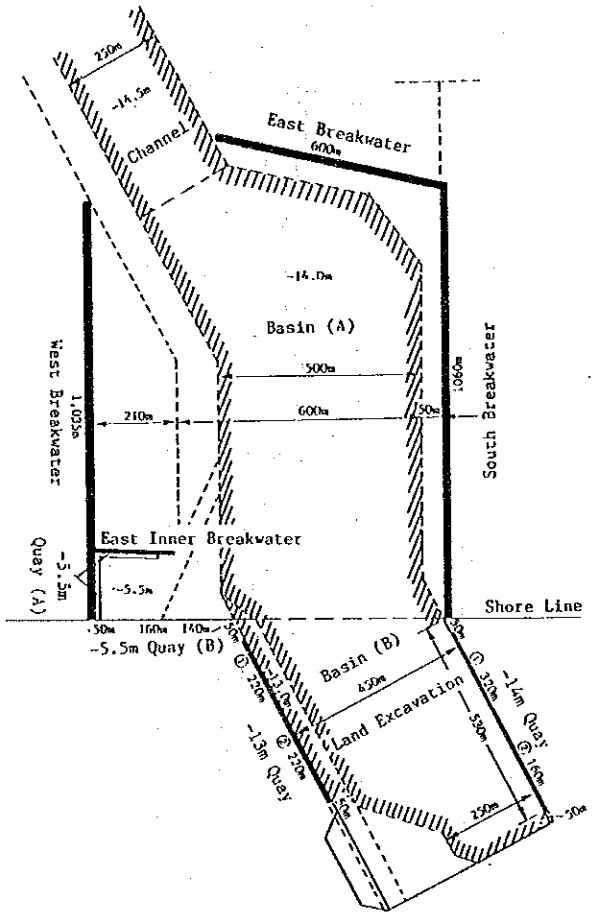


Fig. 9-2-1 Port Facilities

9.2.2 Preliminary Study on Construction Procedure

7. After completion of the detailed design in 1994/1995, the construction of the port facilities is to start in 1996 and be completed by the end of 1999.

The construction method of major works is briefly described below;

(1) Dredging and Land Excavation

7. The required dredging and excavation volume is estimated to be 1,586,000m^3 in the Channel, 6,434,000 m^3 in Basin (A), 3,842,000m^3 in Basin (B) and 596,000m^3 inland.

8. From the borehole data, the types of soils in the dredging area are judged to be as follows:

In the Channel and Basin (A) areas.....N = 30

In Basin (B) and the Land Excavation areas.....N = 50

* N means N-value (Standard Penetration Test)

Dredging work will be conducted by 8,000 P.S. pump dredger and the dredged material will be dumped in the hinterland and landscaped.

The required period is about 3.5 years.

In order to start the construction of the Quay (-14m), (-13m) in the early stage, dredging work in the area of the quays should be carried out at the beginning of the dredging procedure.

Because the dredger has a draft of nearly 4m, a 100m channel should first be dredged through the Basin (A) from the point where the seabed is 5m below sea level towards the existing shore line. After completion of the channel, dredging should be conducted in the Basin (B) area.

As a matter of course, the land excavation should be done before the above dredging works.

The dredging work in the Channel and Basin (A) areas should be completed by the end of 1999.

(2) Quay (-14m) and (-13m)

9. On completion of the dredging work in Basin (B), installation of base rubble stone, in-situ concrete and concrete blocks (1.5m x 1.5m x 5.0m, about 26 ton/unit) should begin.

After that, backfill, placing of coping concrete and apron pavement should be carried out.

Lastly, as regards to the -14m Berth, a concrete beam will be constructed as the base of the container crane site.

(3) Breakwater

10. Since the required volumes of rubble stone and armoured stone are

almost equal for the 600m long East Breakwater, the 1,065m long South Breakwater and the 1,030m long West Breakwater, the construction work is divided into three sections. Construction of the South and West Breakwaters will be carries out from the land, and the East Breakwater will be constructed in the sea using the existing jetty nearby.

An existing quarry located about 30km from the construction site will be utilized for the project.

These, sorted into the above-mentioned sizes and stockpiled at the quarry site, will be directly hauled to each section and dumped by dump trucks and barges.

To secure rock rubble at the start of construction work is indispensable in order that a supply of rock rubble during the construction period can be realized smoothly.

On the other hand, the required number of concrete blocks (16 ton, 12.5 ton, 8 ton) are estimated to be 4,600 to 4,800 for each section and a total area of about 4,000m^2 will be required for manufacturing and temporarily stockpiling them.

9.2.3 Construction Schedule

11. When considering the construction procedure, working capacity and the construction schedule for the above-mentioned method have been set as follows:

(1) Working Capacity

12. The working capacities of the major works which will be used most frequently in the Project have been compiled as follows:

Table 9-2-2 Working Capacity

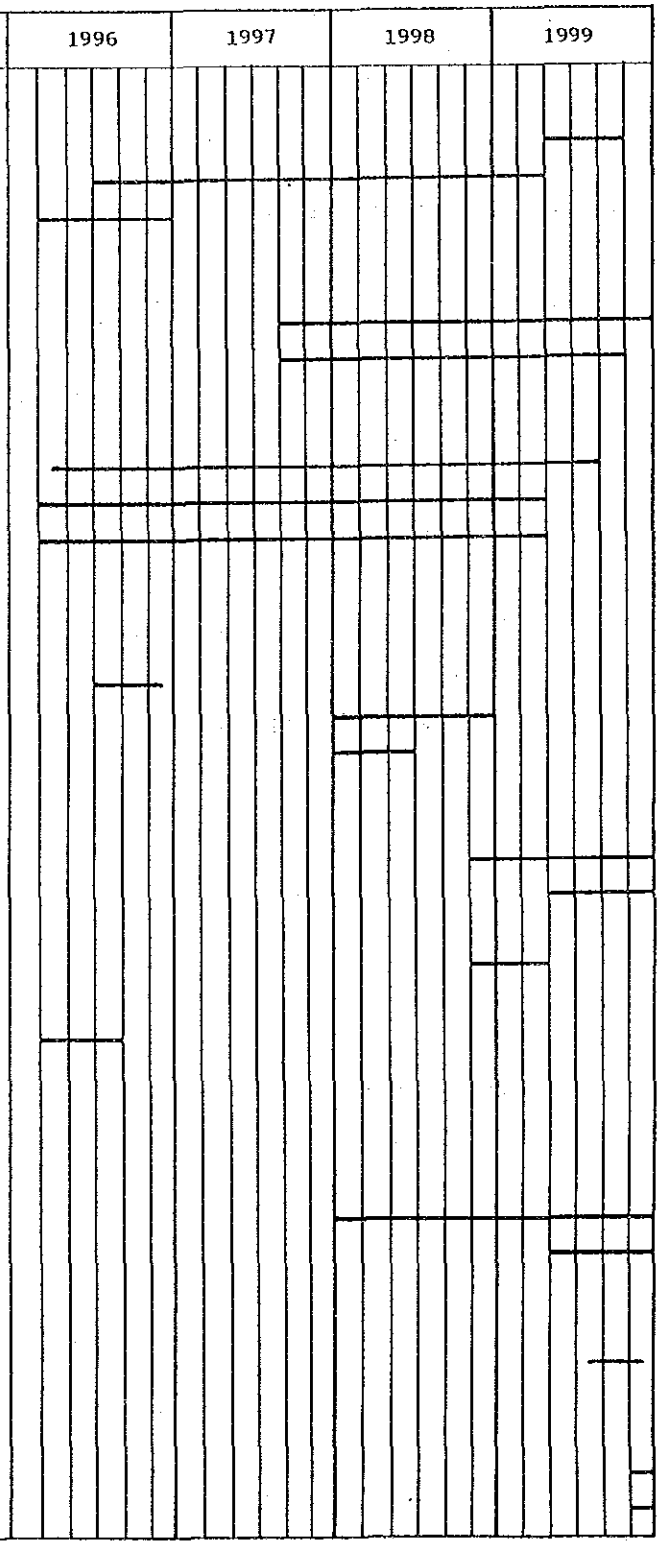
Dredging (pump dredger 8,000 P.S.)	N=30	15,000m^3/day
(operating hours : 17 HRS)	N=50	7,900m^3/day
Pile-driving		4 piles/day
Disposal of rubble and armoured Stone for breakwaters		1,000m^3/day
Installation of concrete block for the quays		20 units/day

(2) Construction Schedule

13. The construction schedule of the project is shown in Table 9-2-3.

Table 9-2-3 Construction Schedule

No.	Item	Unit	Q'ty
1.	Dredging		
	(1) Channel	m3	1,586,000
	(2) Basin (A)/(B)	m3	10,276,000
	(3) Land Excavation	m3	596,000
2.	Quay		
	(1) - 14m Quay	m	580
	(2) - 13m Quay	m	540
3.	Breakwater		
	(1) East Breakwater	m	600
	(2) South Breakwater	m	1,060
	(3) West Breakwater	m	1,035
4.	Small Craft Harbour		
	(1) East Inner Breakwater	m	200
	(2) - 5.5 m Quay (A)	m	340
	(3) - 5.5 m Quay (B)	m	156
5.	Yard Pavement		
	(1) Container Yard	m2	148,000
	(2) Open Yard	m2	100,000
	(3) Tracks for Transfer Crane	m	4,000
6.	Road	m	3,500
7.	Buildings and Facilities		
	(1) Office/ C.F.S. etc	m2	12,950
	(2) Other Facelities	L.S	1
8.	Cargo Handling Equipment	L.S	1
9.	Others		
	(1) Navigation Aids	L.S	1
	(2) Slipway, etc	L.S	1



9.3 Cost Estimation

9.3.1 General

14. The cost of the project has been estimated from the preliminary design, construction method and schedule, and the basic conditions of cost estimation are the same as for Mina Qaboos (refer to 7-13-1).

The indirect cost and administration cost are fixed at 20% of the direct cost.

