5.2.2 Cargo Volume Forecast

(1) Results of cargo volume forecast

The cargo volume handled in 1998 is shown in Table 5-2-3 to Table 5-2-5.

Table 5-2-3 Results of Cargo Volume Forecast in 1998

(Unit:MT)

| | 1992 | | | 1998 | | |
|---|---|---|---|---|---|---|
| | Load | Unload | Total | Load | Unload | Total |
| Foreign | 14,468 | 35,606 | 50,074 | 52,400 | 55,000 | 107,400 |
| Tuna-related | 6,059 | 1,458 | 7,517 | 15,200 | 8,000 | 23,200 |
| Salt | 753 | 0 | 753 | 17,200 | 0 | 17,200 |
| Petroleum | 0 | 24,269 | 24,269 | 0 | 29,700 | 29,700 |
| Others | 7,656 | 9,879 | 17,535 | 20,000 | 17,300 | 37,300 |
| Domestic | 27,176 | 32,471 | 59,647 | 37,200 | 66,900 | 104,100 |
| Tuna-related | 0 | 14,696 | 14,696 | 0 | 37,000 | 37,000 |
| Salt | 10,163 | 0 | 10,163 | 20,100 | 0 | 20,100 |
| Petroleum | 5,890 | 5,770 | 11,660 | 7,400 | 10,900 | 18,300 |
| Others | 11,123 | 12,005 | 23,128 | 9,700 | 19,000 | 28,700 |
| Tranship | 0 | 0 | 108,694 | 0 | 0 | 120,200 |
| Tuna | 0 | 0 | 51,841 | 0 | 0 | 52,000 |
| Petroleum | 0 | 0 | 56,853 | 0 | 0 | 68,200 |
| Total | 41,644 | 68,077 | 218,415 | 89,600 | 121,900 | 331,700 |
| Tuna-related | 6,059 | 16,154 | 74,054 | 15,200 | 45,000 | 112,200 |
| Salt | 10,916 | 0 | 10,916 | 37,300 | 0 | 37,300 |
| Petroleum | 5,890 | 30,039 | 92,782 | 7,400 | 40,600 | 116,200 |
| Others | 18,779 | 21,884 | 40,663 | 29,700 | 36,300 | 66,000 |

Table 5-2-4 Loading Cargo Forecast in 1998 Excluding Petroleum Products

(Unit:MT)

| | 1992 | | | 1998 | | |
|---|---|---|---|---|---|---|
| | Load | Unload | Total | Load | Unload | Total |
| Total | 66,309 | 21,286 | 87,595 | 104,400 | 29,800 | 134,200 |
| (without trs-tuna) | 14,468 | 21,286 | 35,754 | 52,400 | 29,800 | 82,200 |
| Tuna-tranship | 51,841 | 0 | 51,841 | 52,000 | 0 | 52,000 |
| Salts | 753 | 10,163 | 10,916 | 17,200 | 20,100 | 37,300 |
| Rice | 0 | 2,001 | 2,001 | 0 | 1,500 | 1,500 |
| Flour | 846 | 22 | 868 | 0 | 1,100 | 1,100 |
| Cement | 0 | 31 | 31 | 0 | 400 | 400 |
| Fertilizer | 0 | 0 | 0 | 0 | 1,700 | 1,700 |
| Canned food | 6,059 | 0 | 6,059 | 15,200 | 0 | 15,200 |
| Others | 6,810 | 9,069 | 15,879 | 20,000 | 5,000 | 25,000 |

Table 5-2-5 Unloading Cargo Forecast in 1998 Excluding Petroleum Products

(Unit:MT)

| | 1992 | | | 1998 | | |
|---|---|---|---|---|---|---|
| | Load | Unload | Total | Load | Unload | Total |
| Total | 11,337 | 78,542 | 89,879 | 25,300 | 108,000 | 133,300 |
| (without tranship-tuna) | 11,337 | 26,701 | 38,038 | 25,300 | 56,000 | 81,300 |
| Rice | 4,000 | 872 | 4,872 | 0 | 4,600 | 4,600 |
| Flour | 0 | 1,053 | 1,053 | 0 | 3,600 | 3,600 |
| Tuna-related | 1,458 | 66,537 | 67,995 | 8,000 | 89,000 | 97,000 |
| (without tranship-tuna) | 1,458 | 14,696 | 16,154 | 8,000 | 37,000 | 45,000 |
| Cement | 2,195 | 4,752 | 6,947 | 5,600 | 3,700 | 9,300 |
| Coffee | 0 | 303 | 303 | 0 | 1,600 | 1,600 |
| Fertilizer | 0 | 0 | 0 | 1,900 | 0 | 1,900 |
| Animal & Vegetable oil | 437 | 45 | 482 | 1,100 | 200 | 1,300 |
| Metal products | 877 | 334 | 1,211 | 1,100 | 300 | 1,400 |
| Others | 2,370 | 4,646 | 7,016 | 7,600 | 5,000 | 12,600 |

(2) Cargo volume stored in yard and shed

1) Cargo volume stored in yard

According to the interview with CMDM, cargo commodities stored in yard are mainly container and steel, and the share of container cargo shows an increasing trend. Moreover most tuna-related cargoes excluding tuna are already containerized. Based on the data of CMDM, the share of container cargo in "Other cargo" and the volume of container cargo is forecast. The results of the estimate are shown in Table 5-2-6.

Table 5-2-6 Cargo Volume Stored in Yard (1998)

(Unit:%, MT)

| | | Container | | | | | Metal products | Total |
|---|---|---|---|---|---|---|---|---|
| | | Other cargo | | Tuna-related | | Total | | |
| | | Share of container | Container volume | Share of container | Container volume | | | |
| Loading | Foreign | 90 | 18,000 | 100 | 15,200 | 33,200 | 0 | 33,200 |
| | Domestic | 5 | 300 | 100 | 0 | 300 | 0 | 300 |
| Unloading | Foreign | 50 | 3,800 | 100 | 8,000 | 11,800 | 1,100 | 12,900 |
| | Domestic | 15 | 700 | 100 | 0 | 700 | 300 | 1,000 |
| Total | Foreign | - | 21,800 | - | 23,200 | 45,000 | 1,100 | 46,100 |
| | Domestic | - | 1,000 | - | 0 | 1,000 | 300 | 1,300 |
| | Total | - | 22,800 | - | 23,200 | 46,000 | 1,400 | 47,400 |

2) Cargo volume stored in shed

Excluding petroleum products and cargoes stored in yard, most other cargoes are usually stored in shed. As most domestic loading cargoes such as rice, flour, cement and fertilizer are transhipment cargoes, it is necessary to distinguish these cargoes from other cargoes stored in shed so that cargoes are not counted twice. The results of the estimate are shown in Table 5-2-7.

Table 5-2-7 Cargo Volume Stored in Shed (1998)

(Unit:MT)

| | Foreign | | | Domestic | | | Total |
|---|---|---|---|---|---|---|---|
| | Loading | Unloading | Total | Loading | Unloading | Total | |
| Rice | 0 | 0 | 0 | 0 | 4,600 | 4,600 | 4,600 |
| Flour | 0 | 0 | 0 | 0 | 3,600 | 3,600 | 3,600 |
| Cement | 0 | 5,600 | 5,600 | 0 | 3,700 | 3,700 | 9,300 |
| Coffee | 0 | 0 | 0 | 0 | 1,600 | 1,600 | 1,600 |
| Cooking oil | 0 | 1,100 | 1,100 | 0 | 200 | 200 | 1,300 |
| Fertilizer | 0 | 1,900 | 1,900 | 0 | 0 | 0 | 1,900 |
| Others | 2,000 | 3,800 | 5,800 | 4,800 | 4,300 | 9,100 | 14,900 |
| Salt | 17,200 | 0 | 17,200 | 40,100 | 0 | 40,100 | 57,300 |
| Total | 19,200 | 12,400 | 31,600 | 44,900 | 18,000 | 62,900 | 94,500 |

Note: Volume of salt in domestic loading cargo includes cargo for land transpotation

## 5.3 Required Port Facilities and Equipment

### 5.3.1 Forecast of Vessel Size by Vessel Type

In proposing the Master Plan, the statistics of calling vessels were analyzed and future trends in 2010 were forecasted, taking into account the present situation. In the Short-Term Development Plan, too, it is necessary to forecast the maximum calling vessel size by type for the target year, 1998.

As mentioned in section 3.6, in the records of calling vessels to the port of Antsiranana in 1990, some 30,000 DWT class vessels can be seen. Therefore, in the Short-Term Development Plan, in order to accommodate those vessels in full load, it is necessary to plan the maximum berth dimension on the precondition that the maximum calling vessel size is 30,000 DWT.

However, the calling frequency of large vessels is pretty low, that is to say, calling vessels with over 150 m overall length account for less than 8 % of the total in 1990.

If the quay is planned to accommodate 30,000 DWT class vessels in full load, the construction costs would necessarily be high, raising some doubts about the efficacy of such an investment, especially since it is assumed that 30,000 DWT class vessels will seldom call in full load in the near future. Even if 30,000 DWT class vessels do call at the port in full land, they will be able to use the berth for 10,000 DWT class vessels after the draught is decreased through transhipment of the oil products to coastal tankers. On the contrary, it is said that a major shipping company is acquiring 10,000 DWT class cargo vessels in Madagascar. Therefore, it is logical to think that 10,000 DWT class vessels will be the mainstream calling vessels in the near future.

Taking the above into account, it is appropriate to adopt 10,000 DWT as the maximum calling vessel size for the Short-Term Development Plan.

As to coastal vessels and fishery boats, the present maximum vessel size will probably not change in the near future because the economic situation and commercial mode in Madagascar will not drastically change by the target year, 1998.

As a result, both 10,000 DWT and 5,000 DWT class vessels are proposed as the maximum vessel size of coastal vessel and fishery boat, taking account of a slight redundancy and increasing vessel size.

5.3.2 Required Berth Dimension by Vessel Size

Standard dimensions of vessels and of berths corresponding to vessels are adopted here as shown in Table 4-5-1. Next, the berth dimension by vessel type excluding 30,000 DWT is shown in Table 5-3-1.

Table 5-3-1 Berth Dimension by Vessel Type

| Tonnage (DWT) | Cargo Vessel Size | | | Berth Dimension | |
|---|---|---|---|---|---|
| | Overall Length (m) | Moulded Breadth (m) | Full load Draft (m) | Length of Berth (m) | Water Depth of Berth (m) |
| 2,000 | 81 | 12.7 | 4.9 | 100 | 5.5 |
| 5,000 | 109 | 16.4 | 6.8 | 130 | 7.5 |
| 10,000 | 137 | 19.9 | 8.5 | 170 | 10.0 |

5.3.3 Required Number of Berths

(1) Methodology

The method employed in the Master Plan is also adopted here. This method considers the frequency of ship entry and cargo handling productivity. The berth occupancy ratios, one of the most important factors when using this method, are also the same ones as in the Master Plan, which are recommended by UNCTAD. They are shown in Table 4-5-2.

(2) Premises for calculation

1) Annual number of working days

The Study Team adopted 310 days as annual working days in 2010, assuming one day off a week. However, the target year of the Short-Term Development, 1998, is fast approaching. Therefore, based on the present working days, 320 days is proposed as the number of annual working days in the Short-Term Development Plan.

2) Average cargo handling productivity per day by vessel

In the Master Plan, five figures were proposed as the average cargo handling productivity per day by vessel. In the Short-Term Development Plan, too, the same figures have been adopted because they reflect rather closely the present cargo handling capacity.

3) Average cargo volume carried per vessel

a. Conventional general cargo vessel

Formulating the Master Plan in section 4.5.2, average cargo volume carried per vessel was estimated in 1990 and 2010 by ocean-going and coastal vessels respectively. Here, in the Short-Term Development Plan, average cargo volume carried per vessel in 1998 is determined assuming the growth rate as constant from 1990 to 2010. Consequently, 650 tons and 500 tons per vessel are estimated for ocean-going and coastal vessel respectively.

b. Tanker operated by SOLIMA

According to additional surveys and interviews with SOLIMA's managers, it was found that SOLIMA's tankers are operated semi-regularly. However, as far as the relationship between demand and supply of oil products in the hinterland is stable, it is natural that revolving frequency of oil tanks is also stable and that tankers call semi-regularly as they do.

It is thought that coastal and ocean-going tankers will call once a month and once every two months respectively to carry oil products forecasted in 1998. Therefore, the average cargo volume carried by ocean-going and coastal tankers will be 5,000 tons and 1,600 tons per vessel respectively.

c. Fishery boat for tuna

It is appropriate to adopt the same carriage volumes as those in the Master Plan because tuna fishing activities in the Indian Ocean will not change drastically. That is, average volume of tuna carried by fishery boat and fishery cargo vessel is 900 tons and 3,000 tons per vessel respectively.

(3) Berth requirements

Following the same line of thinking as in the Master Plan, total berthing days are calculated (results are shown in Table 5-3-2). In this table, it is necessary to give attention to the cargo volume of petroleum by SOLIMA, parts of which are transhipped from ocean-going to coastal tankers in the Diego-Suarez Bay while the remainder is handled through pipeline outlets alongshore into SOLIMA's storage tanks. Therefore, as to imported oil products, the cargo volume is given, which is left after transhipment is transported through pipeline to the quay.

Table 5-3-2 Calculation of Berthing Days

| Items | Unit | Calculation | General Cargo | | Petroleum by SOLIMA | | Tuna | |
|---|---|---|---|---|---|---|---|---|
| | | | Domestic | International | Domestic | International | Factory | Tranship |
| ① Cargo Volume | 1,000 tons | | 48.80 | 77.70 | 18.30 | 29.70 | 37.00 | 52.00 |
| ② Average Cargo Volume per Vessel | tons | | 500.00 | 650.00 | 1,500.00 | 5,000.00 | 900.00 | 3,000.00 |
| ③ Number of Calling Vessels | calls | ①/② | 98 | 120 | 12 | 6 | 42 | 18 |
| ④ Handling Productivity per Day | tons | | 300.00 | 500.00 | 3,000.00 | 7,200.00 | 400.00 | 400.00 |
| ⑤ Berthing Days per Vessel | days | ②/④ | 1.67 | 1.30 | 0.53 | 0.69 | 2.25 | 7.50 |
| ⑥ Number of Days Necessary other than Cargo Handling | days | | 0.20 | 0.20 | 0.20 | 0.20 | 0.20 | 0.20 |
| ⑦ Total Berthing Days per Vessel | days | ⑤+⑥ | 1.87 | 1.50 | 0.73 | 0.89 | 2.45 | 7.70 |
| ⑧ Total Berthing Days | days | ③*⑦ | 183.00 | 180.00 | 9.00 | 6.00 | 103.00 | 139.00 |

From this table the following berthing days are obtained:

For international cargo

Total berthing days = 186 days

For coastal cargo

Total berthing days = 192 days

For tuna cargo

Total berthing days = 242 days

Considering the recommended maximum berth occupancy ratio, 0.5 for two berths, required number of berths is calculated as follows:

| | |
|---|---|
| For international cargo | 186/320/0.5=1.2 |
| For coastal cargo | 192/320/0.5=1.2 |
| For tuna cargo | 242/320/0.5=1.5 |

From the results, it is observed that either one or two berths are needed for each type of cargo, assuming that international, coastal and tuna cargo would be exclusively handled at separate berths. If one berth for each type of cargo is planned, giving a total

of three berths, congestion may become a problem. On the other hand, allocating two berths for each type of cargo (six berths in all) would raise construction costs to an excessively high level. Thus an alternative which mitigates the negative effects of the above scenarios must be sought.

First, the method of determining berth number is examined. It is said that the recommended berth occupancy ratio is decided on condition of a certain ratio between berth construction cost and ship's expenses. Namely, as a ship's expenses become higher, ship operators move to reduce ship waiting cost etc. This means that berth occupancy ratio changes with the above mentioned ratio. In Madagascar, generally speaking, almost all vessels are superannuated and their expenses are low. Therefore it is possible to apply a larger berth occupancy ratio. If 0.6 or 0.7 is adopted (which are reportedly the actual ratios in ports similar to Antsiranana), the required number of berths is three or four. One more factor that largely controls berthing time is the handling productivity. The values adopted here are not high compared with other ordinary cases. These figures are realistic, in view of the current cargo handling capacity. So, it will be possible for the cargo handling company to achieve higher performance in handling productivity when more cargoes are handled. The higher it gets, the less berthing time becomes, so that the number of required berths will decrease.

Next, berth usage at the port of Antsiranana is considered. In most Japanese ports, each berth has a specified length and almost all calling vessels are assigned to a certain berth by the port management body. In Madagascar, the total length of each berth is not specified, so the number of berths is not fixed. Accordingly, calling vessels are moored alongshore to the extent possible. Figure 5-3-1 shows the typical usage of berths at present. It is observed that the existing quays are usually assigned as three or four berths. Compared with the above results, the required number of berths is nearly sufficient in terms of the present usage, but not quite enough. As the Figure 5-3-1 shows, ocean-going vessels cannot be accommodated at the existing quay because of the shortage of quay length, in case that two domestic vessels are moored. In the Short-Term Development Plan, extension of the quay should be included. Further, it is desirable to adopt the principle of specified use of each berth in terms of management and operation. If this method, is applied, the total required length of the quay must be longer even if the required number of berths is the same as in the present system.

There is another issue at the port of Antsiranana which requires attention. Every year from March to June, a lot of tuna fishery boats rush into the port and cause heavy congestion. It is said that this situation has become more severe year by year. Taking this into account, it is important to give appropriate flexibility or redundancy to the berth.

Based on the above, it is thought that four is the best selection as the required number of berths in the Short-Term Development Plan. In principle, one will be assigned for international cargo, one for fishery cargo and two for coastal cargo, but when many vessels call simultaneously, they can be used flexibly.

One more thing that must be planned is the basin for small crafts where vessels refuge, rest or are repaired by SECREN. The quay to be extended southward by the French aid, should be used to cope with this subject and this has basically been agreed upon by the Madagascan counterpart.

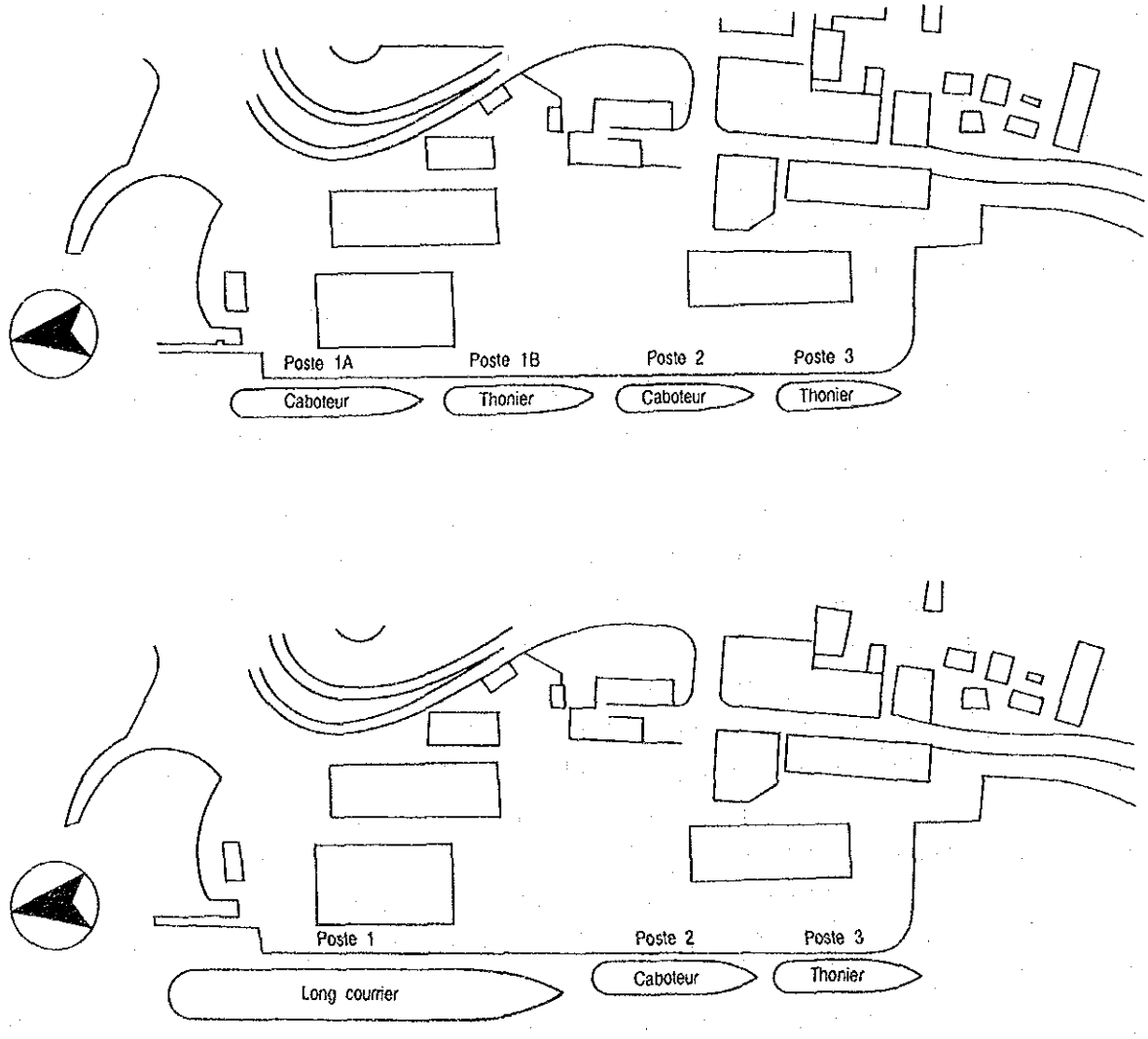



Figure 5-3-1 Typical Berth Usage in the Port of Antsiranana

5.3.4 Required Scale of Facilities

(1) Required Scale of Berths

As mentioned above, required scale of berths is as follows:

Mainly used for ocean-going vessels

- maximum ship size 10,000 D/W class
- number of berth 1
- depth 10 m
- total length 170 m

Mainly used for coastal vessels

- maximum ship size 5,000 D/W class
- number of berth 2 (at high season, they are flexibly assigned for ocean-going vessels or fishery boats, too)
- depth 7.5 m
- total length 260 m

Mainly used for fishery boats

- maximum ship size 5,000 D/W class
- number of berth 1
- depth 7.5 m
- total length 130 m

Related to the layout plan, there is a transition area from the depth of 7.5 m to 10 m. That is, some part of the 7.5 m depth quay is constructed with the same structure as the 10 m depth quay.

Almost the entire area of the existing water basin is 8.5 m in depth. However, there are some places where the depth is only 7.5 m between the area of 8.5 m depth and 10 m depth. This is not a good condition for ship maneuvering.

Considering the convenient usage of the planned 7.5 m depth quay, the transition area between 7.5 m depth and 10 m depth should be planned over 8.5 m in depth.

Consequently, the depth of the transition area is proposed to be 8.5 m to 10 m. This also contributes to reducing the construction cost by using dredged materials for reclamation.

(2) Required Scale of Water Basin

The required scale of water basin is the same as for the Master Plan, excluding 30,000 DWT class, which is not planned for the Short-Term Development Plan.

However, for over 5,000 DWT class vessels, in this case, 10,000 DWT class vessels, maneuvering is assisted in principle by a tugboat. If there are no tugboats, the water basin of a circle with a diameter of not 2*L(L:overall length of maximum vessel size, 137 m for 10,000 DWT class) but 3*L, is preferably planned in front of the 10 m depth quay.

But it must be recognized that the construction cost should be minimized in the Short-Term Development Plan. Therefore, in the Master Plan stage the turning basin with 3*L will be provided, but in the Short-Term Development Plan the cost should be saved by securing the diameter of 2*L.

In addition, under normal weather conditions, it is not difficult for a vessel to turn round at the planned water area in front of 10 m depth quay.

As a result, water basin in front of 5,000 DWT and 10,000 DWT class quay is planned to ensure 7.5 m depth and 10 m, which is a circle of a diameter of 327 m and 274 m, respectively.

(3) Required Scale of Storage Area

In the Short-Term Development Plan, it is also necessary to decide the scale of storage area, for transit sheds, open yard and container stacking area.

The required area to store forecasted cargo volume through storage facilities is calculated by the same method as that in the Master Plan. After that, the capacity of the existing facilities is examined, parts of which will be used after necessary rehabilitation works and the rest of which will be demolished. The scale to be newly constructed by 1998, the target year, must be determined.

In applying the above method, it is necessary to take another look at the parameters, in particular, revolving frequency per year(hereinafter, it is shown as "R"). Annual cargo volume is given by cargo demand forecast. Average unit storage cargo volume per area is determined following the kind of cargo. Peak ratio and utilization ratio have smaller fluctuations than "R". The scale of storage area largely depends on the value of "R". Therefore, after the characteristics of "R" are examined in detail, the value of "R" in the Short-Term Development Plan will be decided.

At first, it is necessary to distinguish transit sheds from warehouses. The former's function is mainly to store temporarily cargoes, which are classified, sorted, inspected, and then moved to customs. On the other hand, the latter is to store cargoes over a long period. Transit sheds are required for the quick dispatch of vessels and for smooth connection with land transportation. Cargoes, in general, are not stored long in transit sheds. On the contrary, in warehouses, the longer cargoes stay, the higher storage charge. Transit sheds and warehouses have different staying time and fee systems.

In general, "R", which is related to staying time, is as follows:

| | |
|---|---|
| For transit shed | 20-25 |
| For warehouse | 8-12 |

In regard to the structure, there is no big difference between transit sheds and warehouses. In some ports, no distinction can be seen at all.

The problem is how transit sheds in the port of Antsiranana are used and will be used in the near future.

