(4) Work apron;

This facility will serve not only as an apron for related dock operations but may also be used for the boarding and disembarking of passengers. From this standpoint, the facility must be made wide enough to allow for vehicular operations and insure passenger safety.

3.4.2 Shore Facilities

(1) Storage Warehouse

Stevedoring operation at the Old Dock are handled by the Majuro Stevedore & Terminal Co., Inc. (MSTC). The 800 m^2 warehouse operated by this company is leased from the Marshall Islands Government. However, since many of the materials imported and distributed by the company, such as foodstuffs and cement, are stored for relatively long periods of time, it is difficult to secure adequate warehouse space at this facility for the storage of cargo that is to be loaded aboard vessels just prior to sailing. While it is clearly necessary to expand storage space to prevent water damage and theft of the stored materials, this has not been possible owing to site problems. In addition, the remoteness (240m) of the existing warehouse from the dock front has lowered the efficiency of loading operations. In order to solve these problems a new warehouse will be built under this Plan on the work apron of the dock. This facility will comprise areas for general and specialty cargoes as well as an administration area.

(2) Passenger Waiting Facility

There is no passenger waiting area at the present Old Dock. As a result, passengers congregate with their luggage and well-wishers on the causeway and working areas of the dock, contributing to a decline in loading efficiency. For this reason , the Port Director strongly desires the building of a passenger waiting area, not only from the standpoint of operating efficiency but also from that of passenger safety. In this Plan, therefore, a new waiting facility is to be built on the base of the causeway with a view to enhancing operational efficiency and passenger safety. This facility will contain both a waiting room and a rest room.

(3) Improvement of the Access Road

The distance of 240 m from the present warehouse area to the dock is covered by an unpaved gravel road, with trucks and forklifts used for the haulage operations. Since the road is gravel surface, it is quite difficult to maintain despite a relatively frequent maintenance schedule. In particular, the forklifts and other narrow-gauge vehicles cause frequent damage to the goods being handled. This Plan, therefore, calls for the paving of the access road from the existing warehouse to the work apron.

3.4.3 Attached Facilities

(1) Fueling Equipment

Fueling operations for medium and large-size vessels on the Old Dock are handled by Mobil Oil, Micronesia, Inc. The fueling equipment, however, including pipelines, is beset by problems of operational responsibility, and the company has been installing and operating the equipment at its own expense. Fueling capability is an essential element of the Plan facilities, and so space has been provided for installing fuel pipelines, but the procurement and installation of the necessary equipment will be the responsibility of Mobil Oil.

Meanwhile, the existing dock has no oil supply service facility for small boats. Therefore, small fishing and cargo boats have been refueled by utilizing spare tanks filled and brought by themselves. Thus, it is desirable to provide a fuel supply facility for these boats. In the Plan, we will provide a fuel supply facility with a storage tank for the purpose of improving both safety and efficiency of fuel supply to small fishing and cargo boats.

(2) Water Supply

Water supply is presently being obtained, as required, from water supply lorries of the Ministry of Public Works. However, since these vehicles are not dedicated to vessel supply operations, waiting time is quite long and after-hour supplies cannot be obtained. It is also necessary to supply good quality water suitable for drinking without boiling to small boats which are usually not equipped with such sterilizing equipment. To eliminate these inconveniences, the Plan calls for the laying of a branch pipe to the work apron for direct water supply to the inter-island vessels, and for small fishing and cargo boats, the provision of water supply facility by installing a water catchment tank from the roof of the warehouse.

(3) Power Facilities

Power facilities at the Old Dock are limited to lighting in only one part of the access road. While night-time operations are possible using illumination from the vessel, this light is hardly adequate and this greatly hampers such operations. In addition, since the power supply from the moored vessel incurs considerable fuel expense for this purpose. To solve this problem, we plan to install lighting equipment operated from commercial outlets together with equipment to provide power to the moored vessels.

3.5 Details of the Plan

3.5.1 Implementing Organization

The implementing organization for the subject Plan will be the Ministry of Transportation and Communications. This Ministry, as its name implies, is responsible for transportation and communication matters, and its Transport Division has jurisdiction over both marine and air transport. Land transport, on the other hand, is under the jurisdiction of the Ministry of Public Works.

Air services are operated by a public corporation, the Airline of the Marshall Islands, which comes under the supervision of the Ministry of Transportation and Communications.

In the area of marine transport, this Ministry, as already noted, operates the 5 inter-island vessels and is, in addition, directly responsible for marine transport administration, including infrastructure.

Since the subject Plan is designed to improve the Old Dock, which serves as the hub for the inter-island fleet, the Transport Division of this Ministry is to be charged with its implementation. This Division is headed by a Deputy Director, and its staff includes the crew members manning the inter-island vessels. Its offices, including the stevedoring and passenger service offices and the port administration office, are ideally situated in terms of managing the Old Dock facility.

However, the organizati n that will be in charge of maintaining the new facility after its completion under this Plan will, as in the case of land transport, be the Ministry of Public Works.

3.5.2 Summary of Plan Facilities

Following is a summary of the facilities to be provided under this Plan:

1. Engineering facilities:
    - (1) Mooring Docks:
        - 1) Dock for use by the inter-island fleet
        - 2) Dock for use by foreign fishing vessels
        - 3) Dock for small fishing and cargo boats
        - 4) Auxiliary facilities
    - (2) Work apron
    - (3) Landing ramp for small boats

2. Shore facilities:
    - (1) Warehouse
    - (2) Passenger waiting area
    - (3) Road surfacing

3. Attached facilities:
    - (1) Power facilities:
        - 1) Outside lighting
        - 2) Power supply for delivery to vessels
    - (2) Water supply and drainage facilities:
        - 1) Water supply to vessels
            - .Inter-island vessels
            - .Small fishing and cargo boats
        - 2) Water supply for general use
    - (3) Fueling facilities:
        - Pit for piping use
        - Fueling facility for small fishing and cargo boats

CHAPTER 4 BASIC DESIGN

4.1 Basic Policy

In connection with the implementation of the Project for Reactivation of Damaged Old Dock, after considering the background and nature of the request, the natural environmental conditions, and the state of the fishing and other industries in the subject area as well as social conditions, we have developed a Basic Design based on the following guidelines:

(1) The details of the Plan have been formulated with a view to maintaining the present functions of the facilities and supplmentary facilities that would be required. In setting the scope of the Plan, we have made suitable demand forecasts so that, after completion, maintenance can be held to a minimum. However, the Plan has been designed to insure that any future expansion would be fully compatible with the existing facilities.

(2) The plan gives due consideration to the topography, oceanography and climate at the plan site.
The facilities thus meet the climatic conditions in the area and harmonize well with the surrounding environment.

(3) The Plan has been coordinated with the developmental plans for the plan site area, particularly those for the shore line, which is related to the subject Plan, by taking into consideration the objectives and nature of these other plans.

(4) With regard to the construction plan, we have chosen buildings, materials, and construction methods in the light of building conditions in the area and plan to utilize, wherever possible, local labor and construction equipment so as to provide a stimulus to the local economy through this construction program.

(5) With regard to building laws, regulations, and standards, we have, with the full consent of the Marshall Islands Government, confirmed to the following policies:

--- Japanese laws and standards will be followed in connection with the engineering work and building design.

--- In connection with electrical and plumbing installations, we shall follow the applicable laws and standards of the Marshall Islands.

4.2 Determination of Facility Scope

4.2.1 Engineering Facility

(1) Basic Conditions:

We have established the following basic conditions in determining the proper scale of the subject facilities:

1) Vessels to be Served by the Facilities:

Since the subject facilities are to carry on the functions of the Old Dock, we have assumed that the vessels using the dock will continue to be inter-island vessels, foreign fishing vessels, oil tankers and small fishing and cargo boats.

2) Mooring in Port

The inter-island vessels make about 8-10 trips each year. They carry an average of 114 R/T per voyage, which leaves ample leeway in the 500 m^3 storage capacity of three Micro-class vessels. Thus, even if the volume of cargo were to expand in the future, we do not believe that there would be any necessity to increase the number of trips in the short term. We have, therefore, used 1986/1987 data to estimate mooring days in port.

With respect to port calls by the foreign fishing vessels, we have concluded that, for the foreseeable future, the present pattern will continue. Accordingly, we have also set the days in port for these fishing vessels on the basis of 1986/1987 figures.

The usage patterns for the small fishing and cargo boats were given in Section 3.3. It can be presumed that there will be an increase in the number of small boats using the new facility as a result of the new berthing areas to be provided specifically for these boats. Since our Plan is, in principle, intended to eliminate present inadequacies, any future growth in demand would have to be met through the facilities planned for the area behind the subject facilities. Accordingly, for purposes of the present Plan, we have anticipated that the new dock will be used by 100 small cargo boats per month and by 10 small fishing boats per day (as at present).

3) Frequency of Port Calls

Table 4.1 shows the total number of vessels per day calling at the Old Dock in 1986/1987, combining inter-island vessels, foreign fishing vessels, and other vessels.

Table 4.1 Frequency of Port Calls at the Old Dock

Number of Vessels Per Day	Days per Year			
	1986	1987	Average Per Year	%/Cumulative %
0	0	6	3	0.82 / 0.82
1	8	25	16.5	4.52 / 5.34
2	48	48	48	13.15 / 18.49
3	80	69	74.5	20.41 / 38.90
4	121	101	111	30.41 / 69.31
5	66	64	65	17.80 / 87.11
6	29	33	31	8.49 / 95.60
7	10	13	11.5	3.15 / 98.75
8	3	6	4.5	1.23 / 99.98

(2) Required Number of Berths

1) For Inter-island and Foreign Fishing Vessels

Berthing requirements for the target vessels have been set on the basis of arrivals during 1986 and 1987. We first calculated the required number of berths on the basis of three criteria:

a) a simple average of arrivals over the 2-year period;

b) an average of the 10 months with the largest number of calls; and

c) an average of the 10 months with the smallest number of calls.

After making a comparative evaluation of the above figures, we have set the optimum number of berths on the basis of an overall judgement.

The number of days spent in port per month by the inter-island and foreign fishing vessels during 1986/1987 were as shown in Table 4.2.

Table 4.2 Time Spent in Port by Inter-Island and Foreign Fishing Vessels

	Inter-island Vessels				Foreign Fishing and Other Vesels	Total	Ranking by Month
1986:	No. of Trips	Days Tied up	Loading/ Unloading Days	Sub-Total (Vessel Days)	(Vessel Days)	(Vessel Days)	
Jan.	3	107	15	122	13	135	6
Feb.	4	53	22	75	16	91	22
Mar.	5	65	31	96	57	153	1
Apr.	5	46	30	76	35	111	16
May	4	86	20	106	9	115	13
Jun.	3	70	25	95	20	115	13
Jul.	2	99	17	116	18	134	7
Aug.	3	103	16	119	19	138	4
Sep.	3	69	24	93	12	105	18
Oct.	3	96	19	115	17	132	8
Nov.	2	85	17	102	18	120	10
Dec.	5	40	32	72	5	77	23
	42	919	268	1,187	239	1,426	
1987:							
Jan.	2	103	17	120	25	145	3
Feb.	3	99	15	114	33	147	2
Mar.	3	77	19	96	41	137	5
Apr.	5	48	44	92	30	122	9
May	5	44	21	65	31	96	21
Jun.	5	25	28	53	19	72	24
Jul.	1	90	16	106	12	118	11
Aug.	5	63	29	92	22	114	15
Sep.	3	82	21	103	15	118	11
Oct.	6	59	27	75	34	109	17
Dec.	6	58	25	83	17	100	19
	47	796	288	1,084	294	1,378	
Annual Average	44.5	857.5	278	1,135.5	266.5	1,042	
Monthly Average	3.7	71.5	23.2	94.6	22.2	116.8	

(a) Calculation based on the annual average

The average number of vessel-days spent in port per month by inter-island and foreign fishing vessels during 1986/1987 totaled 116.8, broken down as follows.

Inter-island:	tied up in port	71.5
	loading/unloading	23.2
Foreign fishing:		22.2

On this basis, the required number of berths becomes:

For tying up:	71.5/30 days = 2.38 berths
For loading/ unloading:	23.2/30 = 0.71
For fishing vessels:	22.2/30 = 0.73
Total berths:	116.8/30 = 3.89

(b) Calculations based on the 10 busiest months

If we next take average days in port for the 10 busiest months during 1986/1987, we obtain a total of 130.3 vessel days, broken down:

Inter-island:	tied up in port	82.2
	loading/ unloading	21.0
Foreign fishing:		27.1

The required number of berths then becomes:

For tying up:	82.2/30 = 2.74 berths
For loading/ unloading	21.0/30 = 0.70

For fishing
vessels: 27.1/30 = 0.90

Total berths: 130.3/30 = 4.33

(c) Calculations based on the 10 slowest months

If we now take the average days in port for the 10 slowest months during the 1986/1987 period, total vessel days in port becomes: 97.5, broken down:

inter-island:	tied up in port	50.5
	loading/unloading	26.4
foreign fishing:		20.6

Accordingly, the required number of berths becomes:

For tying up: 50.5/30 = 1.68 berths

For loading/
unloading: 26.4/30 = 0.88

For fishing
vessels: 20.6/30 = 0.69

Total berths: 97.5/30 = 3.25

Based on the calculations for the 10 busiest months (b), it seems that, if we allow one berth each for loading and unloading inter-island vessels and refueling foreign fishing vessels, the dock facilities for these purposes should not be overtaxed.

The number of berths for inter-island vessels tied up in port comes to 2.38 under assumption (a) and 2.74 under (b). Even under minimum usage conditions (c), 1.68 berths would still be required.

Based on the maximum use calculation (b), the total number of required berths would be 5, with 4 berths needed under the minimum use projection (c). Under present usage patterns at the Old Dock, when arrivals exceed berthing capacity, the problem is overcome by double berthing, off-shore mooring, and diversion to the New Port. Under the subject Plan, if we allow one berth each for the loading and unloading of inter-island vessels and for foreign fishing vessels and another berth for inter-island vessels tied up in port, for a total of 3 berths in all, 38.9% of the total vessel days (as per the "Frequency of Port Calls" table) could be accommodated by direct berthing. If we allow for double berthing, 6 vessels could be moored at any given time, which would then accommodate 95.6% of total arrivals, with a less than 5% overload factor. We deem it appropriate, therefore, to allocate a total of 3 berths under this Plan.

2) For Small Fishing and Cargo Boats

About 10-20 small fishing vessels per day use the Old Dock. But, since their hours of sailing and returning to port are irregular and some 30 minutes are required on the average to load or unload each vessel, a minimum of one berth must be provided for these small fishing boats.

Since there are no suitable mooring facilities at the present Old Dock, most of these boats must be beached for extended stays. Moreover, in view of the lack of a launching ramp at this port, this beaching operation must be performed elsewhere. If, however, moorage facilities were provided at the refurbished Old Port, it may be estimated that a quarter to a half of the vessels using this dock could be accommodated. Accordingly, we have provided, under this Plan, for docking space for 5 boats-- some 25% of maximum usage--, broken down into: 1 berth for discharging cargo and 4 for tying up in port.

Some 10-15 small copra boats from the nearby islands also utilize the Old Dock, making 5-6 trips a month each. Thus, on the average, 2-3 vessels of this type will be in port on a given day.

Under the present usage pattern, cargoes are unloaded on the day of arrival; provisions are taken on and the boat departs the following day. Since the vessel stays at the dock for almost a full day, 3 berths will be required: one for loading and unloading and two for mooring. After giving due consideration to operating efficiency and safety, we have specified a floating dock for the unloading dock.

(3) Determination of Dock Lengths

1) Docks for the Inter-island and Foreign Fishing Vessels

Both the inter-island and foreign fishing vessels dock alongside the pier. We have assumed an average vessel length of 56 m for the inter-island and 35 m for the foreign fishing vessels. The required safety margin will depend on whether the vessels dock singly or in tandem but, figuring that the angle between mooring ropes from bow and stern and the dock face will be a typical 30-45 degrees, it will be sufficient to provide a safety margin of 6-20% in calculating total dock length.

The required unit dock length for inter-island and foreign fishing vessels may be calculated as follows:

Inter-island:

56 m (vessel length)	x	1.06 - 1.20 (safety margin)	= 59.36 - 67.2 m

Foreign fishing:

35 m (vessel length)	x	1.06 - 1.20 (safety margin)	= 37.1 - 42.0 m

From the above, the required dock length becomes:

(59.36 - 67.2 m) x 2 + (37.1 - 42.0 m) = 150.42 - 176.4 m
(inter-island) (No. of vessels) (foreign fishing)

2) Docks for Small Fishing and Cargo Boats

The small fishing and cargo boats also dock along-side the pier. We have set an average length of 8 m for the former and 12 m for the latter, with a safety margin of 10-15%.

The required dock length to serve these boats is calculated as follows:

Small fishing boats:

8 m (length) x 1.10 - 1.15 (safety margin) = 8.8 - 9.2 m

Small cargo boats:

12 m (length) x 1.10 - 1.15 (safety margin) = 13.2 - 13.8 m

Accordingly, the required dock length becomes:

(8.8 - 9.2 m) (fishing boat) x 5 (no.) x (13.2 - 13.8 m) (cargo boat) x 3 (no.) = 83.6 - 87.4 m

(4) <u>Determination of Depths and Crown Heights</u>

We have established design depths by adding a safety margin over and above the full-load draft of vessels using the docks.