9.3.2 Estimation Procedure

15. The estimation procedure has been carried out on the above conditions and the resulting unit prices and rates are as follows:

i) The unit prices for main materials:

- Concrete 15 R.O./m^3
- Steel pipe pile 214 R.O./t
- Steel bar 152 R.O./t
- Armoured Stone (1,000 kg) 2.6 R.O./m^3

ii) The day work for main labourers per day:

- Skilled workers 10 R.O.
- Unskilled workers 4-8 R.O.

iii) The prices per unit quantities of main items:

- Dredging 1.13 R.O./m^3
- Pavement 4.5 - 10.0 R.O./m^2
- Building 89.96 R.O./m^2

9.3.3 Result of Estimation

16. A summary of the estimation results is presented in Table 9-3-1.

On the basis of the construction schedule drawn up in Table 9-2-3, the yearly disbursement schedule has been estimated as shown in Table 9-3-2.

Table 9-3-1 Construction Cost for Each Item

No.	Item	Unit	Q'ty	Unit Cost(R.O.)			Amount (1,000 R.O.)		
				Foreign Portion	Local Portion	Total	Foreign Portion	Local Portion	Total
1.	Dredging								
	(1) Channel	m3	1,586,000	0.89	0.24	1.13	1,412	380	1,792
	(2) Basin	m3	10,276,000	0.89	0.24	1.13	9,146	2,465	11,611
	(3) Land Excavation	m3	996,000	-	1.00	1.00	-	596	569
	Sub-Total						10,588	3,441	13,999
2.	Quay								
	(1) - 14m Quay	m	580	587.93	7,894.82	8,483.00	341	4,579	4,920
	(2) - 13m Quay	m	540	624.07	7,524.07	8,148.00	337	4,063	4,400
	Sub-total						678	8,642	9,320
3.	Breakwater								
	(1) East Breakwater	m	600	-	6,553.00	6,553.00	-	3,920	3,920
	(2) South Breakwater	m	1,060	-	2,916.00	2,916.00	-	3,091	3,091
	(3) West Breakwater	m	1,035	12.56	2,883.44	2,896.00	13	2,984	2,997
	Sub-total						13	9,995	10,008
4.	Small Craft Harbour								
	(1) East Inner Breakwater	m	200	60.00	1,106.00	1,166.00	12	221	233
	(2) - 5.5 m Quay (A)	m	340	520.59	2,091.00	2,612.00	177	711	888
	(3) - 5.5 m Quay (B)	m	156	12.86	2,123.18	2,136.00	2	331	333
	Sub-Total						191	1,263	1,454
5.	Yard Pavement								
	(1) Container Yard	m2	148,000	-	10.00	10.00	-	1,480	1,480
	(2) Open Yard	m2	100,000	-	4.50	4.50	-	450	450
	(3) Tracks for Transfer Crane	m	4,000	-	14.00	14.00	-	56	56
	Sub-Total						-	1,986	1,986
6.	Road	m	3,500	-	86.00	86.00	-	301	301
7.	Buildings and Facilities								
	(1) Office/ C.F.S. etc	m2	12,950	4.86	85.10	89.96	63	1,102	1,165
	(2) Other Facelities	L.S	1				450	-	450
	Sub-Total						513	1,102	1,615
8.	Cargo Handling Equipment	L.S	1				12,581	6	12,587
9.	Others								
	(1) Navigation Aids	L.S	1				32	-	32
	(2) Slipway, etc	L.S	1				-	50	50
	Sub-Total						32	50	82
10.	Total						24,566	26,786	51,352
11.	Indirect Cost								
	(1) I.C/Administration						7,324	2,946	10,270
	(2) Consultation/ Technical Cooperation						2,570	-	2,570
	(3) Contingencies						615	2,382	2,997
	(4) Custom Duties						698	-	698
	(5) Mobilization						450	-	450
	Sub-Total						11,657	5,328	16,985
12.	Grand Total						36,223	32,114	68,337

Table 9-3-2 Yearly Distribution Schedule

Unit: 1,000 R.O.

No.	Item	Construction Cost			1994		1995		1996		1997		1998		1999	
		Foreign Portion	Local Portion	Total	Foreign Portion	Local Portion	Foreign Portion	Local Portion	Foreign Portion	Local Portion	Foreign Portion	Local Portion	Foreign Portion	Local Portion	Foreign Portion	Local Portion
1.	Dredging	10,558	3,441	13,999	-	-	-	-	1,614	1,031	3,228	870	3,228	870	2,488	670
2.	Quay	678	8,642	9,320	-	-	-	-	-	-	101	1,330	302	3,988	275	3,324
3.	Breakwater	13	9,995	10,008	-	-	-	-	-	2,217	-	3,155	-	3,155	13	1,468
4.	Small Craft Harbour	191	1,263	1,454	-	-	-	-	12	221	-	-	179	1,042	-	-
5.	Yard Pavement	-	1,986	1,986	-	-	-	-	-	-	-	-	-	123	-	1,863
6.	Road	-	301	301	-	-	-	-	-	301	-	-	-	-	-	-
7.	Buildings and Facilities	513	1,102	1,615	-	-	-	-	-	-	-	-	32	551	481	551
8.	Cargo Handling Equipment	12,581	6	12,587	-	-	-	-	-	-	-	-	-	-	12,581	6
9.	Others	32	50	82	-	-	-	-	-	-	-	-	-	-	32	50
10.	Direct Cost	24,566	26,786	51,352	-	-	-	-	1,626	3,770	3,329	5,355	3,741	9,729	15,870	7,932
11.	Indirect Cost	11,657	5,328	16,985	500	-	500	-	2,627	1,331	2,385	1,331	2,481	1,331	3,164	1,335
12.	Grand Total	36,223	32,114	68,337	500	-	500	-	4,253	5,101	5,714	6,686	6,222	11,060	19,034	9,267

9.4 Construction Cost for the Master Plan

17. The cost of construction up to year 2,000 has been estimated, as mentioned in Chapter 9.3. The remaining quantities and construction costs for the Master Plan are shown in Table 9-4-1.

Table 9-4-1 Construction Cost for the Master Plan

No.	Item	Unit	Q'ty	Unit Cost(R.O.)			Amount (1,000 R.O.)		
				F.P	L.P	Total	F.P	L.P	Total
1.	Dredging								
	(1) Channel	m3	86,000	0.89	0.24	1.13	76	21	97
	(2) Basin	m3	4,633,000	0.89	0.24	1.13	4,123	1,112	5,235
	(3) Land Excavation	m3	1,710,000	-	1.00	1.00	-	1,710	1,710
	Sub-Total						4,199	2,843	7,042
2.	Quay								
	(1) - 14m Quay	m	480	587.93	7,894.42	8,482.75	282	3,789	4,071
	(2) - 13m Quay	m	745	624.07	7,524.07	8,148.14	465	5,605	6,070
	Sub-total						747	9,394	10,141
3.	Small Craft Harbour								
	(1) South Inner Breakwater	m	150	-	1,106.00	1,106.00	-	166	166
	(2) - 5.5 m Quay (B)	m	154	12.86	2,123.18	2,136.04	2	327	329
	Sub-Total						2	493	495
4.	Yard Pavement								
	(1) Container Yard	m2	282,980	-	10.00	10.00	-	2,830	2,830
	(2) Open Yard	m2	96,500	-	4.50	4.50	-	434	434
	(3) Tracks for Transfer Crane	m	6,500	-	14.00	14.00	-	91	91
	Sub-Total							3,355	3,355
5.	Road	m	5,230	-	86.00	86.00	-	450	450
6.	Buildings and Facilities								
	(1) Transit Shed etc	m2	4,650	4.86	85.10	89.96	22	396	418
	(2) Other Facilities	L.S	1	-	-	-	370	-	370
	Sub-Total						392	396	788
7.	Cargo Handling Equipment	L.S	1	-	6	-	11,119	6	11,257
8.	Others								
	(1) Slipway, etc	L.S	1	-	-	-	-	50	50
	Sub-Total							50	82
9.	Direct Cost						16,459	16,987	33,446
10.	Indirect Cost								
	(1) I.C/Administration						4,820	1,868	6,688
	(2) Consultation/ Technical Cooperation						1,700	-	1,700
	(3) Contingencies						910	1,360	2,270
	(4) Custom Duties						57	-	57
	(5) Mobilization						450	-	450
	Sub-Total						7,937	3,228	11,165
11.	Grand Total						24,306	20,215	44,611

F.P.= Foreign Portion
L.P.= Local Portion

Chapter 10 ECONOMIC ANALYSIS

10.1 Purpose and Methodology of the Economic Analysis

10.1.1 Purpose

1. The purpose of the economic analysis is to appraise the economic feasibility of the Short-term Development Plan for the New Port from the viewpoint of the national economy. For this purpose, after investigating the economic benefits as well as the economic costs which will arise from the project, it is determined whether the net benefits of this project exceed those which could be obtained from other investment opportunities (the opportunity cost of capital) in the Sultanate of Oman.

10.1.2 Methodology

2. The economic internal rate of return (EIRR) based upon cost-benefit analysis is used in order to appraise the feasibility of the project. In estimating the costs and benefits of the project, it should be noted that the values of goods quoted at a market price do not always represent the true value of those goods from the viewpoint of the national economy. The local currency portion of the goods and materials at a market price often includes customs duties. The labour cost at market prices is often influenced by a minimum wage system and other regulations. Therefore, "economic pricing" should be conducted for the economic analysis. Economic pricing here means the appraisal of costs and benefits in terms of international prices (border prices). In the calculation of the costs and benefits, transfer items such as import duties, other taxes and subsidies should be excluded. The market prices are changed to border prices by various conversion factors mentioned below.

10.1.3 Method of Applying Conversion Factors

3. In general, all the costs and benefits are divided into labour, traded goods, non-traded goods and transfer items. Labour is further divided into skilled labour and unskilled labour.

4. Traded goods are expressed at CIF (cost, insurance and freight) prices for imports and at FOB (free on board) prices for exports, which are border prices themselves. The local currency portion after deducting labour costs

and transfer items is considered as non-traded goods, the economic price of which is calculated by multiplying the Standard Conversion Factor (SCF). The SCF is used to determine the economic prices of certain non-traded goods and services which cannot be directly valued at border prices, excluding the price differential between the domestic market and the international market, which is caused by import duties and export subsidies. In this Study, 0.971, the SCF in 1988, is adopted.