According to our surveys, cargoes excluding salt and container cargoes are apt to stay long, that is, the function of the transit shed is more like that of a warehouse.

Salt is stored for about two weeks so that "R" becomes around 25. Storage of container cargoes corresponds to the frequency of calling vessels such as semi-container ships or multi-purpose ships. Those vessels are calling regularly and this situation will continue. In 1998, monthly container service is assumed and "R" is 12. As to other cargoes, it is thought that "R" should be the same as ones of warehouses.

Consequently, "R", other than salt and container cargoes, is taken as 12 in this Plan.

Here, assuming other parameters shown in Table 5-3-3 and applying the formula in section 4.5.4, the storage area of transit sheds can be obtained as follows:

Table 5-3-3 Required Area of Transit Shed

| Good | Cargo volume (W) (ton) | Peak ratio (c) | Revolving frequency per year (R) | Utilization ratio (a) | Unit storage cargo volume (w) (ton/$m^2$) | Storage area (A)($m^2$) |
|---|---|---|---|---|---|---|
| Salt | 57,300 | 1.1 | 25 | 0.6 | 2.0 | 2,100 |
| Other than salt | 26,200 | 1.5 | 12 | 0.6 | 2.0 | 3,900 |

Total required storage area of transit sheds = 6,000 $m^2$

As mentioned before, in this Plan, it is very important to minimize construction cost and not to force owners to reconstruct or replace their facilities. To that end, the existing sheds will be retained as much as possible. Therefore, it is proposed that, excluding transit sheds or other booths which obviously prevent good usage of port facilities as a whole, all of them be retained by doing necessary rehabilitation works. To be concrete, Magazine P, Port Office magazine and two residences near Port Office should be demolished while other transit sheds, buildings and booths will be retained.

Here, the total area of transit sheds (excluding those which are to be demolished) is about 6,800 $m^2$. This is larger than the required area. Thus no further transit sheds will be required.

An open yard for iron and metal products is needed. The annual cargo volume in 1998 is forecasted at only about 1,400 tons. By the similar calculation method as employed for transit sheds, the required area of the open yard is obtained to be under 70 $m^2$. So, an area of 100 $m^2$ is planned as the open yard, allowing for a little redundancy and flexibility for the future and harmonizing with the Master Plan.

The last thing to consider concerning storage areas is the container stacking Yard. The calculation method is already shown in section 4.5.4.

The container throughput number (N) in terms of TEUs in open yard is given. The total number of loaded and unloaded containers is 2,800 TEUs in 1998. However, there are many more loaded containers than unloaded containers. The difference between them corresponds to the number of empty containers which are estimated to represent 1,800 TEUs. Then, assuming that other parameters in this formula are the same as the

ones of the Master Plan, the results can be obtained i.e. the net stacking area of laden and empty containers. Finally, considering working space, required area of open yard for container stacking is as follows (Figure 5-3-2):

| | |
|---|---|
| For laden containers | 3,275 $m^2$ |
| For empty containers | 1,650 $m^2$ |

On the other hand, the area of existing open yard is about 17,000 $m^2$, much larger than total area required for iron and metal products and for container stacking. This means that no open yards be more required. However, the existing open yard is unpaved and undulated so that a newly paved open yard is required.

On another angle, attention must be paid to the layout of the existing storage facilities. The layout is not appropriate from the viewpoint of the line of cargo handling flows. The flow lines should be short and simple without crossing each other and strategically established to make effective use of the quay or storage facilities. From the viewpoint mentioned above, the layout plan of open yard and transit sheds should be harmonized with the one proposed in the Master Plan. However, in this stage, it is not possible to establish a desirable handling flow line. Therefore, it should be understood that this storage area plan is tentative, a result of the need to minimize construction costs.

The existing refrigerator warehouse, which was constructed in 1991 and owned by PFOI, will remain at the present site.

(4) Protective Facilities for harbors

The location of the present quay is the best for protection against wind and wave. The location of the newly extended quay in the Short-Term Development Plan is on the same line of the existing one, northward. Therefore, the calmness of basin in front of the quay will be secured to allow mooring for a sufficient number of days. This means that no breakwater will be needed.

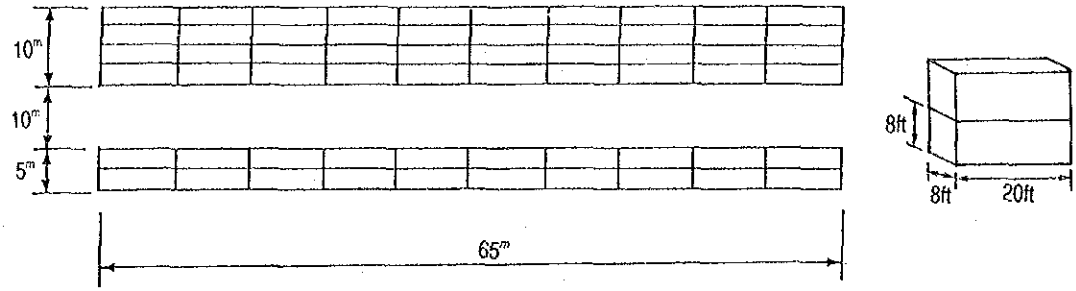
5.3.5 Safety Back-up Facilities

First of all, in order to aid safe navigation, it is necessary to plan a new light marker, at the end of the extended quay that can provided an outline of port facilities.

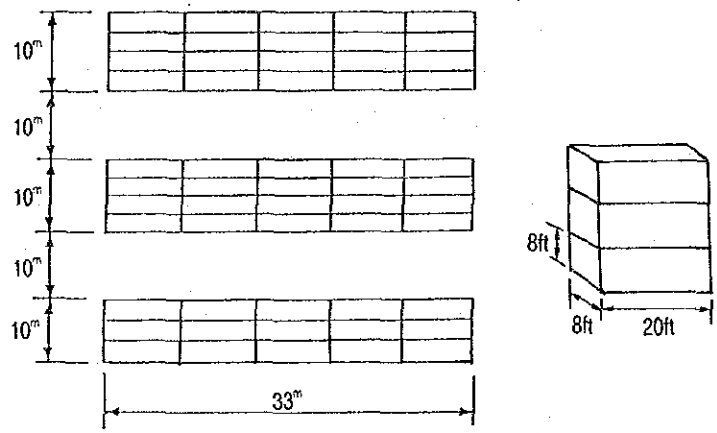
Next, the necessity of tugboat in the Short-Term Development Plan is examined.

According to the method mentioned in section 4.5.5, it is desirable to have at least

<Case 1> for laden containers (C(1))




<Case 2> for empty containers (C(2))




<Case 3> for laden containers (C(3))

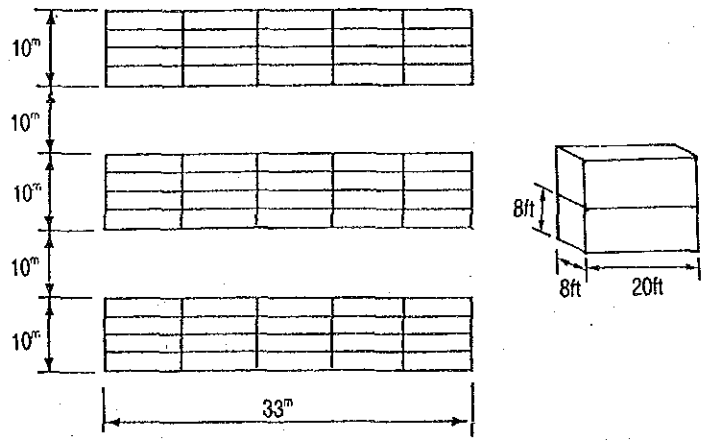



Figure 5-3-2 Open Yard for Stacking Containers

one tugboat. However, considering the low loadfactor of larger vessels, the dominant westerly wind and relatively wide and deep water basin in front of the large quay, 10,000 DWT class vessels can manage to maneuver without tugboats.

The present pilotage system should be kept.

Consequently, in the Short-Term Development Plan, it is believed that safe navigation will be ensured without any additional safety back-up system, on condition that present facilities work well.

5.3.6 Cargo Handling System

In 1998, it is likely that the present system for cargo handling will remain unchanged. At present, almost all oil products are transferred by pipeline, parts of them, i.e. imported ones by ocean-going tankers, are transhipped in the Bay and all other cargoes are handled by ship crane and forklifts etc. In 1998, too, the kinds of cargoes and those package types will be almost the same as at present, so that the cargo handling system will also be the same.

Corresponding to the extension plan of quay, pipeline of oil products transportation should be extended or replaced. The plan will be proposed later.

First the capacity of cargo handling equipment is examined. In principle, in order to handle general cargo efficiently, it is desirable for CMDM, the stevedore, to have at least three or four forklifts per one gang, one of which is in ship's hold, another one or two are on the apron and the remaining one is in the transit shed. At present CMDM owns eight forklifts and their working condition is good. This means that two gangs can smoothly do their jobs simultaneously and three gangs can do so by means of ship's assistance. In addition, CMDM owns other handling equipment to handle over three container cargoes simultaneously. Therefore, even taking account of the handling situation at its peak, it is thought that CMDM will be able to cope with required handling productivity in 1998 without any additional investment. However, if possible, for example, when CMDM replaces or renews some superannuated forklifts, it is recommended that CMDM procure more capable ones (at least over three ton handling capacity). In such a way, CMDM will ensure greater handling productivity more easily.

### 5.3.7 Other Infrastructures and Utilities

In line with the new plan, some of the existing buildings or facilities etc. will be replaced, extended or demolished. Based on the principle that as many of the present infrastructures and utilities will be retained as possible, the following is proposed:

(1) Replacement of two residences for people working at the Port and a warehouse attached to the Port Office

(2) Demolition of the above mentioned residences and warehouse

(3) Pavement of port road
(No new port access road will be planned because additional traffic density due to the new Plan is estimated to be negligible and the existing road will be able to cope with that for the time being)

(4) Extension and construction of new fence and gates

(5) Extension of oil supply pipeline and water supply pipeline
(Part of the former will be rehabilitated)

Both of the above pipelines are owned by private sectors i.e. SOLIMA and JIRAMA. Therefore, those construction costs should be borne by them and those works should be done after coordination with other construction works of relevant port facilities.

## 5.4 Proposed Short-Term Development Plan

The Short-Term Development Plan should be recognized as the first stage of the Master Plan. In addition, as mentioned many times before, it is necessary to retain as many of the existing facilities as possible in order to minimize the total construction cost. This means that the layout plan of the Short-Term Development Plan may slightly differ from that of the Master Plan. In other words, the Short-Term Development Plan has some so-called tentative elements and it is preferable to become coincident with the Master Plan in the long run. Therefore, even though it is necessary to plan the layout in order to retain as many facilities as possible, it is expected that their reconstruction or replacement will be needed in the process of expansion for the Master Plan.

Roughly divided, the layout plan consists of that of the face line and of the ground.

As to the face line, the quay will be extended northwards, connected with the existing quays, and the revetment line will be planned so as to ensure sufficient ground area with a tentative structure at an economical construction cost.

As to the ground plan, reflecting the agreement between the Study Team and the Madagascan counterparts, as many of the existing transit sheds, buildings or booths will be retained as possible. On top of that, it is proposed that port road used in conveying cargo to make clear the division of the port facilities, allow cargo to be handled more smoothly and efficiently and promote orderly port management.

On the other hand, the width behind the quay is about 100 m and not sufficient for a conventional general cargo terminal. So, in this Plan, it is proposed that the aprons be 20 m wide, whereas they are 30 m wide in the Master Plan.

With reference to management and operation, it is thought that the principle of specified usage of each berth, which is proposed in the Master Plan, should be kept.

Following the above mentioned, the Short-Term Development Plan is proposed as in Figure 5-4-1.

By the way, the dictates of necessity have meant that the above plan falls short of the ideal scenario. For example, the quay where ocean-going vessels will usually moor is a little bit away from the open yard and the transit sheds for exported commodities such as salt or canned tuna, so that roads on which cargo is transports are relatively long and some flow lines may cross one another. In the event that Magasin CCI can be replaced, another layout plan has been proposed. That is also different from the Master Plan but it can be converted into the Master Plan. In reference to the next step to the Master Plan, another layout plan is shown in Figure 5-4-2.

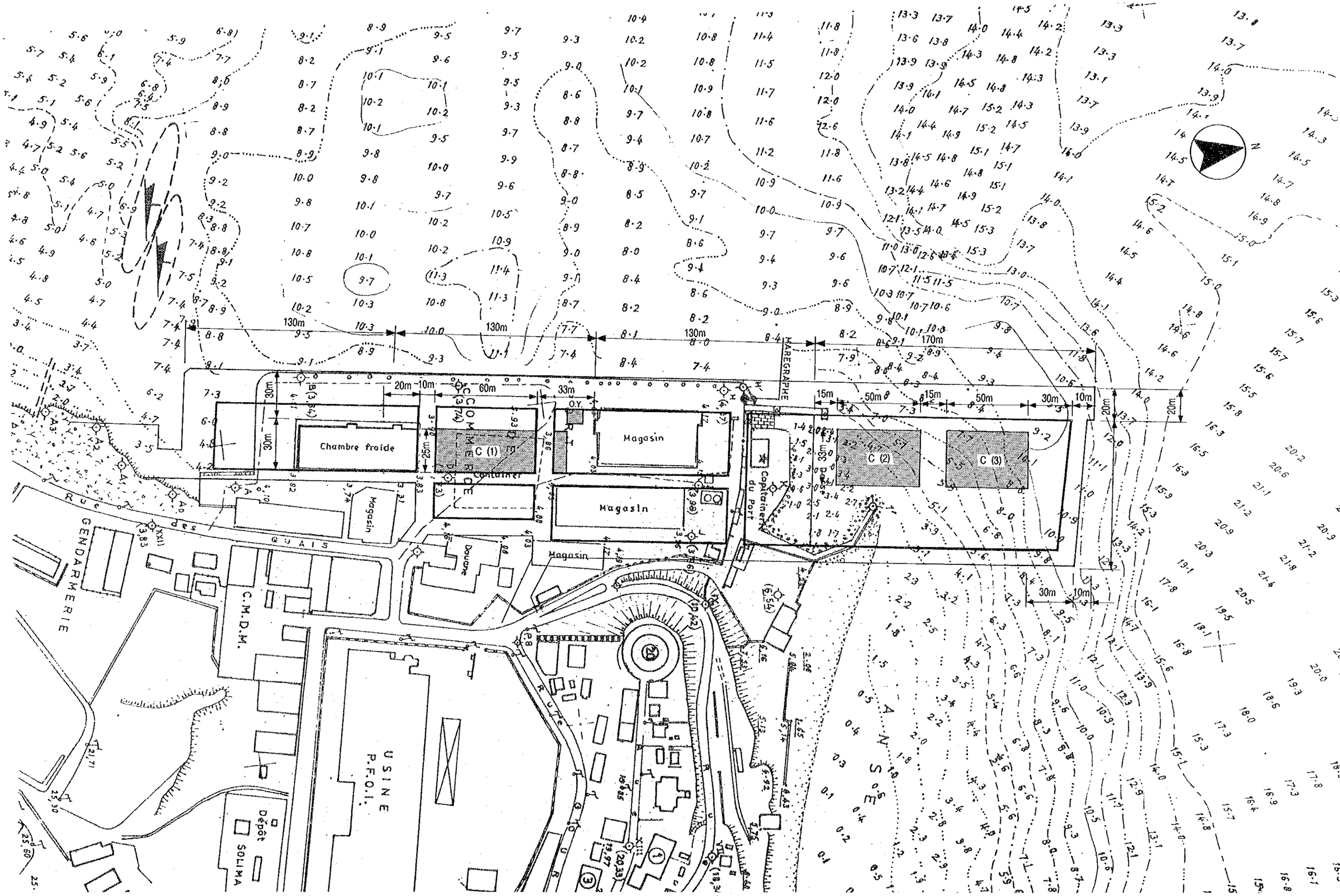



Figure 5-4-1 Proposed Short-Term Development Plan

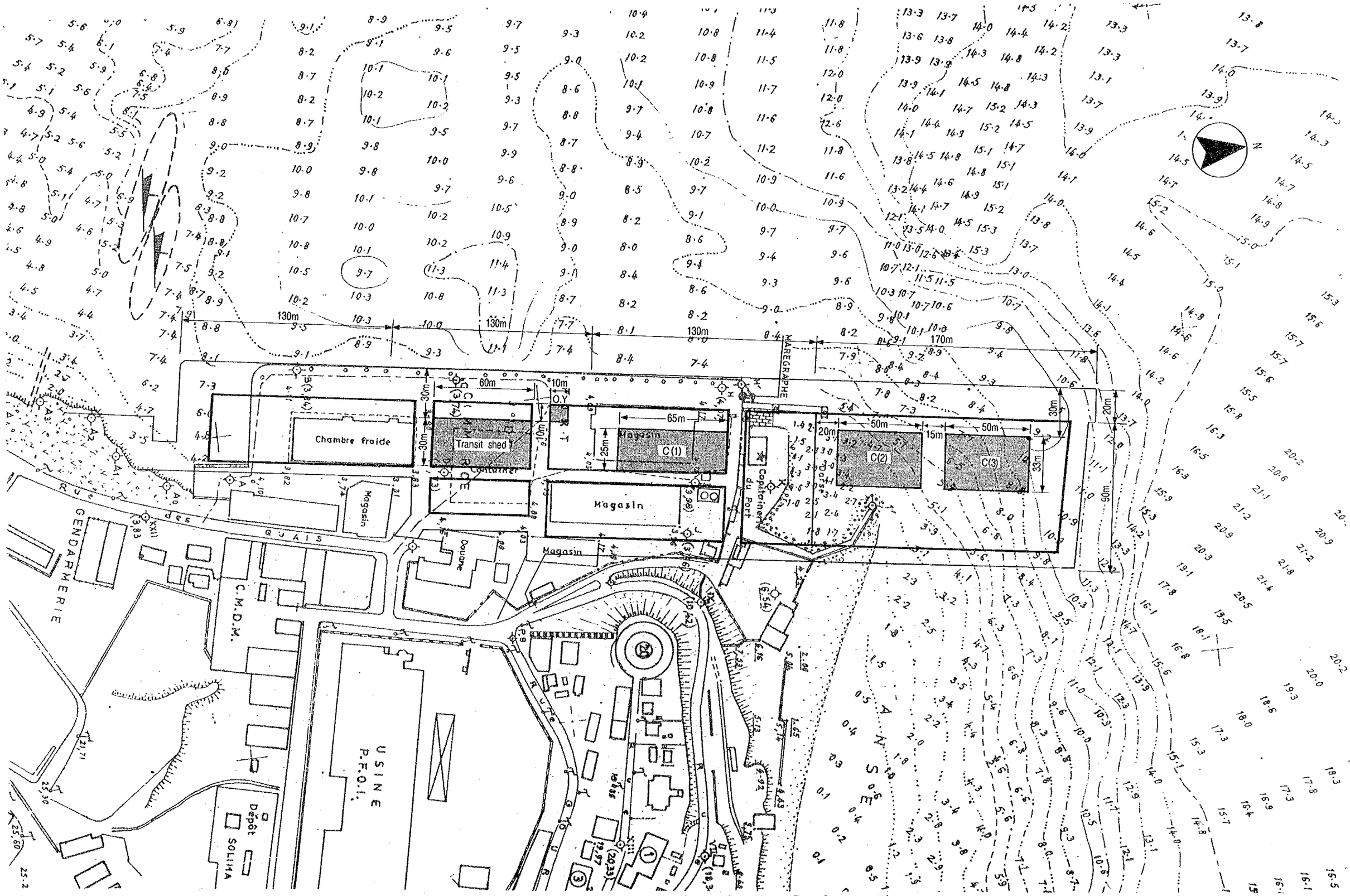



Figure 5-4-2 Alternative Layout Plan of The Short-Term Development Plan

## 5.5 Structural Design

### 5.5.1 Design Premises

Port facilities planned in the Short-Term Development Plan are designed based on the following premises.

- Existing facilities such as superannuated or deteriorated quays are properly repaired and utilized as much as possible.
- Planned port facilities are designed in accordance with the layout plan shown in figure 5-4-1.

### 5.5.2 Existing Port Facilities

(1) Design Conditions

1) Facilities

Existing old quay and new quay are main facilities.

2) Design conditions

The design conditions are shown in Table 5-5-1.

Table 5-5-1 Design Conditions of Existing Quay

| Item | Old Quay | New Quay |
|---|---|---|
| Water Depth | -8.5 m (-7.5 m) | |
| Object Vessel | 5,000 DWT: Coastal Cargo Vessel | |
| Berth Length | 120 m | 181 m |
| Surcharge | 2.0 tf/m$^2$ | |
| Live Load | Forklift Truck: 20 to 40 tf<br>Truck Crane: 40 tf | |
| Lifetime | 20 years | |

Note: The figure in parentheses refers to the Master Plan.

(2) Old Quay

The rehabilitation of the old quay is examined for the slab S2 of the superstructure as described in section 4.7.1. The structural drawings were obtained during the second field study as shown in Appendix A-5.5.1.

From the structural calculation, the stress of this slab is over the allowable stress at the load condition of the surcharge and the present load-carrying capacity will not be sufficient for the live load.

The rehabilitation plan such as reconstruction of the slab S2 is shown in Figure 5-5-1.

(3) New Quay

The new quay is of a steel sheet pile cellular-bulkhead structure and the outline cross section of this quay is shown in Figure 5-5-2, which was drafted with the drawings in 1966.

Under the present situation, the new quay is stable. For the rehabilitation of the quay, corrosion prevention of the steel sheet piles is considered to maintain the stability. The extent of of corrosion can be divided into the area above the tidal zone and the portion in sea water.

The galvanic anode method is adapted mainly because of ease of maintenance below M.L.W.L.in Figure 5-5-2. For the area above the tidal zone, corrosion protection is not required. The reasons are as follows:

- The corrosion rate (0.1mm/year) is small and same order in sea water.
- Damage to the sheet piles surface during the construction work shall be avoided.
- This area is not so important compared to the portion in sea water as structural member.

However, inspection is suggested to be done periodically.

5.5.3 Planned Port Facilities

Port facilities included in the Short-Term Development Plan comprise two portions, namely the Public Portion to be furnished by the Government and the Private Sector Portion to be installed by the private companies relevant to port activities.