The load drafts of the target vessels are: 3.6 m for inter-island, 3.2 m for foreign fishing, 6.89 m for the Mobil Oil tanker, 0.5 m for small fishing boats, and 1.3 m for the small cargo(copra) boats. The generally accepted safety margin is 0.5-1.0 m. Accordingly, the maximum depths become: 7.4-7.9 m for the tanker, 5.1-5.6 m for the inter-island vessels, and 3.7-4.2 m for the foreign fishing vessels.

With respect to crown heights, we have set these on the basis of standard values in "Technical Standards for Pier Facilities" (Japan Port and Harbour Association, 1979), as shown in Table 4.3.

Table 4.3 Crown Height of Mooring Dock

	Tidal Variation	
	3.0 or more	Below 3.0 m
Moorage for large vessels (4.5 m depth of more)	0.5 - 1.5 m	1.0 - 2.0 m
Moorage for small vessels (less than 4.5 m depth)	0.3 - 1.0 m	0.5 - 1.5 m

Since the total tidal variation in Majuro Port is less than 2.0 m, based on the depths in the moorage areas, we have set the crown height at 0.5-2.0 m.

(5) Determination of Work Apron Width

Based on the "Technical Standards for Port Facilities" in Japan, the apron width should take into account usage patterns at the moorage, the types of buildings and warehouse, the types of stevedoring equipment, and the extent of transportation facilities near the port and should be set so as to ensure safe and smooth stevedoring operations.

We have considered the standard values used in relation to berthing depth, as set forth in Table 4.4.

Table 4.4 Standard Values for Apron Width

Berthing Depth (m)	Apron Width (m)
Below 4.5	10
4.5 - 7.4	15
7.5 and over	20

We have, accordingly, planned the apron width at 10-20m, based on berthing depths.

(6) Landing Ramp for Small Fishing Boats

This ramp is to be used by small fishing boats with an average length of some 8 m. At present, beaching operations are performed using mostly small vehicles (such as a pick-up truck), and so, if we are to beach the boats in the same way, the required width of the landing ramp must be based on (a) (the width of the vehicle + safety allowance) or b) (the width of the vessel + safety allowance), whichever is larger:

Vehicle width (approx.)	1.7 m
Vessel width (")	2.0 m
Safety margin (for both)	1.0 m

Accordingly, the required ramp width has been set at:

$$\underset{\text{(vessel width)}}{2.0} + \underset{\text{(safety margin)}}{1\ m} \times 2 = 4\ m$$

The gradient of the ramp has been set at 1:6 on land and 1:4 in the water.

4.2.2 Shore Facilities

(1) Required Floor Area for the Warehouse

The main items to be stored in the warehouse will be cargo to be loaded aboard the inter-island vessels just prior to sailing. The total volume of cargo loaded aboard these vessels at Majuro in 1987 totaled 5,353.8 R/T. The maximum amount loaded for a single voyage was 399.28 m^3, with an average of 114 m^3 for all 47 trips.

In order to eliminate current inconveniences and ensure that the warehouse is able to accommodate peak loading requirements, we have based our calculations on the trips carrying the largest loads. The average amount of cargo carried on the top 10 trips was 287 m^3 during 1987, and this has been designated as the target volume to be handled by the warehouse.

Table 4.5 in the following page shows the volume of cargo and number of passengers handled by inter-island vessels during 1987.

Cargo entering the warehouse in the Old Dock can be classified into: foodstuffs, general merchandise, cement, concrete blocks, and other. At present, foodstuffs, general merchandise, and cement are stored within the existing warehouse, but other items are stored outside. The ratio between inside and outside storage, while slightly weighted to the latter, is approximately equal and so, for Plan purposes, we have assumed that the volume to be stored in the new warehouse will be half of the total volume handled:

$$287\ m^3 \times 0.5 = 143.5\ m^3$$

Based on present conditions, where--

Table 4.5 Cargo and Passenger Carried by Inter-island Fleet (1987)

Vessel	Voyage No.		Outbound Passenger	Cargo (R/T)	Inbound Passenger	Copra (S/T)	
MS Micro Chief	1		65	40.60			
''	2		108	93.74			
''	2	Cont.	0	15.10	108	176.38	
''	3		107	128.72	33	9.08	
''	4		28	130.80	53	223.28	
''	5		83	230.97	128	68.38	
''	6		86	5.43	47	127.92	
''	7		214	194.90	129	155.57	
''	7	Cont.	236	33.92			
''	7		269	74.42	89		
''	8		63	40.19	51		
''	9		79	137.64	90	152.16	
''	10		106	58.31	76		
	13		1,444	1,184.74	804	912.77	
MS Micro Pilot	1		33	198.38	82	72.46	
''	2		36	66.30	63	280.89	
''	3		65	140.52	84	10.44	
''	4		110	37.52	178	164.01	
''	5		179	163.41	104	73.29	
''	6		169	325.81	138		
''	7		28	58.74	6		
	7		620	990.68	655	601.09	
MS Micro Palm	1	Sp.					
''	2		90	204.32	157	77.75	
''	2	Cont.	60	134.57			
''	3		178	79.86	150	34.41	
''	4		88	26.44			
''	5		102	312.03	88		
''	5	Cont.	51	13.35	19		
''	6		11	2.96	259		Sp. to KOS
''	7		26	23.80	10		
''	8		259	56.92			Sp. to KOS
	10		865	854.25	683	112.16	
MS Militobi	1		72	313.80	68	270.27	
''	2		6	17.74	3		
''	4		96	53.21	78	65.50	
''	5		179	30.30	271	140.88	
''	5	Cont.	6	5.11			
''	6		84	45.53	11	101.60	
''	6	Cont.	5	6.80			
''	7		44	27.51	62	101.88	
''	8		46	88.08	102	130.10	
	9		538	588.08	595	810.23	
MS Ailin Kein Ad	1		35	382.85	68	62.94	
''	2		21	167.84	52	77.77	
''	3		36	399.28	164	61.07	
''	4		128	132.53	103		
''	4	Cont.	62	78.21	76		
''	5		77	274.33	60	261.43	
''	6		45	68.30	63	16.43	
''	7		34	232.71	60		
	8		438	1,736.05	646	479.64	
TOTAL	47		3,905	5,353.80	3,383	2,915.89	

... the goods are moved by forklift,

... they are stored to a height of 2.0 m,

... and the storage factor is 50%,

the required floor area become:

$$143.5\ m^3 \times \frac{1}{2.0m} \times \frac{1}{0.5} = 143.5\ m^3$$

Comparing this figure with the standard value in Japan, we may then calculate the floor area according to the general expression for measuring the required area of a warehouse, as contained in the Japanese design materials on building design:

$$A = \frac{a}{b \times c \times d}$$

$$= \frac{5,353.8}{20-25} \times 0.5 - 0.7 \times 1 - 2 = 152 - 535.38\ (m^2)$$

where;

A; Required area (m^2)

a; Volume of cargo per year (ton/yr.)

b; Annual cargo turnover (times/yr.)

c; cargo storage ratio

d; storage volume per unit area (ton/m^2)

Setting the volume of cargo to be accommodated within the warehouse at half of the total cargo volume, the required floor area becomes 76 - 268 m2. And, since the area obtained from the volume of goods handled falls just below the midpoint of the range obtained using the general expression, we feel this is an appropriate value and so have set the floor area at about 140 m^2.

We have provided a separate area for specialty products, such as tobacco and liquor, to permit these to be stored separately from foodstuffs and general merchandise, along with a room to serve as the warehouse office. Specialty products are shipped in cardboard or wooden containers with cubic measurements of 600 (W) x 450 (L) x 400 (H) mm. These items are to be stored in shelves, with a capacity of about 50 cases, which corresponds to the average volume carried per vessel. Should the quantity exceed the above limit, the surplus items can be stored on the floor.

Four shelves will be required, with each accommodating 4 containers piled in 3 layers. Allowing for proper floor space, the required plane area for the shelves will be approximately 14 m^2.

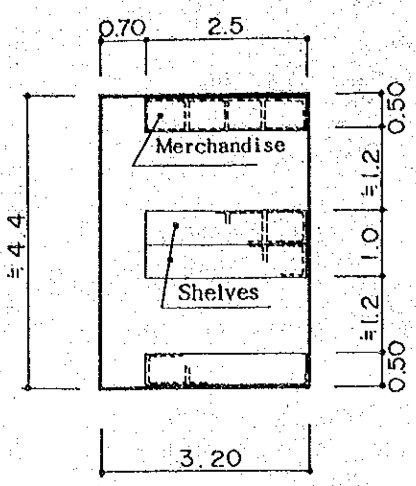


Fig. 4.1 Storage Area for Speciality Products

The management office will be the area from which the receipt and dispatch of merchandise is coordinated. The furnishings should include a desk, chair and cabinets. One administrative personnel will occupy this office and, allowing for space for moving and furnishings, the total required floor area will be 14 m^2.

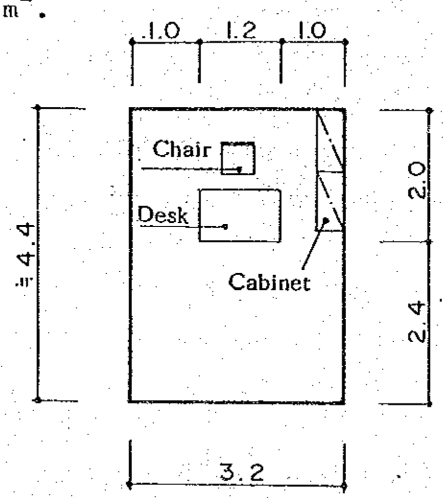


Fig. 4.2 Plan for Warehouse Office

Based on a floor plan that takes into consideration the functions of the warehouse and the flow path for each area, we have set the total required floor area at 140 m^2.

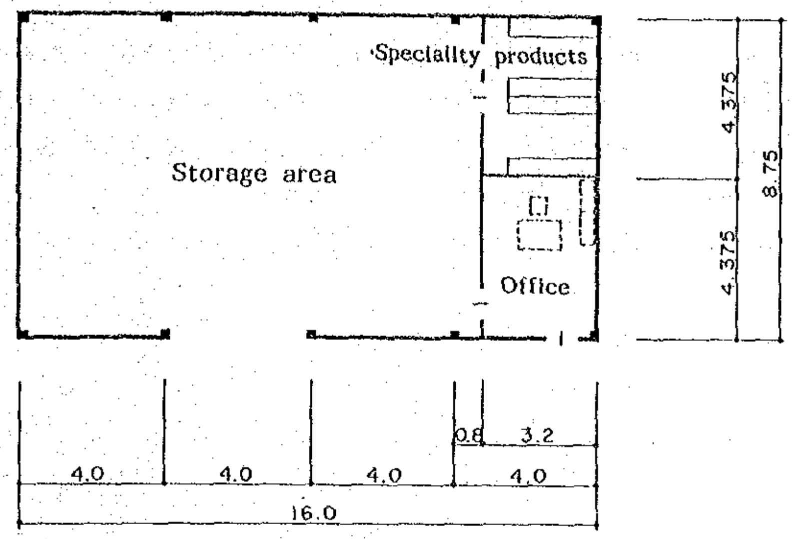


Fig. 4.3 Warehouse Plan

(2) <u>Area of the Passenger Waiting Facility</u>

During 1987, 4,008 passengers were carried from Majuro on the inter-island vessels, with the average per sailing of 85 and a peak of 269. As in the previous section, we have based the requirements on an average of 192 passengers for the 10 peak trips during that year. However, since the bulk of the passengers appear to reside in areas nearby the Dock, a waiting area may not be required for such persons. Thus, the total area of the facility need not be based on the full 192 passenger average. We have, therefore, used a figure of 40 passengers, slightly more than 1/5 of this total, and have assumed that these passengers will be seen off by another 10 persons, for a total of 50 persons in all to be accommodated in the waiting area. Based on the following layout, we have set required floor area of the waiting area at 85 m^2.

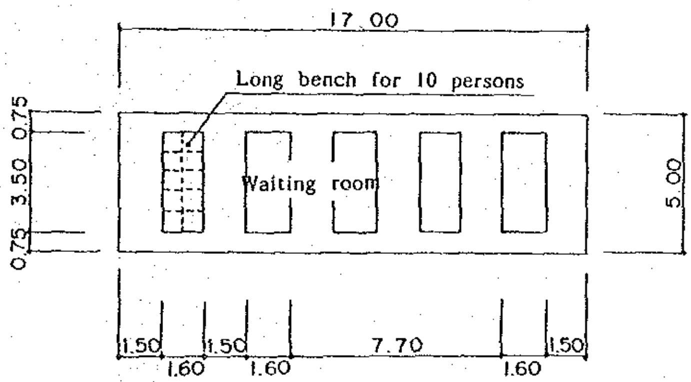


Fig. 4.4 Plan for Waiting Room

We have been guided by Japanese standards in setting the number of sanitary fixtures and the floor area for the rest room. Assuming use by 50 persons, equally divided between male and female, we have specified 2 toilet seats each for the men's and ladies' compartments, 2 urinals, and 2 wash basins in each section. Based on the following layout, we have set the required floor area of the rest room at 25 m^2.

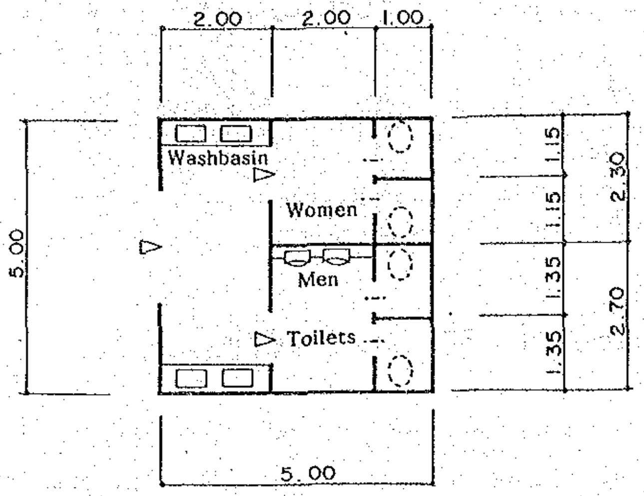


Fig. 4.5 Plan for Toilet

Preparing now a floor plan based on the above requirements, the total floor space of the waiting facility becomes approximately 110 m^2.

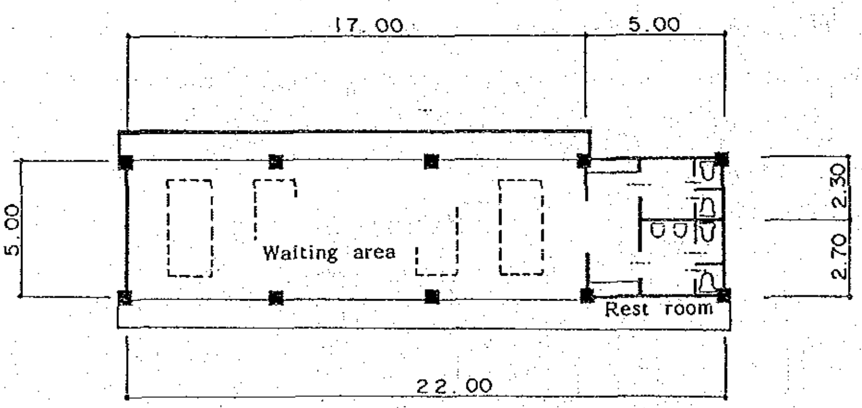


Fig. 4.6 Passenger Waiting Facility Plan

(3) <u>Paving Area of the Access Road</u>

About 175 m of road must be paved, extending from the work apron on the dock to the main road. The width of this access road has been set at 6 m, which should permit 2 transport vehicles to pass each other. Basing our calculations on the access road leading to the existing warehouse facility, we have set the required paving area at 1,100 m^2.

4.2.3 Attached Facilities

The attached facilities will include fueling facilities, water supply and sewage facilities, and electrical facilities.

(1) Fueling facilities

1) Fueling facility for inter-island vessel

Two 6" pipes are laid from the oil tank owned by Mobil to the Old Dock. One pipe is for gasoline and diesel fuel and is used both for receiving fuel from tankers and supplying fuel to the vessels. The other pipe is exclusively reserved for bringing jet fuel from tankers to the storage tank. The pipes run partly on elevated base and partly in concrete pit.

The fuel is supplied to the vessels through a hose extension to the lead valve on the dock. Based on discussions with Mobil Oil, which is responsible for the operation, maintenance and construction of fueling facilities, it has been established that the two existing 6" pipelines will be adequate, so that new pipe construction will not be necessary. In the subject Plan, we have provided sufficient space to ensure safety in the pipe arrangement. From the standpoint of safety and maintenance, pipes within the work apron area will be laid in a pit.