5. For economic analysis, labour costs should be measured in terms of their opportunity costs, that is, the value of lost marginal production which the employment of the labourers for a given project would create for other purposes.

6. The economic cost of skilled labour is obtained by multiplying its market price by the Conversion Factor for Consumption (CFC), assuming that the market mechanism is functioning properly. The CFC is used for converting the prices of consumer goods from domestic market prices to border prices. In this Study, 0.974, the CFC in 1988, is adopted.

7. It is practically impossible to figure out the opportunity cost of unskilled labour in Oman. Since it is common that the inflow of unskilled labour to the project is mainly from the agricultural sector which is relatively elastic in its use of labour, in a simplified manner it is often assumed that the economic cost of unskilled labour is equal to the per capita income of the agricultural sector. In Oman, an average monthly salary for non-Omani workers in farms is available, which can be considered as a proper indicator of the marginal productivity of the agricultural sector. Using this figure with nominal wage rate and the CFC, the conversion factor for unskilled labour is calculated as 0.446.

8. Specific consideration should be given to foreign labour, i.e., whether it is skilled or unskilled. Since foreign workers have a strong tendency to remit most of their earnings to their own homes, the economic cost of foreign labour should be treated just like that of imported goods and services. Therefore, in this Study it is assumed that the conversion factor for foreign labour is 1.00.

10.2 Prerequisites of the Economic Analysis

10.2.1 Period of Calculation

9. Taking into consideration the depreciation period of the main facilities and the construction schedule, the period of calculation the economic analysis is assumed to be thirty-six years between 1994 and 2029.

10.2.2 "Without" Case

10. A cost-benefit analysis is conducted on the difference between the "With" and "Without" investment cases. In this Study, the following conditions are adopted as the "Without" case after various possibilities are discussed:

1) No investment is made for the new port.
2) The development plan of Mina Qaboos that is proposed in our Study is implemented.
3) The distribution of ships and the working efficiency of cargo handling is the same as that assumed in the above plan.

10.2.3 Cargo Throughput

11. The cargo volume under the "With" case is forecast in Chapter 5. The Short-term Development Plan for the New Port is in response to the cargo throughput in 2005 and 2004 for container cargo and the other cargo, respectively, with the optimum berth occupancy at that period. Therefore, the cargo volume used for the economic analysis is assumed not to increase after 2005 for containers and after 2004 for the other cargo. The increase of the cargo volume after these periods is to be coped with by the following stages of the development plan for the new port.

12. The cargo volume under the "Without" case is assumed as follows:

(1) Container Cargo

In the Mina Qaboos Development Plan, ships' waiting time is set within about three hours. Container ships should not to be made to wait longer because of fierce competition with the neighbouring major ports in the UAE. Therefore, waiting time set for the Mina Qaboos Development Plan is considered to be the limit for container ships, and the container cargo volume handled at Mina Qaboos under the "Without" case is the same as that under the "With" case. This means that the opportunity for handling container cargo of 102,354 TEUs, which is to be handled at the new port in

2000, would be lost for Oman, and of these containers the local cargo of 42,054 TEUs is assumed to deviate to the Dubai ports and to enter Oman by land. (This lost cargo volume of containers would increase to 199,187 TEUs in 2005)

(2) Other Cargo

All the other cargo except containers is assumed to be handled at Mina Qaboos. According to the results of a queuing simulation, the average waiting time in 2004 under the "Without" case is 17.4 hours per ship, which does not exceed the limit for waiting time calculated in comparison with the cost of the alternative transport mode, i.e., land transport in Oman's case.

10.3 Benefits

10.3.1 Benefit Items

14. Considering the "With" and "Without" situations mentioned above, the following items are identified as the benefits of the Short-term Development Plan for the New Port:

1) Savings in the waiting costs of vessels.
2) Savings in time costs.
3) Savings in land transportation costs.
4) Foreign currency earnings in handling container cargoes.
5) Promotion of regional development in Sohar as well as national development in Oman.
6) Increase in employment opportunities/incomes.
7) Multiplier effect from the investment of the new port.

Of the above, items 1) to 4) are considered as tangible benefits in terms of the cost-benefit analysis in this Study.

10.3.2 Savings in the Waiting Costs of Vessels

15. If the new port were not constructed, the increased cargo volume would have to be handled at Mina Qaboos only and the waiting time of calling ships would increase in accordance with port congestion. (Container cargo volume would not increase, as mentioned above.) Since implementing the project will prevent this problem and reduce the waiting time of calling

ships, this cost reduction is one of the major benefits of the project.

16. According to the results of a queuing simulation, the difference in average waiting time of vessels between the "With" and "Without" cases is 8.5 hrs/ship and 15.8 hrs./ship in 2000 and 2004, respectively. Ship cost is estimated by ship size based on the estimation made by some Japanese shipping companies. The benefit is calculated based upon the waiting time and the ship cost. The savings in waiting costs of vessels are primarily realized by shipping companies that are not of Omani nationality. However, some portion of these benefits should be returned to Oman after some time-lag, for instance, by decreasing freight rates reflecting the reduced incidence of delays at the port. In this Study it is assumed that 50% of the benefits will accrue to the Omani economy.

10.3.3 Savings in Time Costs

17. The reduction of ships' waiting time brings about a reduction in the time required for imports and exports, and consequently it causes a reduction in usance interest because invested funds will be called in faster. Average cargo value is calculated by commodity based upon the actual value and quantity of imports/exports in 1988. The usance interest rate is estimated at 8.5% per annum based on the London interbank offered rate (LIBOR) in April 1990.

10.3.4 Savings in Land Transportation Costs

18. Since in the "Without" case some of the local container cargo is assumed to deviate to the Dubai ports and to be imported from Dubai by land, the costs of this land transportation can be considered as one of the benefits of the project. The unit cost of land transportation is calculated based on the actual operation performance in Oman. In this Study the unit cost of land transportation (trailer) is estimated as 64.3 RO/TEU.

10.3.5 Foreign Currency Earnings in Handling Container Cargoes

19. Foreign currency earnings in handling the balance of the container cargo volumes between the "With" and "Without" cases (102,354 TEUs in 2000 and 199,187 TEUs in 2005) would be lost to Oman. Therefore, recouping these lost earnings are another major benefit of the project.

10.3.6 Other Benefits

20. There are other important benefits stemming from this project even though they are not calculated in the cost-benefit analysis.

(1) Promotion of regional development in Sohar

There are many proposed projects, such as a Free Trade Zone (FTZ), industries based upon natural gas resources and so forth, which are crucially dependent upon the existence of the new port. Were it not for the new port, it would be impossible to carry out projects that will promote regional development in Sohar and achieve the diversification of Oman's industries.

(2) Increase in employment opportunities/income

The construction of the new port and the subsequent port operation will increase employment opportunities for construction and port workers. Construction work will require 232,046 man-days and the total amount of the compensation of employees during construction will be RO 1,619,000. The number of employees of the port management body will be 925 and annual personnel costs after 2000 will be RO 3,181,000.

(3) Multiplier effect from the project

The construction and the operation of a port create a large amount of added value in the national economy. Although it is very difficult to evaluate this added value, an analysis partly based upon some assumption is made in Annex 7-4-1 of Volume III, which reaches the conclusion that the total added value created by construction of the new port will be RO 23,468,000 for the six years during construction and that the added value produced by the port service industries will be RO 2,889,000 in 2000, which will increase to RO 6,713,000 in 2005.

10.4 Costs

21. The items that should be considered as costs of the project are: construction costs, personnel costs, operating/maintenance costs, administration costs and renewal investment costs.

22. The construction costs estimated in Chapter 9 include facilities/works such as breakwater, dredging and so forth, which are provided not only for the Short-term Development Plan but also used as existing facilities/works

in the Master Plan for 2015. Therefore, it would be excessive to consider all of these costs as those of this short-term project only. In the economic analysis, the costs of these common-use facilities/works are allocated between the short-term plan and the subsequent Master Plan for 2015 according to the number of berths at each stage.

23. Since all the costs are shown at market prices, they have to be converted into economic prices using the conversion factors mentioned above.

10.5 Evaluation

10.5.1 Calculated Results of Costs and Benefits

24. The calculated results of costs and benefits in economic prices are shown in Table 10-5-1.

10.5.2 Calculation of EIRR

25. The economic internal rate of return (EIRR) based upon a cost-benefit analysis is used in order to appraise the economic feasibility of the project.

The EIRR is a discount ratio which makes the costs and benefits of a project during the project life equal. It is calculated by using the following formula:

$$\sum_{i=1}^{n} \frac{Bi-Ci}{(1+r)^{i-1}} = 0$$

n : Period of economic calculation
Bi: Benefit in i-th year
Ci: Cost in i-th year
r : Discount rate

26. The EIRR of the Short-term Development of the New Port is calculated as 5.02 %.

Table 10-5-1 Costs and Benefits of the Project

(Unit: '000 RO)

Year	Costs							Benefits					
	Construction Costs	Personnel Cost	Operation/ Maintenance Cost	Administration Cost	Renewal Investment	Residual Value	Total	Savings in Ships' Waiting Costs	Savings in Time Costs	Savings in Transportation Costs	Foreign Currency Earnings	Total	Benefits - Costs
1994	500						500						-500
1995	500						500						-500
1996	6,408						6,408						-6,408
1997	8,067						8,067						-8,067
1998	12,710						12,710						-12,710
1999	24,601	1,443		289			26,332						-26,332
2000		2,886	477	673			4,035	508	42	2,704	1,565	4,819	784
2001			558	689			4,132	612	51	3,184	1,835	5,682	1,550
2002			638	705			4,228	738	62	3,657	2,110	6,566	2,338
2003			718	721			4,324	888	75	4,125	2,382	7,470	3,146
2004			798	737	216		4,636	1,070	90	4,588	2,658	8,406	3,770
2005			847	747			4,479			5,047	2,933	9,140	4,661
2006													
2007					1,024		5,504						3,636
2008							4,479						4,661
2009					216		4,695						4,445
2010							4,479						4,661
2011													
2012													
2013													
2014					216		4,695						4,445
2015					1,024		5,503						3,637
2016							4,479						4,661
2017													
2018													
2019					1,258		5,737						3,403
2020							4,479						4,661
2021													
2022													
2023					1,024		5,504						3,636
2024					17,225		21,705						-12,565
2025							4,479						4,661
2026													
2027													
2028													
2029						-15,207	-10,728						19,868
Total	52,786	88,014	24,336	22,476	22,204	-15,207	194,638	30,564	2,580	144,424	83,875	261,443	66,805

10.5.3 Conclusion

27. There are various views concerning the appropriate EIRR level used to determine whether a project is feasible or not. The leading view is that the project is feasible if the EIRR exceeds the opportunity cost of capital.