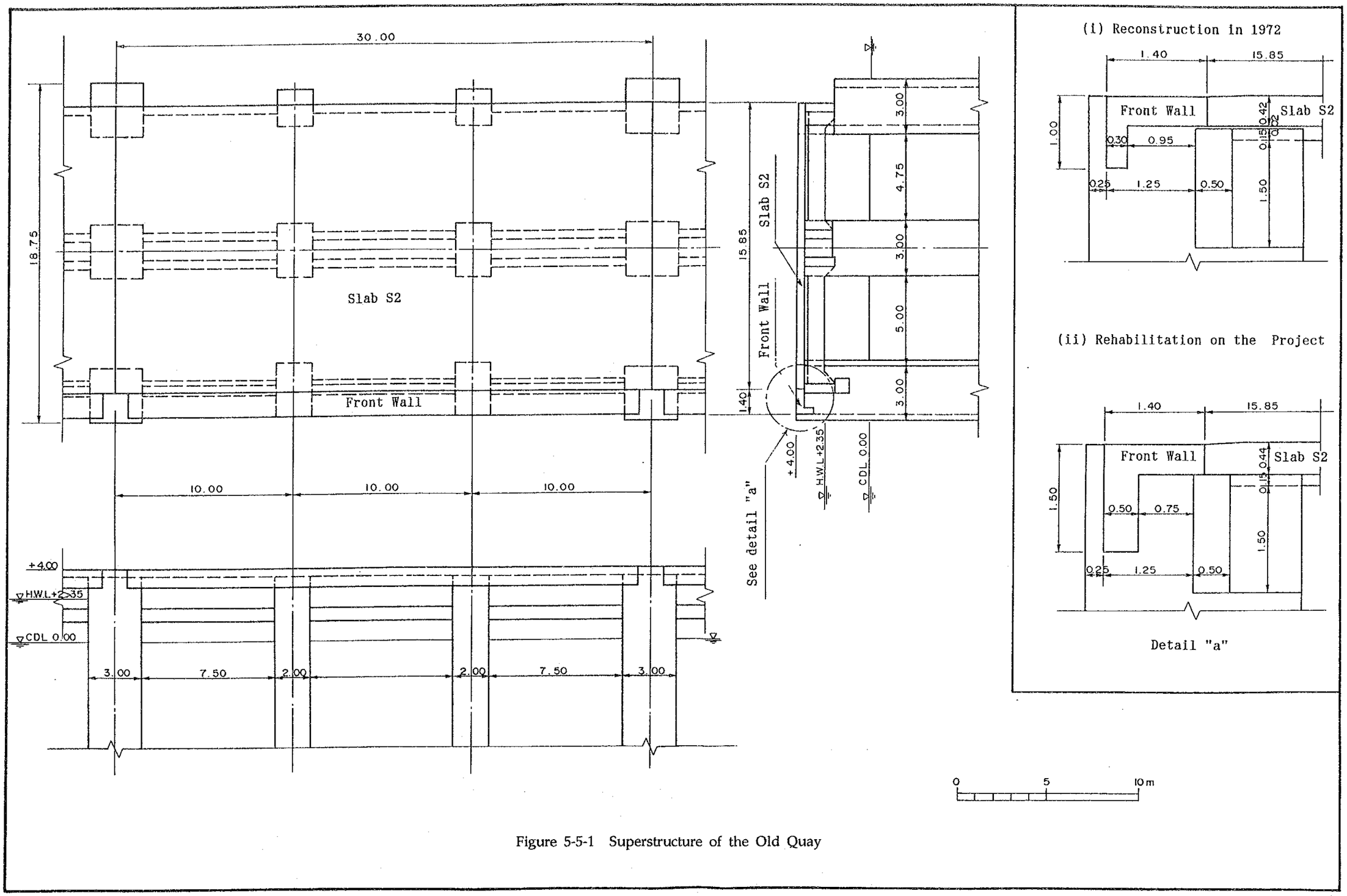



Figure 5-5-1 Superstructure of the Old Quay

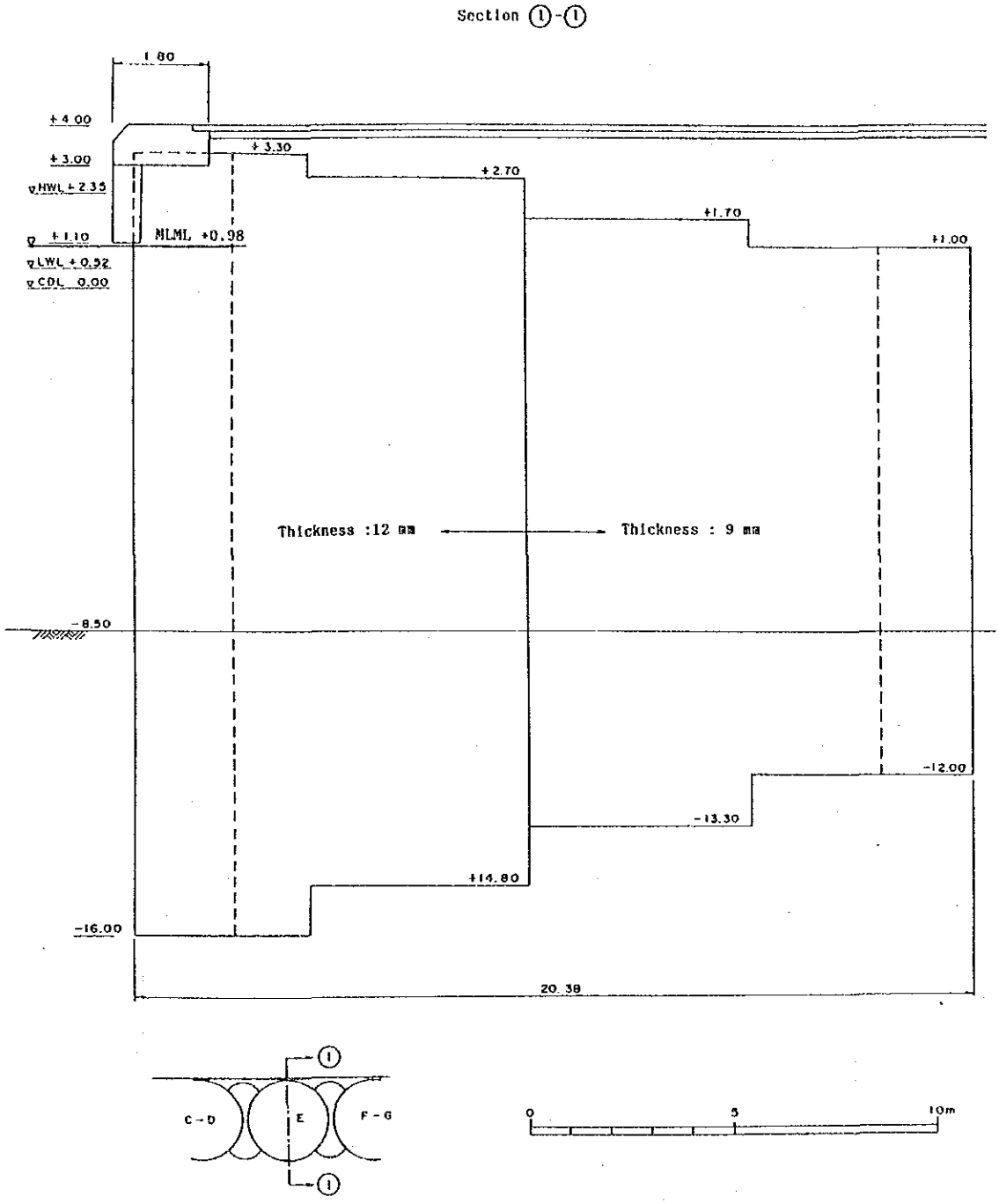



Figure 5-5-2 Cross Section of the New Quay

The Public Portion of the port facilities is composed of the fundamental items for the port activities as follows.

- Quays and Revetment
- Dredging and Reclamation
- Land and Road
- Building of Port Office
- Aids to Navigation

The Private Sector Portion comprises the facilities operated by the private sector, such as CMDM, CCI, SOLIMA, JIRAMA and other relevant companies.

- Shed
- Oil Supply Pipeline
- Water Supply Pipeline

(1) Design Conditions

1) Facilities

A berth for ocean-going vessels comprises the main facilities.

2) Design Conditions

The basic design conditions for the planned facilities are shown in Table 5-5-2.

Table 5-5-2 Design Conditions of Planned Quay

| Item | Planned Berth |
|---|---|
| Water Depth | -10 m |
| Object Vessel | 10,000 DWT |
| Crown Height | +4.0 m |
| Berth Length | 170 m : 1 Berth |
| Surcharge | 2.0 tf/m$^2$ |
| Live Load | Forklift Truck: 20 to 40 tf<br>Truck Crane: 40 tf |
| Lifetime | 50 years |

The natural conditions are as follows:

- Tidal Level : H.W.L.+2.35 m, L.W.L.+0.52 m
  CDL 0.00 m
- Wave Height : H= 1.6 m, T= 3.9 sec
- Seismic Coefficient : Kh= 0.0
- Soil : The typical soil conditions in this area are shown in Figure 5-5-3. The surface soft soil layer consisting of soft clay, plastic clay or silty sand is ignored in designing and soft limy marl or basalt boulders and pebbles which have an N-value of less than 15 are also ignored. Limy marl layer with N-value of over 50 is considered as the reliable bearing stratum.

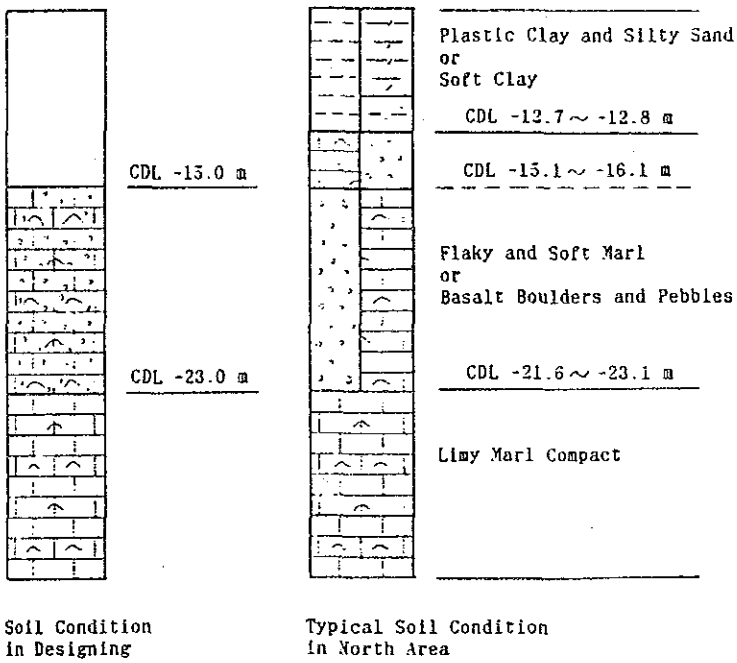



Figure 5-5-3 Soil Condition

The other conditions are listed as follows:

- Berthing velocity : 0.15 m/sec
- Reinforced concrete
  Standard Design Strength : 240 kgf/cm$^2$
- Steel Bar for Reinforcement
  Allowable Tensile Strength : 1800 kgf/cm$^2$

- Steel sheet pile
  Allowable Bending Tensile stress : 1800 kgf/m$^2$

(2) Design of Main Port Facilities

1) Berth for Ocean-going Vessels

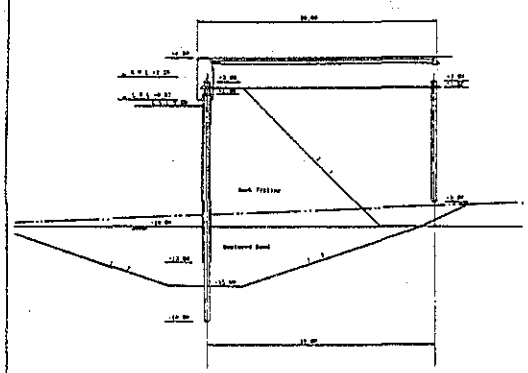
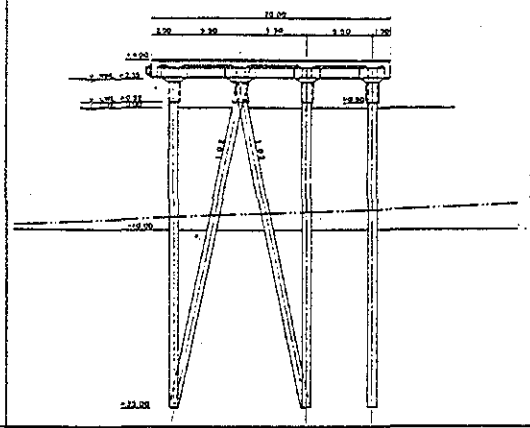
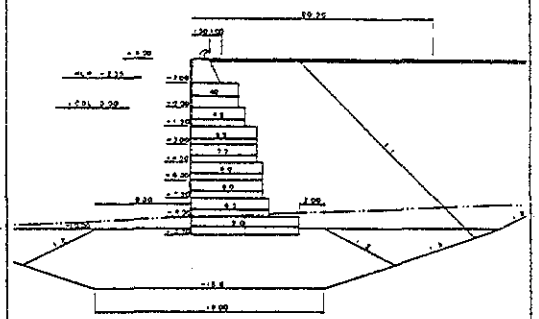
The three basic alternatives of the new berth, gravity type, steel sheet pile and steel pipe pile type, are compared in Table 5-5-3. From the comparison shown in the Table, steel sheet pile type is better than both steel pipe pile type and gravity type considering that the steel pipe pile type requires smaller scale construction equipment and that the construction period is shorter. Furthermore, this type is more economical.

For the new berth, therefore, steel sheet pile type is adopted as the fundamental structure. A typical cross section of a quay for cargo vessels is shown in Figure 5-5-4.

The following matters will require careful consideration in the detailed design and construction stage of this quay.

- Treatment of north end of sheet piles
- Connection between south end of new berth and old quay

Table 5-5-3 Structural Type Comparison of New Berth

| Structural Type | Steel Sheet Pile Type | Steel Pipe Pile Type | Gravity Wall Type |
|---|---|---|---|
| Typical Cross Section |  |  |  |
| Natural Conditions | *This type is suitable even for relatively soft bed layer. But the replacement of surface soft soil layer with sand is required.<br><br>*This structure is subject to wave attack during construction. | *This type is suitable for relatively soft bed layer. In case of batter piling system, the replacement is not required.<br><br>*Platform may be easily damaged by wave force during construction. | *Large scale replacement of surface soft soil layer with sand is required.<br><br>*This structure is stable against wave force during construction. |
| Condition of Use | *Construction of open yard is easy. | *Retaining wall is required behind pier for open yard. | *Construction of open yard is easy. |
| Condition of Execution | *This type requires a shorter construction period and less mobilization of construction equipment. | *This type requires a longer construction period and more mobilization of construction equipment. | *A longer construction period is required. In case of concrete block type, a larger manufacturing yard is required. |
| Construction Cost Rate | 1.0 | 1.2 | 1.5 |
| | adopted | | |

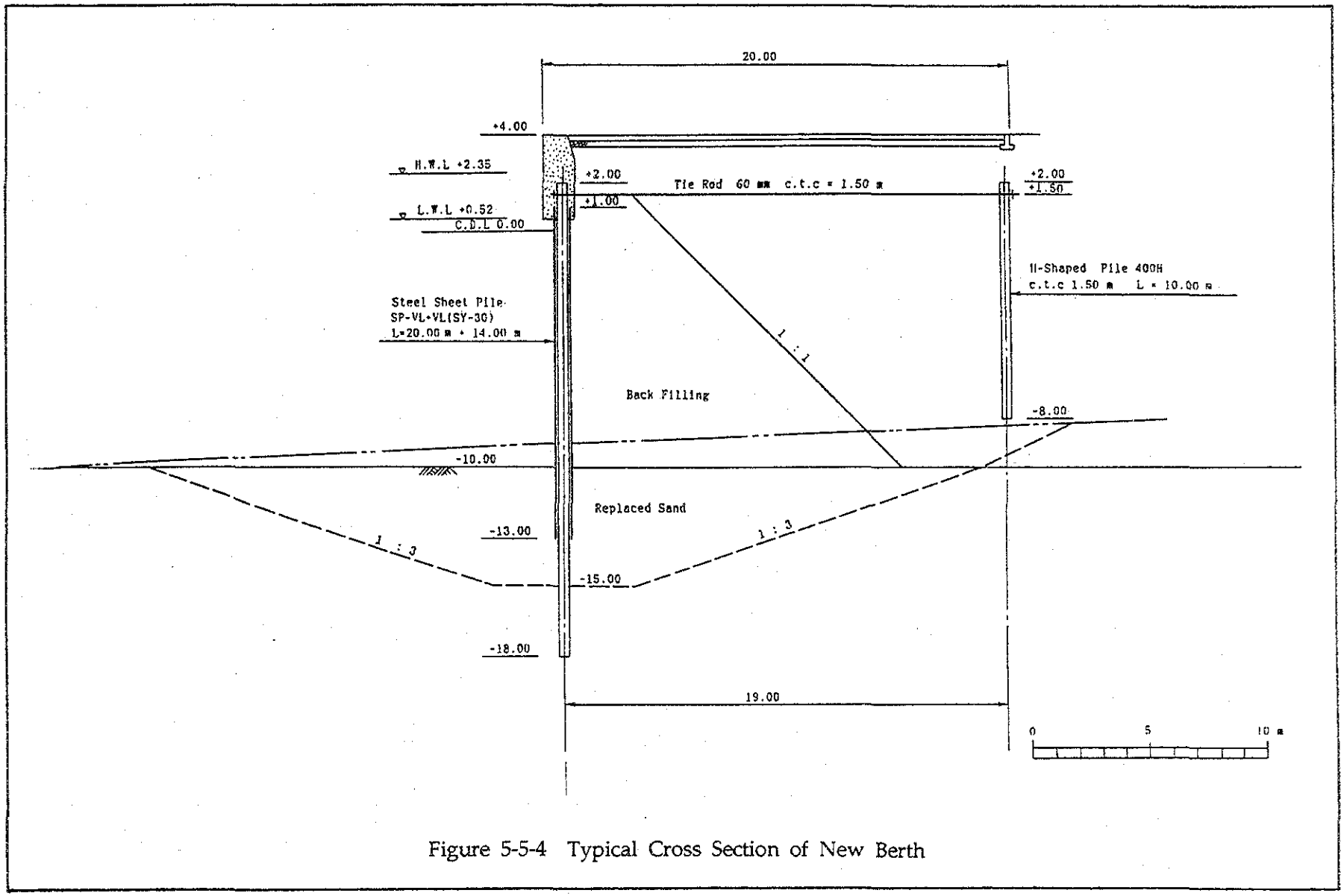



Figure 5-5-4 Typical Cross Section of New Berth

(3) Design of Other Facilities

Other port facilities are divided into Public Portion and Private Sector Portion.

1) Public Portion

- Roads and open yard

  Roads in the port are paved with concrete, 30 cm in thickness as shown in Figure 5-5-5, and have 2 lanes with 10 m width. Furthermore, in principal, the open yard is paved with concrete, 30 cm in thickness.

- Revetment

  The structure of the revetment is rubble-mound type shown in Figure 5-5-6.

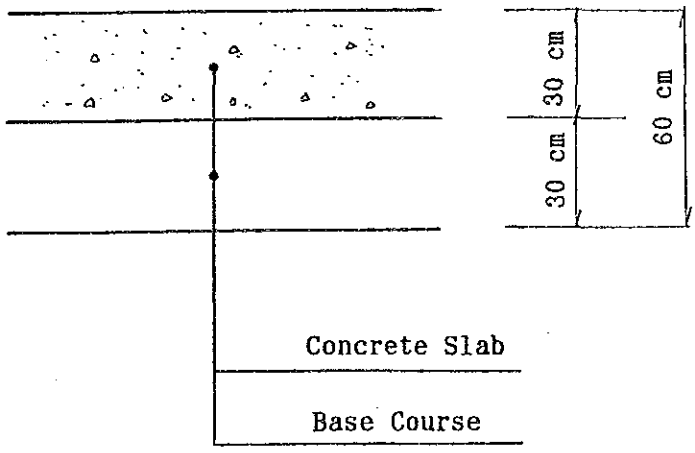



Figure 5-5-5 Cross Section of Concrete Pavement

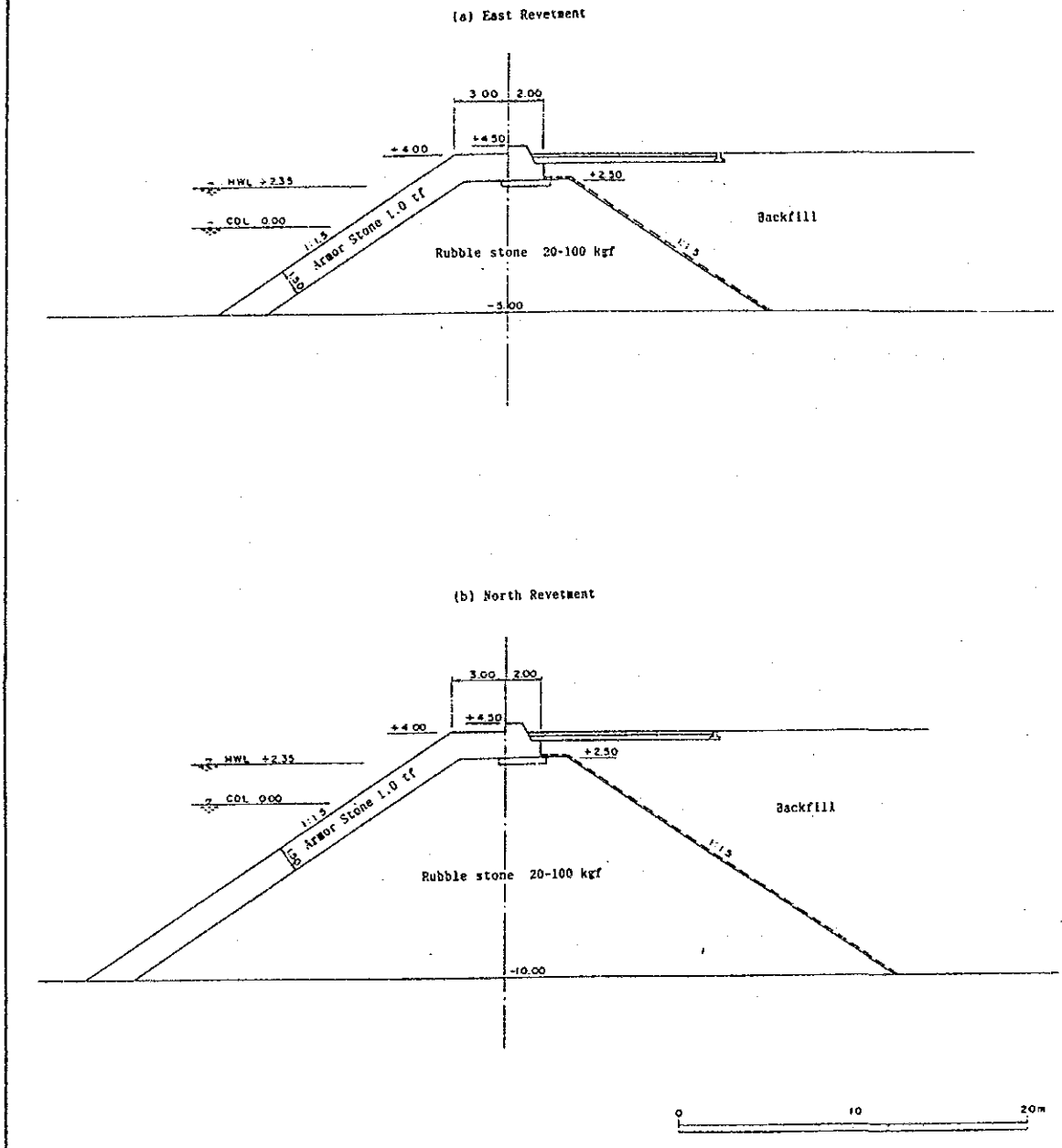



Figure 5-5-6 Cross Section of Revetment

2) Private Sector Portion

- Transit Sheds : CC-I, CC-II, A, H, C

The total area of existing sheds requiring rehabilitation works is estimated as follows:

Roofs : 8,300 sq.m

Walls : 4,000 sq.m

Roofs and walls are of colored steel sheet galvanized with zinc and aluminum. Steel shutters are also replaced.

- Oil Supply Pipelines

The total length of oil pipelines is 691 meters, including 431 meters of extension and 260 meters of rehabilitation as shown in Figure 5-5-7 and Table 5-5-4. Steel pipes of pipeline I and III are installed in a new pipe conduit and the structure is shown in Figure 5-5-8. For a part of the pipe conduit crossing the road, metal cover is used. In case of pipeline II, however, only steel pipes are replaced using the existing pipe conduit.

Table 5-5-4 Dimension of Oil Supply Pipeline

| Name | Type of Oil | Length * Diameter (meter) (inch) | Remarks |
|---|---|---|---|
| Pipeline-I | Fuel Oil<br>Gas Oil | 175 * 12<br>175 * 10 | Extension<br>Extension |
| Pipeline-II | Gas Oil | 260 * 6 | Rehabilitation |
| Pipeline-III | Fuel Oil<br>Gas Oil | 256 * 12<br>256 * 10 | Extension<br>Extension |

- Water Supply Line

The extension length of water supply pipeline is 585 meters, comprising a distribution pipeline of 464 meters and service pipelines of 121 meters as shown in Figure 5-5-7. A distribution pipeline of 175 meters in length is installed in the conduit of oil pipeline I and the other part is laid under the ground. A water meter box and water supply boxes are shown in Figure 5-5-9.