2) Fueling facility for small fishing and cargo boats

a) Gasoline dispenser

Users of this facility will be small fishing boats equipped with outboard motors. At present, 10 to 20 boats are using the Old Dock per day, and their fishing days run to 1 - 2 days. An increased number of fishing boats are expected to use the new dock facilities after its completion and we therefore take 20 boats as the base for determining facility capacity. The target number of boats to use fuel dispenser per day thus comes to the following number.

20 boats x 1 / 2 days = 10 boats / day
(no. of boats) (no. of refuels)

Volume of gasoline consumed by one fishing operation has been calculated from the following conditions.

Average milage	30 n.m.
Average speed	8 kt
Engine output	70 ps
Fuel consumption rate	6.6 gal./hr

30 n.m. / 8 kt (running time) x 6.6 gal. (consumption rate) = 24.75 gal./operation

The daily volume of gasoline consumption is estimated for 10 boats as follows.

24.75 gal. x 10 boats = 247.5 gal.

Gasoline is transported by a tank lorry to the dispenser. In Majuro, fueling station for vehicles is normally filled once a week by tank lorry, but in this Plan, the storage tank must be placed on the work apron which can allow only limited area for facility installation and, due to tie-rods existing underground, makes the underground installation of the storage tank difficult. Small tank capacity is preferable also from the standpoint of security. Therefore, the storage capacity has been calculated on twice a week tank lorry service plus 10% margin.

250 gal. x 7 days / 2 times x 1.1 = 962.5 gal.
= 1,000 gal.(rounded)
(approx. $4m^3$)

b) Diesel Oil Dispenser

The target boat for this facility is the small cargo boat that carries copra and daily necessities between Majuro and Arno and Mili atolls. Fuel consumption per one voyage has been estimated under the following conditions.

Average milage	85 n.m.x 2(round trip to Mili)
Average speed	8 kt
Engine output	60 ps
Fuel consumption rate	4 gal./hr

$$85 \text{ n.m.} \times 2 \ / \ 8 \text{ kt} \times 4 \text{ gal.} = 85 \text{ gal.}$$

(running time) (consumption rate)

As the average number of small cargo boats calling Old Dock is 3 vessels per day, we calculated the total required volume of diesel oil as follows.

$$85 \text{ gal.} \times 3 \text{ vessels} = 225 \text{ gal.}$$

Required storage volume has been set following the same principle established for that of gasoline as described above.

$$255 \text{ gal.} \times 7 \text{ days} \ / \ 2 \text{ times} \times 1.1 = 981.75 \text{ gal.}$$

$$=1{,}000 \text{ gal.(rounded)}$$

(approx. $4m^3$)

(2) Water Supply and Sewage

1) Water supply

Water must be supplied primarily to vessels at the Dock, the rest room in the waiting area, and to fire hydrants. The water for inter-island vessels and for general use in the passenger waiting facility will be carried via branch pipes from the main pipe running along the trunk road. For small fishing and cargo boats, rain water will be supplied from the water catchment tank. Water for toilet flush and fire hydrant is supplied from branch pipe connected to the sea water main pipe recently completed.

Vessels receiving the water directly from the water main pipe will be mainly inter-island vessels, which are equipped with fresh-water tanks of about 58 tons. The target delivery time, corresponding to that for fueling operations, has been set at about 2 hours, at a rate of 51 liters per minute.

A watermain pipe is laid under the main road, meeting the access road at a right angle. There is a distance of about 175 m from the junction point to the proposed dock.

Rain water is supplied to small fishing and cargo boats. The number of boats and their cruising days are the same as set for fueling facility. As the number of crew, we use average number of 3 persons for fishing boats and 10 persons for cargo boats.

Daily water requirements by these boats are estimated at 10 gal. per person, following the U.S. Public Health Service standard of 8 gal. per day for drinking water, plus 2 gal. for miscellaneous use. The rain water volume consumed per day is calculated as follows.

	Consumption per person	No. of person	No. of vessel	Cruising day	Total
Fishing boat	10 gal.	3	10	2	600 gal.
Cargo boat	10 gal.	10	3	2	600 gal.
				Total	1,200 gal.

Average daily rainfall in Majuro is 10 mm. The expected water catchment volume from the warehouse roof is approximately 2.0 m^3 (528 gal.) per day. This volume corresponds to 44% of the daily required volume and clearly shows the need for additional supply by a water tank lorry. We have set the water catchment tank capacity at 2,500 gal. (approx. 10 m^3), considering volume for 2 days' reserve and frequency of lorry supply plus a certain level of margin.

2) Sewage

Sewage systems at the Plan facility are classified into 3 types: soil water, waste water, and rainwater drainage.

Since the sewer main pipe construction in Majuro is expected to be completed by the end of 1988, soil water will be disposed of through the soil water pipe connecting to the sewer main pipe. Waste water will be treated by a seepage tank and rainwater will be released directly into the sea in front of the facility.

(3) Power Facilities

As in the case of the water mains, there is an overhead 13,800 V. high voltage power transmission lines along the main road. Lights are provided along the causeway but there are none in the area of the work apron on the dock.

We have planned the above facilities to make them both simple and effective, avoiding the use of materials that are complicated to handle or require maintenance. In the interest of easy maintenance, we have specified, to the maximum possible extent, standard materials and products which are in relatively common use in Majuro and so readily available. We have also given careful consideration to accommodating possible future expansion of the facilities or modifications in the use plan.

The main power supply facilities will include lighting for the work apron and causeway and outlets for hook up to vessels at the dock and for supplying power to the warehouse and passenger waiting area.

Power will be brought in from the 13,800 V, 60 Hz high voltage overhead transmission line running along the main road and stepped down, via pole-top transformers, for delivery to the main power distribution board. The various receiving facilities will receive power through branch outlets. In principle, the trunk lines to the various facilities will be buried and distributed within the various locations in PVC pipes. The power system will be divided into one for the lighting outlets and another for supplying power to vessels.

1) Lighting Outlets

Lighting fixtures in the buildings will be mainly fluorescent, supplemented by incandescent ones, as required. The outdoor lighting in the work apron area and along the causeway will use mercury lamps. Brightness values in the main facilities have been set as follows:

Office	300 Lx
Waiting Area	300
Warehouse/restroom	100
Causeway and apron	10

The lighting fixtures will be anti-corrosive treated. Load voltages will be 120 V, 60 Hz, the prevailing standard in Majuro.

2) Power supply to vessels

We will provide a power connection board for vessels in the apron area. Power consumption by the inter-island vessels, which are to be the primary users of this facility, is a maximum of 50 KVA for Micro-class (790 ton) vessels. In this Plan, the target facilities will be vessel lighting, refrigerators, and galley equipment. Loading cranes will be powered by the vessel's auxiliary engine. The power capacity will be 30 KW/vessel, serving 2 inter-island vessels at a time. Power supply will be 3-phase, 440 V, 60 Hz.

The respective loads within the Plan facilities have been calculated as in Table 4.6.

Table 4.6 Required Power Load

Equipment to be Served	Rated Capacity (kw)	Day Time		Night Time	
		Estimated Use Ratio	Use Load (kw)	Estimated Use Ratio	Use Load (kw)
Outside lighting	4.0	-	-	100 %	4.0
Indoor lighting	2.6	10%	0.26	100 %	2.6
Power outlets	6.0	10%	0.50	10 %	0.5
Vessel Power	30 x 2	100%	60.00	100 %	60.0
TOTAL	71.6	86%	60.76	92 %	67.1

The maximum load is estimated at 67.1 KW.

4.3 The Layout Plan

4.3.1 Placement of Docks and Norm Line

We have determined the dock locations and norm line on the basis of the following guidelines, taking into consideration both the natural environment and development plans in the immediate vicinity.

(1) Conformity with Land Use Plans

Based on our depth measurement data, the waters to the north of the Plan site are not of adequate depth to receive medium-large sized vessels. In order to permit such vessels to use the dock, a major dredging operation would be required, which is why these waters have been positioned in the land development plan as a mooring area for small-size vessels only.

It will, therefore, be desirable to set the norm line of the dock from southeast to northwest, with an extension direction to the northwest side, and thereby secure the maximum possible area of calm water for the small vessels moored behind this extension. The southeast side has been positioned for later expansion of the facility in the event that the future dock extension were to prove inadequate.

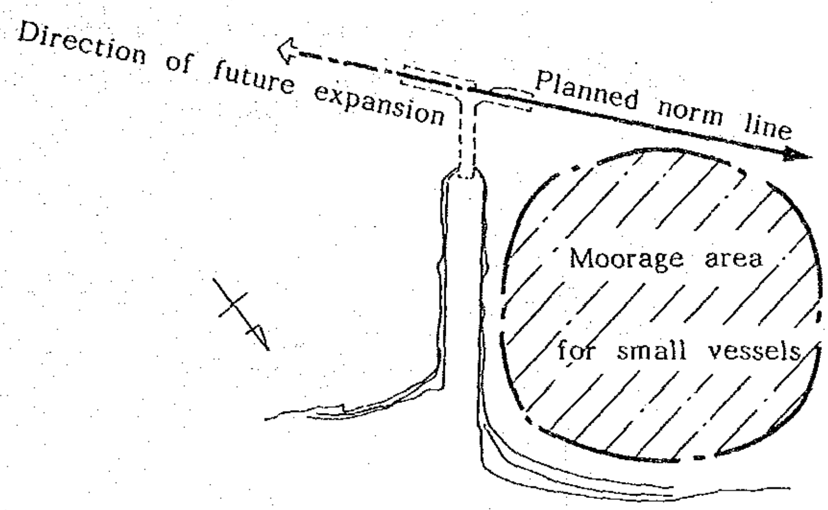


Fig. 4.7 Placement of Dock

(2) Environmental Considerations

Oceanographic and meteorological conditions (wind, waves, tides, etc.) have a major influence on vessel operation and moorage, while the topography of the ocean bottom, drift sand, and silting are highly relevant to dock design and construction. Accordingly, dock placement has been planned with due regard for the above conditions.

1) Prevailing wind direction

With regard to wind, the location has been chosen in such manner that the prevailing winds will not come at a right angle with the dock front face. Considering the fact that the prevailing winds in the Plan area are from the NE, the dock alignment should properly be set at SE-NW, with berthing on the SW side. The NE side should be used only by small vessels, which are relatively unaffected by wind. The norm line of the existing dock runs in the same direction.

2) The planned depth has been set at 7.5 m at the main dock.

By placing the norm line of the dock along the 7-8 m line of the topographical chart below, material and construction costs can be reduced, permitting a shortening of the construction period and a more economical construction budget.

If we then place the dock at this 7-8 m depth line, the norm line of the dock must be drawn about 30 m closer to shore at the same angle as the existing dock.

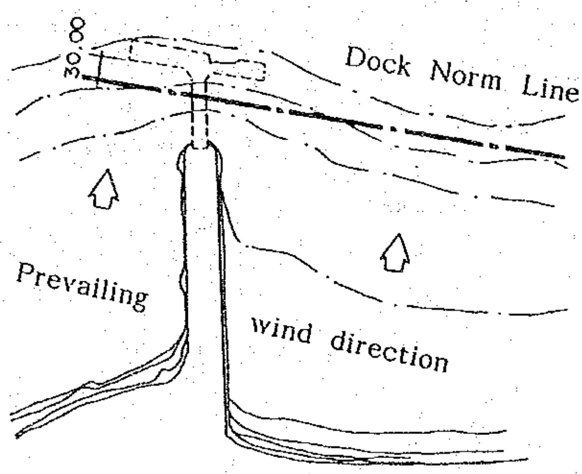


Fig. 4.8 Dock Norm Line and Water Depth

3) Tide, drift sand and siltation

Based on the field survey on the water current at the Plan site, no observations were taken of tidal flow. The sea bottom, based on the samples taken, is of sand-texture with relatively large-diameter particles. Our observations in the area did not reveal any evidence of conspicuous drift sand or silting. We do not foresee therefore the likelihood of major silting developing after completion of the facility.

After determining the dock location and norm direction with the due regard for the above factors, we prepared the following two plans for consideration:

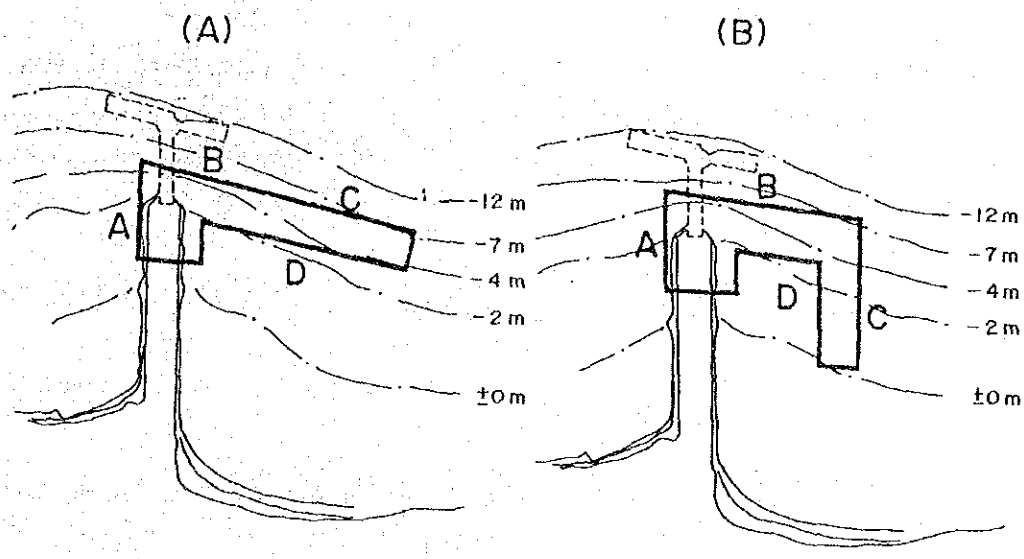


Fig. 4.9 Two Plans under Evaluation

Results of our evaluation:

(1) Under Plan B, since single docking is provided at B and C, the total length is greater than under Plan A.

(2) Plan A provides a wider area of calm water.

(3) Under Plan A, the layout can follow the bottom topography at the required depth.

Based on the above evaluation, we have decided on the layout shown in Plan A.

4.3.2 Facility Layout Plan

The layout of the various facilities has been based, in principle, on the respective functions to be performed. The plan facilities include the dock and a complementary warehouse and passenger waiting area. The dock functions are divided into: refueling, loading and unloading, and the tying up of both inter-island and small vessels. It will be desirable, therefore, to locate the refueling and stevedoring functions as close as possible to the access road. Since the smaller vessels do not require much depth, the layout allows for a floating dock for mooring and loading as well as the construction of a landing ramp.

With regard to the shore-based facilities, the plan locates the warehouse as close as possible to the loading/unloading dock and the passenger waiting area in a safe location that will not hamper stevedoring operations.

(1) Placement of the Engineering Facilities

1) The Dock

Under the Plan, the dock is to run in a SE to NW directional norm, with the loading/unloading and tying up of the inter-island vessels to be done on the SW and the vessels to be docked in tandem.

The northern side will be used for berthing the small vessels in tandem, while, on the east side, foreign fishing vessels will be berthed singly in a NE-SW direction for refueling and reprovisioning. The landing ramp will be positioned in parallel with the causeway.

1) Dock for inter-island vessels

Since this dock is to accommodate 2 vessels berthed alongside in tandem, the required length, including the 6% safety margin, as discussed in Section 4.2.1(3), becomes:

(51 m x 2 vessels) (inter-island vessel)	x 1.06 (safety margin)	=	118.72 m (rounded to 120 m)

Planned depth is set at 7.5 m basing on the draft of the oil tanker which is the largest among the target vessels. The crown height is set at M.L.W.L +3.0 m.

2) <u>Dock for foreign fishing vessels</u>

Since these vessels are to dock singly alongside the dock, a somewhat larger safety factor (12%) will be applied than in the case of tandem berthing. The required length becomes:

35 m (foreign fishing vessel) x 1.12 (safety margin) = 39.2 m, rounded to 40 m

Required depth is 5.0 m as set forth from Section 4.2.1 (4), and the crown height is M.L.W.L + 3.0 m.

3) <u>Dock for small fishing and cargo boats:</u>

a) <u>Small fishing boats</u>

These vessels are to dock alongside and so we are setting a safety margin of 15%. On this basis, the length may be calculated at:

For tying up purposes--

8 m x 4 vessels x 1.15 (safety margin) = 36.8 m (rounded to 40.0 m)

For unloading--

8 m x 1 vessel x 1.15 = 8.8 m (10 m)

b) <u>Small cargo boats</u>

Three vessels are to be moored at a time alongside the dock, with the same safety margin applied as in (a).

Thus,

Tying up-- 12 m x 2 vessels x 1.15 (safety factor) = 27.6 m (30 m)

Unloading-- 12 m x 1 vessel x 1.15 = 13.8 m (15 m)

Required depth is set at -2.0 m.

The dock to be used by these small fishing and cargo boats will be of the floating dock type to permit operations independent of tidal levels. Both sides of the dock can be used freely.

The required length will be 15 m from the overall length of the cargo boats, while the width has been set at 3 m, based on operating and safety considerations.