28. The opportunity cost of capital in Oman is not known. However, the opportunity cost of capital in various countries is considered to range from 8% to 15%. It is generally considered that an EIRR of more than 10% is economically feasible for infrastructure or social service projects. Compared with this, the result of the EIRR calculation, 5.02%, is not high enough to convince us that this project is feasible from the viewpoint of the national economy.

29. However, it should be noted that this analysis takes into consideration only four benefit items, as mentioned in 10.3. Adjacent to the new port, there are many proposed projects, such as a free trade zone, an industrial estate, industries based upon natural gas resources and so forth. At the present time, no concrete plans have been made yet and there is no way at all of knowing the scale, output, earnings/costs or profits of these projects. Although it is very difficult to quantify how these kinds of projects could benefit from a port development project in terms of a cost-benefit analysis, the EIRR will become considerably higher when the added value or net gain of these projects is calculated as a benefit of the new port project.

Chapter 11 FINANCIAL ANALYSIS OF THE NEW PORT

11.1 Purpose of the the Financial Analysis

1. The purpose of the financial analysis is to appraise the financial feasibility of the short-term development plan for the new port. This analysis forcuses on the viability of the project itself and the financial soundness of the port management body (PMB) during the project life.

11.2 Approach and Methodology

11.2.1 Approach

2. The Long-term Development Plan of the new port is based on the following concepts:

- Supplementary port for Mina Qaboos
- Transshipment port in Oman
- Industrial/Regional development core in northern Oman
- Free trade zone
- Fishery port
- Other services

However, regional development is not a directly concerned with the port project itself. Therefor the regional development function is excluded from the financial analysis. In the same way, the Industrial Estate and Free Trade Zone are excluded from the financial analysis taking into account the present situation of the Rusayl Industrial Estate Authority which is operated independently.

11.2.2 Methodology

3. Financial Analysis is carried out using the following two methods:

(1) The financial soundness of the PMB is appraised using the projected financial statements and some indices calculated based upon these statements. The financial indices employed in this analysis are as follows:

- Working Ratio
- Operating Ratio
- Rate of Return on Net Fixed Assets
- Debt Service Coverage Ratio

Note: For the meanings of these indices, see Vol 3 Chapter 8.

Sensitivity analysis also carried out so as to measure the impact of changing conditions on the financial performance of the PMB.

(2) The viability of the project itself is analyzed using the Financial Internal Rate of Return (FIRR) by means of the discounted cash flow method. Sensitivity analysis is conducted to measure the impact of changing conditions on the financial status of the project.

11.3 Presuppositions

11.3.1 Project Life

4. Considering the economic service lives of facilities/equipment, the project life for the financial analysis is determined as 36 years, which consists of 6 years for the engineering service and construction and 30 years of operation.

11.3.2 Self-sustaining Basis

5. According to the rules for public authorities as set out in financial circular No. 6/85 from the Office of the H.E. of the Deputy Prime Minister for Financial and Economic Affairs, any surplus or deficit arising as a result of the operations of authorities is payable to or recoverable by the Government.

In this study, however, the rules mentioned above cannot be adopted because the purpose of the financial analysis is to examine the financial feasibility of the body implementing the project. The PMB should be managed on a self-sustaining basis to the best of its ability. Therefore, the principal accounting policies adopted by the PSC are also basically used for this analysis.

11.3.3 Financial Management

(1) Fund Management

6. The amount of cash on hand is assumed to be 3% of operating expenses. The rest is assumed to be in banks with a 7.5% interest rate per annum. On the other hand, the annual deficit will be covered by short-term loans with an 11.5% interest rate.

(2) Corporate Income Tax

7. It is assumed that corporate income tax will not to be levied on the PMB because it is a public authority.

(3) Investment for Renewal

8. The investment funds for the renewal of facilities/equipment will be covered by internal resources reserved as accumulated depreciation costs.

11.3.4 Effects of Inflation

9. In this analysis, the effects of inflation are not dealt with. However, cost escalation is examined as one of the cases for the sensitivity analysis.

11.4 Appraisal of the Project

11.4.1 Fund-raising Plan

10. The funds necessary for this project will be assumed as follows:

(1) Government Funds

Funds necessary for construction of the breakwater, quay, fishery port, quayside gantry cranes and dredging is assumed to be covered by Government funds as investment in the project. The amount of government funds for this project is 57,245 thousand Rial Omani, i.e., 83.8% of the total cost for the project.

(2) Other Portion

It is assumed that the other funds for this project will be raised as following conditions.

- Loan Period : 20 years
- Grace Period : 5 years
- Interest Rate : 4.4% per annum
- Repayment : Fixed Amount Repayment of Principal

In addition to this, the case of an 8% interest rate will be examined in order to evaluate the impact of interest rates on the body implementing the project in the sensitivity analysis.

11.4.2 Bases for Revenue Projection

11. The revenue sources for this project are revenue from ships (port dues), revenue from cargo (stevedoring, shorehandling and storage charges) and other miscellaneous charges. These charges are calculated based upon the present tariffs used in Mina Qaboos. There should not be so-called "cut-throat" competition between Mina Qaboos and the new port. Actual rates are summarized in Vol.3 Table 8-4-1. The cargo volume that can be handled in the new port will reach the limit in 1994 in the case of conventional cargoes and in 1995 in the case of containers.

11.4.3 Bases for Expenditure Projection

12. The expenditures of the PMB consist of personnel costs, repair/maintenance and operating costs, administration costs, cost of the depreciation of fixed assets, cost of the amortization of deferred assets, interest on long-term loans and interest on short-term loans. The bases for calculation are mainly derived from the financial data of the PSC and are summarized in Vol.3 Table 8-4-2.

11.4.4 Financial Soundness of the PMB

(1) Base Case

13. The projected profit and loss statement, cash flow statement and balance sheet of the PMB are shown in Table 11-4-1.

(a) Operational Efficiency

The working ratio is continuously below 60% from 2004 till the end of the project life. Generally speaking, this ratio should remain under 50 to 60%. On the other hand, the operating ratio slightly exceeds 75% for almost the entire project life. The IBRD requests that it is preferable for this ratio to remain under 70% to 75%. Therefore, it would be better to increase the present tariff rates, especially in the case of ratio for transshipment containers, to the greatest possible extent in order to recover the cost of fixed assets, taking into account the present tariff level, which is the lowest among the ports of the UAE and Oman, as shown in Vol.3 Table 8-4-4.

In addition to this, the operating ratio can be reduced to about 71% if the PMB can reduce 10% of the personnel cost of the base case.

Note:IBRD=International Bank for Reconstruction and Development

(b) Profitability

The profitability of the project can be appraised using the rate of return on net fixed assets. This rate exceeds 4.4% which is the assumed interest rate for this project, from 2011. Therefore, this project will remain profitable during the project life.

(c) Loan Repayment Ability

As shown in Table 11-4-1, the projected debt service coverage ratio will maintain a portion far above 1.0 times during the study period.

(2) Sensitivity Analysis

14. In order to examine the soundness of the PMB, sensitivity analysis is conducted in the following cases:

- Case I : Higher interest rate of 8%
- Case II : Cost increases by 10%
- Case III : Revenue decreases by 10%
- Case IV : Decrease of personnel cost by 10%

Calculation results for each case are shown in Vol.3 Table 8-4-7, 8-4-8, 8-4-9 and 8-4-10, respectively. In Case III, the operating ratio exceeds 80% during the project life. Therefore, the increase of handling charges for transshipment containers should be taken into consideration.

The comparison of each result is summarized as follows:

(a) Balance in Finance

Amount unit:1000 Rail Omani

Case	Year(Deficit)/Year(Surplus)	Retained Earinings in 2029
Base Case	2007/2008	163,908
Case I	2009/2010	131,899
Case II	2010/2011	128,599
Case III	2011/2012	90,994
Case IV	2005/2006	205,315

(b) Operating Efficiency in 2005

Case	Working Ratio	Operating Ratio
Base Case	55.76%	75.38%
Case I	55.76%	75.38%
Case II	60.13%	81.72%
Case III	60.62%	71.01%
Case IV	51.38%	71.01%

11.4.5 Viability of the Project Itself

15. The viability of the project is analyzed using the FIRR, which makes the costs and the benefits during the project life equal. The costs and benefits that are taken into account for the calculation of the FIRR are summarized as follows:

Costs	Benefits
• Initial investment cost, including reinvestment for renewal • Operating expenses	• Port operating revenue • Residual value the Fixed assets at the end of the project life

16. As far as initial investment is concerned, construction costs of the breakwaters and dredging are allocated between the short-term development plan and Master Plan based upon the number of berths, as mentioned in paragraph 22 of Chapter 10. And the construction cost of fishery port is also neglected because the revenue from this facility is excluded from the benefits.

17. In addition to the Base Case, the following two cases are calculated in order to examine the impact of construction costs and revenue on this project:

Case A : Cost increases by 10%
Case B : Revenue decreases by 10%

Table 11-4-2, Table 11-4-3(a), Table 11-4-3(b) and Table 11-4-3 (c) shows the calculation results of each case

Table 11-4-2 FIRR Calculation

Case	FIRR	Lower Limit
Base Case	4.62%	
		0.71%
Case A	3.14%	
		(1.30%)
Case B	2.85%	

Note : ( )=Lower Limit in case of 8% anual interest rate

18. Taking into account the fund-raising plan, the FIRR should exceed the lower limit of 0.71% which is the weighted average interest rate for all the project funds. In all the cases, the FIRRs exceed not only this limit but also the limit in the case of an 8% interest rate.