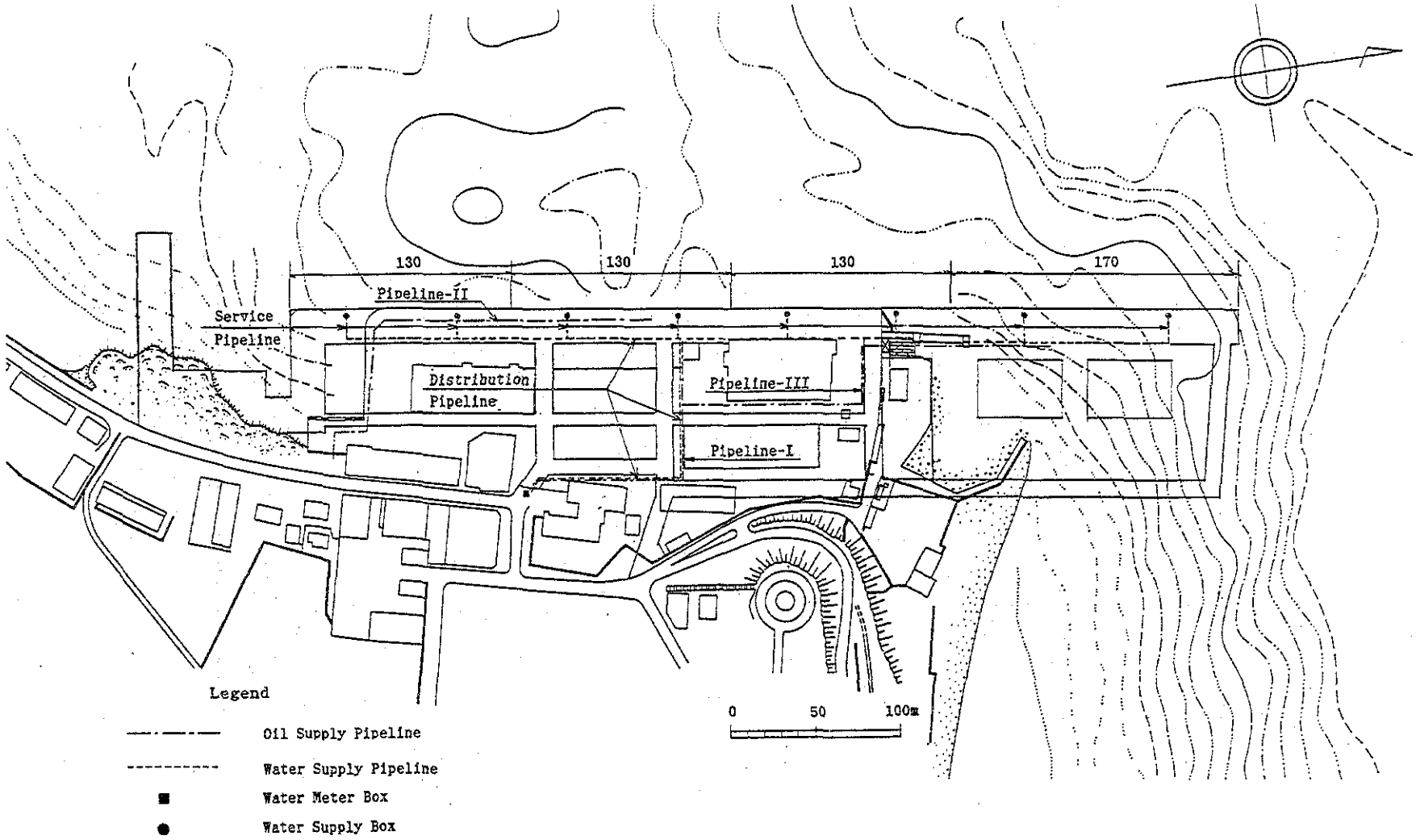



Figure 5-5-7 Arrangement of Oil and Water Supply Pipeline

Pipe Conduit

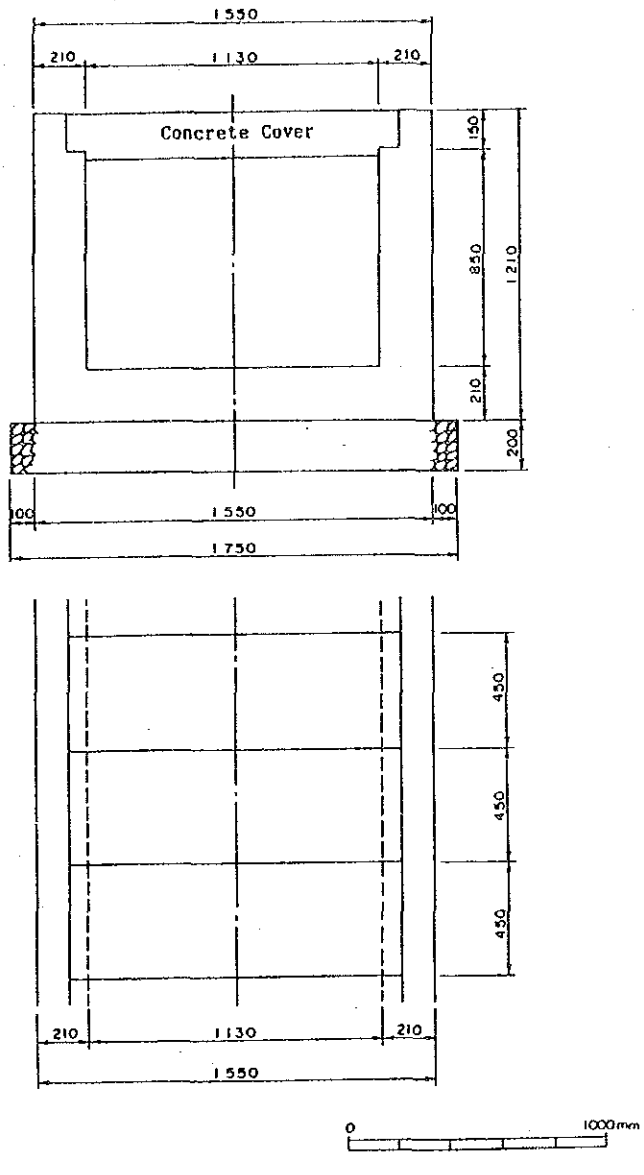
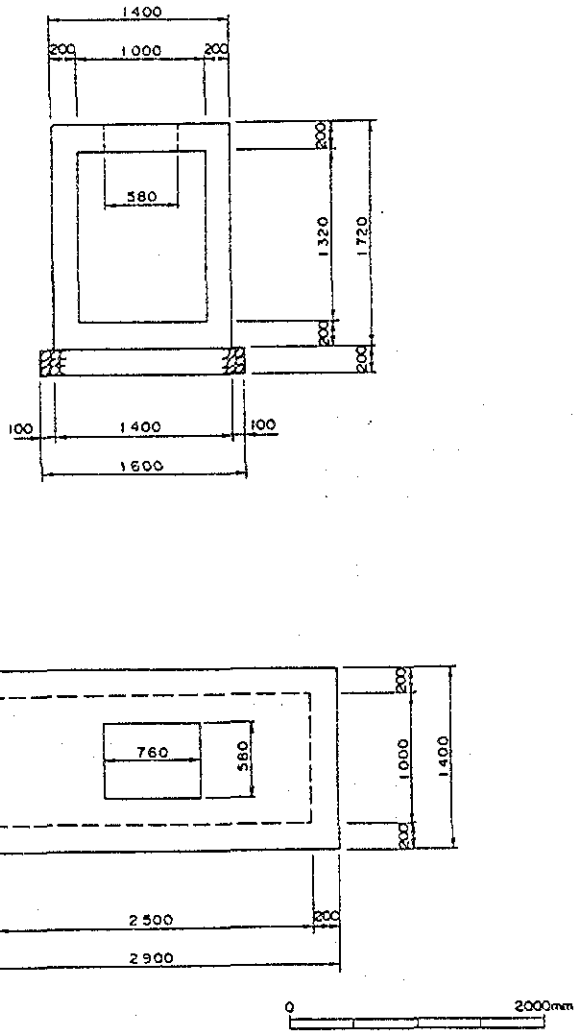



Figure 5-5-8 Pipe Conduit of Oil Supply Pipeline

Water Meter Box




Water Supply Box

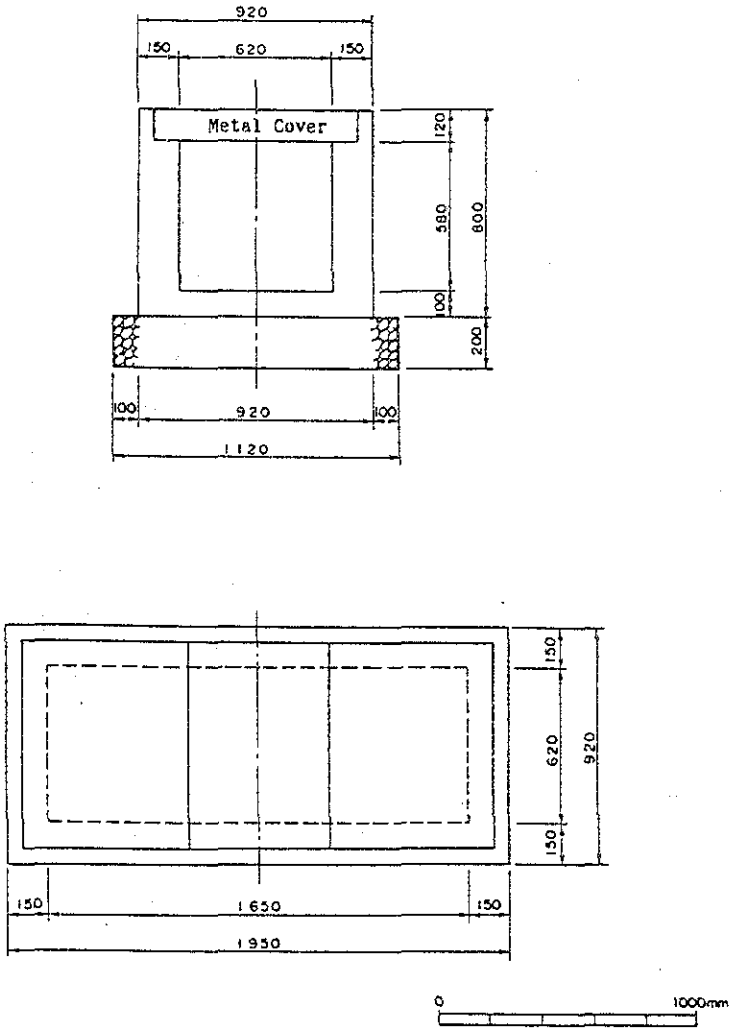



Figure 5-5-9 Boxes of Water Supply Pipeline

## 5.6 Construction Plan

### 5.6.1 Construction Quantities

(1) Facilities

Construction quantities of the Public Portion and the Private Sector Portion included in the Short Term Plan are shown respectively in Table 5-6-1.

Regarding the construction quantities, the following work items are newly added in the Project.

i) The dredging work for the berthing area is newly added in the Short Term Plan to improve the utilization of the existing quay.

ii) Dredged sand is utilized for reclamation to reduce the construction costs. For stock of dredged material, the temporary revetment to compartmentalize the stock and to protect from wave attack is installed in front of the Port office.

iii) The existing sheds in the port area are rehabilitated by the Private Sector. The newly installed sheds in the Master Plan are excluded from the Short Term Plan.

iv) Buildings of Port office, namely one storage and two residences of the port office staff are demolished due to the construction work and are newly constructed.

v) Rehabilitation and extension of the oil pipe line and water supply line are included as the Private Sector Portion.

Table 5-6-1(1) Port Facility and Construction Quantities of Public Portion (Short-Term Development Plan)

| Facility | | Unit | Quantity | Remarks |
|---|---|---|---|---|
| Item | Sub Item | | | |
| 1.Dredging | (1)-10.0m Berth | m 3 | 28,000 | Berthing Area |
| | (2)Old Quay | $m^3$ | 8,000 | Berthing Area |
| 2.Reclamation | (1)Reclaimed Material | $m^3$ | 70,000 | Transferred from Other Area |
| | (2)Dredged Material | $m^3$ | 52,000 | Dredged Material of Berthing Area and Quaywall Foundation |
| | (3)Temporary Revetment | m | 60 | For Stock of Dredged Material |
| 3.Quays | (1)-10.0m Berth | m | 170 | With 20 m Access of North Side |
| | (2)-8.5m to -10.0m Berth | m | 41.5 | With Side Wall Facing Old Quay |
| | (3)Revetment North | m | 90 | Rubble Mound Type |
| | (4)Revetment East | m | 155 | Rubble Mound Type |
| 4.Rehabilitation of Existing Quays | (1)Old Quay | m | 120 | |
| | (2)New Quay | m | 181 | |
| 5.Road | (1)Road | m | 1,062 | 7m, 10m Wide Concrete Pavement |
| | (2)Fence and Gate | m | 300 | With 2-Gates |
| 6. Buildings of Port Office | (1)Storage | $m^2$ | 100 | Magasin to be Replaced |
| | (2)Residence | $m^2$ | 120 | 2-Residences to be Replaced |
| 7. Land | (1)Open Yard(No.1) | $m^2$ | 1,625 | for Laden Container |
| | (2)Open Yard(No.2) | $m^2$ | 1,650 | for Empty Container |
| | (3)Open Yard(No.3) | $m^2$ | 1,650 | for Laden Container |
| | (4)Open Yard(No.4) | $m^2$ | 100 | for Steel Product |
| 8. Aids to Navigation | (1)Light Marker | set | 1 | North End of Quay |
| 9.Demolition | (1)Maritime Structure | LS | 1 | Mooring Dolphin, Breakwater |
| | (2)Land Structure | LS | 1 | Magasin P, Port Office Magasin, 2-Residences near Port Office |

Table 5-6-1(2) Port Facility and Construction Quantities of Private Portion (Short-Term Development Plan)

| Facility | | Unit | Quantity | Remarks |
|---|---|---|---|---|
| Item | Sub Item | | | |
| 1.Rehabilitation of Existing Sheds | (1)Shed(CCI) | $m^2$ | 2,009 | CMDM and Other Relevant Private Sector |
| | (2)Shed(CCII) | $m^2$ | 2,066 | |
| | (3)Shed(A) | $m^2$ | 901 | |
| | (4)Shed(H) | $m^2$ | 1,021 | |
| | (5)Shed(C) | $m^2$ | 930 | |
| 2.Oil Supply Pipeline | (1)Rehabilitation | m | 260 | SOLIMA |
| | (2)Extension | m | 431 | SOLIMA |
| 3.Water Supply Pipeline | (1)Extension | m | 585 | JIRAMA |

(2) Materials

The main materials needed for the construction of the Public Portion are listed in Table 5-6-2. Consumption of water, fuel and electricity for the construction works is not included in this Table.

With respect to the reclamation, the volume of reclamation material is reduced by the utilization of dredged sea bed material.

As shown in the Table, a great amount of construction materials, particularly stone and filling are required for the port construction. Therefore, the supply method of the construction materials should be examined prior to the commencement of the construction.

Table 5-6-2 Main Construction Materials of Public Portion

| Item | Main Materials | | | | | Others |
|---|---|---|---|---|---|---|
| | Steel (t) | Concrete (m3) | Stone (m3) | Gravel (m3) | Filling (m3) | |
| 1.Dredging | --- | --- | 6,390 | --- | --- | |
| 2.Reclamation | --- | --- | --- | --- | 70,000 | |
| 3.Quays | 2,160 | 3,600 | 87,300 | 2,270 | 36,300 | Fender, Bollard, Curbing, Corrosion Protection |
| 4.Rehabilitation | 70 | 850 | --- | --- | --- | Fender, Bollard, Curbing, Corrosion Protection |
| 5.Road | --- | 3,530 | --- | 5,280 | --- | Fence, Gate |
| 6.Buildings and Transit Sheds | 190 | 140 | --- | 100 | --- | |
| 7.Land | --- | 1,510 | --- | 2,270 | --- | |
| 8.Aids to Navigation | --- | --- | --- | --- | --- | Light Beacon |
| 9.Demolition | --- | --- | --- | --- | --- | |
| Total | 2,420 | 9,630 | 93,690 | 9,920 | 106,300 | |

### 5.6.2 Construction Procedure

The port facilities proposed in the Short Term Plan will be constructed using the same methods as mentioned in the Master Plan of Chapter 4.8.2.

### 5.6.3 Construction Schedule

The construction schedule of the Public Portion and the Private Sector Portion is presented respectively in Table 5-6-3. The progress of the construction work according to the construction schedule is illustrated in Figure 5-6-1.

The construction period of the Short Term Plan is expected to be from the last quarter of 1994 to the first quarter of 1998.

Table 5-6-3(1) Construction Schedule of Public Portion (Short-Term Development Plan)

| Facility | | Construction Year | | | | |
|---|---|---|---|---|---|---|
| Item | Sub Item | 1994 | 1995 | 1996 | 1997 | 1998 |
| 1.Dredging | (1)-10.0m Berth | | | | | |
| | (2)Old Quay | | | | | |
| 2.Reclamation | (1)Reclaimed by Transferred Material | | | | | |
| | (2)Reclaimed by Dredged Material | | | | | |
| | (3)Temporary Revetment | | | | | |
| 3.Quays | (1)-10.0m Berth | | | | | |
| | (2)-8.5m to -10.0m Berth | | | | | |
| | (3)Revetment North | | | | | |
| | (4)Revetment East | | | | | |
| 4.Rehabilitation of | (1)Old Quay | | | | | |
| Existing Quays | (2)New Quay | | | | | |
| 5.Road | (1)Road | | | | | |
| | (2)Fence and Gate | | | | | |
| 6.Buildings of Port | (1)Storage | | | | | |
| Office | (2)Residence | | | | | |
| 7.Land | (1)Open Yard(No.1) | | | | | |
| | (2)Open Yard(No.2) | | | | | |
| | (3)Open Yard(No.3) | | | | | |
| | (4)Open Yard(No.4) | | | | | |
| 8.Aids to Navigation | (1)Light Marker | | | | | |
| 9.Demolition | (1)Maritime Structure | | | | | |
| | (2)Land Structure | | | | | |

Table 5-6-3(2) Construction Schedule of Private Portion (Short-Term Development Plan)

| Facility | | Construction Year | | | | |
|---|---|---|---|---|---|---|
| Item | Sub Item | 1994 | 1995 | 1996 | 1997 | 1998 |
| 1.Rehabilitation of Existing Sheds | (1)Shed(CCI) | | | | | |
| | (2)Shed(CCII) | | | | | |
| | (3)Shed(A) | | | | | |
| | (4)Shed(H) | | | | | |
| | (5)Shed(C) | | | | | |
| 2.Oil Supply Pipeline | (1)Rehabilitation | | | | | |
| | (2)Extension | | | | | |
| 3.Water Supply Pipeline | (1)Extension | | | | | |

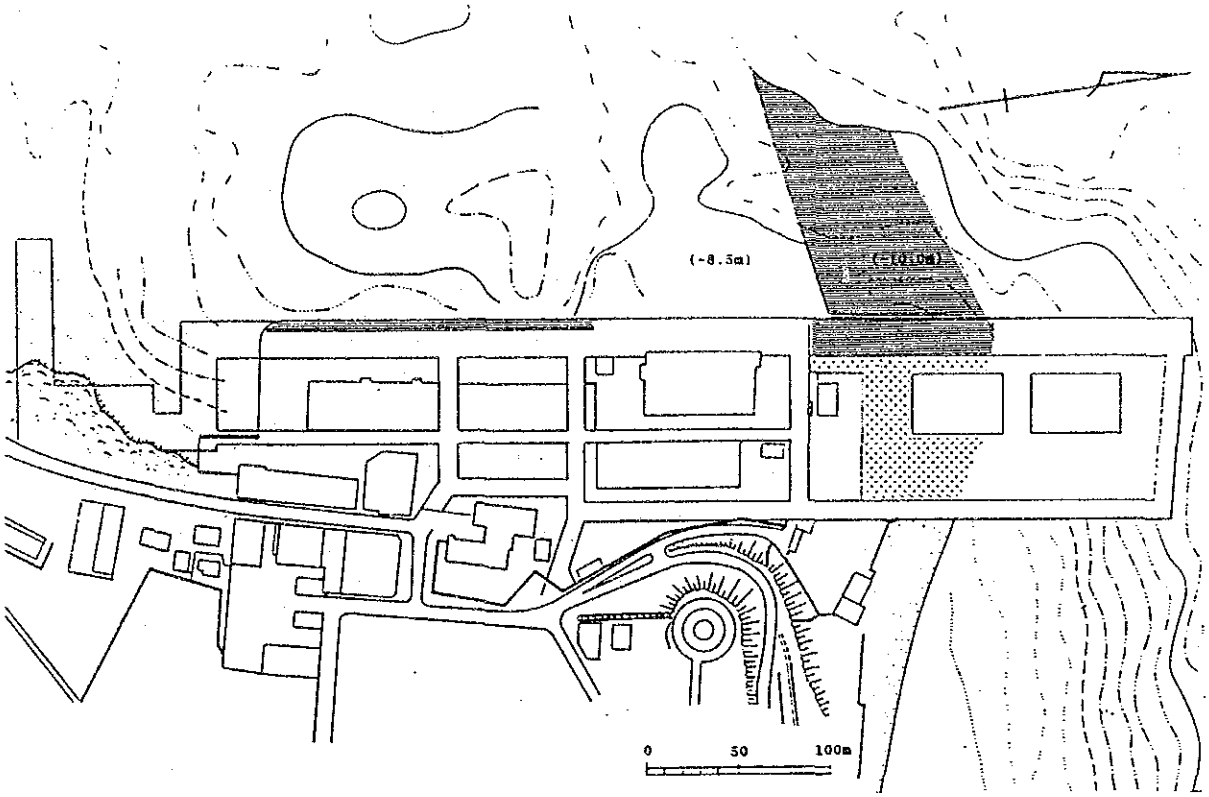



Figure 5-6-1(1) Construction Progress by the End of 1995

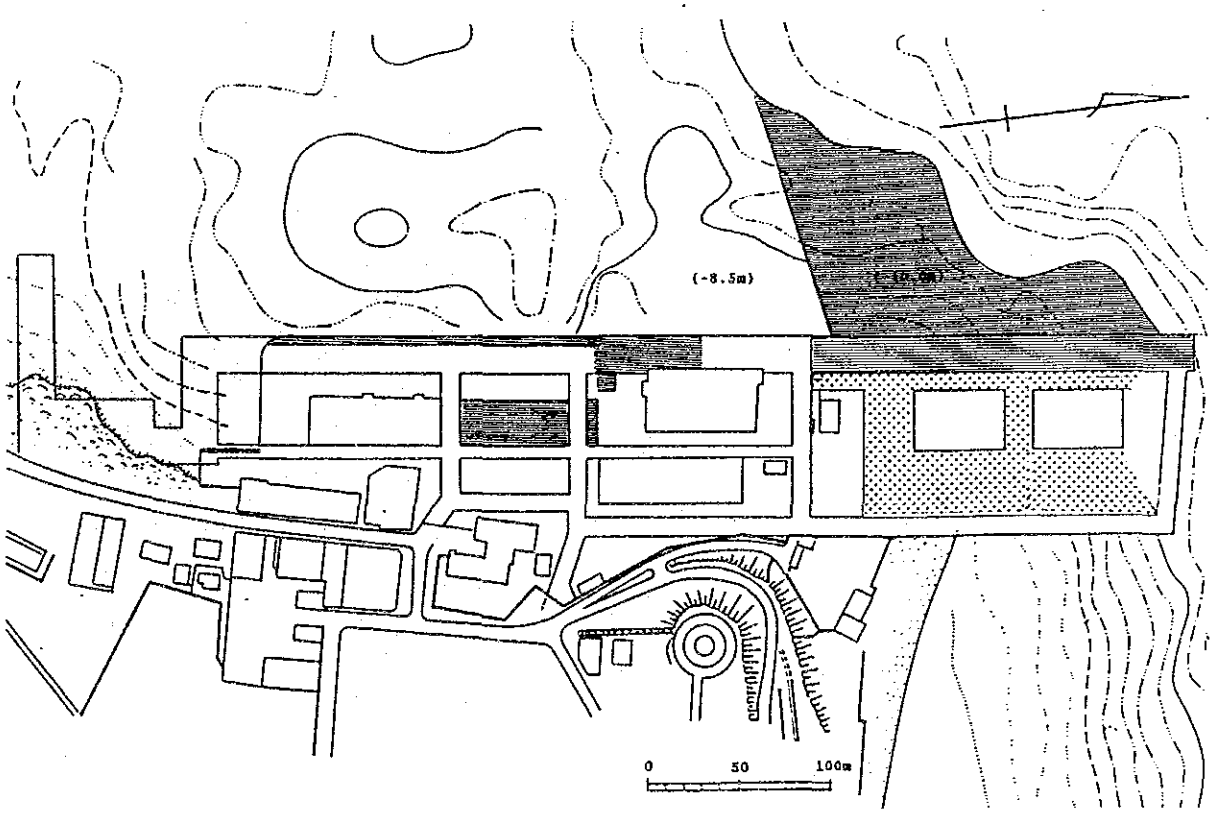



Figure 5-6-1(2) Construction Progress by the End of 1996

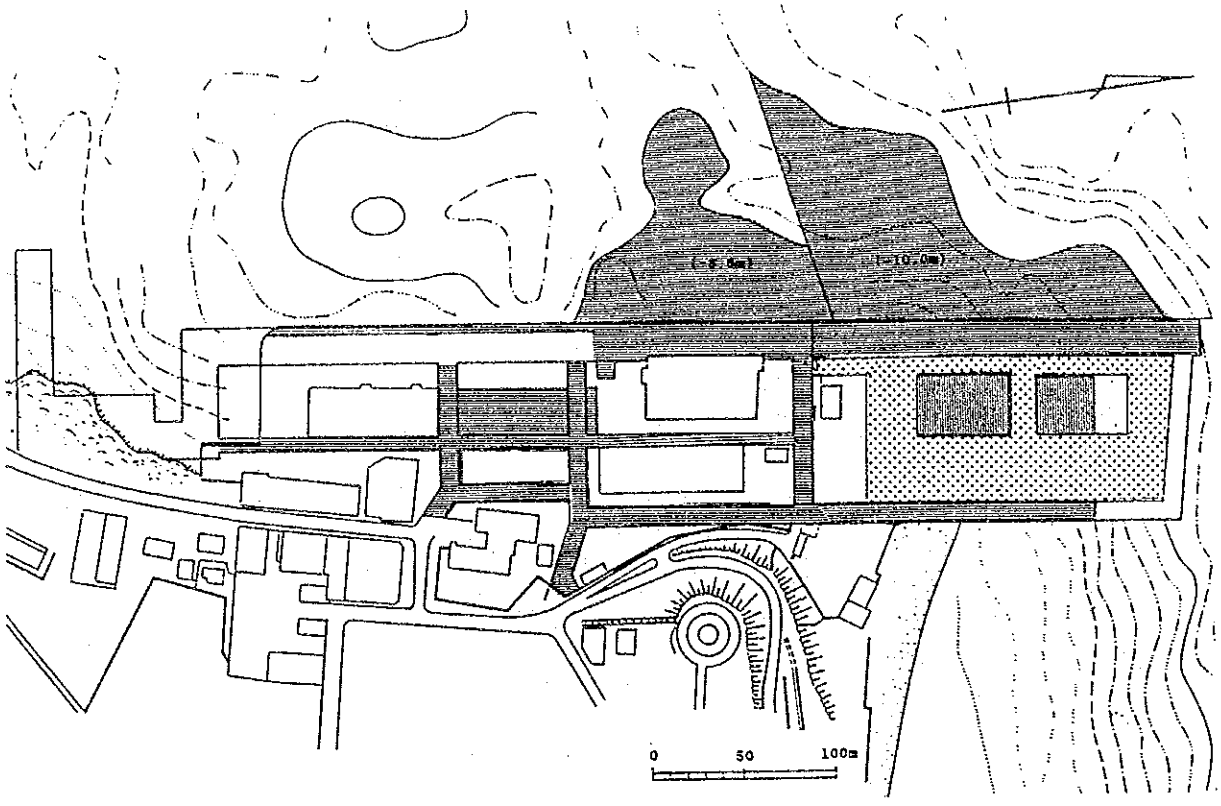



Figure 5-6-1(3) Construction Progress by the End of 1997

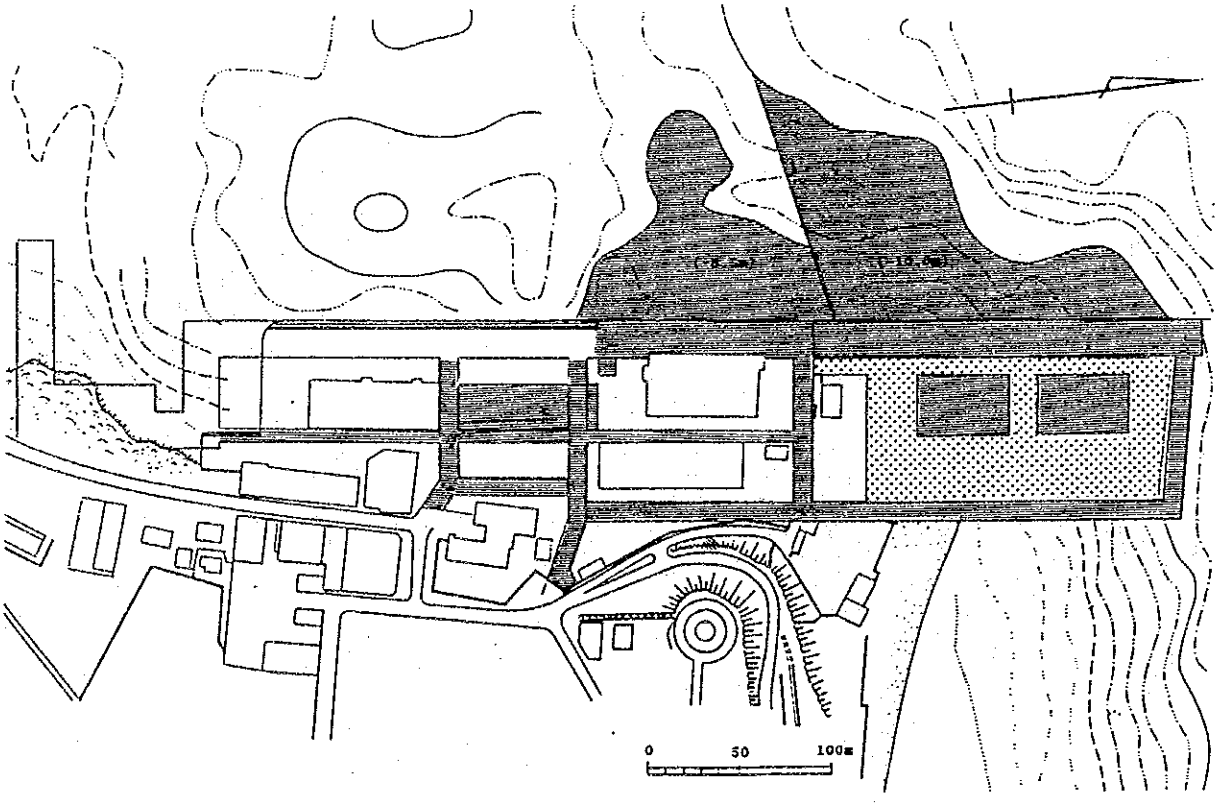



Figure 5-6-1(4) Completion of Construction Work in 1998

## 5.7 Cost Estimation

### 5.7.1 Estimation Basis

Some limits for the estimation are as follows:

i) The costs of the main port facilities proposed in the ShortTerm Plan are estimated.

ii) Estimation limits in the Master Plan described in Chapter 4.9 are also applied in this chapter.