The crown height is set at M.L.W.L + 3.0 m. However, for ease of accessing to and from small fishing and cargo boats, the upper portion of this side of the dock will be setback configuration.

2) Width of the Work Apron

The standard width of a mooring dock of the class envisaged under this Plan is 10-20 m. Allowing for vehicles to pass from opposite directions and for the temporary placement of cargo as well as a safety margin, we have set this width at 15 m. However, the width of the apron in front of the warehouse will be 24 m in consideration of the 8.75 m required width for the warehouse itself plus a safety margin to the rear.

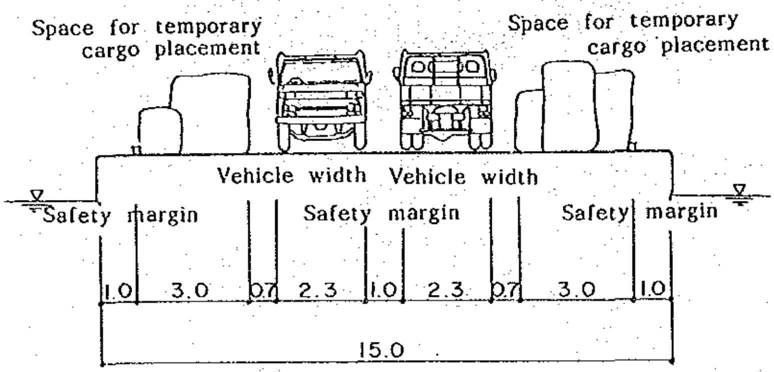


Fig. 4.10 Work Apron Width

3) Landing Ramp for Small Fishing Boats

The width of the landing ramp is to be 4 m; the gradient on land will be 1:6 and, in the water, 1:4; the draft for the small fishing boats is set at 0.4 m and the cradle height at 0.5 m; the depth safety margin is set at 0.1

m, the tide level at ± 0 m, and the crown height for the causeway at +3.0 m. On this basis, the required length becomes:

3 x 6 + 1 x 4 = 22 m

If we then add, as a safety margin, the length of one vehicle (4.7 m), the total length becomes 26.7--rounded to 27 m.

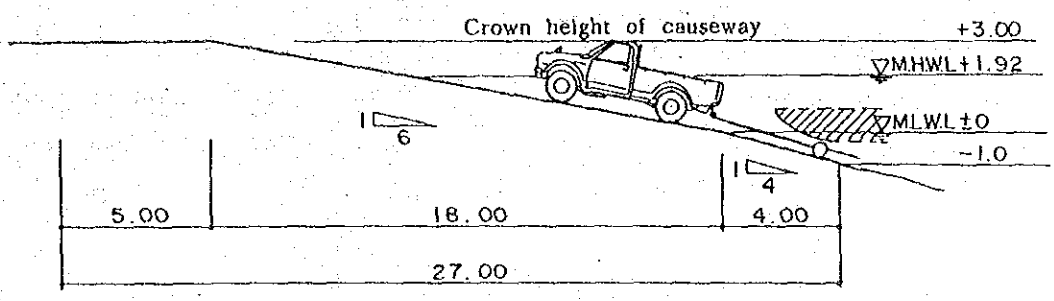


Fig. 4.11 Landing Ramp Length

Based on the above calculations, the overall layout plan for the engineering facilities will be as shown below:

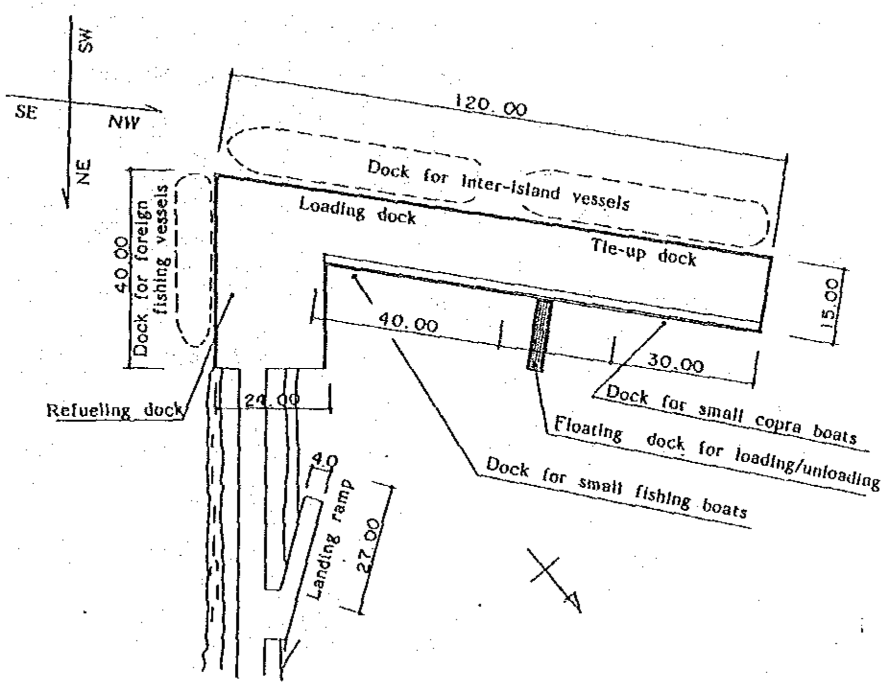


Fig. 4.12 Layout Plan for Engineering Facility

(2) Placement of Shore Facilities

1) Warehouse

The area of the warehouse has been set at 140 m^2. It will be placed on the dock in a NE to SW direction close to the access road for convenient cargo handling. We have allowed 16 m on the long NE to SW side for the materials handling flow and 8.75 m on the short SE to NW side.

2) Passenger Waiting Facility

The required area of the waiting facility has been set at 85 m^2 plus another 25 m^2 for a restroom. The facility is to be located on the base of causeway extension so as to avoid disruption with loading operations and ensure the safety of departing passengers and their parties.

3) Water Catchment and Fuel Oil Tanks

The required area for the water catchment and fuel oil tanks comes to approximately 40m^2, considering space for tank itself, clearance necessary for maintenance and servicing space for water and fuel oil supply. These tanks will be installed outside of the warehouse office, as this location is convenient for the supply of water and fuel oil to small boats as well as for the management of the operations. Furthermore, the water catchment tank must be connected to the eaves gutter of the warehouse roof for collecting the rain water.

The layout plan for water catchment and fuel tanks is as follows.

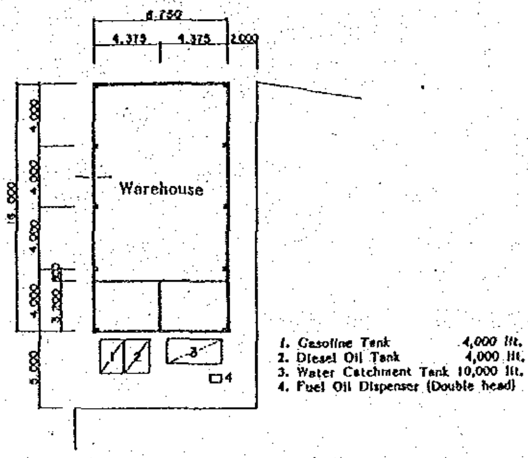


Fig. 4.13 Water Catchment and Fuel Tanks Layout

Based on the above determination, the overall lay-out plan for the shore facilities is as shown below:

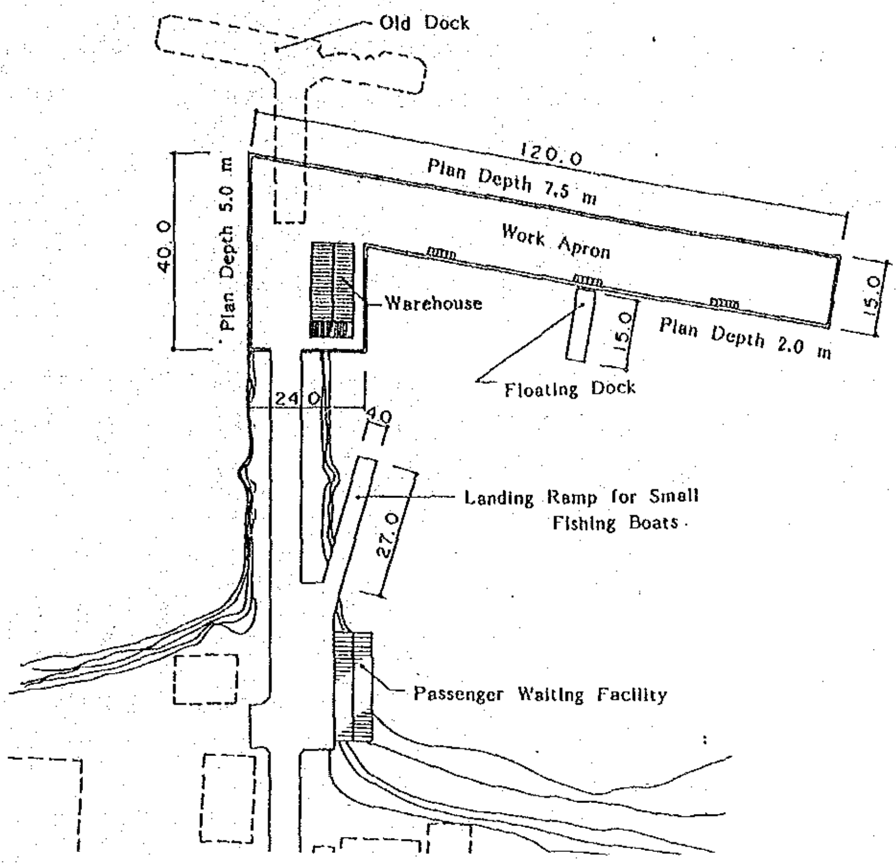


Fig. 4.14 Layout Plan for Shore Facility

4.4 Design of the Engineering Facilities

4.4.1 Determination of the Structure for the Docks

There are essentially four basic structural options for the mooring docks: 1) gravity type; 2) sheet pile type; 3) piling type; and 4) floating dock.

Considering the special characteristics of the various options, we have determined the appropriate structure on the basis of a comprehensive assessment of the construction period and cost, involving a relative examination of a) the natural environment, b) usage conditions, and c) construction conditions.

With regard to the floating dock option, its strengths include: suitability to deep water areas with large tidal variation; relative simplicity of installation and relocation. However, this type of dock has certain drawbacks such as a low resistance to vessel impact and traction force and low cargo bearing capacity. The floating dock is, accordingly, inferior to the other 3 types in terms of flexibility of dock use from the standpoint of vessel moorage, stevedoring operations, and vehicle passage and is also expensive to maintain after completion. We have, therefore, eliminated this type from further consideration.

(1) Diagram of the 3 Remaining Structural Options

After giving careful consideration to the requirements, scale, location plan, and layout plan, for the various facilities, as presented in the previous chapter, we have prepared the following diagram outlining the 3 remaining structural options:

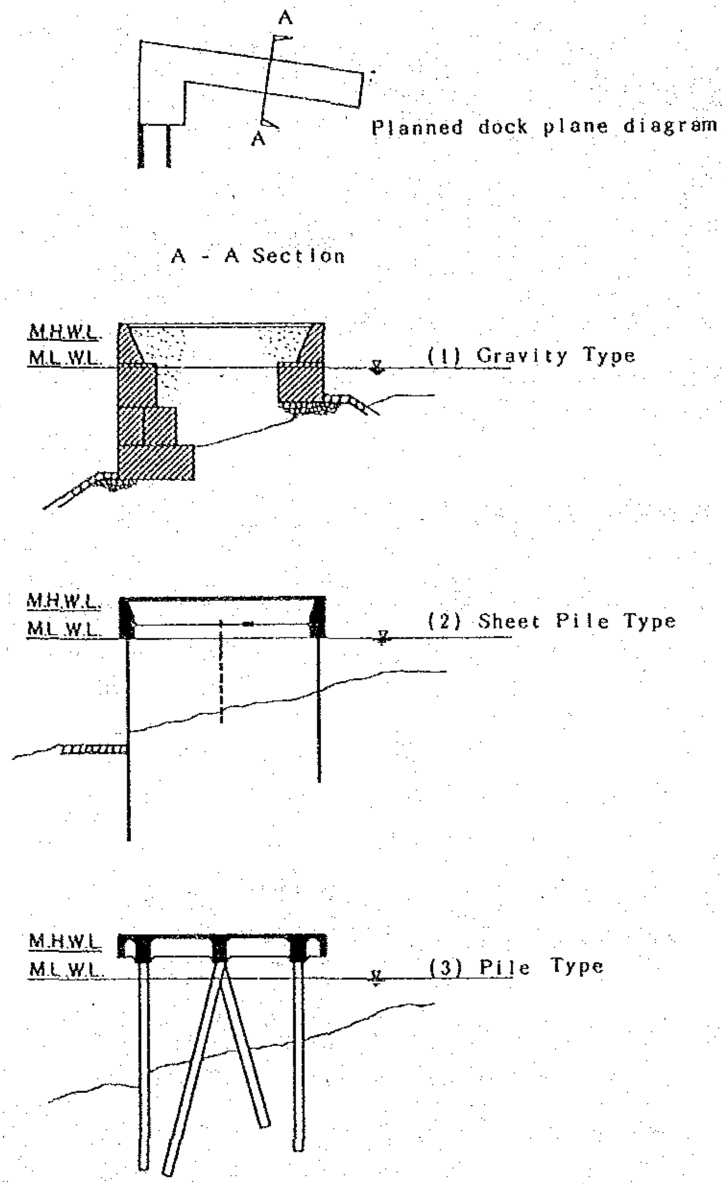


Fig. 4.15 Outline Section of Three Structural Options

Table 4.7 Comparative Evaluation of the 3 Structural Options

Evaluation Category	(1) Gravity	(2) Sheet Pile	(3) Pile
a) Natural Environment (1) Adjusting to existing soil conditions	Generally suitable for hard sand and gravel bottom, but the sand layers at the site, based on a standard penetration test, show a wide dispersion of N values from 4-30, while the depth of rubble mound would require close inspection.	Suitable for sand layers, but the sand layers at the site contain boulders and so, when driving sheet pile, considera-tion would have to be given to combining normal method with another driving method, such as water jet.	With the pile driving method, the same special consideration would be required as with (2).
b) Usage Conditions (1) Safety in terms of vessel impact	Strongest of the 3 methods	Relatively strong in this respect, with high absorptive power	While resistant to vessel impact, can easily lose its stability if serious damage should occur.
(2) Ease of stevedoring operations	All 3 typs are excellent in this respect. (However, consideration must be given to installing steps for small vessels at the rear of the Dock.)		
(3) Shelter effects on the water behind the structure	(1) and (2) types function as a breakwater, thereby enhancing the calmness of the waters to the rear of the Dock.		In comparision with (1) and (2), no effect can be anticipated.
c) Construction Conditions (1) Main materials	Large rubble mound would be required for the foundation work beneath the concrete brocks, but there is no quarry in the plan area.	Would require procurement of sheet piles from Japan.	Would require the procurement of steel piles and materials for work platform from Japan.
(2) Proposed items of imported construction equipment	Would require large construction equipment to install the concrete block.	Cranes, Vivro-hammer and generator would be required to drive sheet piles.	A pile driving vessel would be required.
(3) Main items of temporary construction	A yard for fabricating concrete blocks would be required in the vicinity of the plan site.	A simple scaffold would be required which can be obtained locally.	Provisional work platform would be required for beams and slab concrete work.
(4) Major construction work and technology	Extensive underwater construction would be required to form rubble mound and install the blocks, creating the need for skilled technicians. However, since the concrete work would be done on shore, this method would be simpler than pile structure.	This is the easiest of the 3 methods under review. It is virtually the same method that was used for the exixting commercial port.	Would require considerable pipe driving and concrete work in the water and so would call for a relatively high level of technology. Skilled technicians would, therefore, be required.

Table 4.8 Comparative Assessment of the 3 Structural Methods

Evaluation Category	(1) Gravity	(2) Sheet Pile	(3) Pile
a) Natural conditions			
(1) Adjusting to site topography	△	△	△
b) Usage conditions			
(1) Resistance to vessel impact	○	△	X
(2) Ease of stevedoring	○	○	○
(3) Sheltering effects	○	○	X
c) Construction conditions			
(1) Main imported materials	○	△	X
(2) Main items of imported equipment	△	○	X
(3) Requirements for provisional construction	△	○	△
(4) Ease of construction	△	○	X

KEY: ○ Suitable; minor requirement

△ Average-- requires special consideration

X Not suitable-- major requirement

After giving overall consideration to both the construction period and construction costs, we have selected sheet pile method for the subject facility.

4.4.2 Design of the Attached Facilities

(1) Bollards

1) Selection of the bollards was based on the traction force operating on the subject bollard, as shown in the following table. Since vessels will

normally be anchored offshore during periods of strong winds, there is no particular need for a straight-type bollard.