11.4.6 Conclusion

19. Judging from the above analysis, this project can be regarded as feasible provided that more than 80% of the funds necessary for this project will be raised as Government funds with no interest and no repayment required. Instead, the Government can receive a certain percent of retained earnings as dividends after appropriation of necessary reserves by the PMB in the future.

20. As clearly indicated through the financial analysis of the port's operating efficiency, it will be very much difficult for the PMB to recover the cost of fixed assets based upon the present tariff rates. This is mainly due to the fund-raising method generally applied by GCC countries, whereby major port facilities are constructed by governments and at least the operating cost should be earned through daily operations.

21. Taking into consideration the present competitive situation among ports in GCC countries, the provision of Government funds is a must.

Table 11-4-1 Projected Financial Statements (Base Case)

Revenue Factor	
Construction Cost Factor	
Personnel Cost Factor	
Interest Rate	0.01

PROFIT AND LOSS STATEMENT

	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
Operating Revenue																																				
Revenue from Ships	0	0	0	0	0	0	448	505	583	820	674	716	716	716	716	716	716	716	716	716	716	716	716	716	716	716	716	716	716	716	716	716	716	716	716	716
Revenue from Cargo	0	0	0	0	0	0	4,329	5,077	5,823	6,588	7,300	7,779	7,779	7,779	7,779	7,779	7,779	7,779	7,779	7,779	7,779	7,779	7,779	7,779	7,779	7,779	7,779	7,779	7,779	7,779	7,779	7,779	7,779	7,779	7,779	7,779
Other Revenue	0	0	0	0	0	0	137	160	183	208	228	229	229	229	229	229	229	229	229	229	229	229	229	229	229	229	229	229	229	229	229	229	229	229	229	229
Total	0	0	0	0	0	0	4,914	5,742	6,589	7,392	8,210	8,724	8,724	8,724	8,724	8,724	8,724	8,724	8,724	8,724	8,724	8,724	8,724	8,724	8,724	8,724	8,724	8,724	8,724	8,724	8,724	8,724	8,724	8,724	8,724	8,724
Operating Expenses																																				
Personnel Cost	0	0	0	0	0	1,591	3,181	3,181	3,181	3,181	3,181	3,181	3,181	3,181	3,181	3,181	3,181	3,181	3,181	3,181	3,181	3,181	3,181	3,181	3,181	3,181	3,181	3,181	3,181	3,181	3,181	3,181	3,181	3,181	3,181	3,181
Operating/Maintenance Cost	0	0	0	0	0	0	491	574	657	739	822	872	872	872	872	872	872	872	1,023	841	872	872	872	872	872	872	872	872	1,023	872	872	872	872	872	872	872	872
Administration Cost	0	0	0	0	0	318	734	761	788	744	401	811	811	811	811	811	811	811	841	811	811	811	811	811	811	811	811	811	841	811	811	811	811	811	811	811
Total	0	0	0	0	0	1,909	4,407	4,516	4,625	4,664	4,404	4,864	4,864	4,864	4,864	4,864	4,864	4,864	5,045	4,834	4,864	4,864	4,864	4,864	4,864	4,864	4,864	4,864	5,045	4,864	4,864	4,864	4,864	4,864	4,864	4,864
Depreciation	0	0	0	0	0	0	1,712	1,712	1,712	1,712	1,712	1,712	1,712	1,712	1,712	1,712	1,712	1,712	1,712	1,712	1,712	1,712	1,712	1,712	1,712	1,712	1,712	1,712	1,712	1,712	1,712	1,712	1,712	1,712	1,712	1,712
Amortization	0	0	0	0	0	0	514	514	514	514	514	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Operating Expenses	0	0	0	0	0	1,909	6,633	6,733	6,852	6,891	7,079	6,576	6,576	6,576	6,576	6,576	6,576	6,576	6,757	6,546	6,576	6,576	6,576	6,576	6,576	6,576	6,576	6,576	6,757	6,576	6,576	6,576	6,576	6,576	6,576	6,576
Net Operating Income	0	0	0	0	0	-1,909	-1,719	-991	-263	481	1,187	2,148	2,148	2,148	2,148	2,148	2,148	2,148	1,967	2,178	2,148	2,148	2,148	2,148	2,148	2,148	2,148	2,148	1,967	2,148	2,148	2,148	2,148	2,148	2,148	2,148
Non Operating Income	0	0	0	0	0	0	0	0	0	0	54	198	397	830	804	1,072	1,346	1,648	1,984	2,350	2,748	3,181	3,523	4,016	4,568	5,127	5,840	6,341	7,104	7,928	8,732	8,378	9,295	10,282	11,343	12,483
Non Operating Expenses																																				
Interest on Long-Term Loans	0	0	18	18	53	486	486	486	486	486	482	450	417	385	352	320	287	255	222	190	157	124	92	60	28	0	0	0	0	0	0	0	0	0	0	0
Interest on Short-Term Loans	0	0	0	2	4	10	243	297	259	134	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Net Income	0	0	-18	-18	-57	-2,405	-2,451	-1,775	-1,009	-159	758	1,698	2,128	2,393	2,599	2,900	3,025	3,541	3,910	4,308	4,737	5,184	5,578	6,103	6,687	7,275	7,807	8,489	9,251	10,074	10,879	10,525	11,443	12,430	13,490	14,631
Tax																																				
Net Income after Tax	0	0	-18	-18	-57	-2,405	-2,451	-1,775	-1,009	-159	758	1,698	2,128	2,393	2,599	2,900	3,025	3,541	3,910	4,308	4,737	5,184	5,578	6,103	6,687	7,275	7,807	8,489	9,251	10,074	10,879	10,525	11,443	12,430	13,490	14,631
Retained Earnings	0	0	-18	-18	-57	-2,405	-2,451	-1,775	-1,009	-159	758	1,698	2,128	2,393	2,599	2,900	3,025	3,541	3,910	4,308	4,737	5,184	5,578	6,103	6,687	7,275	7,807	8,489	9,251	10,074	10,879	10,525	11,443	12,430	13,490	14,631
Accumulated Earnings	0	0	-18	-34	-91	-2,499	-4,949	-6,724	-7,733	-7,892	-7,134	-5,239	-3,111	-718	1,881	4,780	7,806	11,347	15,258	19,564	24,301	29,485	35,064	41,167	47,854	55,089	62,896	71,384	80,635	90,510	101,389	111,914	123,357	135,787	149,278	163,908

CASH FLOW STATEMENT

	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
Cash Decrease	0	0	0	-18	-34	-91	-2,117	-2,579	-2,256	-1,187	716	2,837	5,441	8,512	10,863	14,435	18,088	22,122	26,599	31,482	36,763	42,023	47,118	53,892	60,792	68,512	75,344	84,899	94,864	105,827	118,589	111,847	124,085	137,240	151,382	166,585
Cash Inflow																																				
Net Operating Income	0	0	0	0	0	-1,909	-1,719	-991	-263	481	1,187	2,148	2,148	2,148	2,148	2,148	1,967	2,148	2,148	2,148	2,148	2,148	2,148	2,148	2,148	2,148	1,967	2,148	2,148	2,148	2,148	2,148	2,148	2,148	2,148	2,148
Depreciation	0	0	0	0	0	0	1,712	1,712	1,712	1,712	1,712	1,712	1,712	1,712	1,712	1,712	1,712	1,712	1,712	1,712	1,712	1,712	1,712	1,712	1,712	1,712	1,712	1,712	1,712	1,712	1,712	1,712	1,712	1,712	1,712	1,712
Amortization	0	0	0	0	0	0	514	514	514	514	514	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Government Funds	500	500	6,490	11,193	16,176	22,368	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Long-Term Loans	0	0	361	0	852	9,879	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other Current Liabilities Incremental	0	0	0	0	0	382	500	20	20	20	20	12	0	0	0	0	36	-36	0	0	0	0	0	0	0	0	0	38	-36	0	0	0	0	0	0	0
Other Long-Term Liabilities Incremental	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Received Interest	0	0	0	0	0	0	0	0	0	0	54	198	397	830	804	1,072	1,346	1,648	1,984	2,350	2,748	3,181	3,523	4,016	4,568	5,127	5,840	6,341	7,104	7,928	8,732	8,378	9,295	10,282	11,343	12,483
Cash Inflow Total	500	500	6,851	11,193	17,028	30,735	1,007	1,255	1,983	2,708	3,486	4,070	4,257	4,690	4,664	4,932	5,061	5,472	5,844	6,210	6,608	7,001	7,383	7,876	8,408	8,987	9,355	10,185	10,964	11,788	12,592	12,238	13,155	14,142	15,203	16,343
Cash Outflow																																				
Investment	500	500	6,651	11,193	17,028	32,265	0	0	0	0	270	0	0	1,044	0	270	0	0	0	0	0	449	1,044	0	0	0	2,158	0	0	0	1,044	17,314	0	0	0	0	0
Long-Term Loan Repayment	0	0	0	0	0	0	24	24	81	739	739	739	738	738	739	739	739	739	739	739	739	715	715	715	659	0	0	0	0	0	0	0	0	0	0	0
Interest on Long-Term Loans	0	0	18	18	53	486	486	486	486	486	482	450	417	385	352	320	287	255	222	190	157	124	92	60	28	0	0	0	0	0	0	0	0	0	0	0
Other Current Assets Incremental	0	0	0	0	0	0	737	124	124	123	124	76	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other Fixed Assets Incremental	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tax	0	0																																		
Payed Appropriation	0	0																																		
Interest on Short-Term Loans	0	0	0	1	4	10	243	297	259	134	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cash Outflow Total	500	500	6,667	11,211	17,085	32,763	1,489	933	895	824	1,585	1,288	1,157	2,168	1,092	1,279	1,027	994	962	929	1,345	1,908	807	778	688	2,158	0	0	0	1,044	17,314	0	0	0	0	0
Cash Inflow - Outflow	0	0	-16	-18	-57	-2,028	-482	323	1,089	1,883	1,921	2,804	3,100	2,321	3,572	3,652	4,034	4,477	4,882	5,281	5,281	5,093	6,575	7,100	7,721	6,831	9,355	10,185	10,984	10,742	-4,722	12,238	13,155	14,142	15,203	16,343
Cash Ending	0	0	-16	-34	-91	-2,117	-2,579	-2,256	-1,167	716	2,637	5,441	8,542	10,863	14,435	18,088	22,122	26,599	31,482	36,763	42,023	47,116	53,692	60,792	68,512	75,344	84,699	94,884	105,827	116,589	111,847	124,085	137,240	151,382	166,585	182,927
Cash Excess	0	0	0	0	0	0	0	0	0	716	2,637	5,441	8,542	10,863	14,435	18,088	22,122	26,599	31,482	36,763	42,023	47,116	53,692	60,792	68,512	75,344	84,699	94,884	105,827	116,589	111,847	124,085	137,240	151,382	166,585	182,927
Short-Term Loan	0	0	16	34	91	2,117	2,579	2,256	1,167	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