### 5.7.2 Estimation Result

The summary of the construction cost estimate expected in the Short-Term Development Plan is presented in Table 5-7-1 and the detailed construction cost is listed in Table 5-7-2. The annual investment for each of the major facilities installed by the Government and the Private Sectors is listed in Table 5-7-3, according to the construction schedule and the construction costs.

Table 5-7-1 Approximate Construction Cost of Short-Term Development Plan

| Facility | | Construction Cost(US$) | | |
|---|---|---|---|---|
| | | Total | Foreign Portion | Local Portion |
| I. Public Portion | 1.Dredging | 766,500 | 698,400 | 68,100 |
| | 2.Reclamation | 1,783,800 | 593,300 | 1,190,500 |
| | 3.Quays | 16,680,000 | 11,568,900 | 5,111,100 |
| | 4.Rehabilitation of Existing Quays | 2,771,200 | 2,140,300 | 630,900 |
| | 5.Road | 2,203,500 | 1,155,000 | 1,048,500 |
| | 6.Buildings of Port Office | 518,900 | 352,600 | 166,300 |
| | 7.Land | 795,500 | 403,600 | 391,900 |
| | 8.Aids to Navigation | 46,100 | 44,500 | 1,600 |
| | 9. Demolition | 128,500 | 101,900 | 26,600 |
| | Sub-total | 25,694,000 | 17,058,500 | 8,635,500 |
| | Tax | 540,000 | - - - | 540,000 |
| | Total | 26,234,000 | 17,058,500 | 9,175,500 |
| II. Private Portion | 1.Rehabilitation of Existing Sheds | 3,254,600 | 2,308,200 | 946,400 |
| | 2.Oil Supply Pipeline | 1,163,800 | 581,600 | 582,200 |
| | 3.Water Supply Pipeline | 183,500 | 128,400 | 55,100 |
| | Sub Total | 4,601,900 | 3,018,200 | 1,583,700 |
| | Tax | 85,700 | - - - | 85,700 |
| | Total | 4,687,600 | 3,018,200 | 1,669,400 |
| Grand Total | | 30,921,600 | 20,076,700 | 10,844,900 |

Table 5-7-2(1) Approximate Construction Cost of the Facilities of Public Portion (Short-Term Development Plan)

| Facility | | Unit | Quantity | Construction Cost (US$) | | |
|---|---|---|---|---|---|---|
| Item | Sub Item | | | Total | Foreign Portion | Local Portion |
| 1.Dredging | (1)-10.0m Berth | $m^3$ | 28,000 | 596,100 | 543,200 | 52,900 |
| | (2)Old Quay | $m^3$ | 8,000 | 170,400 | 155,200 | 15,200 |
| | Sub-total | LS | 1 | 766,500 | 698,400 | 68,100 |
| 2.Reclamation | (1)Reclaimed by Transferred Material | $m^3$ | 70,000 | 1,216,400 | 285,800 | 930,600 |
| | (2)Reclaimed by Dredged Material | $m^3$ | 52,000 | 242,400 | 212,300 | 30,100 |
| | (3)Temporary Revetment | m | 60 | 325,000 | 95,200 | 229,800 |
| | Sub-total | LS | 1 | 1,783,800 | 593,300 | 1,190,500 |
| 3.Quays | (1)-10.0m Berth | m | 170 | 9,748,300 | 7,928,400 | 1,819,900 |
| | (2)-8.5m to -10.0m Berth | m | 41.5 | 2,859,400 | 2,286,400 | 573,000 |
| | (3)Revetment North | m | 90 | 2,348,800 | 747,900 | 1,600,900 |
| | (4)Revetment East | m | 155 | 1,723,500 | 606,200 | 1,117,300 |
| | Sub-total | LS | 1 | 16,680,000 | 11,568,900 | 5,111,100 |
| 4.Rehabilitation of Existing Quays | (1)Old Quay | m | 120 | 1,906,300 | 1,341,300 | 565,000 |
| | (2)New Quay | m | 181 | 864,900 | 799,000 | 65,900 |
| | Sub-total | LS | 1 | 2,771,200 | 2,140,300 | 630,900 |
| 5.Road | (1)Road | m | 1,062 | 2,089,600 | 1,060,200 | 1,029,400 |
| | (2)Fence and Gate | m | 300 | 113,900 | 94,800 | 19,100 |
| | Sub-total | LS | 1 | 2,203,500 | 1,155,000 | 1,048,500 |
| 6.Buildings of Port Office | (1)Storage | $m^2$ | 100 | 235,900 | 160,300 | 75,600 |
| | (2)Residence | $m^2$ | 120 | 283,000 | 192,300 | 90,700 |
| | Sub-total | LS | 1 | 518,900 | 352,600 | 166,300 |
| 7.Land | (1)Open Yard(No.1) | $m^2$ | 1,625 | 257,200 | 130,500 | 126,700 |
| | (2)Open Yard(No.2) | $m^2$ | 1,650 | 261,200 | 132,500 | 128,700 |
| | (3)Open Yard(No.3) | $m^2$ | 1,650 | 261,200 | 132,500 | 128,700 |
| | (4)Open Yard(No.4) | $m^2$ | 100 | 15,900 | 8,100 | 7,800 |
| | Sub-total | LS | 1 | 795,500 | 403,600 | 391,900 |
| 8.Aids to Navigation | (1)Light Marker | set | 1 | 46,100 | 44,500 | 1,600 |
| | Sub-total | LS | 1 | 46,100 | 44,500 | 1,600 |
| 9.Demolition | (1)Maritime Structure | LS | 1 | 53,200 | 42,100 | 11,100 |
| | (2)Land Structure | LS | 1 | 75,300 | 59,800 | 15,500 |
| | Sub-total | LS | 1 | 128,500 | 101,900 | 26,600 |
| Total | | | | 25,694,000 | 17,058,500 | 8,635,500 |
| Tax | | | | 540,000 | - - - | 540,000 |
| Grand Total | | | | 26,234,000 | 17,058,500 | 9,175,500 |

Table 5-7-2(2) Approximate Construction Cost of the Facilities of Private Portion (Short-Term Development Plan)

| Facility | | Unit | Quantity | Construction Cost (US$) | | |
|---|---|---|---|---|---|---|
| Item | Sub Item | | | Total | Foreign Portion | Local Portion |
| 1.Rehabilitation of Existing Sheds | (1)Shed(CCI) | $m^2$ | 2,009 | 1,080,900 | 777,300 | 303,600 |
| | (2)Shed(CCII) | $m^2$ | 2,066 | 966,900 | 692,700 | 274,200 |
| | (3)Shed(A) | $m^2$ | 901 | 379,500 | 261,600 | 117,900 |
| | (4)Shed(H) | $m^2$ | 1,021 | 442,600 | 311,500 | 131,100 |
| | (5)Shed(C) | $m^2$ | 930 | 384,700 | 265,100 | 119,600 |
| | Sub-total | LS | 1 | 3,254,600 | 2,308,200 | 946,400 |
| 2.Oil Supply Pipeline | (1)Rehabilitation | m | 260 | 78,700 | 40,700 | 38,000 |
| | (2)Extension | m | 431 | 1,085,100 | 540,900 | 544,200 |
| | Sub-total | LS | 1 | 1,163,800 | 581,600 | 582,200 |
| 3.Water Supply Pipeline | (1)Extension | m | 585 | 183,500 | 128,400 | 55,100 |
| | Sub-total | LS | 1 | 183,500 | 128,400 | 55,100 |
| Total | | | | 4,601,900 | 3,018,200 | 1,583,700 |
| Tax | | | | 85,700 | --- | 85,700 |
| Grand Total | | | | 4,687,600 | 3,018,200 | 1,669,400 |

# Table 5-7-3(1) Annual Investment of Public Portion (Short-Term Development Plan)

(thousand US$)

| Facility | | Unit | Quantity | 1994 | | | 1995 | | | 1996 | | | 1997 | | | 1998 | | | Construction Cost | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Item | Sub Item | | | Total | F/P | L/P | Total | F/P | L/P | Total | F/P | L/P | Total | F/P | L/P | Total | F/P | L/P | Total | F/P | L/P |
| 1.Dredging | (1)-10.0m Berth | $m^3$ | 28,000 | | | | 198.8 | 181.1 | 17.7 | 397.3 | 362.1 | 35.2 | | | | | | | 596.1 | 543.2 | 52.9 |
| | (2)Old Quay | $m^3$ | 8,000 | | | | | | | | | | 170.4 | 155.2 | 15.2 | | | | 170.4 | 155.2 | 15.2 |
| | Sub-total | LS | 1 | | | | 198.8 | 181.1 | 17.7 | 397.3 | 362.1 | 35.2 | 170.4 | 155.2 | 15.2 | | | | 766.5 | 698.4 | 68.1 |
| 2.Reclamation | (1)Reclaimed by Transferred Material | $m^3$ | 70,000 | | | | | | | 810.9 | 190.5 | 620.4 | 405.5 | 95.3 | 310.2 | | | | 1,216.4 | 285.8 | 930.6 |
| | (2)Reclaimed by Dredged Material | $m^3$ | 52,000 | | | | 97.0 | 85.0 | 12.0 | 97.0 | 84.9 | 12.1 | 48.4 | 42.4 | 6.0 | | | | 242.4 | 212.3 | 30.1 |
| | (3)Temporary Revetment | m | 60 | 325.0 | 95.2 | 229.8 | | | | | | | | | | | | | 325.0 | 95.2 | 229.8 |
| | Sub-total | LS | 1 | 325.0 | 95.2 | 229.8 | 97.0 | 85.0 | 12.0 | 907.9 | 275.4 | 632.5 | 453.9 | 137.7 | 316.2 | | | | 1,783.8 | 593.3 | 1,190.5 |
| 3.Quays | (1)-10.0m Berth | m | 170 | | | | 3,249.4 | 2,642.8 | 606.6 | 6,498.9 | 5,285.6 | 1,213.3 | | | | | | | 9,748.3 | 7,928.4 | 1,819.9 |
| | (2)-8.5m to -10.0m Berth | m | 41.5 | 953.2 | 762.2 | 191.0 | 1,906.2 | 1,524.2 | 382.0 | | | | | | | | | | 2,859.4 | 2,286.4 | 573.0 |
| | (3)Revetment North | m | 90 | | | | | | | 1,565.8 | 498.6 | 1,067.2 | 783.0 | 249.3 | 533.7 | | | | 2,348.8 | 747.9 | 1,600.9 |
| | (4)Revetment East | m | 155 | | | | 1,723.5 | 606.2 | 1,117.3 | | | | | | | | | | 1,723.5 | 606.2 | 1,117.3 |
| | Sub-total | LS | 1 | 953.2 | 762.2 | 191.0 | 6,879.1 | 4,773.2 | 2,105.9 | 8,064.7 | 5,784.2 | 2,280.5 | 783.0 | 249.3 | 533.7 | | | | 16,680.0 | 11,568.9 | 5,111.1 |
| 4.Rehabilitation of | (1)Old Quay | m | 120 | | | | | | | 953.2 | 670.7 | 282.5 | 953.1 | 670.6 | 282.5 | | | | 1,906.3 | 1,341.3 | 565.0 |
| Existing Quays | (2)New Quay | m | 181 | | | | 864.9 | 799.0 | 65.9 | | | | | | | | | | 864.9 | 799.0 | 65.9 |
| | Sub-total | LS | 1 | | | | 864.9 | 799.0 | 65.9 | 953.2 | 670.7 | 282.5 | 953.1 | 670.6 | 282.5 | | | | 2,771.2 | 2,140.3 | 630.9 |
| 5.Road | (1)Road | m | 1,062 | | | | | | | | | | 1,671.6 | 848.1 | 823.5 | 418.0 | 212.1 | 205.9 | 2,089.6 | 1,060.2 | 1,029.4 |
| | (2)Fence and Gate | m | 300 | | | | | | | | | | 56.9 | 47.4 | 9.5 | 57.0 | 47.4 | 9.6 | 113.9 | 94.8 | 19.1 |
| | Sub-total | LS | 1 | | | | | | | | | | 1,728.5 | 895.5 | 833.0 | 475.0 | 259.5 | 215.5 | 2,203.5 | 1,155.0 | 1,048.5 |
| 6.Buildings of Port | (1)Storage | $m^2$ | 100 | | | | | | | | | | 235.9 | 160.3 | 75.6 | | | | 235.9 | 160.3 | 75.6 |
| Office | (2)Residence | $m^2$ | 120 | 283.0 | 192.3 | 90.7 | | | | | | | | | | | | | 283.0 | 192.3 | 90.7 |
| | Sub-total | LS | 1 | 283.0 | 192.3 | 90.7 | | | | | | | 235.9 | 160.3 | 75.6 | | | | 518.9 | 352.6 | 166.3 |
| 7.Land | (1)Open Yard(No.1) | $m^2$ | 1,625 | | | | | | | 257.2 | 130.5 | 126.7 | | | | | | | 257.2 | 130.5 | 126.7 |
| | (2)Open Yard(No.2) | $m^2$ | 1,650 | | | | | | | | | | 261.2 | 132.5 | 128.7 | | | | 261.2 | 132.5 | 128.7 |
| | (3)Open Yard(No.3) | $m^2$ | 1,650 | | | | | | | | | | 174.1 | 88.3 | 85.8 | 87.1 | 44.2 | 42.9 | 261.2 | 132.5 | 128.7 |
| | (4)Open Yard(No.4) | $m^2$ | 100 | | | | | | | 15.9 | 8.1 | 7.8 | | | | | | | 15.9 | 8.1 | 7.8 |
| | Sub-total | LS | 1 | | | | | | | 273.1 | 138.6 | 134.5 | 435.3 | 220.8 | 214.5 | 87.1 | 44.2 | 42.9 | 795.5 | 403.6 | 391.9 |
| 8.Aids to Navigation | (1)Light Marker | set | 1 | | | | | | | | | | | | | 46.1 | 44.5 | 1.6 | 46.1 | 44.5 | 1.6 |
| | Sub-total | LS | 1 | | | | | | | | | | | | | 46.1 | 44.5 | 1.6 | 46.1 | 44.5 | 1.6 |
| 9.Demolition | (1)Maritime Structure | LS | 1 | | | | | | | 53.2 | 42.1 | 11.1 | | | | | | | 53.2 | 42.1 | 11.1 |
| | (2)Land Structure | LS | 1 | 37.6 | 29.9 | 7.7 | 37.7 | 29.9 | 7.8 | | | | | | | | | | 75.3 | 59.8 | 15.5 |
| | Sub-total | LS | 1 | 37.6 | 29.9 | 7.7 | 37.7 | 29.9 | 7.8 | 53.2 | 42.1 | 11.1 | | | | | | | 128.5 | 101.9 | 26.6 |
| Total | | | | 1,598.8 | 1,079.6 | 519.2 | 8,077.5 | 5,868.2 | 2,209.3 | 10,649.4 | 7,273.1 | 3,376.3 | 4,760.1 | 2,489.4 | 2,270.7 | 608.2 | 348.2 | 260.0 | 25,694.0 | 17,058.5 | 8,635.5 |
| Tax | | | | 30.2 | --- | 30.2 | 129.5 | --- | 129.5 | 207.2 | --- | 207.2 | 154.8 | --- | 154.8 | 18.3 | --- | 18.3 | 540.0 | --- | 540.0 |
| Grand Total | | | | 1,629.0 | 1,079.6 | 549.4 | 8,207.0 | 5,868.2 | 2,338.8 | 10,856.6 | 7,273.1 | 3,583.5 | 4,914.9 | 2,489.4 | 2,425.5 | 626.5 | 348.2 | 278.3 | 26,234.0 | 17,058.5 | 9,175.5 |

Note: F/P=Foreign Portion, L/P=Local Portion

## Table 5-7-3(2) Annual Investment of Private Portion (Short-Term Development Plan)

(thousand US$)

| Facility | | Unit | Quantity | 1994 | | | 1995 | | | 1996 | | | 1997 | | | 1998 | | | Construction Cost | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Item | Sub Item | | | Total | F/P | L/P | Total | F/P | L/P | Total | F/P | L/P | Total | F/P | L/P | Total | F/P | L/P | Total | F/P | L/P |
| 1.Rehabilitation of | (1)Shed(CCI) | $m^2$ | 2,009 | | | | | | | | | | 1,080.9 | 777.3 | 303.6 | | | | 1,080.9 | 777.3 | 303.6 |
| Existing Sheds | (2)Shed(CCII) | $m^2$ | 2,066 | | | | | | | 966.9 | 692.7 | 274.2 | | | | | | | 966.9 | 692.7 | 274.2 |
| | (3)Shed(A) | $m^2$ | 901 | | | | 379.5 | 261.6 | 117.9 | | | | | | | | | | 379.5 | 261.6 | 117.9 |
| | (4)Shed(H) | $m^2$ | 1,021 | | | | 442.6 | 311.5 | 131.1 | | | | | | | | | | 442.6 | 311.5 | 131.1 |
| | (5)Shed(C) | $m^2$ | 930 | 384.7 | 265.1 | 119.6 | | | | | | | | | | | | | 384.7 | 265.1 | 119.6 |
| | Sub-total | LS | 1 | 384.7 | 265.1 | 119.6 | 822.1 | 573.1 | 249.0 | 966.9 | 692.7 | 274.2 | 1,080.9 | 777.3 | 303.6 | | | | 3,254.6 | 2,308.2 | 946.4 |
| 2.Oil Supply Pipeline | (1)Rehabilitation | m | 260 | | | | | | | | | | 52.4 | 27.1 | 25.3 | 26.3 | 13.6 | 12.7 | 78.7 | 40.7 | 38.0 |
| | (2)Extension | m | 431 | | | | | | | | | | 723.4 | 360.6 | 362.8 | 361.7 | 180.3 | 181.4 | 1,085.1 | 540.9 | 544.2 |
| | Sub-total | LS | 1 | | | | | | | | | | 775.8 | 387.7 | 388.1 | 388.0 | 193.9 | 194.1 | 1,163.8 | 581.6 | 582.2 |
| 3.Water Supply | (1)Extension | m | 585 | | | | | | | | | | 122.3 | 85.6 | 36.7 | 61.2 | 42.8 | 18.4 | 183.5 | 128.4 | 55.1 |
| Pipeline | Sub-total | LS | 1 | | | | | | | | | | 122.3 | 85.6 | 36.7 | 61.2 | 42.8 | 18.4 | 183.5 | 128.4 | 55.1 |
| Total | | | | 384.7 | 265.1 | 119.6 | 822.1 | 573.1 | 249.0 | 966.9 | 692.7 | 274.2 | 1,979.0 | 1,250.6 | 728.4 | 449.2 | 236.7 | 212.5 | 4,601.9 | 3,018.2 | 1,583.7 |
| Tax | | | | 5.9 | --- | 5.9 | 12.2 | --- | 12.2 | 13.5 | --- | 13.5 | 41.0 | --- | 41.0 | 13.1 | --- | 13.1 | 85.7 | --- | 85.7 |
| Grand Total | | | | 390.6 | 265.1 | 125.5 | 834.3 | 573.1 | 261.2 | 980.4 | 692.7 | 287.7 | 2,020.0 | 1,250.6 | 769.4 | 462.3 | 236.7 | 225.6 | 4,687.6 | 3,018.2 | 1,669.4 |

Note: F/P=Foreign Portion, L/P=Local Portion

## 5.8 Management and Operation

### 5.8.1 Introduction

Not only proper port planning but also the establishment of an effective port management and operation system is required to carry out port projects. In this chapter, problems in the present system of management and operations have been examined, and management and operation plans for new terminals in the Short-term Development Plan have been drafted.

### 5.8.2 *Present Situation of Management and Operations*

In Madagascar, commercial ports are classified into four categories and managed by the Direction of Maritime Transport (DTM) which is under the control of the Ministry of Transportation and Meteorology (MTM).
Antsiranana is classified as a secondary long distance carrier port and managed by a local agency of DTM.

Ports and harbors have a close relation with both the society and the economy. As the bridge between sea and land, ports and harbors support industrial growth and supply citizens with daily necessities. And thus a port and harbor, as important social capital, must be managed and operated accordingly.

In general, the following principles should be adhered to in establishing a port management system.

- The port which is of greatest importance to the country is managed by an independent organization that is under the government's control.

- To preserve the port's identity, the budget is independent of the government's budget. Also port charges, which account for most of the revenue, need to be kept at a reasonable level.

- Unified management by a single body is the most important principle in performing the main function of a port and increasing efficiency of port operation.

Concerning the above points, there are various problems with the present management system as follows;

(1) The relationship between the headquarters and local agencies of DTM.

The tasks of local agencies are monotonous such as permission for port use, berth assignment and levy of port charge. The other tasks such as administration and maintenance, management policy, port planning are authorized by the headquarters of DTM, and local agencies must follow decisions of headquarters without exception.

But, Antsiranana is a long way from the headquarters in Antananarivo, the capital of Madagascar. Actual state of traffic and communication conditions in Madagascar is not so good. It is said that the headquarters often fails to grasp the actual situation in local areas or that the situation is not discussed at all, moreover the central office usually requires a long period of time before it reaches a decision.

It goes without saying that a local agency can best understand the local situation and should be given authority to make decisions on management and operations.

At present, the Madagascar government is examining the possibility of entrusting local agencies with more authority. This is necessary for port management to cope accurately and timely with the social situation and actual state of the local area.

The port of Antsiranana has an important role for the distribution and production of goods that sustain life and bring prosperity to the region.
So it is also necessary for the local agency to have authority concerning future development. In addition, considering that it takes a long time and a large amount of money to develop the port, the Madagascar government should have long term plans or clearly enunciated policies on port development, management and operation.

Therefore the headquarters should have clearly enunciated policies regarding the functional allotment of port, financial resources for investment and maintenance at every port by inviting the participation of local agencies.

(2) The relationship between public and private sectors in Antsiranana.

In Antsiranana, general cargo handling is conducted by CMDM, which is a private company created with French capital, petroleum cargo handling is conducted by SOLIMA, a private company, and delivery of petroleum and pilotage is also run by a private company.
In addition , the sheds are owned and administrated by the Chamber of Commerce and Industry.

Thus, as a number of organizations conduct operations at the port of Antsiranana, it is necessary that responsibility be clearly assigned to ensure smooth and efficient

operations. The local agency should have the proper authority to deal with this situation.

(3) Level of port tariff

In Antsiranana, local agency levies port charges such as entering the port charge, wharfage change, cargo handling charge, occupancy charge and receives royalties from private companies such as CMDM and pilot company.
The port sector needs to keep port charges at a reasonable level for managing the port and organization. But at the present tariff level it is impossible to manage the port including the depreciation, renewal of port facilities and organization.