Table 4.9 Traction Force

GT	traction force (t) acting on curved bollard
200 t to 500 t	10 t
500 t to 2,000 t	15 t
2,000 t to 5,000 t	25 t

Source: "Technical Standards and Comments on Port Facilities" (Japan Port Association)

2) Location of Bollards

The bollards will be located in accordance with the following standard values:

Table 4.10 Bollards Location (1)

GT	Maximum interval	No. of bollards to be installed per berth
Below 2000 t	10-15 m	4
2000 - less than 5000	20	6

Source: ibid. 1)

Table 4.11 Bollards Location (2) (Fishing vessels)

Depth at moorage	Maximum interval
Below 3 m	5.0 m
3 m -- less than 5 m	7.5
5 m or over	10.0

Source: "Standard Design for Fishing Port Structures" (Japan Fishing Port Association)

Considering that the Mobil Oil tankers will use the dock serving the inter-island vessels, the required number of 25t curved bollards will be installed. 15 t curved bollards will be installed on the dock serving foreign fishing vessel.. The interval on both the inter-island vessel and fishing vessel docks will be about 10 m.

Bollards will not be used at the mooring facility for small boats. We have instead specified mooring rings for small boats.

At the floating dock, we shall install a cross bitt 100 mm in diameter. The layout plan for the bollards at each dock is shown below:

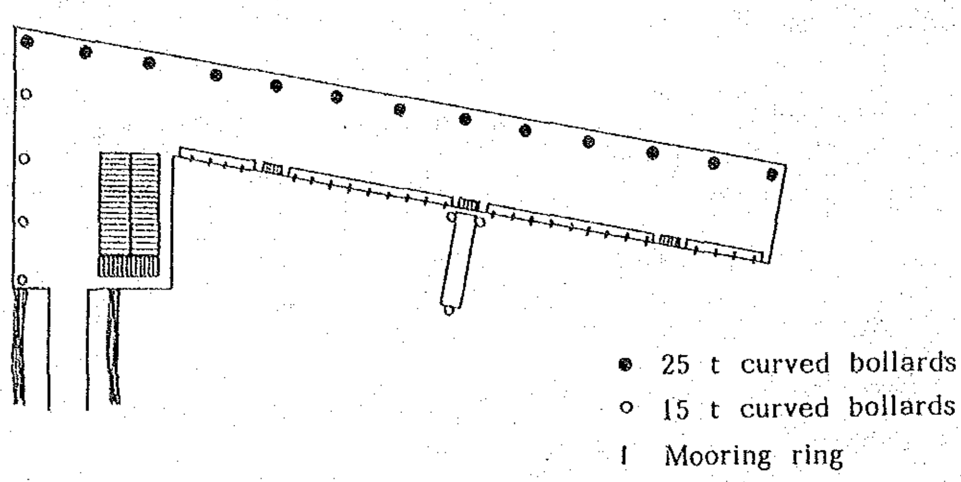


Fig. 4.16 Bollard Layout

(2) Fender Material

1) Material Selection

The fender material was selected on the basis of effective berthing energy in the following equation, under conditions of berthing point by a fully loaded vessel at the 1/4 mark.

$$E = \frac{(W + Wa)V^2}{4g} \ (t.m)$$

E : effective berthing energy of vessel

g : gravity acceleration (9.8 m/sec^2)

W : displacement tonnage

Wa: additional weight (based on Sterson's formula)

V : vessel berthing speed (m/sec)

a) Dock for inter-island vessels

Setting the berthing speeds of the inter-island vessels and the Mobil Oil tankers at V=0.3 m/sec. and V=0.15 m/sec. respectively, we calculated the effective berthing energies, as shown above, and selected the fender material for the higher value obtained.

Inter-island vessels:

(Micro Pilot class V=0.30m/sec, W= 1348 ton, Wa 589 ton)

$$E = \frac{(1348 + 589) \times 0.30^2}{4 \times 9.8} = 4.45 \text{ (t.m)}$$

Mobil Oil tankers:

(Golden Craig class V = 0.15m/sec, W = 9384 ton, Wa = 3842 ton)

$$E = \frac{(9384 + 3842) \times 0.15^2}{4 \times 9.8} = 7.59 \text{ (t.m)}$$

b) Dock for foreign fishing vessels

The dock length cannot be termed adequate for mooring inter-island vessels but, since these vessels are expected to dock during congested periods, the fender material for this dock has been selected on the basis of the effective berthing energy of the inter-island vessels, as computed above.

As the fender material for both the inter-island and foreign fishing vessels docks, we have specified V-shape rubber, which is normally employed for this purpose. Based on a tidal variation of some 2 m, the material will be vertically installed, as shown in the following diagram.

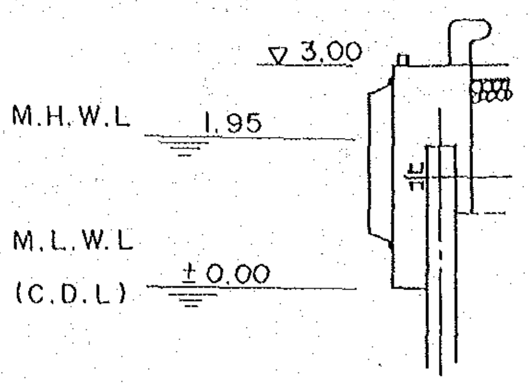


Fig. 4.17 Dock for Inter-island vessels and foreign fishing vessels

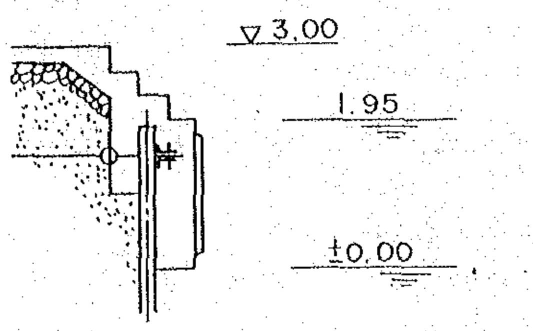


Fig. 4.18 Dock for small fishing boats and cargo boats

2) Fender Deployment

The installation intervals for the protective material have been set, as given in Table 4.12, with due consideration for the values show, which were developed on the basis of past experience, as well as the shapes of the target vessels:

Table 4.12 Fender Installation

Depth	Spacing Dock Fender
4-6 m	4-6 m
6-8 m	4-10 m

Source: Port Technical Materials (1967) -- (Port Research Laboratory, Ministry of Transport)

We have set the following intervals by type of dock:

1) for inter-island vessels 7 m
2) for foreign fishing vessels 5 m
3) for small fishing and cargo boats 3 m

4.4.3 Design of the Floating Dock

(1) Placement

The crown height of the main dock will prove inconvenient for the unloading of small fishing and copra boats during periods of large tidal variations. We have, therefore, decided to construct a floating dock in the center of the area directly behind the main dock.

Since this dock will float on the surface of the water, it cannot generally be used in areas of high waves or strong currents.

Since the current in the Plan area are barely capable of being measured and, with respect to the wave action, the windward side exposed to the prevailing NE and ENE trade winds is blocked by shore, fetch distances are short, and the rare winds that blow in from the lagoon (SW) would be cut off by the main dock. Thus, no particular problems should be encountered in using the floating dock.

(2) Structure of the Float

Possible materials for the float unit may be classified broadly into 3 categories according to the material used: 1) reinforced concrete, 2) steel, and 3) FRP (fiber reinforced plastic). The characteristics of each materials are as follows:

1) Reinforced concrete

Highly durable, with a deep draft, so that pitch is small. Can be easily damaged in a collision.

2) Steel

Easy to construct, collision-resistant, and easy to repair, but regular painting is required as an anti-corrosion measure.

3) FRP

Light-weight, with shallow draft and so unstable, but highly durable and simple to install.

After considering the site conditions, facility scale, and construction costs, we found that--

1) the reinforced concrete type is comparatively expensive in relation to the size of the facility, while ocean transport fees would be high to bring this type of dock to Majuro.

2) since use of the steel type would involve periodic maintenance and, therefore, a maintenance budget, we have designated FRP as the structural material for the floating dock under this Plan.

Since the FRP draft is shallow, some rolling must be anticipated during berthing and unloading operations of a boat but, inasmuch as the target vessels for the facility are small in size, a design should be possible that would eliminate such problems even with respect to the unloading of coconut and similar products.

(3) <u>Installation Method and Auxiliary Facilities</u>

Two installation methods are available:

(1) a method based on the mooring anchor; and

(2) a method to raise and lower the dock by fixing to piles in accordance with the tides.

We have chosen the method whereby the dock is connected to the piling, based on the fact that the pile driving can be done with the same equipment as is used in the sheet pile construction for the main dock and the fact that this method will reduce the pitching of the floating dock.

Auxiliary items will include protective materials and mooring cross-bitts for small boat use. No provision need be made for a connecting bridge between the floating dock and the main dock. It will be sufficient to provide a staircase on the main dock side. Fig. 4.19 shows standard section of a float.

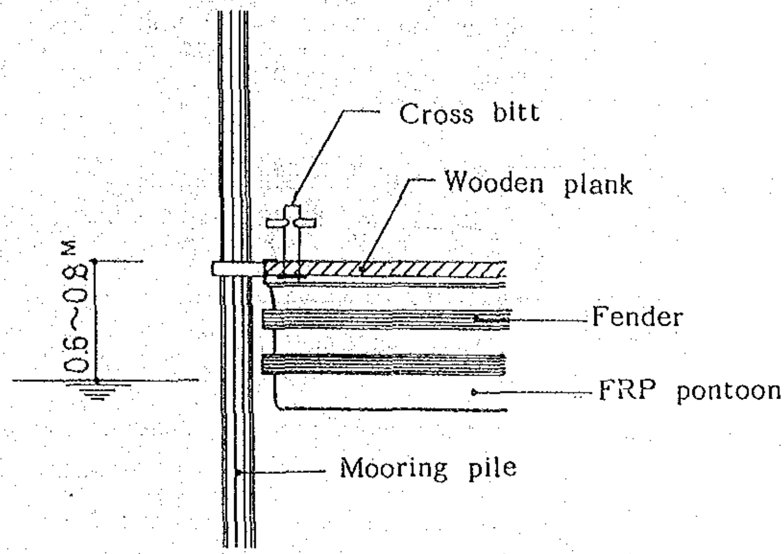


Fig. 4.19 Section of Float

4.4.4 Design of the Work Apron and Surface Pavement

The paving medium for the work apron will be concrete, in view of the fact that it has to be supported by backfill soil after completion of the sheet pile work; that, during loading and unloading operations, it will have to accommodate large forklifts and trucks; and that this material stands up well to vessel berthing.

The major properties of concrete paving are as follows:

1) It is not particularly affected by unevenness in the road bed and so adequate structural strength can be achieved.

2) It is advantageous vis-a-vis concentrated loads of high ground pressure.

3) It is highly durable, and so the pavement has a long useful life.

4) If uneven subsidings develop, it is vulnerable to cracking.

5) Once the concrete starts to break up, repairs become difficult, and demolition of the road is most time-consuming.

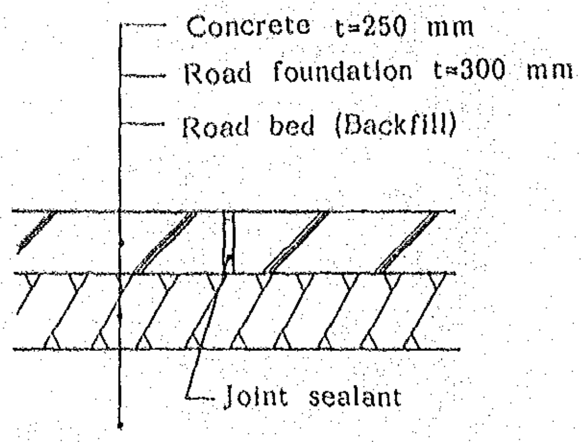


Fig. 4.20 Standard Sectional Plan for the Concrete Road

The paving medium for the present access road extending from the existing warehouse to the dock apron will be asphalt in view of the relatively good foundation, making it unnecessary to improve the road bed, and the local availability of maintenance facilities.

Estimated on the basis of our field survey and the results of the boring tests, the road bed can be expected to have a soil bearing capacity of at least 10 t/m^2 and a CBR value of 8 or more. Following are the generally accepted characteristics of an asphalt road:

1) It has the ability to adjust somewhat to a slight uneven subsiding of road bed.

2) It is quite easy to repair.

3) It is weak under conditions of continuous heavy traffic over a particular point, while depressions, ruts, and ditches are prone to develop.

A standard sectional plan is shown in Fig. 4.21.

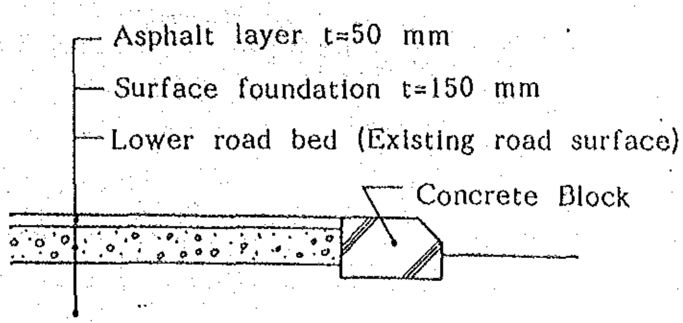


Fig. 4.21 Standard Sectional Plan for the Asphalt Road

4.5 Construction Plan

In developing our construction plan, we have given careful consideration to the following environmental and sociological conditions in the Plan area:

... Since the facility is to face sea water, it is vulnerable to salt damage.

... The weather is hot and wet throughout the year.

... A large amount of precipitation is concentrated in a short period.

... The main construction materials must be imported.

... The construction industry in Majuro is small and incapable of coping with a large-scale contract.

... The construction period will be limited.

Our construction plan has been developed with due regard for the above conditions.

4.5.1 Structural Forms

The target structures are the warehouse and the passenger waiting facility. The structural method has been decided on the basis of the intended use and scale of the facilities, ease of material procurement during the construction phase, and ease of maintenance upon completion.

Small private structures in Majuro tend to be of either block or wooden construction, with reinforced concrete also used in certain large public buildings.

As in Japan, factories and warehouses requiring high eaves and wide spans are generally steel-frame structures since, with this type of building, it is easier to obtain large spaces and to procure building materials of a certain quality than with the other structural techniques. In addition, the construction period for steel-frame buildings is relatively short.

Since the warehouse in the Plan calls for high eaves and broad spans and is to be situated on the backfilled work apron, this building should be lightweight and must be built in a short period of time. And, since the structure will be totally enclosed, it should not be exposed directly to salt confirm. In consideration of the above, we have concluded that a rigid frame structure would be most appropriate.

With respect to the foundation, with a view toward shortening the construction period, foundation work should get underway at the same time as the land fill operation. Accordingly, we have chosen piles as the foundation method as a way of dealing with any initial subsiding and to prevent any unforeseen load from acting on the dock.

In the case of the passenger waiting area, there is no need for high eaves or broad spans. It would be desirable to make this structure as open and airy as possible. We have, therefore, specified reinforced concrete and posts and beams without walls so as to provide good ventilation and breezes.

The ground level of the Plan site is set at $\pm$ 0 m, which is below the +3.0 m crown height of the causeway. In order to place the floor height of the facility at the same level as that of the passenger entry ramp, we have specified a high-floor structure on pilings.

4.5.2 Finishing Materials

(1) The Roofs

The most common types of roof construction in the Plan area are gable and hipped roofs, with flat roofs occasionally found. The most frequent type of roofing material is galvanized sheet, though aluminum type has also come into use in recent years. Concrete is used in flat roofs. In medium to large structures, such as large stores and warehouses, vinyl coated steel sheets, treated against corrosion, are also used to some extent.

For the subject Plan, we have selected PVC coated iron roofing, since this is easy to maintain and repair, and will simplify construction. Care must be taken in the Plan to provide adequate ventilation and anti-corrosive treatment in the interests of maximum durability.

(2) Exterior Walls

The most popular wall materials used in the target area are wood, steel sheet, and block. Both steel sheet and wood are imported, but concrete blocks are locally available and economical and are used relatively often as structural wall materials.

From a functional standpoint, we plan to use block construction for the lower section of the walls up to a height of 1.5 m from the floor, since this has relatively high shock resistance. For the upper part of the wall, we shall employ the same material as for the roof-- PVC coated iron sheeting.

In the case of the passenger waiting area, we plan to hold the use of walls to an absolute minimum in the interests of proper ventilation but, where walls are required, we shall use concrete block.

(3) Interior Finish

Considering the functions of the respective facilities, there will be no need for any special finishes. Given the basic requirement for ease of operations and durability, we shall standardize the mortar finish on the concrete slab.

As to the wall finish, the wall blocks will be given a mortar finish. The warehouse office wall will be paint finish on plywood. The ceiling will also be paint finish on plywood in the office, but no ceilings are planned elsewhere in the interest of proper ventilation.

Since all of the above finishing materials are in general use in Majuro, with replacement materials easy to obtain, no maintenance problems are anticipated after completion.

4.6 Facilities Plan

4.6.1 Fueling Facilities

The oil pipe will be generally exposed. It will run on elevated base on the access road and will use concrete pit in the work apron area. To prevent oil leakage, we will use a trap drainage so that any oil seeping through the apron pit will be prevented, at least for a time, from directly discharging into the sea. The top of the pit will be covered by grating to permit direct viewing of the pit interior during maintenance checks.