BALANCE SHEET

	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
Current Assets																																				
Cash & Deposit																																				
Cash on Hand	0	0	0	0	0	0	0	0	0	0	0	148	148	148	148	148	151	148	148	148	148	148	148	148	148	148	151	148	148	148	148	148	148	148	148	148
Short-term Deposit	0	0	0	0	0	0	0	0	0	716	2,637	5,295	8,398	10,717	14,288	17,942	21,970	26,453	31,338	36,617	41,876	46,970	53,548	60,646	68,368	75,196	84,548	94,718	105,682	118,424	111,701	123,939	137,094	151,236	166,439	182,782
Other Current Assets	0	0	0	9	0	0	737	881	985	1,109	1,232	1,309	1,309	1,309	1,309	1,309	1,309	1,308	1,308	1,309	1,309	1,309	1,309	1,309	1,309	1,309	1,309	1,309	1,309	1,309	1,309	1,309	1,309	1,309	1,309	1,309
Total Current Assets	0	0	0	9	0	0	737	881	985	1,825	3,869	6,750	9,850	12,172	15,744	19,398	23,430	27,908	32,790	38,071	43,332	48,425	55,000	62,100	69,821	76,652	86,007	96,172	107,138	119,878	113,158	125,393	138,549	152,691	167,893	184,236
Fixed Assets																																				
Capital Assets	0	0	0	0	0	0	85,787	85,787	85,787	85,787	85,787	85,787	85,787	85,787	85,787	85,787	85,787	85,787	85,787	85,787	85,787	85,787	85,787	85,787	85,787	85,787	85,787	85,787	85,787	85,787	85,787	85,787	85,787	85,787	85,787	85,787
Accumulated Depreciation	0	0	0	0	0	0	1,712	3,425	5,137	6,849	8,561	10,054	11,766	13,478	15,190	16,902	18,614	20,326	22,038	23,751	25,463	27,175	28,887	30,599	32,311	34,023	35,735	37,447	39,159	40,871	42,583	44,295	46,007	47,719	49,431	51,143
Net Fixed Assets	0	0	0	0	0	0	84,075	82,362	80,650	78,938	77,226	75,733	74,021	72,309	70,597	68,885	67,173	65,461	63,749	62,036	60,324	58,612	56,900	55,188	53,476	51,764	50,052	48,340	46,628	44,916	43,204	41,492	39,780	38,068	36,356	34,644
Capital Work in Progress	0	0	8,747	17,727	34,518	85,787	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other Fixed Assets	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Fixed Assets	0	0	8,747	17,727	34,518	85,787	84,075	82,362	80,650	78,938	77,226	75,733	74,021	72,309	70,597	68,885	67,173	65,461	63,749	62,036	60,324	58,612	56,900	55,188	53,476	51,764	50,052	48,340	46,628	44,916	43,204	41,492	39,780	38,068	36,356	34,644
Deferred Assets	500	1,000	1,104	1,317	1,556	2,570	2,958	1,542	1,028	514	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Assets	500	1,000	7,851	19,044	36,072	88,357	86,848	84,746	82,644	81,257	81,295	82,483	83,851	85,505	87,384	89,524	71,648	74,812	77,782	81,351	85,348	89,773	94,838	100,023	108,032	113,307	120,950	129,402	138,854	148,728	159,807	170,132	181,575	194,005	207,495	222,128
Current Liabilities																																				
Short-term Loans	0	0	16	34	91	2,117	2,579	2,256	1,167	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other Liabilities	0	0	0	0	0	382	881	901	921	941	981	973	973	973	973	973	1,009	973	973	973	973	973	973	973	973	973	1,009	973	973	973	973	973	973	973	973	973
Total Current Liabilities	0	0	16	34	91	2,499	3,460	3,157	2,088	941	981	973	973	973	973	973	1,009	973	973	973	973	973	973	973	973	973	1,009	973	973	973	973	973	973	973	973	973
Long-Term Liabilities																																				
Long-term Loans	0	0	361	381	1,213	11,092	11,092	11,088	11,044	10,983	10,224	9,484	8,745	8,005	7,266	6,526	5,787	5,047	4,308	3,568	2,829	2,089	1,374	659	0	0	0	0	0	0	0	0	0	0	0	0
Other Long-term Liabilities	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Long-term Liabilities	0	0	361	381	1,213	11,092	11,092	11,088	11,044	10,983	10,224	9,484	8,745	8,005	7,266	6,526	5,787	5,047	4,308	3,568	2,829	2,089	1,374	659	0	0	0	0	0	0	0	0	0	0	0	0
Net Worth																																				
Retained Earnings	0	0	-18	-34	-91	-2,499	-4,949	-6,724	-7,733	-7,892	-7,134	-5,239	-3,111	-718	1,881	4,780	7,806	11,347	15,258	19,564	24,301	29,485	35,064	41,167	47,854	55,089	62,896	71,384	80,635	90,510	101,389	111,914	123,357	135,787	149,278	163,908
Reserves																																				
Government Fund	500	1,000	7,490	18,683	34,859	87,245	87,245	87,245	87,245	87,245	87,245	87,245	87,245	87,245	87,245	87,245	87,245	87,245	87,245	87,245	87,245	87,245	87,245	87,245	87,245	87,245	87,245	87,245	87,245	87,245	87,245	87,245	87,245	87,245	87,245	87,245
Total Liabilities & Net worth	500	1,000	7,851	19,044	36,072	88,357	86,848	84,746	82,644	81,257	81,295	82,483	83,851	85,505	87,384	89,524	71,648	74,812	77,782	81,351	85,348	89,773	94,838	100,023	108,032	113,307	120,950	129,402	138,854	148,728	159,807	170,132	181,575	194,005	207,495	222,128

Financial Indicators	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
Working Ratio(%)	0	0	0	0	0	0	89.68	78.46	70.11	63.84	58.48	55.78	55.78	55.78	55.78	55.78	57.83	55.78	55.78	55.78	55.78	55.78	55.78	55.78	55.78	55.78	57.83	55.78	55.78	55.78	55.78	55.78	55.78	55.78	55.78	55.78
Operating Ratio(%)	0	0	0	0	0	0	134.98	117.25	104.00	93.78	85.58	75.38	75.38	75.38	75.38	75.38	77.48	75.38	75.38	75.38	75.38	75.38	75.38	75.38	75.38	75.38	77.48	75.38	75.38	75.38	75.38	75.38	75.38	75.38	75.38	75.38
Rate of Return on Net Fixed Assets(%)	0	0	0	0	0	0	-2.88	-1.59	-0.43	0.76	2.07	3.85	3.98	4.03	4.16	4.26	4.08	4.80	4.77	4.98	5.11	5.19	5.42	5.69	5.93	5.86	5.83	6.48	6.81	6.88	4.82	4.80	4.99	5.20	5.42	5.67
Debt Service Coverage Ratio(Times)	0	0	0	0	0	0	11.12	12.22	13.48	13.95	7.14	7.34	7.54	7.76	7.99	8.24	8.50	8.78	8.07	9.39	9.73	10.10	10.81	11.24	12.09											

Table 11-4-3(a) FIRR Calculation (Base Case)

FIRR : 0.046187993636 BASE CASE

NO.	YEAR	COST	BENEFIT	BNFT.-COST	P.COST	P.BNFT	P.VALUE
1.	1994	500	0	-500	500	0	-500
2.	1995	500	0	-500	478	0	-478
3.	1996	3,081	0	-3,081	2,815	0	-2,815
4.	1997	5,908	0	-5,908	5,160	0	-5,160
5.	1998	10,249	0	-10,249	8,555	0	-8,555
6.	1999	30,752	0	-30,752	24,537	0	-24,537
7.	2000	4,407	4,914	507	3,361	3,748	387
8.	2001	4,506	5,742	1,236	3,285	4,186	901
9.	2002	4,605	6,569	1,964	3,209	4,577	1,369
10.	2003	4,704	7,392	2,688	3,133	4,924	1,790
11.	2004	5,023	8,216	3,193	3,198	5,231	2,033
12.	2005	4,864	8,724	3,860	2,960	5,309	2,349
13.	2006	4,864	8,724	3,860	2,829	5,075	2,245
14.	2007	5,908	8,724	2,816	3,285	4,851	1,566
15.	2008	4,864	8,724	3,860	2,585	4,636	2,051
16.	2009	5,084	8,724	3,640	2,583	4,432	1,849
17.	2010	4,864	8,724	3,860	2,362	4,236	1,874
18.	2011	4,864	8,724	3,860	2,258	4,049	1,792
19.	2012	4,864	8,724	3,860	2,158	3,870	1,712
20.	2013	4,864	8,724	3,860	2,063	3,699	1,637
21.	2014	5,313	8,724	3,411	2,154	3,536	1,383
22.	2015	5,908	8,724	2,816	2,289	3,380	1,091
23.	2016	4,864	8,724	3,860	1,801	3,231	1,429
24.	2017	4,864	8,724	3,860	1,722	3,088	1,366
25.	2018	4,864	8,724	3,860	1,648	2,952	1,306
26.	2019	7,020	8,724	1,704	2,270	2,821	551
27.	2020	5,045	8,724	3,679	1,560	2,697	1,137
28.	2021	4,864	8,724	3,860	1,437	2,578	1,141
29.	2022	4,864	8,724	3,860	1,374	2,464	1,090
30.	2023	5,908	8,724	2,816	1,595	2,355	760
31.	2024	22,504	8,724	-13,780	5,807	2,251	-3,556
32.	2025	4,864	8,724	3,860	1,200	2,152	952
33.	2026	4,864	8,724	3,860	1,147	2,057	910
34.	2027	4864	8,724	3,860	1,096	1,966	870
35.	2028	4864	8,724	3,860	1,048	1,879	831
36.	2029	-23950	8,724	32,674	-4,931	1,796	6,728
	TOTAL	190,299	250,933	60,634	104,026	104,026	0