(4) Administration of port facilities

In Antsiranana, some of the port facilities are owned and administrated by private interests such as sheds (Chamber of Commerce and Industry),water supply line (JIRAMA) and oil pipe line (SOLIMA).
These companies have not kept these port facilities in good condition: the current arrangements are not suitable. For example, pipe lines can't be maintained because they are under the yard.
In the Short-Term Plan, it is necessary to repair sheds, and lay pipe lines again to return the port facilities to good condition; expenses are to be paid by owners

5.8.3 Recommendations on the Present Management and Operation

As mentioned above, local agency in Antsiranana should have authority of management and operation, and maintain port facilities in good condition and increase efficiency of port operation for port users.
To this end, local agency should have an organization that can manage and operate the port as stipulated above, and reasonable financial resources, and further, independent management and operation.

(1) Strengthening of the Organization

At present, organization of Antsiranana has inadequate sections for accounting, statistics, etc, making it impossible to maintain port facilities in a good condition for port users. Therefore, it is necessary to consider a new organization.
Figure 5-8-1 shows a proposal of the organization and functions.
The new organization has sections for general affairs, port operation and technical matters to carry out port management and organization itself by port revenue.
And the new organization must maintain a high morale among port workers.

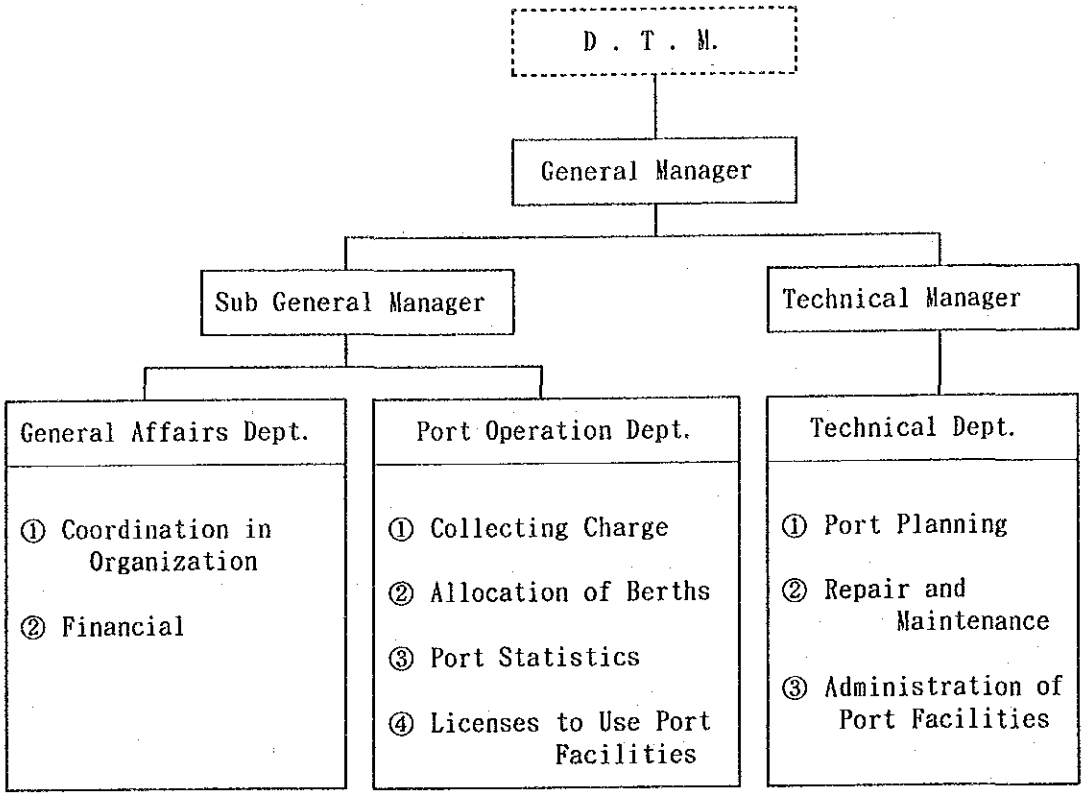



Figure 5-8-1 Proposal of the Organization and Functions

(2) Coordination among public and private sectors

In Antsiranana, a variety of organizations are engaged in operations such as the local agency, cargo handling company, pilot company and the Chamber of Commerce and Industry.
So it is beneficial to introduce new fields of communication and cooperation between public and private sectors for efficient operations. And, a policy of operation, system of maintenance and allocation of berths under control of local agency should be examined.

(3) Level and system of port tariff

The level of port tariff was examined comparing Antsiranana with Toamasina. Toamasina, the only main long distance carrier port, is managed and operated by SEPT which was created with government funds.

Tables 5-8-1 to 5-8-3 show the ratio of Antsiranana's and Toamasina's port tariff, entering the port charge, wharfage charge and cargo handling charge.
Based on these Tables, the revenue which would be generated if Antsiranana were to

adopt Toamasina's port tariff was examined ( average sized vessels, which represent the majority in the Short-Term Plan were used for calculation), as shown in Table 5-8-4.

Table 5-8-1 Entering the Port Charge

| Volume of Vessel | Antsira nana ① | Toamasina | | | | | |
|---|---|---|---|---|---|---|---|
| | | Domestic Cargo ② | | ②/① | Foreign Cargo ③ | | ③/① |
| 250m³~ 500m³ | FMG 5,000 | FMG 4,000 | | 0.80 | FMG 7,606 | | 1.52 |
| 500m³~ 1,500m³ | FMG 10,000 | FMG 4,003 | ECU 1.668 | 0.40 | FMG 7,606 | ECU 3.169 | 0.76 |
| 1,500m³~ 3,000m³ | FMG/m³ 7 | FMG/m³ 1.8 | | 0.26 | FMG/m³ 3.4 | | 0.49 |
| 3,000m³~ 9,000m³ | FMG/m³ 8 | ECU/m³ 10.3 | ECU/ 100m³ 0.428 | 1.29 | FMG/m³ 19.5 | ECU/ 100m³ 0.813 | 2.44 |
| 9,000m³~ 35,000m³ | FMG/m³ 10 | FMG/m³ 16.2 | ECU/ 100m³ 0.673 | 1.62 | FMG/m³ 30.7 | ECU/ 100m³ 1.278 | 3.07 |
| 35,000m³ ~ | FMG/m³ 12 | FMG/m³ 16.2 | | 1.35 | EMG/m³ 30.7 | | 2.56 |

1ECU = 2,400FMG (Base year 1992)

Table 5-8-2 Wharfage Charge

| Volume of Vessel | Antsira nana ① | Toamasina | | | | | |
|---|---|---|---|---|---|---|---|
| | | Domestic Cargo ② | | ②/① | Foreign Cargo ③ | | ③/① |
| 250m³~ 500m³ | FMG 5,000 | - | - | - | - | - | - |
| 500m³~ 1,500m³ | FMG/m/h 8 | FMG/ m/h 72 | ECU/ m/h 0.030 | 9.00 | FMG/ m/h 137 | ECU/ m/h 0.057 | 17.1 |
| 1,500m³~ 3,000m³ | FMG/m/h 8 | | | 9.00 | | | 17.1 |
| 3,000m³~ 9,000m³ | FMG/m/h 11 | | | 6.55 | | | 12.1 |
| 9,000m³~ 35,000m³ | FMG/m/h 71 | | | 1.01 | | | 1.93 |
| 35,000m³ ~ | FMG/m/h 147 | | | 0.49 | | | 0.93 |

1ECU = 2,400FMG (Base year 1992)

Table 5-8-3 Cargo Handling Charge

| | Antsiranana ① | Toamasina ② | ②/① |
|---|---|---|---|
| Loading | 1,140 FMG/t | 986 FMG/t (0.411 ECU/t) | 0.86 |
| Unloading | 570 FMG/t | 494 FMG/t (0.206 ECU/t) | 0.87 |

1ECU = 2,400FMG (Base year 1992)

Table 5-8-4 Rate of Revenue

| Kinds of Vessels | Antsiranana | | Toamasina | | ③/① | ④/② |
|---|---|---|---|---|---|---|
| | Entering the Port ① (t.FMG) | Wharfage ② (t.FMG) | Entering the Port ③ (t.FMG) | Wharfage ④ (t.FMG) | | |
| 1,000D/W | 2,724 | 3,496 | 556 | 31,468 | 0.20 | 9.00 |
| | 6,220 | | 32,024 | | 5.15 | |
| 5,600D/W | 16,033 | 34,639 | 25,973 | 66,838 | 1.62 | 1.93 |
| | 50,672 | | 92,811 | | 1.83 | |
| Total | 56,892 | | 124,835 | | 2.19 | |

Following factors are shown in Chapter 5.10.4

1,000D/w: General cargo(Domestic):Volume 2,800m3, Length 64m
Number of vessels 139, Staying time 45hr(98), 59hr(41)

5,600D/w: General cargo(Foreign):Volume 13,250m3, Length 112m
Number of vessels 121, Staying time 36hr

The above shows that if Antsiranana applies Toamasina's tariffs, Antsiranana's entering the port and wharfage revenue will increase by about 2 times more than the present level.

In particular, Toamasina's wharfage charge is 9 times higher than Antsiranana's for small vessels, which leads one to believe that the long staying time of vessels at Antsiranana is a result of the extremely low wharfage charge. This runs counter to effective port management, thus it is thought necessary to reconsider the port tariff level.

As Toamasina has a tariff for foreign cargo, it should be also examined to introduce a tariff for foreign cargo like Toamasina in line with the increase of foreign cargo.

Next, a port tariff system is recommended. At present, the local agency levies an occupancy charge on CMDM and a pilot company which occupies public ground.

In addition, it is reasonable to levy an occupancy charge on sheds (the Chamber of

Commerce and Industry),water supply line (JIRAMA) and oil pipe line (SOLIMA). Also, local agency should levy an occupancy charge on users of the new open yard that will be constructed in the Short-Term Plan.

(4) Arrangement and repair of port facilities

Local agency should play a leading role in construction work of the Short-Term Plan. Following the Short-Term Plan, water supply line and oil pipe line must be laid under the new road. And sheds must be restored to good condition for efficient operation and service.

(5) Others

1) Port planning and investment

Long-term development and improvement plans are essential for the orderly development of port areas. Without long-range plans and clearly enunciated policies, haphazard construction is likely to take place which may disturb the future development of the ports.
It is necessary for the headquarters, local agencies and municipal corporations to work together.

In Madagascar, financial resources are limited because of delayed economic growth, so investment projects are financed by foreign cooperation capital.
In Japan, investment cost of port facilities is supplied by port users who benefit from the facilities.

2) Port statistics

In Madagascar,the present port statistics are insufficient.
Port statistics are important information for port planning and management.
The local agency should prepare timely and accurate port statistics.

3) Port marketing activities

To ensure the success of the new port, intensive port marketing must be carried out in cooperation with the central office, local agency and municipal corporations. Without a positive approach, clients may not be attracted to the port. In addition, it should be noted that a reputation for prompt, reliable, economical and efficient service is essential for attracting clients.
To this end, a quick passage through customs, efficient immigration and quarantine procedures are also vital in attracting potential clients.

## 5.9 Economic Analysis

### 5.9.1 Purpose and Methodology of the Economic Analysis

(1) Purpose of the Economic Analysis

The purpose of the economic analysis is to appraise the economic feasibility of the Short-Term Development Plan for the port of Antsiranana in the target year(1998) from the viewpoint of the national economy. The facilities to be constructed in the Short-Term Development Plan are general cargo quays, while quays and sheds are to be rehabilitated.

Therefore, the purpose of this section is to investigate the economic benefits as well as the economic costs that will arise from this project, and to evaluate whether the net benefits of the project exceed those that could be obtained from other investment opportunities in Madagascar.

(2) Methodology of the Economic Analysis

An economic analysis will be carried out according to the following method. Short-Term Development Plan will be defined and it will be compared to the "Without" case. All benefits and costs of it in market price for the difference from "With" case will be calculated and it will be converted to economic price. All benefits and costs are evaluated using economic prices in the economic analysis based on the border price concept.

There are various methods to evaluate the feasibility of this type of development project. Here, the economic internal rate of return(EIRR) based on a cost-benefit analysis is used to appraise the feasibility of the project. The EIRR is a discount rate which makes the costs and the benefits of the project during the project life equal. The procedure used for this economic analysis is shown in figure 5-9-1.

### 5.9.2 Prerequisites of the Economic Analysis

In order to estimate the costs and benefits, the following requisites are assumed for the analysis.

(1) Base Year

The "Base Year" here means the standard year in the estimation of costs and benefits. Taking into consideration the base year in cost estimation of construction in section 5.6, Construction Plan, 1994 is set as the "Base Year" for this study.

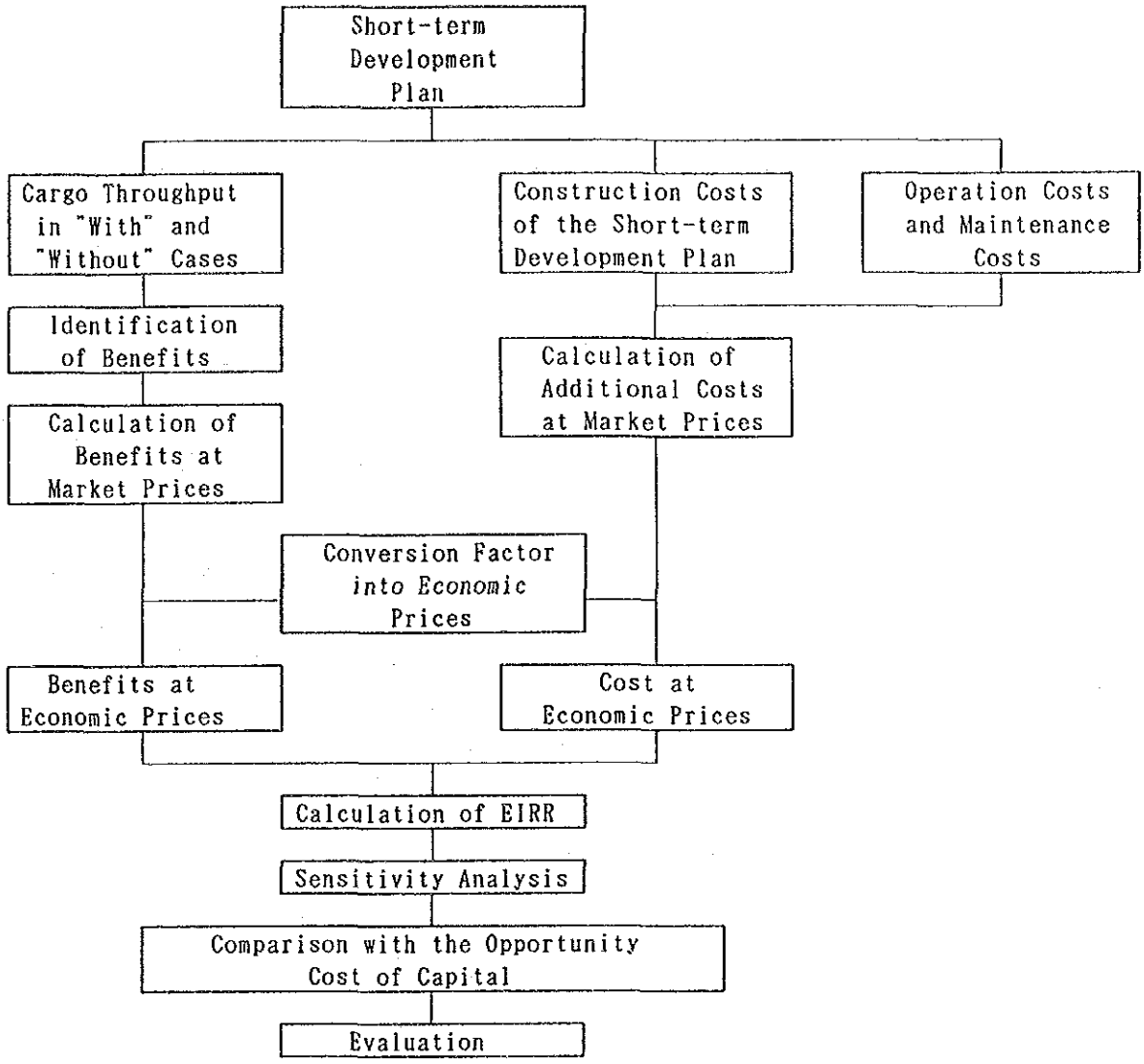



Fig. 5-9-1 Procedure of the Economic Analysis

(2) Project Life

Taking into consideration the depreciation period of the main facilities mentioned in the section of Financial Analysis and construction period of 5 years, the period of calculation ("project life") in the economic analysis is assumed to be 30 years from the beginning of construction(from 1994 to 2023).

(3) Foreign Exchange Rate

The exchange rate adopted for this analysis is US$ 1.00 = 1,860 FMG, the same rate as used in the cost estimation.

(4) "Without" case and "With" case

In the cost-benefit analysis, the benefits and the project costs are defined as the difference between the "Without" the project and the "With" the project cases. Therefore, it is very important to define the difference between "Without" case and "With" case in the economic analysis in order to evaluate the feasibility of the development project. In this study, the following conditions comprise the "Without" case.

1) "Without" case

(i) Port facilities

In the "Without" case, it is assumed that no additional investment will be made to enlarge and rehabilitate the existing port facilities since past records reveal no investment for radical rehabilitation and the Government has no budgetary margin to rehabilitate at present. Therefore the existing old quay and sheds will be out of use because the extent of deterioration is considerable. Thus the capacity level of the port substantially declines. The conditions of port facilities in the "Without" case are assumed as follows.

Table 5-9-1 Port Facilities in "Without" Case

| Facilities | Scale | Remark |
|---|---|---|
| Berth | Length:181m<br>Depth:8.5m | Old quay is unavailable |
| Shed | - | Cold storage only is available |

(ii) Cargo handling volume

In these conditions, it is assumed that transhipment cargoes of tuna will not be handled because those cargoes are not related completely to the hinterland of Antsiranana port, and fishery boats of tuna calling now will be attracted to foreign ports as the increase in ship staying costs at Antsiranana port will make those ports much more competitive.

The maximum volume of handling cargo in the "Without"case is set as follows.

It is assumed that the maximum volume of handling cargo in the "Without" case will be the handling volume which makes ship waiting time reach the economical limit. The economical limit of ship waiting time for berth is assumed, which makes ship waiting costs at Antsiranana port and costs of land transportation (by truck) through Nosybe port to Antsiranana port per metric ton of cargo equal.

The cargo handling volume without transhipment tuna in 1998 is estimated to reach the maximum volume. Therefore, the cargo handling volume after 1998 is assumed to be the same as in 1998.

In the "Without" case, the data of cargo handling volume and calling ship are shown in the following Table 5-9-2.

Table 5-9-2 Cargo Handling Volume and Calling Ship in the "Without" Case

| Handling volume | | | Calling ship | |
|---|---|---|---|---|
| Name | | Volume | Name | Number |
| FOREIGN | General | 77,700 | OCEAN LARGE | 42 |
| | | | OCEAN SMALL | 78 |
| | Petroleum | 29,700 | OCEAN TANKER | 6 |
| | Total | 107,400 | Total | 126 |
| DOMESTIC | General | 48,800 | COASTAL GENERAL | 98 |
| | Petroleum | 18,300 | COASTAL TANKER | 12 |
| | Tuna | 37,000 | TUNA BOAT | 42 |
| | Total | 104,100 | Total | 152 |
| TRANSHIP | Tuna | 0 | TUNA BOAT | 0 |
| TOTAL | | 211,500 | Total | 278 |

2) "With" case

(i) Port facilities

In the "With" case, it is assumed that the Short-Term Plan for port development is completed and the capacity level of the port, which includes efficiency of loading and unloading, available berth length and so on, is improved. The conditions of port facilities in the "With" case are assumed as follows.

Table 5-9-3 Port Facilities in "With" Case

| Facilities | Scale | Remark |
|---|---|---|
| Domestic Berth | Length : 342.5m<br>Depth : 8.5m | |
| Foreign Berth | Length : 170 m<br>Depth : 10.0 m | |
| Shed | Number : 5<br>Area : 6855 sq.m | |

(ii) Cargo handling volume

Berth occupancy rate in 2004 is estimated at about 55 %, which corresponds to the upper level deemed suitable in the UNCTAD report. Therefore, the cargo handling volume after 2004 is assumed to be the same as in 2004, and the excess volume will be dealt with in the next phase project.

In the "With" case, the data of cargo handling volume and calling ship are shown in the following Table 5-9-4.

Table 5-9-4 Cargo Handling Volume and Calling Ship in the "With" Case

| Handling volume | | | | Calling ship | | |
|---|---|---|---|---|---|---|
| Name | | Volume | | Name | Number | |
| | | 1998 | 2004 | | 1998 | 2004 |
| FOREIGN | General | 77,700 | 100,300 | OCEAN LARGE | 42 | 45 |
| | | | | OCEAN SMALL | 78 | 81 |
| | Petroleum | 29,700 | 37,600 | OCEAN TANKER | 6 | 7 |
| | Total | 107,400 | 137,900 | Total | 126 | 133 |
| DOMESTIC | General | 48,800 | 63,200 | COASTAL GENERAL | 98 | 111 |
| | Petroleum | 18,300 | 23,500 | COASTAL TANKER | 12 | 11 |
| | Tuna | 37,000 | 37,000 | TUNA BOAT | 42 | 42 |
| | Total | 104,100 | 123,700 | Total | 152 | 164 |
| TRANSHIP | Tuna | 52,000 | 52,000 | TUNA BOAT | 57 | 57 |
| TOTAL | | 263,500 | 313,600 | Total | 335 | 354 |

### 5.9.3 Economic Prices

#### (1) Method for Converting to Economic Prices from Market Prices

For the economic analysis, prices are expressed in economic prices rather than prices based on the border price concept. There are various methods to convert the market prices into border prices. Here, the border prices (economic prices) are calculated by eliminating transfer items such as taxes, subsidies, etc.

In general, all the costs and benefits are divided into three categories : labor, tradable goods and non-tradable goods. And labor is further classified into skilled labor and unskilled labor. As for skilled labor, the economic price is determined by multiplying the market wage by the conversion factor for consumption. On the other hand, the economic price of unskilled labor is determined by multiplying the nominal wage by the shadow wage rate and the conversion factor for consumption.

The prices of tradable goods are expressed in CIF and FOB value for import goods and export goods respectively.

These values show the actual border prices. However, as the border price of non-tradeable goods cannot be converted directly, the border price of the inputs needed to produce the non-tradable goods is considered. After some classification of the non-tradable goods, the economic price of a small amount of the non-tradable goods is calculated by multiplying the market prices by the standard conversion factor directly.

#### (2) Transfer items

Import / export duties, other taxes and subsidies are merely transfer items which do not actually reflect any consumption of national resources. Therefore, these transfer items should be excluded in the calculation of the costs and benefits of the project for the economic analysis.

#### (3) Conversion factors

Conversion factors for goods and labor are determined as follows:

##### 1) Standard Conversion Factor (SCF)

The standard conversion factor is used to determine the economic prices of certain goods which cannot be directly revalued at border prices. These goods include most non- tradable goods and services. The standard conversion factor is expressed by the following equation:

$$SCF = \frac{\{X + M\}}{\{(X - Tx) + (M + Tm)\}}$$

Where, X : Value of exports
M : Value of imports
Tx : Value of taxes on export
Tm: Value of taxes on import

In this study, the SCF of 0.900 in 1992 is adopted according to the past records of trade and customs as shown in table 5-9-5.

Table 5-9-5 Conversion Factors in 1992

( Unit:Million FMG )

| Items | S C F | C F C |
|---|---|---|
| Value of import (CIF) | 844,936 | 330,802 |
| Value of export (FOB) | 499,806 | 291,894 |
| Taxes on import | 174,196 | 83,077 |
| Taxes on export | 24,430 | 0 |
| Conversion Factor | 0.900 | 0.882 |

2) Conversion Factor for Consumption (CFC)

This conversion factor is used to convert the market prices of consumption goods into the border prices. The conversion factor for consumption is usually calculated in the same manner as the SCF, replacing total imports and exports by those of consumption goods only.

In this study, the CFC of 0.882 in 1992 is adopted according to the past records of trade and customs as shown in table 5-9-5.

3) Conversion Factor for Labor (CFL)

For the economic analysis, labor costs are usually measured in terms of their opportunity costs, that is the value of the foregone marginal product from other alternate employment due to the employment of laborers for the project.

(i) Conversion Factor for skilled labor

The cost of skilled labor is calculated based on actual market wages, assuming that the market mechanism is functioning properly. However, as these are domestic costs or market costs, they are converted into border prices by multiplying the market wages by the CFC.

Thus, the conversion factor for skilled labor

= (Market wage rate) x (CFC)

= 1 x 0.882

= 0.882

(ii) Conversion Factor for unskilled labor

As the wages paid to unskilled labors by a project are usually far above the opportunity cost, these market wages should not be used for calculation of the economic value of the unskilled labors. Considering the labor market, the labor is usually provided from the agricultural sector and the marginal wage rate is calculated based on the labor market in the agricultural sector.

Therefore, in this study, it is assumed in a simplified manner that the economic cost of unskilled labor is equal to the per capita income of the agricultural sector. Based on the data of Banque Centrale de Madagascar and the World Bank, an average monthly wage for agricultural workers in 1991 is estimated to be 26,120 FMG, and it can be considered as a proper indicator of marginal productivity, that is, the opportunity cost of unskilled labor. Based on government data, the average monthly wage of unskilled labor for construction in the domestic market is estimated to be 40,490 FMG.

Thus, the conversion factor for unskilled labor is calculated by the following formula.

$$\text{CFL for unskilled labor} = \frac{\text{Opportunity Cost}}{\text{Worker's Cost of Construction}} \times \text{CFC}$$

= (26,120 / 40490) x 0.882

= 0.569

### 5.9.4 Costs of the Project

The project costs must be converted from market prices into economic prices for the economic analysis. The costs arising from the implementation of this project are as follows:

(1) Investment Costs

In the economic analysis, investment costs have to be divided into the foreign currency portion and the local currency portion. Moreover, the local currency portion can be divided into non-traded goods, skilled labor and unskilled labor. As the foreign currency portion is shown in CIF prices, there is no need for conversion into economic prices. The labor costs (skilled and unskilled) should be converted into economic prices by using the conversion factor estimated in section 5-9-3. Table 5-9-6 and 5-9-7 show the economic prices of the investment costs including investment schedule.