4.6.2 Water Supply and Drainage

(1) Water Supply

Water supply systems under this Plan will be divided into those for ordinary water, vessel water, and water for the fire-hydrants.

Ordinary water will be branched from the pipe for the vessel supply system and brought into the passenger waiting facility. The servicing point is sinks in the toilet. Sea water will be used for toilet flushing which is supplied via branch pipes from the sea water main pipe. The branch pipe material is PVC and buried in the ground.

The vessel supply system comprises those for inter-island vessels and for small fishing and cargo boats.
For inter-island vessels, water distribution pipe will be branched from the main pipe to the work apron of the dock. The distribution pipe will again be PVC and buried in the ground. Distribution valves will be placed in 2

locations on the apron. Since the water will be supplied at one location, the distribution pipe will be of single type.
The water supply system for small fishing and cargo boats will use rain water stored in a water catchment tank. Tank material will be of maintenance-free FRP and the panel fabrication type will be used.
The hydrant facilities will branch off from the sea water main pipe and will be brought underground to the vicinity of the warehouse on the work apron. This will be an independent pipe of PVC made. The hydrants will use standard locally available material and will be installed at one location near the warehouse.

(2) Sewage

The sewage to be handled under this Plan will be of 3 types: soil water, waste water, and rainwater. Soil water will be discharged to the sewer main pipe. The connecting pipes will be PVC and placed underground.

The waste water from the sink will be seeped underground after being collected in a seepage pit.

Rainwater from the passenger waiting area is to be directly discharged into the sea after being collected in the eaves gutter, while that from the warehouse roof is collected and stored into the water catchment tank to be installed beside the warehouse.

4.6.3 Electrical Work

The main distribution board will be installed in the warehouse office and branched from there to the circuit boards in the various facilities. The power boards for the warehouse, outdoor lighting, and vessel power will be installed in the warehouse office (containing the main distribution board), while that in the passenger waiting facility will be installed in the restroom. All control circuits will be of the simple manual type.

(1) Lighting Outlets

The target facilities will be lighting outlets on the work apron, the access road lights, the warehouse and passenger waiting facility.

In connection with the lighting fixtures, we have specified disposable items, such as light bulbs, of a type that can be locally procured. In addition, since the outdoor lighting fixtures will be at the water's edge, special attention will be paid to the problem of salt damage. The electrical outlets will be for use with the ventilating fan in the passenger waiting area, in the warehouse, for the air conditioner in the office, and for office equipment. The power source will be 120 V, 60 Hz.

(2) Power source for vessels

The terminals and junction boxes for the vessel power packs will be installed in two locations on the work apron. The boxes will be of steel construction and will be both salt-resistant and water-proof.

The layout plan for the water and electrical fixtures is summarized below:

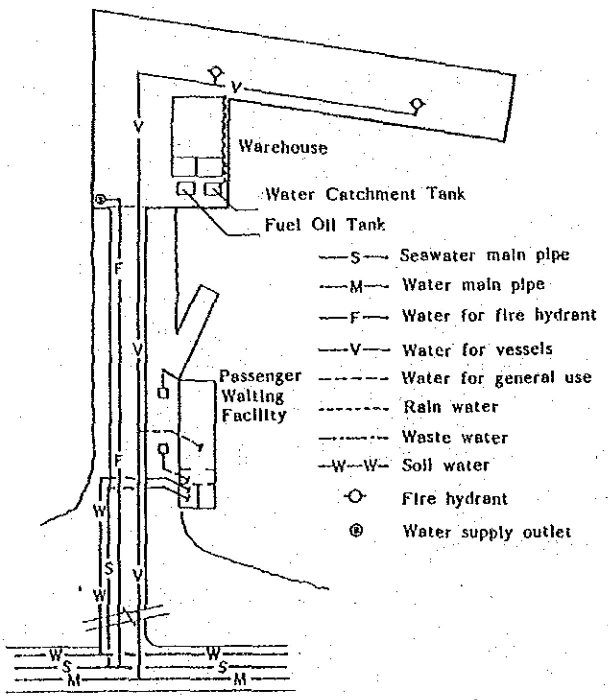


Fig 4.22 Water Supply and Drainage System

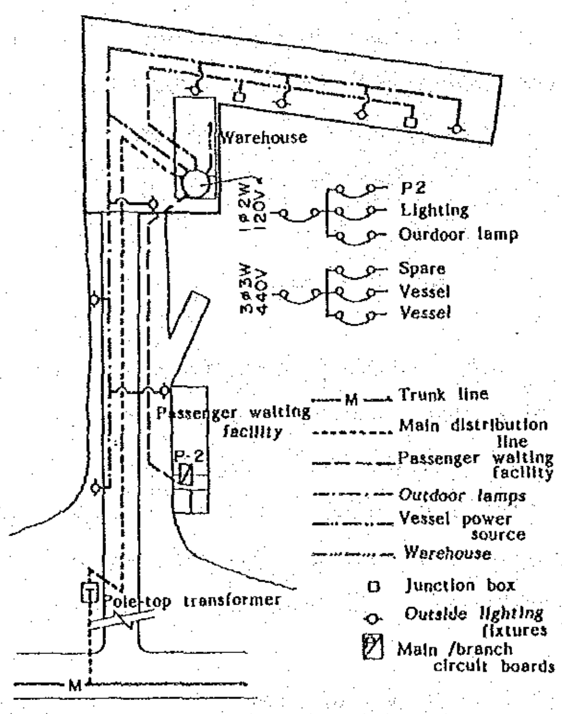


Fig. 4.23 Electrical System

4.7 Summary of Plan Facilities

We summarize below the various facilities that have been discussed in the previous section:

1. Engineering Facilities

   (1) Mooring Docks

   1) Dock for use by inter-island vessels

      Dock length: 120m

      Plan depth: M.L.W.L. -7.5m

      Plan crown height: M.L.W.L. +3.0m

   2) Dock for use by foreign fishing vessels

      Dock Length: 40m

      Plan depth: M.L.W.L. -5.0m

      Plan crown height: M.L.W.L. +3.0m

   3) Dock for small fishing and cargo boats

      Dock length: 96m

      Plan depth: M.L.W.L. -2.0m

      Plan crown height: M.L.W.L. +3.0m

      Floating dock for unloading purposes:

      width x length: 3.0 x 15m

      freeboard: 0.6 - 0.8m

   (2) Work Apron

      Width: 15m, 24m (warehouse portion)

   (3) Landing Ramp for Small Fishing Boats

      Width x Length: 4.0 x 27m

      Depth at forward block: M.L.W.L. -1.0m

2. Shore Facilities:

   (1) Warehouse: Steel-frame, single-storied; floor area -- 140m^2

   (2) Passenger waiting facility:

      Steel-frame, single-storied; floor area -- 110m^2

   (3) Paving of access road:

      width x length: 6.0 x 175m

3. Attached Facilities:

(1) Power facilities:

Outside lamps and lighting

Power facilities for delivery to vessels

(2) Water supply and drainage facilities:

Water supply for vessels

.Inter-island vessels

.Small fishing and cargo boats

Water supply for general use

(3) Refueling facilities

Pipe pit

Fueling facility for small fishing and cargo boats

4.8 Conditions for Developing the Facility Plan

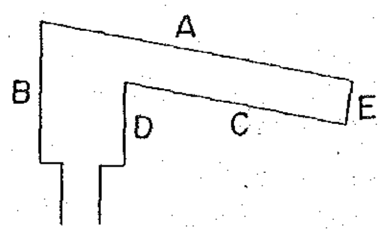
(1) Applicable Standards

No standards in published form exist at present in the Marshall Islands for structural design. In general, the country follows U.S. standards. With respect to the engineering works and the design of the building facilities, we have generally applied Japanese standards.

(2) Structural Specifications

1) Mooring facilities

Main dock: (Dock framework)



Location	A Dock	B Dock	C Dock	D Dock	E Dock
Length	120m	40m	about 96 m	about 25 m	15 m
Plan Depth	MLWL-7.5m	-5.0m	-2.0m		
Crown height	MLWL +3.0 m				

Floating dock: (FRP)

Width x length 3.0 m x 15 m
Top-side height 0.6 - 0.8 m

2) Landing ramp for small boats

Width x length 4.0m x 27m

Depth at forward block MLWL -1.0m

Ramp gradient: 1:6 (on land)
1:4 (in the water)

3) Vessels to be served

User Vessels	GT (max)	Displace-ment tonnage	Length (m)	Breadth (m)	Loaded draft	Comment
Oil tankers/ inter-island vessels	5511	9,384	107.8	17.6	6.89	A dock
Foreign fishing vessels/ inter-island vessels	805	1,348	56.4	10.1	3.95	B "
Small fishing and copra boats	-	-	8.12	3	1.3	C-dock Floating dock

4) Oceanographic conditions

Tidal levels

Highest High Water Level	H.H.W.L.	+2.13m
Mean High Water Level	M.H.W.L.	+1.95m
Mean Water Level	M.W.L.	+1.07m
Mean Low Water Level	M.L.W.L.(C.D.L.)	±0.00m
Lowest Low Water Level	L.L.W.L.	-0.03m

5) Seismic force

There are no records of earthquake activity, and so we have not considered this factor in the design.

6) Wind pressure

This has been determined on the basis of the following equation (from the Ordinance for the Application of Construction Standards).

The design wind velocity for this equation was computed on the basis of an instant velocity of 62 m/sec.

$q = \sqrt{60}\ h$ q: velocity pressure (kg/m^2)
h: Height (m) from ground level

7) Load

a)Carrying load (loadage): $W=1.0\ t/m^2$

b)Vehicle load: T-20 (equivalent truck load)
(Specifications for Roads and Bridges, Japan Road Association- applied to a 20 ton total load)

Soil conditions

(Cf. Annex VI-6 for the determination of the soil constant)

(i) Base foundation

Average N value	N = 13
Internal friction angle	$\phi = 32.5$
Weight in the water	$r\ sub = 0.9\ t/m^3$
Moist weight:	$r\ t = 1.8\ t/m^3$

(ii) Backfill sand

Internal friction angle	ϕ 30
Weight in the water	$r\ sub = 0.9\ t/m^3$

Moist weight $\gamma t = 1.8\ t/m^3$

The resulting soil constant is as shown in Fig. 4.24.