Table 11-4-3(b) FIRR Calculation (Case A)

FIRR : 0.031399699571 CASE A

NO.	YEAR	COST	BENEFIT	BNFT.-COST	P.COST	P.BNFT	P.VALUE
1.	1994	550	0	-550	550	0	-550
2.	1995	550	0	-550	533	0	-533
3.	1996	3,766	0	-3,766	3,540	0	-3,540
4.	1997	7,027	0	-7,027	6,405	0	-6,405
5.	1998	11,951	0	-11,951	10,561	0	-10,561
6.	1999	34,170	0	-34,170	29,276	0	-29,276
7.	2000	4,789	4,914	125	3,978	4,082	104
8.	2001	4,888	5,742	854	3,937	4,625	688
9.	2002	4,987	6,569	1,582	3,894	5,130	1,235
10.	2003	5,086	7,392	2,306	3,851	5,597	1,746
11.	2004	5,405	8,216	2,811	3,968	6,031	2,063
12.	2005	5,246	8,724	3,478	3,734	6,209	2,475
13.	2006	5,246	8,724	3,478	3,620	6,020	2,400
14.	2007	6,290	8,724	2,434	4,208	5,837	1,628
15.	2008	5,246	8,724	3,478	3,403	5,659	2,256
16.	2009	5,466	8,724	3,258	3,438	5,487	2,049
17.	2010	5,427	8,724	3,297	3,309	5,320	2,010
18.	2011	5,246	8,724	3,478	3,101	5,158	2,056
19.	2012	5,246	8,724	3,478	3,007	5,001	1,994
20.	2013	5,246	8,724	3,478	2,916	4,848	1,933
21.	2014	5,695	8,724	3,029	3,069	4,701	1,632
22.	2015	6,290	8,724	2,434	3,286	4,558	1,272
23.	2016	5,246	8,724	3,478	2,657	4,419	1,762
24.	2017	5,246	8,724	3,478	2,576	4,284	1,708
25.	2018	5,246	8,724	3,478	2,498	4,154	1,656
26.	2019	7,402	8,724	1,322	3,417	4,028	610
27.	2020	5,427	8,724	3,297	2,429	3,905	1,476
28.	2021	5,426	8,724	3,298	2,355	3,786	1,431
29.	2022	5,246	8,724	3,478	2,207	3,671	1,463
30.	2023	6,290	8,724	2,434	2,566	3,559	993
31.	2024	22,560	8,724	-13,836	8,923	3,451	-5,473
32.	2025	5,246	8,724	3,478	2,012	3,346	1,334
33.	2026	5,246	8,724	3,478	1,951	3,244	1,293
34.	2027	5,246	8,724	3,478	1,891	3,145	1,254
35.	2028	5,246	8,724	3,478	1,834	3,049	1,216
36.	2029	-26,831	8,724	35,555	-9,093	2,956	12,049
	TOTAL	203,505	250,933	45,428	135,257	135,257	0

Table 11-4-3(c) FIRR Calculation (Case B)

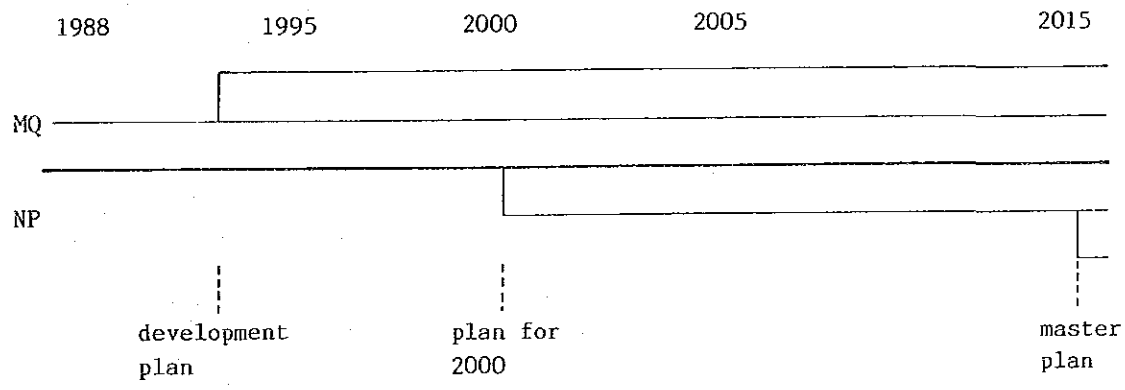
FIRR : 0.028509139303 CASE B

NO.	YEAR	COST	BENEFIT	BNFT.-COST	P.COST	P.BNFT	P.VALUE
1.	1994	500	0	-500	500	0	-500
2.	1995	500	0	-500	486	0	-486
3.	1996	3,081	0	-3,081	2,913	0	-2,913
4.	1997	5,908	0	-5,908	5,430	0	-5,430
5.	1998	10,249	0	-10,249	9,159	0	-9,159
6.	1999	30,752	0	-30,752	26,720	0	-26,720
7.	2000	4,407	4,423	16	3,723	3,737	14
8.	2001	4,506	5,168	662	3,701	4,245	544
9.	2002	4,605	5,912	1,307	3,678	4,721	1,044
10.	2003	4,704	6,653	1,949	3,653	5,166	1,513
11.	2004	5,023	7,394	2,371	3,792	5,582	1,790
12.	2005	4,864	7,852	2,988	3,570	5,764	2,193
13.	2006	4,864	7,852	2,988	3,471	5,604	2,132
14.	2007	5,908	7,852	1,944	4,100	5,448	1,349
15.	2008	4,864	7,852	2,988	3,282	5,297	2,016
16.	2009	5,084	7,852	2,768	3,335	5,151	1,816
17.	2010	4,864	7,852	2,988	3,102	5,008	1,906
18.	2011	4,864	7,852	2,988	3,016	4,869	1,853
19.	2012	4,864	7,852	2,988	2,933	4,734	1,802
20.	2013	4,864	7,852	2,988	2,851	4,603	1,752
21.	2014	5,313	7,852	2,539	3,028	4,475	1,447
22.	2015	5,908	7,852	1,944	3,274	4,351	1,077
23.	2016	4,864	7,852	2,988	2,621	4,231	1,610
24.	2017	4,864	7,852	2,988	2,548	4,113	1,565
25.	2018	4,864	7,852	2,988	2,477	3,999	1,522
26.	2019	7,020	7,852	832	3,476	3,888	412
27.	2020	5,045	7,852	2,807	2,429	3,781	1,352
28.	2021	4,864	7,852	2,988	2,277	3,676	1,399
29.	2022	4,864	7,852	2,988	2,214	3,574	1,360
30.	2023	5,908	7,852	1,944	2,615	3,475	860
31.	2024	22,504	7,852	-14,652	9,683	3,379	-6,305
32.	2025	4,864	7,852	2,988	2,035	3,285	1,250
33.	2026	4,864	7,852	2,988	1,978	3,194	1,215
34.	2027	4,864	7,852	2,988	1,924	3,105	1,182
35.	2028	4,864	7,852	2,988	1,870	3,019	1,149
36.	2029	-23,950	7,852	31,802	-8,954	2,936	11,890
	TOTAL	190,299	225,850	35,551	128,410	128,410	0

Chapter 12 Port Development Strategy-A Conclusion

1. Development and management of ports are largely dependent upon the behaviour of the national economy. The country's GDP between 1965 and 1980, according to World Bank estimates, increased by an average 12.5% per annum in real terms. The comparable increase between 1973 and 1984 was 6.1% per annum. According to official estimates the annual increase in GDP, measured in constant 1978 prices, was 17.0% in 1981, 11.5% in 1982 and 16.6% in 1984. Although Oman's economy is still largely based on revenue from the petroleum sector, in recent years there has been increasing industrial diversification. The attitude to manage the economy is highly prudent. Revenues from petroleum have been used to implement three five-year development plans. The third development plan was started in 1986 with special emphasis on the development of agriculture, fisheries and light industry. Since there is much reason to believe the economy will continue to be prudently managed and thus the growth of the economy will continue, the cargo volume handled in the country will likely increase.
2. It is widely recognized that Mina Qaboos, though it is the only gateway port to Oman and continues to play an important role in various aspects of the country's economic life, cannot properly adapt itself to the present increasing cargo demand and the technological progress of relevant industries. Since 1982, a series of port development studies have been conducted. Our study, taking into consideration and making appraisal of those preceeding studies, proposed a comprehensive scheme for port development in the northern part of Oman.

The time series of the scheme is shown in Fig. 12-1.



Notes: MQ-Mina Qaboos; NP-New Port;
Width of the bars does not indicate cargo handling capacity.

Fig.12-1 Action Plan of Port Development

3. Under the present circumstances, where the states arround the Gulf are extremely enthusiastic about constructing their ports, resulting in growing competition between ports, clients are tending to choose more modernized and better equipped ports. In order to meet this demands, something should be done immediately. For this purpose, the development work at Mina Qaboos should be expedited. Speedy construction work is also required with a view to saving on financial costs as well as minimizing the unfavourable effects on day-to-day port operations during the construction period. In this sense, Mina Qaboos should be improved by adhering to the schedule suggested in Chapter 7 of the report, rather than carrying it over on extended period.