(2) Maintenance and Operation Costs

1) Maintenance Costs

As mentioned in section 5-10, 1.0% of the investment costs of structures and rehabilitated facilities is to be considered as Annual maintenance costs. The maintenance costs in economic prices are calculated in the same manner as the investment costs and are estimated to be US$ 265,400.

Table 5-9-6 Investment Costs in Economic Prices

(Unit:'000 US$)

| Facilities | | Cost of Investment in Market Prices | Foerign Portion (CIF) | Local Portion | | | | Investment Costs in Economic Prices | Overall Conversion Factor |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Total | Unskilled Labour (CFL) | Skilled Labour (CFC) | Local Products (SCF) | | |
| Item | Sub Item | | 1.000 | | 0.569 | 0.882 | 0.900 | | |
| Dreging | -10.0m Berth | 596.1 | 543.2 | 52.9 | 10.6 | 5.3 | 37.0 | 587.2 | 0.985 |
| | Old Quay | 170.4 | 155.2 | 15.2 | 3.1 | 1.5 | 10.6 | 167.8 | 0.985 |
| Reclamation | Reclaimed Material | 1216.4 | 285.8 | 930.6 | 2.3 | 5.5 | 922.8 | 1122.5 | 0.923 |
| | Dreged Material | 242.4 | 212.3 | 30.1 | 1.7 | 4.4 | 24.0 | 238.7 | 0.985 |
| | Temporary Revetment | 325.0 | 95.2 | 229.8 | 1.6 | 8.8 | 219.4 | 301.3 | 0.927 |
| Quay | -10.0m Berth | 9748.3 | 7928.4 | 1819.9 | 148.5 | 145.9 | 1525.5 | 9514.5 | 0.976 |
| | -8.5m to -10.0m Berth | 2859.4 | 2286.4 | 573.0 | 44.0 | 43.9 | 485.1 | 2786.7 | 0.975 |
| | Revetment North | 2348.8 | 747.9 | 1600.9 | 8.4 | 68.3 | 1524.2 | 2184.7 | 0.930 |
| | Revetment East | 1723.5 | 606.2 | 1117.3 | 13.4 | 57.7 | 1046.2 | 1606.3 | 0.932 |
| Rehabilitation of Quay | Old Quay | 1906.3 | 1341.3 | 565.0 | 43.5 | 58.2 | 463.3 | 1834.4 | 0.962 |
| | New Quay | 864.9 | 799.0 | 65.9 | 6.5 | 15.0 | 44.4 | 855.9 | 0.990 |
| Road | Road | 2089.6 | 1060.2 | 1029.4 | 51.7 | 58.4 | 919.3 | 1968.5 | 0.942 |
| | Fence and Gate | 113.9 | 94.8 | 19.1 | 2.5 | 4.7 | 11.9 | 111.1 | 0.975 |
| Buildings of Port Office | Storage | 235.9 | 160.3 | 75.6 | 7.9 | 11.8 | 55.9 | 225.5 | 0.956 |
| | Residence | 283.0 | 192.3 | 90.7 | 9.5 | 14.1 | 67.1 | 270.5 | 0.956 |
| Open Yard | No.1 | 257.2 | 130.5 | 126.7 | 6.4 | 7.2 | 113.1 | 242.3 | 0.942 |
| | No.2 | 261.2 | 132.5 | 128.7 | 6.5 | 7.3 | 114.9 | 246.0 | 0.942 |
| | No.3 | 261.2 | 132.5 | 128.7 | 6.5 | 7.3 | 114.9 | 246.0 | 0.942 |
| | No.4 | 15.9 | 8.1 | 7.8 | 0.4 | 0.4 | 7.0 | 15.0 | 0.942 |
| Aids to Navig | Light Marker | 46.1 | 44.5 | 1.6 | 0.2 | 0.1 | 1.3 | 45.9 | 0.995 |
| Demolition | Maritime Structure | 53.2 | 42.1 | 11.1 | 2.4 | 4.1 | 4.6 | 51.2 | 0.963 |
| | Land Structure | 75.3 | 59.8 | 15.5 | 3.1 | 5.6 | 6.8 | 72.6 | 0.964 |
| Rehabilitation of Shed | CC1 | 1080.9 | 777.3 | 303.6 | 31.7 | 49.4 | 222.5 | 1039.2 | 0.961 |
| | CC2 | 966.9 | 692.7 | 274.2 | 28.7 | 44.5 | 201.0 | 929.2 | 0.961 |
| | A | 379.5 | 261.6 | 117.9 | 12.3 | 18.6 | 87.0 | 363.3 | 0.957 |
| | H | 442.6 | 311.5 | 131.1 | 13.7 | 21.0 | 96.4 | 424.6 | 0.959 |
| | C | 384.7 | 265.1 | 119.6 | 12.5 | 18.8 | 88.3 | 368.3 | 0.957 |
| Oil Pipe Line | Rehabilitation | 78.7 | 40.7 | 38.0 | 7.5 | 10.2 | 20.3 | 72.2 | 0.918 |
| | Extention | 1085.1 | 540.9 | 544.2 | 29.8 | 43.0 | 471.4 | 1020.0 | 0.940 |
| Watersupply Line | Extention | 183.5 | 128.4 | 55.1 | 6.3 | 8.6 | 40.2 | 175.7 | 0.958 |
| Total | | 30295.9 | 20076.7 | 10219.2 | 523.2 | 749.6 | 8946.4 | 29087.1 | 0.960 |

Table 5-9-7 Investment Plan in Economic Prices

(Unit:'000 US$)

| Facilities | | Economic Praices Total | 1994 | 1995 | 1996 | 1997 | 1998 |
|---|---|---|---|---|---|---|---|
| Item | Sub Item | | | | | | |
| Dreging | -10.0m Berth | 587.2 | | 195.8 | 391.4 | | |
| | Old Quay | 167.8 | | | | 167.8 | |
| Reclamation | Reclaimed Material | 1122.5 | | | 748.3 | 374.2 | |
| | Dreged Material | 238.7 | | 95.5 | 95.5 | 47.7 | |
| | Temporary Revetment | 301.3 | 301.3 | | | | |
| Quay | -10.0m Berth | 9514.5 | | 3171.3 | 6343.2 | | |
| | -8.5m to -10.0m Berth | 2786.7 | 928.9 | 1857.8 | | | |
| | Revetment North | 2184.7 | | | 1456.4 | 728.3 | |
| | Revetment East | 1606.3 | | 1606.3 | | | |
| Rehabilitation of Quay | Old Quay | 1834.4 | | | 917.2 | 917.2 | |
| | New Quay | 855.9 | | 855.9 | | | |
| Road | Road | 1968.5 | | | | 1574.7 | 393.8 |
| | Fence and Gate | 111.1 | | | | 55.5 | 55.6 |
| Buildings of Port Office | Storage | 225.5 | | | | 225.5 | |
| | Residence | 270.5 | 270.5 | | | | |
| Open Yard | No.1 | 242.3 | | | 242.3 | | |
| | No.2 | 246.0 | | | | 246.0 | |
| | No.3 | 246.0 | | | | 163.9 | 82.1 |
| | No.4 | 15.0 | | | 15.0 | | |
| Aids to Navig | Light Marker | 45.9 | | | | | 45.9 |
| Demolition | Maritime Structure | 51.2 | | | 51.2 | | |
| | Land Structure | 72.6 | 36.3 | 36.3 | | | |
| Rehabilitation of Shed | CC1 | 1039.2 | | | | 1039.2 | |
| | CC2 | 929.2 | | | 929.2 | | |
| | A | 363.3 | | 363.3 | | | |
| | H | 424.6 | | 424.6 | | | |
| | C | 368.3 | 368.3 | | | | |
| Oil Pipe Line | Rehabilitation | 72.2 | | | | 48.0 | 24.2 |
| | Extention | 1020.0 | | | | 680.0 | 340.0 |
| Watersupply Line | Extention | 175.7 | | | | 117.1 | 58.6 |
| Total | | 29087.1 | 1905.3 | 8606.8 | 11189.7 | 6385.1 | 1000.2 |

2) Operation Costs

Operation costs consist of personnel costs and administration costs. Based on the estimation of operation costs in the following section 5-10, the necessary operation costs for the newly built quay and rehabilitated facilities are considered as follows:

(i) Personnel costs

The conversion factor for skilled labor is applied to convert the personnel costs at market prices into the economic prices. The personnel costs in economic prices are estimated to be US$ 5,200.

(ii) Administration Costs

Based on the analysis of DTM data, the administration costs are set at 60% of the personnel costs. The economic prices of the administration costs are calculated by multiplying the market costs by the standard conversion factor, and are estimated to be 3,200 US$.

(3) Renewal Investment Costs

The renewal investment costs for facilities and equipment after their useful lifetimes are considered. The renewal investment costs are shown in Table 5-9-8.

Table 5-9-8 Renewal Investment Costs in Economic Prices

(Unit : '000 US$)

| Facilities | Lifetime(years) | Renewal costs |
|---|---|---|
| Light marker | 15 | 45.9 |
| Fence and gate | 15 | 111.1 |
| Shed | 15 | 1,858.3 |
| Oil pipe line | 15 | 338.1 |
| Water supply line | 15 | 175.7 |
| sub-total | | 2,529.1 |
| Rehabilitated quay | 20 | 2,690.3 |
| Total | | 5,219.4 |

5.9.5 Benefits of the Project

(1) Kinds of Benefits

The development of the port of Antsiranana will greatly contribute to the national economy. Considering the "With" and "Without" case, the following items are identified as major benefits of the short-term development plan for the port of Antsiranana from the viewpoint of the national economy.

1) Savings in ship staying costs.
2) Savings in interest of cargo costs.
3) Benefits of use of sheds.
4) Benefits of port service industries derived from handling of transhipment tuna.
5) Savings in transportation costs from other port.
6) Promotion of regional economic development.
7) Increase in employment opportunities and incomes.
8) Reduction of cargo damage and accidents at the port.

It is impossible to evaluate all these benefits in monetary terms, but of the above, items 1), 2), 3) and 4) are considered countable and the monetary benefits of these items are calculated.

Item 5) is considered countable, but the monetary benefits are not calculated in this study.

The other benefits are considered uncountable and only a qualitative analysis is undertaken.

(2) Calculation of Benefits

In converting the market prices into economic prices, benefits derived from benefit item 1) and 2) are considered at economic prices without any converting procedure, because they are already presented at international prices. However, benefits derived from benefit item 3) and 4) are expressed in market prices, and therefore the conversion factor is applied to these benefits for converting market prices into economic prices.

1) Savings in ship staying costs

In accordance with the implementation of the project, the total ship staying time (ship waiting time for berthing and ship mooring time for unloading / loading at the port) will be greatly decreased. The reduction of the ship staying time under the "With"

case is one of the main benefits of the project. In this study, the benefits derived from the reduction of the ship staying costs is calculated by the following formula.

Saving in ship staying costs = Difference of ship staying time between "Without" and "With" cases

x Ship staying cost

x Share accruing to Madagascar

(i) Ship staying time

Ship staying time at the port comprises the waiting time for berthing and the mooring time for unloading / loading. As for the ship waiting time, the total waiting time for "Without" and "With" cases is calculated using queuing simulations based on the estimated number of calling ships in both cases respectively. The results of the calculation are shown in Table 5-9-9.

Table 5-9-9 Ship Waiting Days for Berth

(UNIT:DAY)

| YEAR | | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 -2023 | TOTAL 1998-2023 26YEARS |
|---|---|---|---|---|---|---|---|---|---|
| WITHOUT CASE(A) | OCEAN LARGE | 239.4 | 239.4 | 239.4 | 239.4 | 239.4 | 239.4 | 239.4 | 6224.4 |
| | OCEAN SMALL | 388.4 | 388.4 | 388.4 | 388.4 | 388.4 | 388.4 | 388.4 | 10098.4 |
| | COASTAL GENERAL | 485.5 | 485.5 | 485.5 | 485.5 | 485.5 | 485.5 | 485.5 | 12623.0 |
| | OCEAN TANKER | 9.2 | 9.2 | 9.2 | 9.2 | 9.2 | 9.2 | 9.2 | 239.2 |
| | COASTAL TANKER | 62.4 | 62.4 | 62.4 | 62.4 | 62.4 | 62.4 | 62.4 | 1622.4 |
| | TUNA BOAT | 195.0 | 195.0 | 195.0 | 195.0 | 195.0 | 195.0 | 195.0 | 5070.0 |
| | TOTAL | 1379.9 | 1379.9 | 1379.9 | 1379.9 | 1379.9 | 1379.9 | 1379.9 | 35877.4 |
| WITH CASE (B) | OCEAN LARGE | 11.0 | 12.7 | 14.5 | 16.3 | 18.3 | 21.0 | 23.6 | 566.4 |
| | OCEAN SMALL | 3.3 | 3.6 | 3.9 | 4.3 | 4.7 | 5.3 | 5.7 | 139.9 |
| | COASTAL GENERAL | 2.4 | 2.9 | 3.0 | 3.5 | 4.0 | 4.5 | 5.1 | 122.1 |
| | OCEAN TANKER | 1.2 | 1.3 | 1.5 | 1.9 | 2.1 | 2.3 | 2.6 | 62.7 |
| | COASTAL TANKER | 0.5 | 0.5 | 0.6 | 0.6 | 0.6 | 0.7 | 0.8 | 19.0 |
| | TUNA BOAT | 3.3 | 3.7 | 4.1 | 4.5 | 5.0 | 5.4 | 5.8 | 141.5 |
| | TOTAL | 21.6 | 24.7 | 27.6 | 31.2 | 34.7 | 39.2 | 43.6 | 1051.6 |
| SAVINGS IN WAITING TIME(A-B) | OCEAN LARGE | 228 | 227 | 225 | 223 | 221 | 218 | 216 | 5658 |
| | OCEAN SMALL | 385 | 385 | 384 | 384 | 384 | 383 | 383 | 9958 |
| | COASTAL GENERAL | 483 | 483 | 482 | 482 | 482 | 481 | 480 | 12501 |
| | OCEAN TANKER | 8 | 8 | 8 | 7 | 7 | 7 | 7 | 177 |
| | COASTAL TANKER | 62 | 62 | 62 | 62 | 62 | 62 | 62 | 1603 |
| | TUNA BOAT | 192 | 191 | 191 | 190 | 190 | 190 | 189 | 4929 |
| | TOTAL | 1358 | 1355 | 1352 | 1349 | 1345 | 1341 | 1336 | 34826 |

(ii) Share accruing to Madagascar

The benefit derived from the savings of ship staying costs will belong to the shipping companies. Therefore, for foreign ships the benefits accrue to the foreign carrier and for Madagascan ships the benefits accrue to Madagascar. However, it is now standard practice to include some of the benefits accruing to foreign carrier in the appraisal on the understanding that in the long run this benefit will filter through to the national economy, for example, through lower freight rates.

Thus, in this study, it is assumed that 50% of the benefits belonging to foreign ship carriers will return to Madagascar as well as 100% of benefits for Madagascan ship carriers will accrue to the Madagascan economy. Moreover, the share of Madagascan ships in the ships calling at Antsiranana port is unknown. Therefore, it is assumed that the share in the ocean general cargo ships will be 50%, in the coastal ships 100% and in the ocean tankers and tuna boats 0%.

(iii) Savings of ship staying costs

Benefits derived from savings of ship staying costs due to the implementation of this project are calculated in Table 5-9-10.

Table 5-9-10 Benefits of Savings in Ship Staying Costs

| YEAR | | | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 -2023 | TOTAL 1998-2023 26YEARS |
|---|---|---|---|---|---|---|---|---|---|---|
| SAVINGS IN WAITING TIME (DAY) | OCEAN LARGE | | 228 | 227 | 225 | 223 | 221 | 218 | 216 | 5662 |
| | OCEAN SMALL | | 385 | 385 | 384 | 384 | 384 | 383 | 383 | 9965 |
| | COASTAL GENERAL | | 483 | 483 | 482 | 482 | 482 | 481 | 480 | 12493 |
| | OCEAN TANKER | | 8 | 8 | 8 | 7 | 7 | 7 | 7 | 185 |
| | COASTAL TANKER | | 62 | 62 | 62 | 62 | 62 | 62 | 62 | 1612 |
| | TUNA BOAT | | 192 | 191 | 191 | 190 | 190 | 190 | 189 | 4924 |
| | TOTAL | | 1358 | 1356 | 1352 | 1348 | 1346 | 1341 | 1337 | 34841 |
| TOTAL DEMARAGE ('000$) | OCEAN LARGE | 5500$/SHIP/DAY | 1254.0 | 1248.5 | 1237.5 | 1226.5 | 1215.5 | 1199.0 | 1188.0 | 31141.0 |
| | OCEAN SMALL | 2500 | 962.5 | 962.5 | 960.0 | 960.0 | 960.0 | 957.5 | 957.5 | 24912.5 |
| | COASTAL GENERAL | 1700 | 821.1 | 821.1 | 819.4 | 819.4 | 819.4 | 817.7 | 816.0 | 21238.1 |
| | OCEAN TANKER | 11000 | 88.0 | 88.0 | 88.0 | 77.0 | 77.0 | 77.0 | 77.0 | 2035.0 |
| | COASTAL TANKER | 6000 | 372.0 | 372.0 | 372.0 | 372.0 | 372.0 | 372.0 | 372.0 | 9672.0 |
| | TUNA BOAT | 11000 | 2112.0 | 2101.0 | 2101.0 | 2090.0 | 2090.0 | 2090.0 | 2079.0 | 54164.0 |
| | TOTAL | | 5609.6 | 5593.1 | 5577.9 | 5544.9 | 5533.9 | 5513.2 | 5489.5 | 143162.6 |
| BENEFITS ACCRUING TO MADA-GASCAR ('000$) | OCEAN LARGE | 75% | 940.5 | 936.4 | 928.1 | 919.9 | 911.6 | 899.3 | 891.0 | 23355.8 |
| | OCEAN SMALL | 75% | 721.9 | 721.9 | 720.0 | 720.0 | 720.0 | 718.1 | 718.1 | 18684.4 |
| | COASTAL GENERAL | 100% | 821.1 | 821.1 | 819.4 | 819.4 | 819.4 | 817.7 | 816.0 | 21238.1 |
| | OCEAN TANKER | 50% | 44.0 | 44.0 | 44.0 | 38.5 | 38.5 | 38.5 | 38.5 | 1017.5 |
| | COASTAL TANKER | 100% | 372.0 | 372.0 | 372.0 | 372.0 | 372.0 | 372.0 | 372.0 | 9672.0 |
| | TUNA BOAT | 50% | 1056.0 | 1050.5 | 1050.5 | 1045.0 | 1045.0 | 1045.0 | 1039.5 | 27082.0 |
| | TOTAL | | 3955.5 | 3945.9 | 3934.0 | 3914.8 | 3906.5 | 3890.6 | 3875.1 | 101049.7 |

2) Savings in interest of cargo cost

In accordance with the implementation of the project, the total ship staying time will be greatly decreased. According to the reduction of the ship staying time under the "With" case, interest of cargo cost will be decreased. In this study, the benefits of savings in interest of cargo costs are calculated by the following formula.

| | | | | | |
|---|---|---|---|---|---|
| Savings in interest of cargo costs | = | Ship staying time in "Without" case | x | Interest of cargo | |
| | - | Ship staying time in "With" case | x | Interest of cargo | |

According to the above, benefits derived from savings of interest of cargo costs due to the implementation of this project are calculated in Table 5-9-11 and the benefit in 1998 is estimated to be US$ 368,000.

3) Benefits of use of sheds

In the "Without" case, it is assumed that no additional investment will be made to rehabilitate the existing sheds and sheds will be out of use. Therefore, it is assumed that the cargoes using sheds at Antsiranana port will use the warehouse in land, and one-way transportation costs by trucks between the warehouse and the port and cargo handling labor costs for loading / unloading trucks will be increased.

In this study, the increased costs are assumed to be the benefits derived from the use of sheds at the port, which are calculated by the following formula.

| | | | | |
|---|---|---|---|---|
| Saving in land tfransportation costs | = | Difference of land transportation costs between "Without" and "With" cases | | |
| | | x | Transportation volume (volume stored in sheds) | |

(i) Transportation cargo volume (Cargo volume stored in sheds)

The cargo volume stored in sheds in 1998 is shown in Table 5-2-7. In this study, the salts transported by ship in the shed cargoes are not considered because it is

Table 5-9-11 Savings in Interest of Cargo Cost in 1998

(1) "Without" Case (1998 - 2023)

| SHIP NAME | CARGO (MT) | AVE. VALUE (US$/MT) | TOTAL VAL. ('000US$) | AVE. STAY T (DAY) | INTEREST RATE(%) | INTEREST ('000US$) |
|---|---|---|---|---|---|---|
| OCEAN LARGE | 47,400 | 994.7 | 47,149 | 5.57 | 21 | 151.1 |
| OCEAN SMALL | 30,300 | 994.7 | 30,139 | 4.92 | 21 | 85.3 |
| COASTAL GENERAL | 48,800 | 403.9 | 19,710 | 4.95 | 21 | 56.1 |
| OCEAN TANKER | 29,700 | 203.1 | 6,032 | 1.53 | 21 | 5.3 |
| COASTAL TANKER | 18,300 | 250.3 | 4,580 | 5.20 | 21 | 13.7 |
| TUNA BOAT | 37,000 | 667.7 | 24,705 | 4.64 | 21 | 66.0 |
| TOTAL | 211,500 | 625.6 | 132,316 | 26.81 | 21 | 377.5 |

(2) "With" Case

| | SHIP NAME | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 - 2023 |
|---|---|---|---|---|---|---|---|---|
| Cargo Volume (MT) | OCEAN LARGE | 47400 | 49700 | 52200 | 54100 | 56400 | 59100 | 61400 |
| | OCEAN SMALL | 30300 | 31700 | 32600 | 34500 | 36000 | 36900 | 38900 |
| | COASTAL GENERAL | 48800 | 51000 | 53400 | 55700 | 58300 | 60600 | 63200 |
| | OCEAN TANKER | 29700 | 30900 | 32100 | 33400 | 34700 | 36000 | 37600 |
| | COASTAL TANKER | 18300 | 19100 | 19900 | 20700 | 21500 | 22400 | 23500 |
| | TUNA BOAT | 89000 | 89000 | 89000 | 89000 | 89000 | 89000 | 89000 |
| | TOTAL | 263500 | 271400 | 279200 | 287400 | 295900 | 304000 | 313600 |
| Average Staying Time (day) | OCEAN LARGE | 0.26 | 0.30 | 0.33 | 0.37 | 0.42 | 0.47 | 0.53 |
| | OCEAN SMALL | 0.04 | 0.05 | 0.05 | 0.05 | 0.06 | 0.07 | 0.07 |
| | COASTAL GENERAL | 0.02 | 0.03 | 0.03 | 0.03 | 0.04 | 0.04 | 0.05 |
| | OCEAN TANKER | 0.19 | 0.21 | 0.24 | 0.27 | 0.30 | 0.33 | 0.38 |
| | COASTAL TANKER | 0.04 | 0.04 | 0.05 | 0.05 | 0.06 | 0.06 | 0.07 |
| | TUNA BOAT | 0.03 | 0.04 | 0.04 | 0.05 | 0.05 | 0.05 | 0.06 |
| | TOTAL | 0.58 | 0.67 | 0.74 | 0.82 | 0.93 | 1.02 | 1.16 |
| Total Interest ('000 US$) | OCEAN LARGE | 7.1 | 8.5 | 9.9 | 11.5 | 13.6 | 15.9 | 18.6 |
| | OCEAN SMALL | 0.7 | 0.9 | 0.9 | 1.0 | 1.2 | 1.5 | 1.6 |
| | COASTAL GENERAL | 0.2 | 0.4 | 0.4 | 0.4 | 0.5 | 0.6 | 0.7 |
| | OCEAN TANKER | 0.7 | 0.8 | 0.9 | 1.1 | 1.2 | 1.4 | 1.7 |
| | COASTAL TANKER | 0.1 | 0.1 | 0.1 | 0.1 | 0.2 | 0.2 | 0.2 |
| | TUNA BOAT | 1.0 | 1.4 | 1.4 | 1.7 | 1.7 | 1.7 | 2.1 |
| | TOTAL | 9.8 | 12.0 | 13.6 | 15.7 | 18.4 | 21.2 | 24.9 |

(3) Savings in Interest of Cargo Cost

| | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 - 2023 | Total |
|---|---|---|---|---|---|---|---|---|
| Saving Cost ('000 US$) | 368 | 366 | 364 | 362 | 359 | 356 | 353 | 9226 |

assumed that those cargoes are rarely stored in the inland warehouse. Therefore, the transportation cargo volume in 1998 is estimated to be 57,300 MT.

(ii) Transportation costs by trucks and handling labor costs

Based on the interview with shipping agent, the transportation costs are estimated, and based on the data of government, handling labor costs are estimated.

(iii) Benefits of use of sheds

Based on the above, the benefits derived from use of sheds are calculated, and in 1998 and after are estimated to be US$ 211,100.

4) Benefits of port service industries derived from handling of transhipment tuna.

In the "With" case, foreign fishery boats will call, as at present, at the port of Antsiranana, but in the "Without" case they will be attracted to foreign ports and transhipment cargoes of tuna will not be handled due to the increase of port congestion. Therefore, the difference of incomes between "Without" and "With" cases derived from handling of transhipment tuna is one of the major benefits of the project.