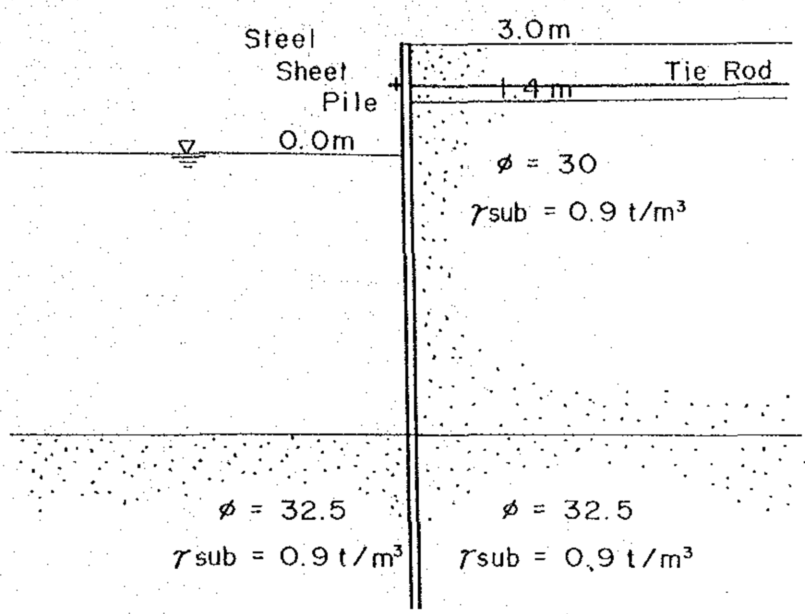


Fig. 4.24 Soil Constant

9) Materials

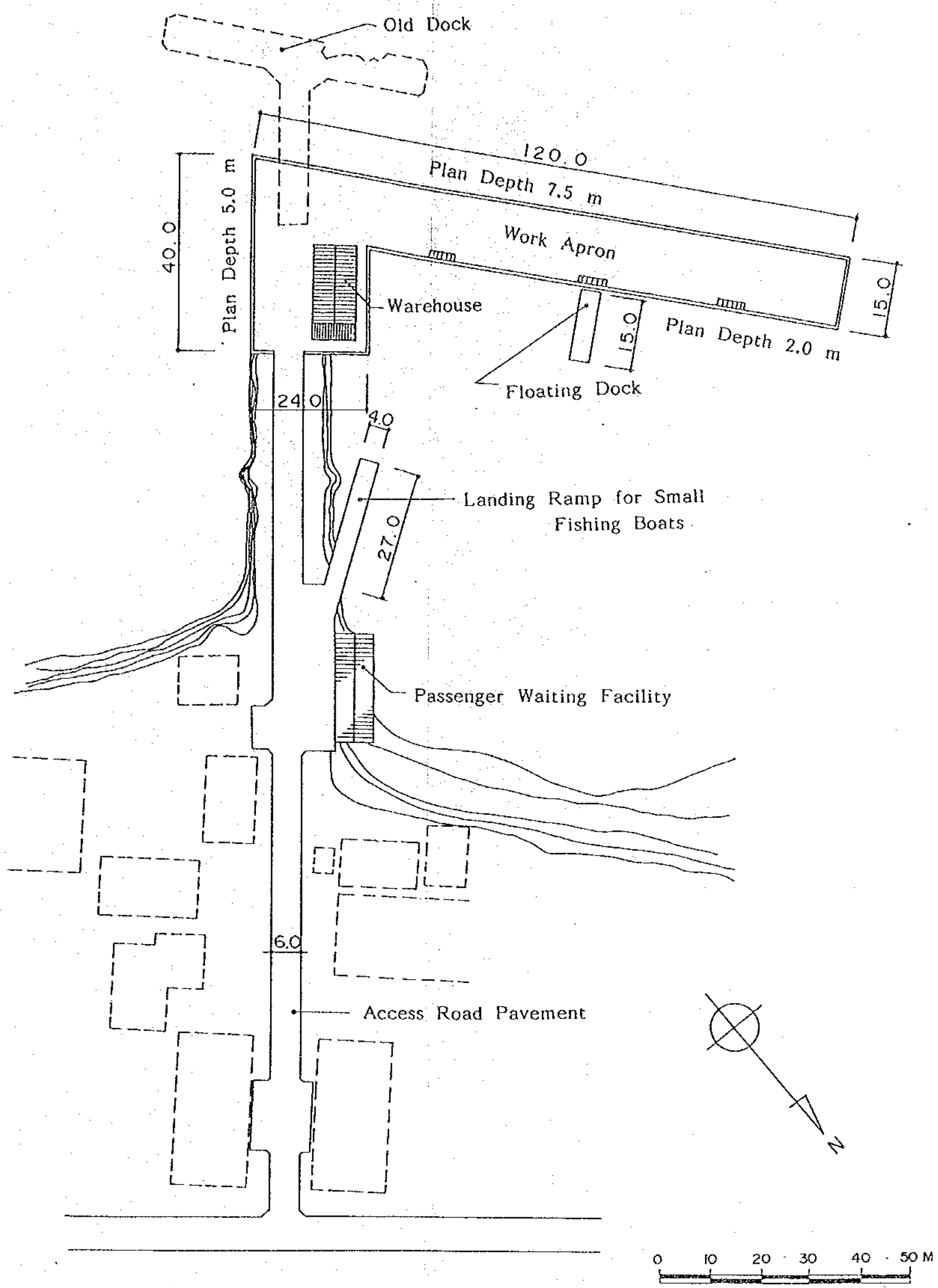
1) Concrete

Ordinary concrete: standard design strength = FC = 210 kg/cm^2

2) Steel materials

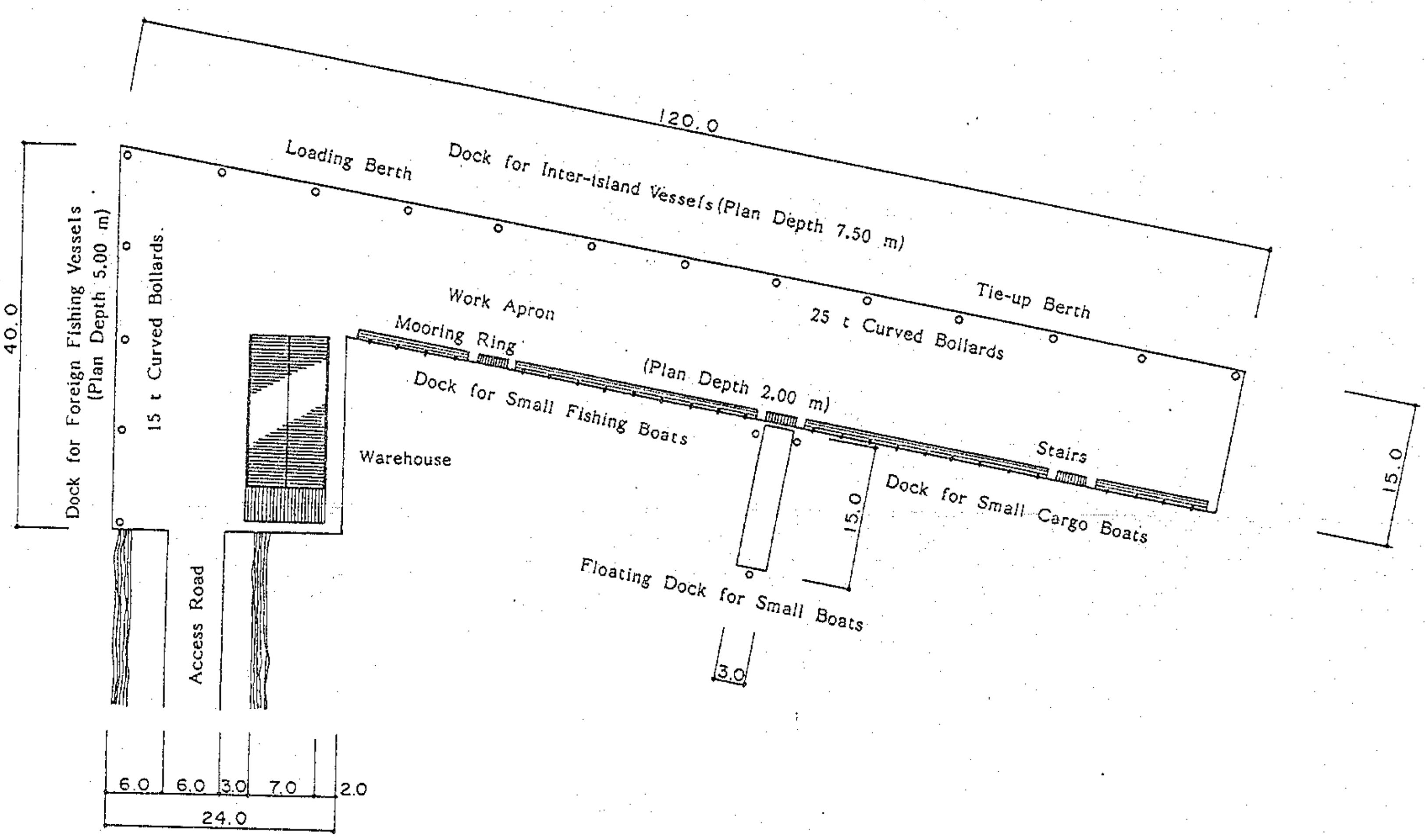
Type of steel	Standard		No.	Type
Structural steel	Steel materials for general structural use	JIS G 3101	SS41	Formed steel
Steel pipes	Carbon steel pipes for general structural use	JIS G 3444	STK41	Steel piling
Sheets	Steel sheets	JIS A 5528	SY30	U-shape
Steel bars	Reinforced concrete bars	JIS G312	SD30	Deformed bar

4.9 BASIC DESIGN DRAWINGS

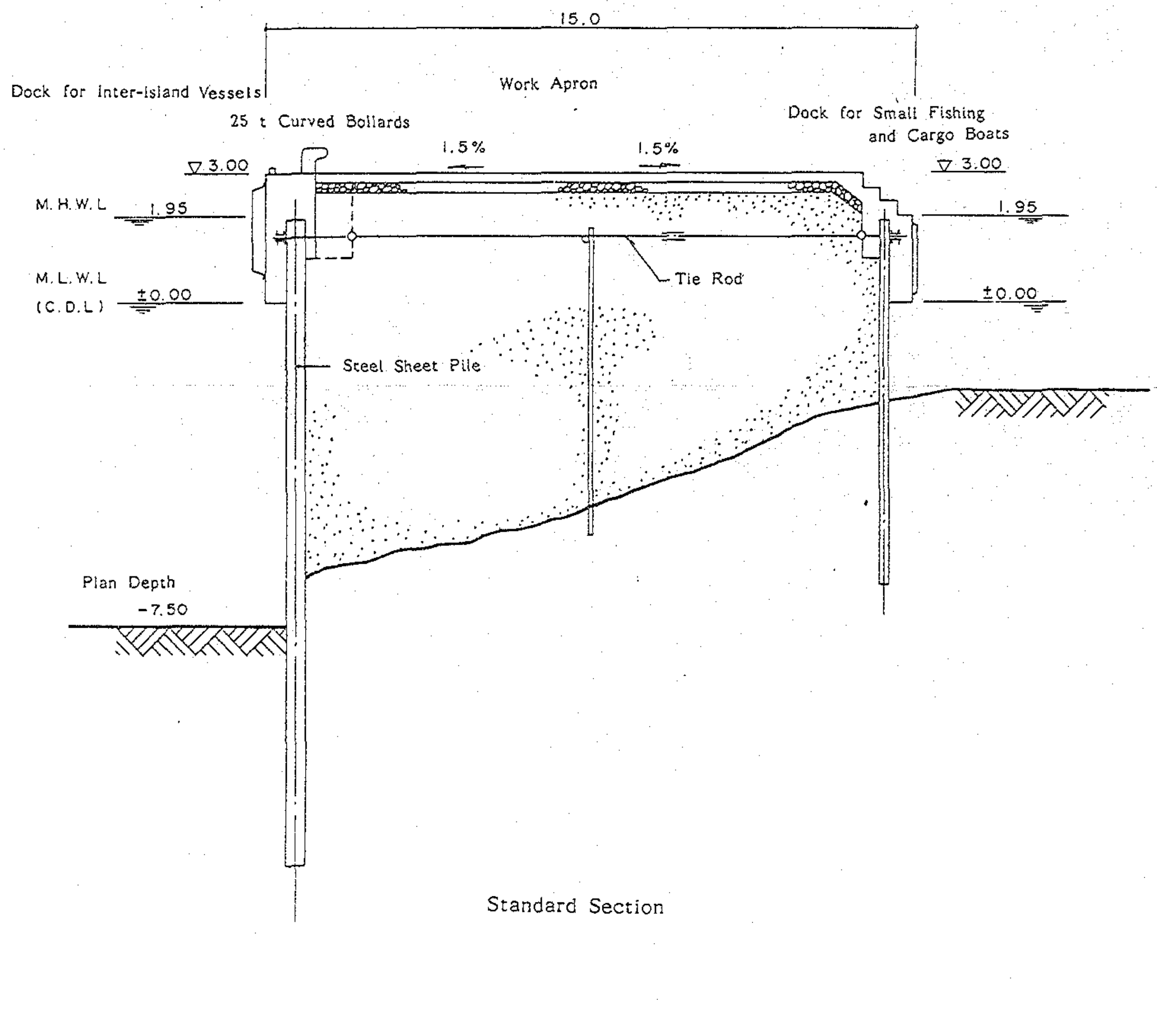


Old Dock
120.0
Plan Depth 7.5 m
40.0
Plan Depth 5.0 m
Work Apron
Warehouse
15.0
15.0
Plan Depth 2.0 m
Floating Dock
24.0
4.0
Landing Ramp for Small Fishing Boats
27.0
Passenger Waiting Facility
6.0
Access Road Pavement
N
0 10 20 30 40 50 M