4. As far as development of a new port is concerned, it is pointed out in Chapter 10.5.2 that the economic internal rate of return (EIRR) based on a cost-benefit analysis is 5.0%. The figure is far below the level that is generally considered to be economically feasible in terms of construction of infrastructure. This is the biggest impediment of giving the project high priority.

According to the financial analysis using the financial internal rate of return (FIRR), the project is financially viable in terms of a port management body on the assumption that about 80% of the funds necessary for the project are borne by the government on an interest-free and no-repayment basis. These terms seems to be attainable, because they are similar to the funding arrangement of Mina Qaboos.

There are some other concern regarding the new port project. The Sultanate of Oman attaches great importance on the preservation of the environment. In this regard, at the site selection and actual planning at the selected site, the highest priority is given to keeping the impact of the port development to a minimum. The environmental aspects of the project should be kept in mind in future detailed design and construction stages.

When beginning operation at the new port, a high level of expertise is indispensable for various fields of port activity, e.g. management, operation, machinery, traffic, etc. Selection and training of cargo handling personnel are also very important. Studies of how to recruit experts and how to establish a training scheme should be commenced at an early stage of the project.

As repeatedly stated in the report, competition to attract clients is growing among the ports on the Gulf's west coast. It should be noted that

whether the port survives after being confronted by fierce competition with preceding ports depends upon intensive port sales and fund-raising necessary for carrying on port operation during the period immediately after completion when the port's revenues are still insufficient.

5. Assuming that impediments stated in the above paragraph are so serious that construction of the new port must be given up, there are two alternatives. One is to expand Mina Qaboos as proposed in the report, and another is large-scale and long-term expansion of Mina Qaboos, as proposed in the report of Consulting Engineering Services (CES), 1988.

The first alternative is same as "without case" in the economic analysis of the new port (Chapter 10). The demerit of this case are described in Chapter 10.2.3, the major points of which are increase of ships' waiting time and lost container cargo clients, in particular those involving transshipment.

The second alternative is to construct 5 berths more by reclaiming Shutaify Bay and building up a 500 m long breakwater. As is estimated in Appendix of Vol.II 6-2-1, the extremely high cost of construction cannot be made up by a gain of only 4 berths. Moreover, operation of new berths will increase traffic volume in the port, which may result in congestion surrounding the capital area. And difficulty is envisaged in furnishing enough area corresponding to the new berths for container manoeuvering.

6. The points outlined in the previous paragraph may suggest that it is unavoidable to construct a new port development in northern Oman. However, other factors should be mentioned favouring the new port development.

(1) There are several ongoing plans or studies for developing industries of various fields in the region with a view to promoting independence from the oil-dependent economy. The port could act as a substantial tool for carrying out and further expanding the work of the industries located in the hinterland of the port through providing transport facilities for their materials or products.

(2) It is generally recognized that ports stimulate economic activities, thus promoting the development of the adjacent region. This is because port business creates employment, encourages provision of urban infrastructure such as electricity, water supply, drainage, telephones etc., and also stimulates various peripheral manufactures. These facts may contribute to materializing the policy of the government, which aims to avoid overcentralization of population and industrial and commercial activities.

(3) As stated in the report, Oman faces the challenge of port expansion in various neighboring countries. It is clear the country will be left behind other countries if a mew port is not built in the very near future. Although this problem cannot be expressed quantitatively, in view of the dignity of the state this aspect should not be overlooked.

(4) The calculation of the economic analysis is conducted for a period extending 35 years from the beginning of construction. However after that period the port facilities will continue to serve for cargo movement. Even though return on this investment is lower than on other investments, for example, magnificent buildings, shopping complexes or even equities or securities, by building a port the nation can obtain an asset that will contribute to expanded productivity, thus maintaining the competitiveness of the manufacturing sector. This is indispensable for the growth and modernization of the country.

7. Some may believe it better to immediately construct a now port, rather than waiting for improvement of Mina Qaboos. This idea, besides the disadvantages which have already been pointed out in Chapter 7.1, runs the risk of losing many clients in all areas of trade even if the new port is built as soon as possible. This is because it would take more time than the construction of port facilities, for such related industries as those providing services of sea transport, handling of seaborne cargo, storage, and so on as well as commercial and financial firms to take root in the port area. While bulk cargo is generated where factories or receiving equipment exist, placement of related industries is required to induce general cargo, which is more important in terms of port revenues.

8. If the above account is proved to be right and the two-tier development is authorized, consideration should be given to their time scale. What appeared in Fig. 12-1 of paragraph 2 suggest that the capacity of the port does not increase all at one time but makes phased increases, corresponding to the amount of cargo, which may not radically rise. Requirement in terms of budget, engineering and human resources also should not be too concentrated. At this stage the idea in Fig. 12-1 is considered to be the best, however, the timing of the new port's construction should be carefully re-examined in the future, taking into account the budgetary conditions of the time, and the following points:

(1) To assure that the new port is operating smoothly and realizing its full potential, a concerted development with related schemes is required. These include industrial deployment schemes such as a petrochemical

industry, an industrial estate and desalination plants as well as development plans of infrastructures necessary for the port, e.g. roads, electricity and water supply, drainage, sewage disposal, schools and housings. Studies of a petrochemical plant, an industrial estate in the area and regional developlment plans are under way but not fully revealed yet. At the same time it should be noted by the officials in charge of the above plannings activities that the most appropriate schedule for new port construction is the one that appears in Fig. 12-1 of paragraph 2.

(2) The forecast of handled cargo demand should be reviewed since an authorized forecast of relevant economic indices is not entirely known. The timing of implementation of the master plan will vary in accordance with the changes of demand and even the plan for 2000 might be moved ahead or back.

9. Besides the above-mentioned points, there are a lot of problems to be resolved before launching operation of the new port. A concrete scheme of such ancillary services as water, fuel and other supplies for vessels, pilots, tugboats, navigational aids, telephone service, etc., should be established. Schemes regarding management and operation are more important since clients are attracted by a well-run operation. The following are main issues:

(1) Institutional Matters

The management body of the new port may be a corporation, a large portion of the capital of which will be owned by the government but independent from the existing PSC. The reason is that a large part of investment should be borne by the government and the PSC cannot bear the huge deficit envisaged at its initial stage, although the body will be self-sustaining in the long term.

There are a large number of variations throughout the world as to the extent of the work that port managing bodies actually conduct. The most important feature is cargo handling. The Port Service Corporation (Mina Qaboos) owns all the handling equipment except bulk grain and conducts by itself loading and unloading. It is considered a wise tentative course of action that the body for the new port follows the example of Mina Qaboos with a view to learning its port management.

The organizational structure may be like that of the PSC, since the area of the work is similar. However, differences in functions such as ship repairing, fishery, may require slight modification in organization.

(2) Recruitment and Training

For proper operation of a port, personnel and manning are most important factors. It is indicated in Chapter 4 that the expansion of Mina Qaboos requires staff increase in the area of maintenance of equipment and cargo handling. Launching the new port requires some 900 more staff members. With respect to the training of Mina Qaboos' staff, the 1988 CES Report put forward a scheme which seems to be adequate and should be implemented as soon as possible.

For the new port, an enormous task has to be done before port inauguration as well as during its first few years of operation. In order to carry out the task, it might be an idea to have a detailed study for recruitment and training, the contents of which includes in particular: (i) identifying problems, (ii) making criteria for recruitment in each work field, (iii) making training schemes for each field.

Under the circumstances where difficulty is envisaged in recruiting a sufficient number of experts for higher-ranking officials of the PMB, it may be advisable to hire foreign experts with much experience of port management, preferably including a general manager, with a view to assist in the smooth operation of the port and also to transfer port management expertise in the inauguration period.

(3) Port Sales

A growing trend exists whereby major ports in nations with free market economies are eager to attract their customers using various techniques. These kinds of activities do in fact contribute to the prosperity of ports to a large extent. For example, last year Jebel Ali which has enjoyed a large growth in cargo as well as increased number of clients using its FTZ in the ten years the port has been operating, and has made an intensive effort to "sell" the port. For new comers it is absolutely true that without such efforts the port may not survive. In this context, the new port site is well-chosen, because it is said Sindbad the Sailor left from there when setting out on his adventures. Stressing this point may at least draw the attention of possible clients. However, it should be emphasized that publicity can only do a little on its own. Reputation accompanied by substance is more effective. From the customers' viewpoint the best substance is a sure and speedy cargo movement. To attain this, a quick customs, immigration and quarantine (CIQ) procedures too are vital.

(4) Means of Coordination

The new port and Mina Qaboos will be competitors in terms of getting cargo, but at the same time they should cooperate and coordinate their activities in many fields. The latter is more important in order that both ports maintain growth in the future, since in the market economy, which encourages industries' motivation to develop, allocation of cargo to each port is not possible nor desirable, hence concerted action between PMBs is needed. With this point in mind, it may be advisable to establish a national port council under the Ministry of Communications consisting of executives of the PSC (Mina Qaboos) and of the port managing body of the new port with a small secretariat. Meetings should be convened regularly with a view to exchange information and to draft a port policy.

Another facet of coordination relates to various projects of the region. The importance of coordination in the planning stage was already touched on in paragraph 8(1), In the operation stage this is applied, and to ensure concerted action as far as possible, some means of linking all the relevant bodies should be developed. Relevant bodies include municipalities, regional branches of central organizations dealing with housing, education, energy, customs, quarantine and immigration, the industrial estate authority, the governing body of the free-trade zone and the petro-chemical factory.

10. Launching a new port is a very ambitious project, and naturally it involves a large volume of work. As the above paragraph suggests, there are still question to be solved. Another study, which may be named as the study for preparation for the new port at Sohar, will be useful in finding solutions to some of the questions including fixing exact timing based upon economic indices forecasts and information regarding related projects at the time. Also, detailed plans of ancillary services and plans for recruitment and training may well be a part of the study. Taking into account the time schedule for the new port construction, the study should be concluded by 1997.

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