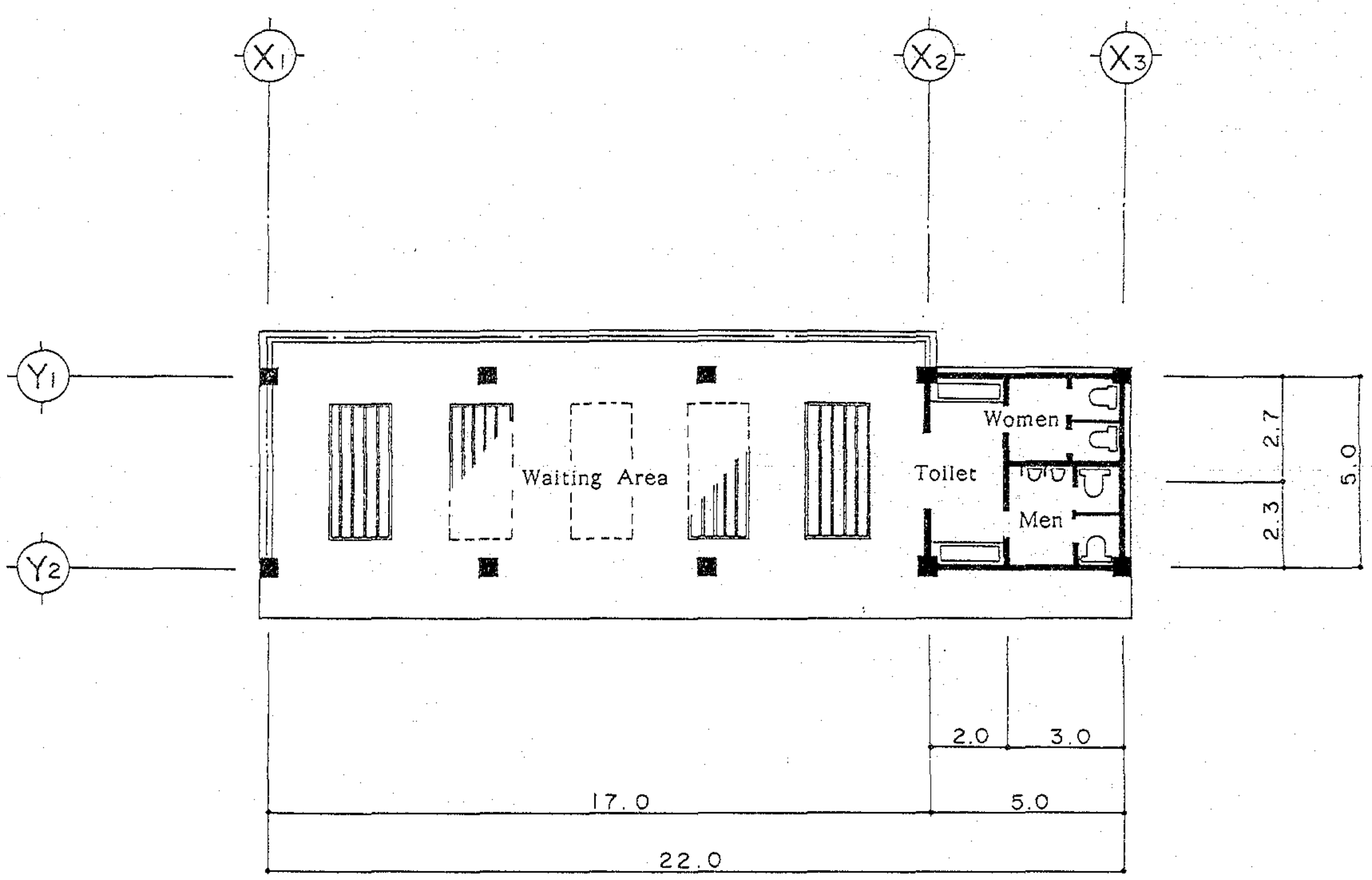
Site Plan



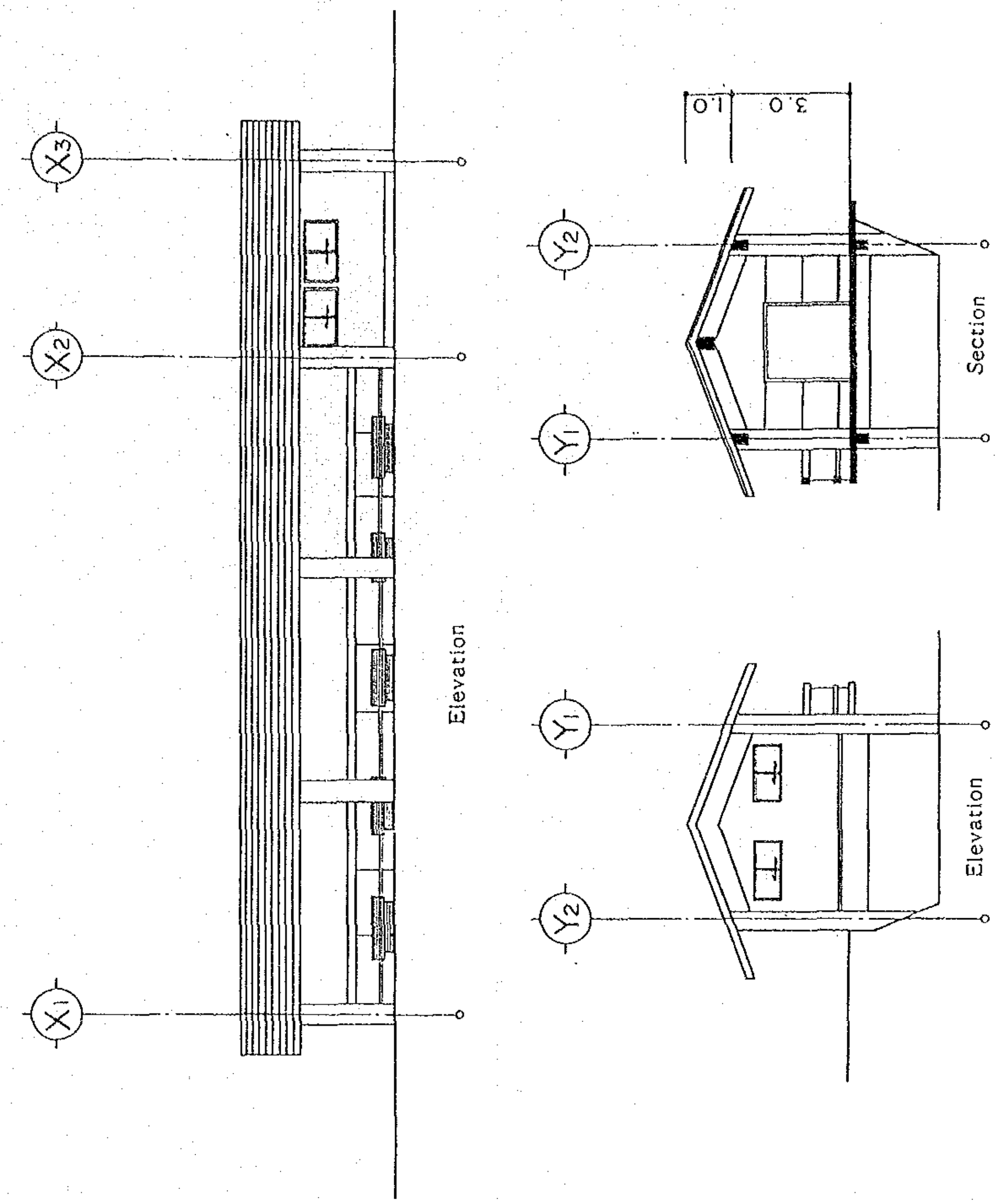
Dock General Plan



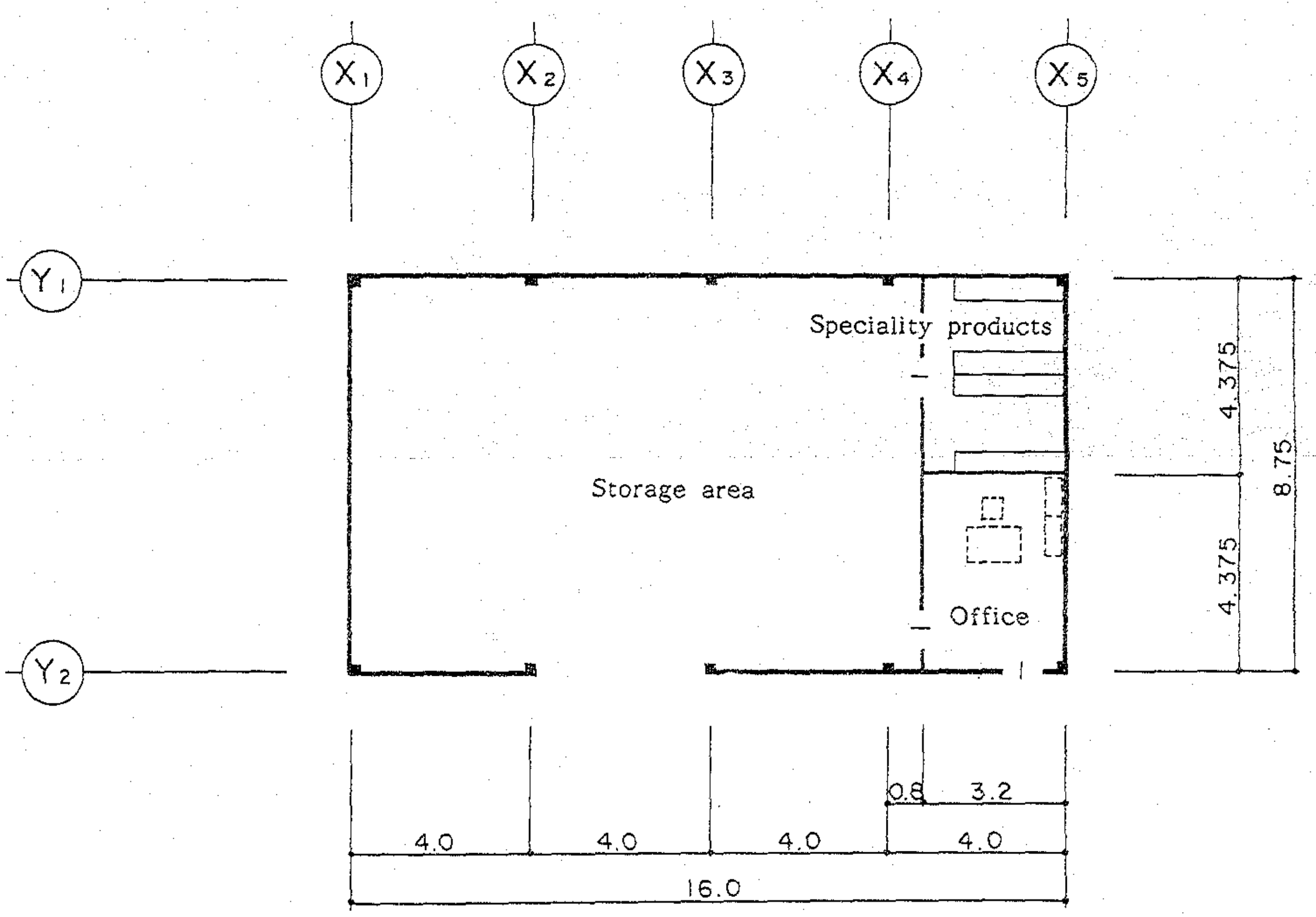
Standard Section



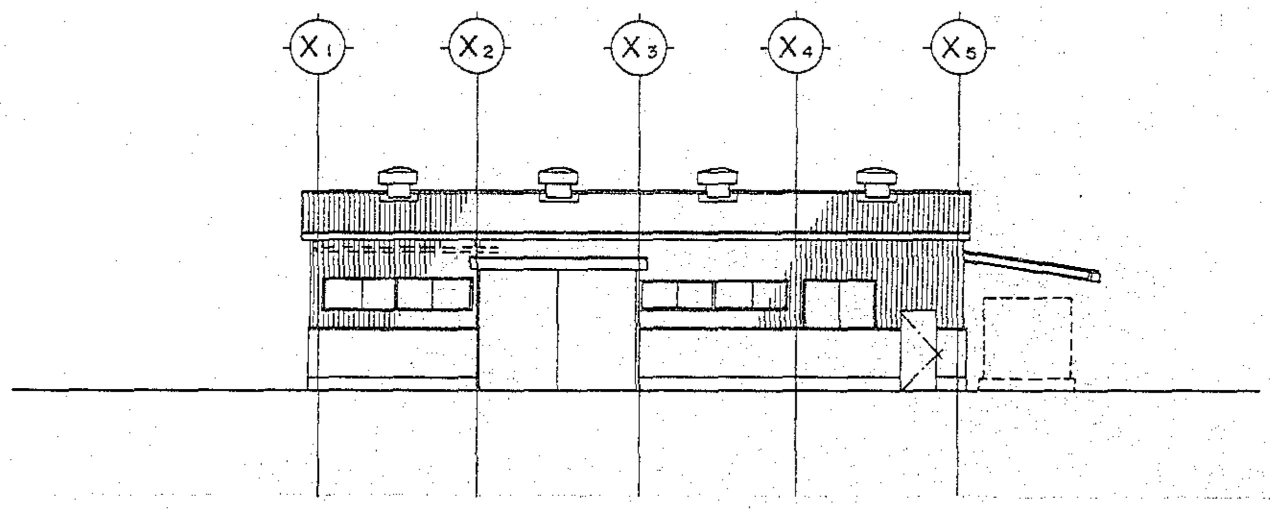
Passenger Waiting Facility Floor Plan



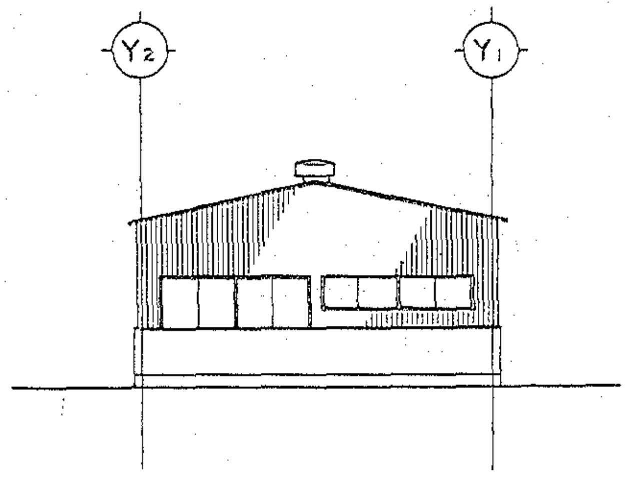
Passenger Waiting Facility



Warehouse Floor Plan

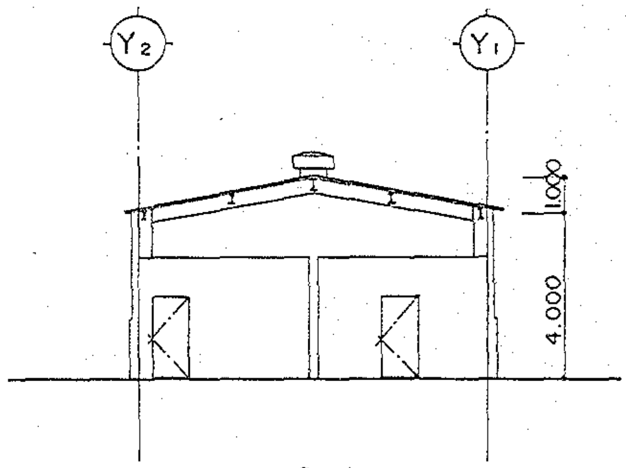


Elevation

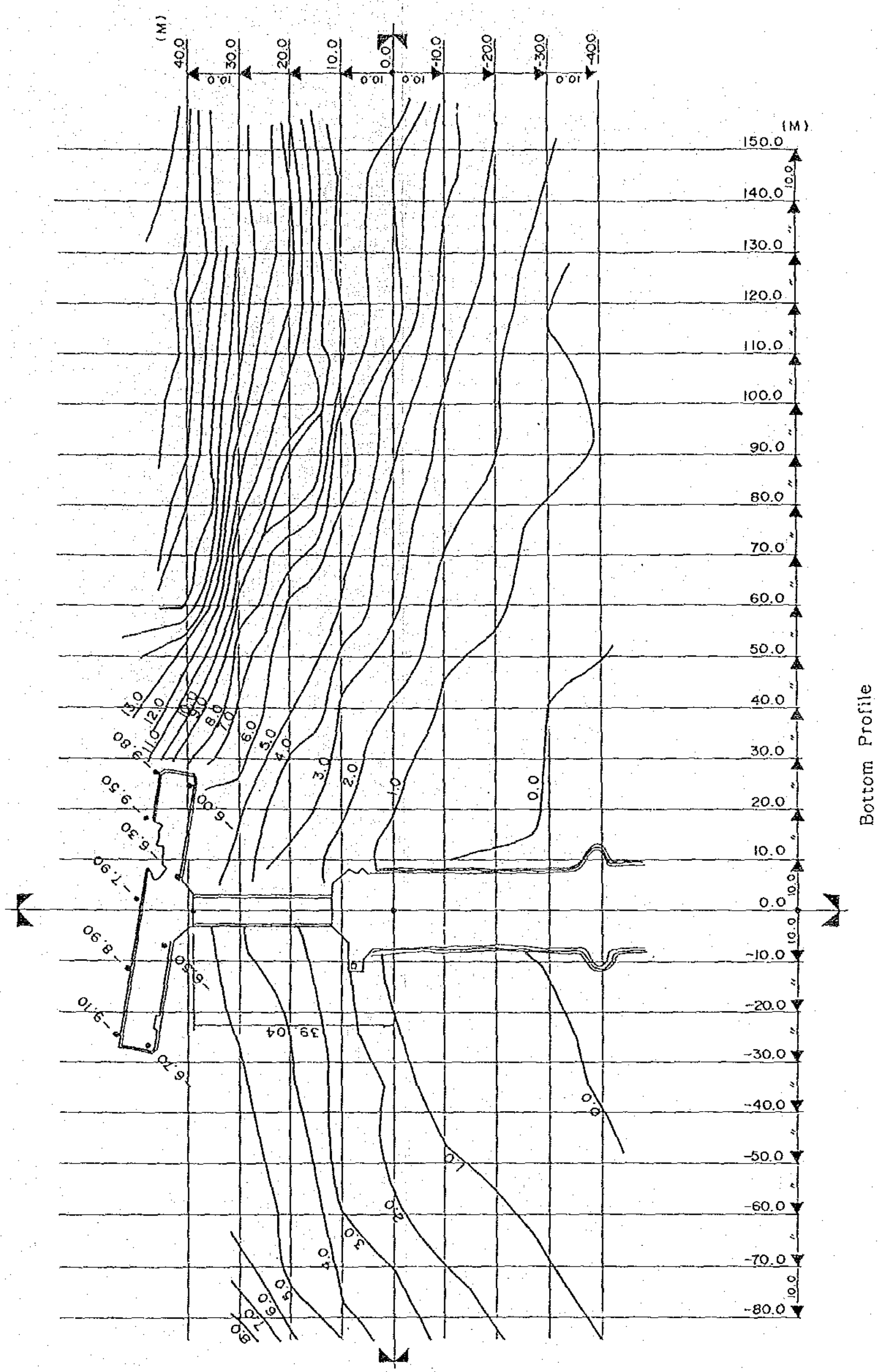


Elevation

Warehouse



Section


Bottom Profile

CHAPTER 5 PROJECT IMPLEMENTATION PLAN

5.1 Implementation Structure

The implementation of the Plan and all activities associated with its administration will become the responsibility of the Ministry of Transportation and Communications, which will also handle bids, issuance of certifications and other necessary procedures. At the actual implementation stage, the CIP (Capital Improvement Project) office will be responsible for all technical details, including certification, inspection and approvals of the civil engineering work, buildings, facilities, and the construction program.

Upon completion, operations will be handled by the above Ministry, but maintenance, as in the case of the other public facilities, will be the responsibility of the Ministry of Public Works.

5.2 Division of Responsibility for the Construction Program

(1) Phases to be Undertaken by the Government of Japan

Assuming that this Plan is implemented under a grant-in-aid from Japan, the Government of Japan will take responsibility for the following phases:

1) Construction of docking facilities
2) Construction of shore facilities
3) Construction of attached facilities
4) Ocean and inland transport of the construction materials required and payment of all freight and insurance charges
5) Implementation design, assistance on bids, and consulting services in connection with construction supervision.

(2) Phases to be Undertaken by the Marshall Islands Government

Assuming implementation under a grant-in-aid from Japan, the Marshall Islands Government will assume responsibility for the following phases of the project:

1) Securing and preparation of construction site

2) Obtaining all necessary approvals for land fill and dredging operations and all permits and licenses required for Plan implementation

3) All procedural matters, including the giving of advance notice to users of the present dock that the facility will not be available during the construction period

4) Prompt customs clearance of the required imported materials as well as exemption from all duties thereon

5) Exemption of Japanese nationals from taxes and levies in the Marshall Islands in connection with the provision of construction materials and personal services

6) All other services required under this Plan that are not specifically delegated to the Government of Japan.

5.3 Construction Plan

5.3.1 Basic Guidelines

(1) Use arrangements during the Construction Period:

The existing dock is being used by inter-island vessels (for loading/unloading, tie-up, and reprovisioning); by foreign fishing vessels (for refueling); and by small fishing and copra boats (for unloading and taking on supplies).

Upon the start of the construction work, the Old dock will be dismantled, and so virtually none of the above vessels will be able to utilize the facility during the construction period. Therefore, the New Port will become the substitute port during the construction work for all vessels using the existing facility.

Proper liaison will be maintained with the authorities with respect to the termination of use of the Old Dock so as not to interfere with the progress of the construction work.

(2) Points to be Considered during the Construction Work:

1) With regard to access by electrical and water-supply agencies, proper liaison will be maintained regarding the timing and pipe-laying standards to avoid any disruptions.

2) For the driving of sheet piles and dredging operations, barges will be obliged to occupy the waters in the site area for a considerable period of time. Careful consideration must, therefore, be given to the safety of vessels in these waters.

3) Every possible effort will be made to eliminate any damage from pollution of surrounding waters, such as during the dismantling of the existing dock.

(3) Outline of the Construction Work:

The items of construction under this Plan may be summarized as Table 5.1.

Table 5.1 Construction Work Outline

Main Construction Items	Specifications	Main Stages
Civil engineering Work Mooring docks	length 120, 40, 96m depth 7.5, 5.0, 2.0m	1 preliminary construction 2 driving of sheet piles 3 waling work 4 tie-rod installation 5 backfilling 6 dredging 7 superstructure concrete 8 incidental work
Work apron	15m x 120m 24m x 25m	1 preparation work 2 concrete paving (road bed, road base)
Landing ramp for small boats	4m x 27m	1 preparatory work 2 dredging 3 foundation work (riprap, cover stone) 4 production, transportation, and installation of concrete blocks 5 concrete work
Shore facilities		

Warehouse	steel-frame, single-story 8.75m x 16m	1 temporary work 2 foundation work (earth, re-bar, concrete works) 3 steel frame work 4 roof work 5 wall work (block, metal works) 6 finishing work (plumbing, fittings, painting works) 7 electric and water supply drainage works
Passenger waiting facility	RC, 5m x 22m	1 temporary work 2 foundation work 3 form work 4 roofing work 5 finishing work 6 electric and water supply drainage work
Pavement of access road	width 6m length 175m	1 road foundation work 2 asphalt paving work

5.3.2 Construction and Supervision Plan

The construction program will start immediately following the exchange of notes between the Marshall Islands Government and the Government of Japan, and the conclusion of a consulting contract between the Ministry of Transportation and Communications and the consulting organization in Japan.

The consultant will prepare detailed designs and bid documents for the construction project. After obtaining approval and following the necessary procedures of the Marshall Islands Government, the construction contract will be awarded to the successful bidder in Japan. The contractor will be selected on the basis of the lowest bid submitted and, after the contract is signed and verification is received from the Government of Japan, the construction work will get underway.

The consultant will supervise the entire construction project up to completion and delivery of the facilities and, to insure proper progress and quality of the construction work, will dispatch a resident supervisor to the Marshall Islands. The contractor will dispatch, for the required periods, a general supervisor, a technical supervisor for the civil engineering and construction phases, and specialist technicians for the driving of the steel sheets, concrete forms, underwater work, etc.

5.3.3 Procurement Plan for Construction Materials and Equipment

(1) Principal Materials:

With the exception of aggregate and certain concrete products, the construction materials will have to be imported. We have developed a sourcing plan for the principal materials, based on a consideration of quality, stability of supply, and prices:

Main Materials	Application	Source
Concrete materials	Civil engineering, shore facilities	Local
Sand	"	"
Gravel	"	"
Cement	"	"
Cobblestone,riprap	"	"
Concrete block	Warehouse, passenger waiting facility	"
		"
Concrete forms		Japan
Steel materials	Passenger waiting facility	"
Incidental facilities for mooring docks	Dock facilities	"
F.R.P. floating dock	Dock facilities	"
Roof materials	Warehouse	"
Wall materials	"	"
Water supply and drainage pipes		"
Electrical and		

lighting equipment "

(2) Main Items of Construction Equipment:

Crawler crane	Both Japan and local
Barge (with winch)	Japan
Anchor boat	"
Vibro-hammer	"
Generator	Japan/local
Jet pump	Japan
Compressor	Japan/local
Welding equipment	"
Grab bucket	Japan
Back hoe	Local
Bulldozer	"
Dump truck	"
Track crane	Japan/local
Hopper	Japan
Concrete breaker	Japan

5.4 Implementation Schedule

The implementation stages for the subject Plan may be divided into three stages: detail design, biddings, and construction of the docks and shore facilities.

(1) Detail Design

The bid documents will be prepared on the basis of the basic design study results. The documents include detail design drawings, technical specifications, structural calculation and cost estimation. Discussions will be held with the concerned parties of the Marshall Islands Government during the early, middle and end part of this detail design stage. The final draft of the bid documents should be approved by the Marshall Islands Government before execution of bids.

(2) Bidding

Following the detail design, a public notice will be made in Japan for pre-qualifing the prospective bidders. In accordance with pre-qualification results, qualified bidders will be invited to bid by the implementation agency. The bids will be opened in front of the concerned officials to be presented, and the lowest bidder will conclude the construction contract with the Marshall Islands Government, after his bid has been confirmed as appropriate.

(3) Construction Work

The construction works will start immediately after the verification of the construction contract by the Government of Japan. We have established the construction work schedule by evaluating the scale of temporary works, required materials, work period and cost of respective component of the work which is classified in accordance with nature of the works, viz., work to be started in advance, work to be processed in parallel and independency of work.

The overall project flow will be as shown in the following chart.

PROJECT FLOW CHART