In this study, based on the data of Association Thoniere Commission de l'ocean Indien, these benefits are estimated as follows:

(i) Foreign fishery boat repair

The benefits of foreign fishery boat repair are calculated by the following formula.

| Benefits of boat repair | = | Number of boats repaired |
|---|---|---|
| | | x Repair cost per boat |

- Number of boats repaired

It is assumed that about 40% (average from 1990 to 1992) of the 40 fishery boats operating in West Indian Ocean will be repaired at Antsiranana port, and the number of boats related to transhipment will be 10.

- Repair cost per boat

The repair cost per boat in market prices is US$ 136,500, (average of 1991 and 1992) and converting into economic prices, it is estimated to be US$ 51,000.

According to the above, the benefits of foreign fishery boat repair in 1998 and after are estimated to be US$ 510,000.

(ii) Supply of gas oil

The benefits due to supply of gas oil is calculated by the following formula.

| Benefits due to supply of gas oil | = | Consumption volume of gas oil Per MT of tuna |
|---|---|---|

X Transhipment volume

X Economic price of gas oil per MT

- Consumption volume of gas oil per MT of tuna

Based on the above data, the consumption volume of gas oil per MT of tuna is 0.3 MT.

- Transhipment volume

As described in section 5-2-2, the transhipment volume of tuna in 1998 and after is 52,000 MT.

- Economic price of gas oil per MT

CIF import price of gas oil is US$ 203 per MT, and the price purchased by fishery boats is US$ 280 per MT. The difference in the two prices is one of the benefits accruing to Madagascar. Converting into economic prices, the economic price of gas oil per MT is estimated to be US$ 6.7.

According to the above, the benefits due to supply of gas oil in 1998 and after is estimated to be US$ 104,500.

(iii) Supply of salt

The benefits due to supply of salt is calculated by the following formula.

| Benefits due to supply of gas oil | = | Consumption volume of gas oil Per MT of tuna |
|---|---|---|

X Transhipment volume

X Economic price of gas oil per MT

- Consumption volume of salt per MT of tuna

Based on the above data, the consumption volume of salt per MT of tuna is 0.078 MT.

- Transhipment volume

As described in section 5-2-2, the transhipment volume of tuna in 1998 and after is 52,000 MT.

- Economic price of salt per MT

The price purchased by fishery boats is US$ 84.8 per MT. Converting into economic prices, the economic price of salt per MT is estimated to be US$ 60.8.

According to the above, the benefits due to supply of salt in 1998 and after is estimated to be US$ 246,600.

(iv) Benefits due to handling transhipment tuna

The benefits due to handling transhipment tuna is calculated by the following formula.

| Benefits due to handling transhipment tuna | = | Transhipment volume |
|---|---|---|
| | | x Economic price of handling costs per MT of tuna |

- Transhipment volume

As described in section 5-2-2, the transhipment volume of tuna in 1998 and after is 52,000 MT.

- Economic price of handling costs per MT of tuna

Cargo handling productivity : 200 MT / 8hr / day, 2 gang
Number of worker per gang : chief 1 person, worker 9 persons

Based on the above data, and converting into economic prices , the economic price of handling costs per MT of tuna is estimated to be US$ 0.16.

According to the above, the benefits due to handling transhipment tuna in 1998 and after is estimated to be US$ 8,300.

(v) Benefits of port service industries derived from handling of transhipment tuna.

According to the above, the total benefits of port service industries derived from handling of transhipment tuna in 1998 and after is estimated to be US$ 869,400.

5) Savings in transportation costs from other ports.

As described in section 5-9-2 of the cargo handling in the "Without" and "With" cases, the excess cargo volume which is the difference of handling volume between "Without" and "With" cases from 1999 to 2004 is assumed to be handled at other ports. The additional transportation costs under this case are the benefits of savings in transportation costs if the Short-Term Development is executed. Therefore, the difference of the transportation costs between the "Without" and "With" cases can be calculated as the benefit.

In reality, however, there are no alternative ports for the users of Antsiranana port because the only roads connecting Antsiranana port with other ports are dirt roads in poor condition, and the port facilities of Nosy-be port are on an island and the capacity of sea transportation connecting Nosy-be port with Ambanja is poor.

Therefore, the alternative proposal in which the excess cargo is handled at other ports is not feasible, and the monetary benefits of savings in transportation costs from other ports are not calculated in this study.

Having established that there are no alternatives to Antsiranana port, the development of Antsiranana port is indispensable to the people in the hinterland.

(3) Uncountable benefits

As described in Section 5-9-5(1), there are other benefits derived from the implementation of this project. However, they are difficult to appraise in monetary terms. Therefore, qualitative analyses are undertaken as follows:

1) Promotion of regional economic development.

Without the implementation of the development project, the port of Antsiranana will be operating at a decreased capacity that cannot so much as maintain the existing cargo flow, and the development or expansion of industries and services which are dependent on the port will be hardly expected. On the contrary, the activity of industries and services in the hinterland will be damaged by the increase of port congestion. Furthermore, the limited port activity will diminish the probability of the establishment of new business. On the other hand, the new development project will make port-related industries more active.

Therefore, the value added from those industries and employment opportunities from them are considered as economic benefits of this project. Also, the development of the port contributes to the improvement of the distribution mechanism and to the activation of industries in the hinterland.

2) Increase in employment opportunities and incomes.

Additional employment will arise directly from the project, both assumed employment for construction during the construction period and employment for operations after the construction. The construction will provide employment for those people who would remain unemployed if the project does not take place. This employment is one of the major benefits of the project. The increase in employment

opportunities is estimated as 86,000 person days for skilled labor and 43,000 person days for unskilled labor.

Along with the increased direct employment, secondary employment will also occur based on the new demand from the expanding industries and services through the port activities. Similarly, the income of already employed local workers is also expected to rise. These rippling effects are also generated by the development.

3) Reduction of cargo damage and accidents at the port.

The existing facilities such as yards, sheds and roads are too damaged for safe and efficient cargo handling and storage. Furthermore, according to the increase in the cargo volume and the decrease of berth length under the "Without" case, the port will be very congested.

On the other hand, with the implementation of the project, the port facilities will be rehabilitated, and by that the port capacity will not only be improved but also reduce cargo damage, accidents and pilferage at the port will be reduced. It is obviously considered to be one of the great benefits of this project.

5.9.6 Calculation of EIRR and Evaluation

(1) Calculation of the EIRR

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

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

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

where, n : Period of economic calculation (project life)
Bi : Benefits in i-th year
Ci : Costs in i-th year
r : Discount rate

The EIRR of the Short-Term Plan is calculated as 14.2%. Calculation result of the EIRR is shown in Table 5-9-12.

## Table 5-9-12 Cost/Benefit Analysis (Port of Antsiranana)

Base Case

(Unit: '000 US$)

| | Year | Cost | | | | | Benefit | | | | | Benefit - Cost | Net Present Value (NPV) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Construction | Maintenance | Replacement Investment | Residual Value | Total | Savings in Marine Transportation Cost | Savings in Interrest Cost | Rehabili of Shed | Transhipment of Tuna | Total | | Benefit | Cost | Benefit - Cost |
| 1 | 1994 | 1905 | 0 | 0 | 0 | 1905 | 0 | 0 | 0 | 0 | 0 | -1905 | 0 | 1905 | -1905 |
| 2 | 1995 | 8607 | 0 | 0 | 0 | 8607 | 0 | 0 | 0 | 0 | 0 | -8607 | 0 | 7538 | -7538 |
| 3 | 1996 | 11190 | 0 | 0 | 0 | 11190 | 0 | 0 | 0 | 0 | 0 | -11190 | 0 | 8583 | -8583 |
| 4 | 1997 | 6385 | 0 | 0 | 0 | 6385 | 0 | 0 | 0 | 0 | 0 | -6385 | 0 | 4290 | -4290 |
| 5 | 1998 | 1000 | 274 | 0 | 0 | 1274 | 3956 | 368 | 211 | 869 | 5404 | 4130 | 3179 | 750 | 2430 |
| 6 | 1999 | 0 | 274 | 0 | 0 | 274 | 3946 | 366 | 211 | 869 | 5392 | 5118 | 2779 | 141 | 2637 |
| 7 | 2000 | 0 | 274 | 0 | 0 | 274 | 3934 | 364 | 211 | 869 | 5378 | 5105 | 2427 | 124 | 2304 |
| 8 | 2001 | 0 | 274 | 0 | 0 | 274 | 3915 | 362 | 211 | 869 | 5357 | 5083 | 2118 | 108 | 2009 |
| 9 | 2002 | 0 | 274 | 0 | 0 | 274 | 3907 | 359 | 211 | 869 | 5346 | 5072 | 1851 | 95 | 1756 |
| 10 | 2003 | 0 | 274 | 0 | 0 | 274 | 3891 | 356 | 211 | 869 | 5327 | 5054 | 1615 | 83 | 1532 |
| 11 | 2004 | 0 | 274 | 0 | 0 | 274 | 3875 | 353 | 211 | 869 | 5308 | 5034 | 1410 | 73 | 1337 |
| 12 | 2005 | 0 | 274 | 0 | 0 | 274 | 3875 | 353 | 211 | 869 | 5308 | 5034 | 1235 | 64 | 1171 |
| 13 | 2006 | 0 | 274 | 0 | 0 | 274 | 3875 | 353 | 211 | 869 | 5308 | 5034 | 1081 | 56 | 1026 |
| 14 | 2007 | 0 | 274 | 0 | 0 | 274 | 3875 | 353 | 211 | 869 | 5308 | 5034 | 947 | 49 | 898 |
| 15 | 2008 | 0 | 274 | 0 | 0 | 274 | 3875 | 353 | 211 | 869 | 5308 | 5034 | 829 | 43 | 787 |
| 16 | 2009 | 0 | 274 | 0 | 0 | 274 | 3875 | 353 | 211 | 869 | 5308 | 5034 | 726 | 37 | 689 |
| 17 | 2010 | 0 | 274 | 0 | 0 | 274 | 3875 | 353 | 211 | 869 | 5308 | 5034 | 636 | 33 | 603 |
| 18 | 2011 | 0 | 274 | 0 | 0 | 274 | 3875 | 353 | 211 | 869 | 5308 | 5034 | 557 | 29 | 528 |
| 19 | 2012 | 0 | 274 | 2529 | 0 | 2803 | 3875 | 353 | 211 | 869 | 5308 | 2505 | 488 | 258 | 230 |
| 20 | 2013 | 0 | 274 | 0 | 0 | 274 | 3875 | 353 | 211 | 869 | 5308 | 5034 | 427 | 22 | 405 |
| 21 | 2014 | 0 | 274 | 0 | 0 | 274 | 3875 | 353 | 211 | 869 | 5308 | 5034 | 374 | 19 | 355 |
| 22 | 2015 | 0 | 274 | 0 | 0 | 274 | 3875 | 353 | 211 | 869 | 5308 | 5034 | 328 | 17 | 311 |
| 23 | 2016 | 0 | 274 | 0 | 0 | 274 | 3875 | 353 | 211 | 869 | 5308 | 5034 | 287 | 15 | 272 |
| 24 | 2017 | 0 | 274 | 2690 | 0 | 2964 | 3875 | 353 | 211 | 869 | 5308 | 2344 | 251 | 140 | 111 |
| 25 | 2018 | 0 | 274 | 0 | 0 | 274 | 3875 | 353 | 211 | 869 | 5308 | 5034 | 220 | 11 | 209 |
| 26 | 2019 | 0 | 274 | 0 | 0 | 274 | 3875 | 353 | 211 | 869 | 5308 | 5034 | 193 | 10 | 183 |
| 27 | 2020 | 0 | 274 | 0 | 0 | 274 | 3875 | 353 | 211 | 869 | 5308 | 5034 | 169 | 9 | 160 |
| 28 | 2021 | 0 | 274 | 0 | 0 | 274 | 3875 | 353 | 211 | 869 | 5308 | 5034 | 148 | 8 | 140 |
| 29 | 2022 | 0 | 274 | 0 | 0 | 274 | 3875 | 353 | 211 | 869 | 5308 | 5034 | 130 | 7 | 123 |
| 30 | 2023 | 0 | 274 | 0 | 0 | 274 | 3875 | 353 | 211 | 869 | 5308 | 5034 | 114 | 6 | 108 |
| | Total | 29087 | 7119 | 5219 | 0 | 41425 | 101049 | 9226 | 5489 | 22604 | 138369 | 96943 | 24521 | 24521 | -0 |

(2) Sensitivity Analysis

In order to determine whether the project is feasible when certain conditions change, a sensitivity analysis is made for three alternatives.

Case A : The costs increase by 10%
Case B : The benefits decrease by 10%
Case C : The costs increase by 10% and the benefits decrease by 10%

The sensitivity analysis for three alternative is calculated by using above formula as the base case and the results are shown in Table 5-9-13.

Table 5-9-13 Results of Sensitivity Analysis

| Case | EIRR ( % ) |
|---|---|
| Base Case | 14.2 |
| Case A | 12.8 |
| Case B | 12.7 |
| Case C | 11.4 |

(3) Evaluation

There are various views concerning the appropriate EIRR level used to determine whether a project is feasible. The leading view is that the project is feasible if the EIRR exceeds the opportunity cost of capital.

In general, the opportunity cost of capital in various countries is considered to range from 8% to 12% according to the degree of development in each country. It is generally considered that a project with an EIRR of more than 10% is economically feasible for infrastructure or social service projects.

For this project, even though the economic calculation only takes into account the items which are easily quantified, the EIRR fairly exceeds 10%, and even in the case of (C) in which EIRR is minimized, it exceeds 10%.

Therefore, this Short-term Development Project is feasible from the viewpoint of the national economy.

## 5.10 Financial Analysis

### 5.10.1 Purpose of the Financial Analysis

The purpose of the financial analysis is to examine the viability of the project of the short-term development plan.

### 5.10.2 Methodology of the Financial Analysis

(1) Viability of the project

The viability of the project is analyzed using the Financial Internal Rate of Return(FIRR) by means of the discount cash flow method. The FIRR is a discount rate that makes the costs and revenues during the project life equal, and it is calculated using the following formula;

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

n :Project life
Bi :Revenue in the i-th year
Ci :Cost in the i-th year
r :Discount rate

Here, the revenues and costs in this analysis cover the following items;

Revenues : Operating revenues
Residual value of the fixed assets at the end of the project life
Costs : Investment(initial investment and re-investment for renewal) Operating expense

The following revenues and costs are exempted from calculation of the FIRR.

Revenues : Fund management income
Costs : Depreciation cost
Repayment of the principal loan
Interest on loan

When the calculated FIRR exceeds the weighted average interest rate of the total funds for the investment, the project is regarded as financially feasible.

(2) Financial soundness of the port management body

The financial soundness of the implementation body is appraised based on its projected financial statements(Profit and Loss Statement, Cash Flow Statement and Balance Sheet). The appraisal is made from the viewpoints of profitability, loan repayment capacity and operational efficiency, using the following ratios;

1) Profitability

Rate of Return on Net Fixed Assets:

$$\frac{\text{Net Operating Income}}{\text{Total Fixed Assets}} \times 100(\%)$$

This indicator shows the profitability of the investments, which are presented as net total fixed assets. It is necessary to keep the rate above the average interest rate of the funds for investment.

2) Loan repayment capacity

Debt Service Coverage Ratio:

$$\frac{\text{Net Operating Income before Depreciation}}{\text{Repayment and interest of Long-term loans}}$$

This indicator shows whether the operating income can cover the repayment and the interest on long-term loans. The ratio must be higher than 1.0.

3) Operational Efficiency

Operating Ratio:

$$\frac{\text{Operating Expenses}}{\text{Operating Revenues}} \times 100(\%)$$

Working Ratio:

$$\frac{\text{Operating Expenses - Depreciation Expense}}{\text{Operating Revenues}} \times 100(\%)$$

The operating ratio shows the operational efficiency of the organization as an enterprise, and the working ratio shows the efficiency of the routine operations of the port. When the calculated operating ratio is less than 70-75%, and the working ratio is less than 50-60%, the operations of port are efficient.

5.10.3 Prerequisites of the Financial Analysis

(1) Project life

Taking account of the conditions of the long-term loans and the service lives of the port facilities, the project life for the financial analysis is determined to be 30 years,including 5 years of detailed design and construction of port facilities.

(2) Base year

For the estimation, costs, expenditures and revenues analyzed quantitatively here, 1994 prices are predominantly used. Neither price inflation nor increases in nominal wages are considered during the project life.

(3) Cargo handling volume

Cargo handling volume is estimated based on the demand forecast. Table 5-10-1 shows cargo handling volume for each type of cargo. The berths in the short-term plan will reach the maximum handling capacity in 2004.
(berth occupancy: 55%)

Table 5-10-1 Cargo Handling Volume

(t/year)

| Type of cargo | Cargo handling volume 1998 / after 2004 |
|---|---|
| <General Cargo> | 160,600 -> 210,800 |
| Foreign | 54,500 -> 77,100 |
| Domestic | 48,800 -> 63,200 |
| Tranship | 57,300 -> 70,500 |
| <Tuna Cargo> | 112,200 -> 112,200 |
| Foreign | 23,200 -> 23,200 |
| Domestic | 37,000 -> 37,000 |
| Tranship | 52,000 -> 52,000 |
| <Petroleum Cargo> | 116,200 -> 147,500 |
| Foreign | 29,700 -> 37,600 |
| Domestic | 18,300 -> 23,500 |
| Tranship | 68,200 -> 86,400 |
| Total | 389,000 -> 470,500 |

(4) Number of vessels

Number of vessels is calculated using cargo handling volume and cargo handling volume per vessel. Number of vessels for each type of cargo is shown in Table 5-10-2, while dimensions of vessels are shown in Table 5-10-3.

Table 5-10-2 Number of Vessels

| Type of cargo | Ave. Size of Vessels | Number of Vessels 1998 / 2004 | Cargo Handling Vol. per Vessels 1998 / 2004 |
|---|---|---|---|
| <General Cargo > | | 297 -> 332 | (t/Num.) |
| Foreign | 5,600 D/W | 84 -> 97 | 650 -> 800 |
| Domestic | 1,000 D/W | 98 -> 111 | 500 -> 570 |
| Tranship | Barge | 115 -> 124 | 500 -> 570 |
| <Tuna Cargo> | | 96 -> 89 | |
| Foreign | 5,600 D/W | 36 -> 29 | 650 -> 800 |
| Domestic | 1,000 D/W | 42 -> 42 | 900 -> 900 |
| Tranship | 5,600 D/W | 18 -> 18 | 3,000 -> 3,000 |
| <Petroleum C.> | | 18 -> 18 | |
| Foreign | 25,000 D/W | 6 -> 7 | 5,000 -> 5,400 |
| Domestic | 5,000 D/W | 12 -> 11 | 1,600 -> 2,200 |
| Total | | 411 -> 439 | |

Table 5-10-3 Dimensions of Vessels

| Kinds of Vessels | Tonnage | Overall Length | Moulded Breadth | Full Load Draft | Vol. of Vessels |
|---|---|---|---|---|---|
| Cargo Ship | 5,600 D/W | 112 m | 16.9 m | 7.0 m | 13,250 $m^3$ |
| Cargo Ship | 1,000 D/W | 64 m | 10.4 m | 4.2 m | 2,800 $m^3$ |
| Oil Tanker | 25,000 D/W | 174 m | 22.6 m | 10.4 m | 40,900 $m^3$ |
| Oil Tander | 5,000 D/W | 104 m | 16.2 m | 6.5 m | 10,950 $m^3$ |

5.10.4 Revenue

The revenues from the port activities are calculated based on the present tariff level. The following charges are the sources of revenue generated from the operation.

(1) Entering the port charge

Entering the port charge is calculated by vessel's number and volume and is shown in Table 5-10-4.

Table 5-10-4 Entering the Port Charge

(t. FMG/y)

| Type of Cargo | Num. of Vessels 1998 / 2004 | Vol. of Vessels | Tariff Level | Revenue 1998 / 2004 (thousand FMG/y) |
|---|---|---|---|---|
| <General Cargo> | 182 -> 208 | | | 13,051 -> 15,029 |
| Foreign | 84 -> 97 | 13,250 $m^3$ | 10 FMG/$m^3$ | 11,130 -> 12,853 |
| Domestic | 98 -> 111 | 2,800 $m^3$ | 7 FMG/$m^3$ | 1,921 -> 2,176 |
| <Tuna Cargo> | 96 -> 89 | | | 7,978 -> 7,051 |
| Foreign | 36 -> 29 | 13,250 $m^3$ | 10 FMG/$m^3$ | 4,770 -> 3,843 |
| Domestic | 42 -> 42 | 2,800 $m^3$ | 7 FMG/$m^3$ | 823 -> 823 |
| Transhipp | 18 -> 18 | 13,250 $m^3$ | 10 FMG/$m^3$ | 2,385 -> 2,385 |
| <Petroleum C.> | 18 -> 18 | | | 4,259 -> 4,641 |
| Foreign | 6 -> 7 | 40,900 $m^3$ | 12 FMG/$m^3$ | 2,945 -> 3,436 |
| Domestic | 12 -> 11 | 10,950 $m^3$ | 10 FMG/$m^3$ | 1,314 -> 1,205 |
| Total | 296 -> 315 | | | 25,288 -> 26,721 |

(2) Wharfage charge

Wharfage charge is calculated by vessel's number, length and staying time and shown in Table 5-10-5.

Table 5-10-5 Wharfage Charge

| Type of Cargo | Num. of Vessels 1998 / 2004 | Lenght (m) | Staying T. 1998 / 2004 (hr) | Tariff L. (FMG/m /hr) | Revenue 1998 / 2004 (thousand FMG/y) |
|---|---|---|---|---|---|
| <General C.> | 297 -> 332 | | | | 26,031 -> 35,591 |
| Foreign | 84 -> 97 | 112 | 36 -> 43 | 71 | 24,047 -> 33,168 |
| Domestic | 98 -> 111 | 64 | 45 -> 50 | 8 | 1,581 -> 1,989 |
| Tranship | 115 -> 124 | - | - | t.FMG 5 | 403 -> 434 |
| <Tuna Cargo> | 96 -> 89 | | | | 29,730 -> 9,916 |
| Foreign | 36 -> 29 | 112 | 36 -> 43 | 71 | 10,306 -> 9,916 |
| Domestic | 42 -> 42 | 64 | 59 -> 59 | 8 | 888 -> 888 |
| Tranship | 18 -> 18 | 112 | 185 -> 185 | 71 | 18,536 -> 18,536 |
| <Petro. C.> | 18 -> 18 | | | | 4,339 -> 5,369 |
| Foreign | 6 -> 7 | 174 | 21 -> 23 | 147 | 3,223 -> 4,118 |
| Domestic | 12 -> 11 | 104 | 18 -> 22 | 71 | 1,116 -> 1,251 |
| Total | 411 -> 439 | | | | 60,100 -> 70,300 |

(3) Cargo handling charge

Cargo handling charge is calculated after dividing cargo handling into loaded and unloaded cargo and shown in Table 5-10-6.

Table 5-10-6 Cargo Handling Charge

| Type of Cargo | Load Vol. 1988 / 2004 (t/year) | Unload Vol. 1988 / 2004 (t/year) | Tariff Level | Revenue 1988 / 2004 (thousand FMG/y) |
|---|---|---|---|---|
| <General Cargo> | 67,000 -> 90,000 | 93,600 -> 119,900 | LOAD FMG/t 1,140 UNLOAD FMG/t 570 | 129,732 -> 171,969 |
| <Tuna Cargo> | 15,200 -> 15,200 | 45,000 -> 45,000 | | 42,978 -> 42,978 |
| <Petroleum Cargo> | 7,400 -> 9,400 | 40,600 -> 51,700 | | 31,578 -> 40,185 |
| Total | 89,600 -> 115,500 | 179,200 -> 216,600 | | 204,288 -> 255,132 |

(4) Occupancy charge

Occupancy charge, shown in Table 5-10-7, is calculated based on area occupied and used except by public.

Table 5-10-7 Occupancy Charge

| Facilities | Area ($m^2$) | Tariff Level | Revenue (thousand FMG/y) |
|---|---|---|---|
| Sheds | 8,849 | FMG/$m^2$/month 500 | 53,094 |
| Open Yard | 5,025 | | 30,150 |
| Total | 13,874 | | 83,244 |

(5) Royalties

Royalties received from CMDM and pilotage company are calculated based on present rate and increasing rate of cargo handling volume and number of vessels. Royalties are shown in Table 5-10-8.

Table 5-10-8 Royalties

| CMDM | 1998 / 2003 | 2004 |
|---|---|---|
| Cargo handling vol. | 22,800 -> 261,800 (t/y.) | 271,000 (t/y.) |
| Royalties (*1) | 121,500 (thousand FMG/y) | 125,770 (thousand FMG/y) |
| Pilotage company | 1998 / 2004 | |
| Number of vessels | 296 -> 315 | |
| Royalties (*2) | 4,996 -> 5,317 (thousand FMG/y) | |

(*1) The rate of royalty is fixed to 2003.

(*2) Based on 1992(Number of vessels: 188, Royalties: 3,173 thousand FMG)

The revenues/year during the project life are shown in Table 5-10-9.

Table 5-10-9 Revenue

(thousand FMG/y)

| year | Entering the port C. | Wharfage Charge | Cargo han -dling C. | Occupancy Charge | Royalties | Total |
|---|---|---|---|---|---|---|
| 1998 | 25,288 | 60,100 | 204,288 | 83,244 | 126,496 | 499,416 |
| 7999 | 26,083 | 61,576 | 212,382 | | 126,551 | 509,836 |
| 2000 | 26,274 | 62,976 | 220,305 | | 126,600 | 519,399 |
| 2001 | 26,204 | 65,271 | 228,513 | | 126,653 | 529,885 |
| 2002 | 26,376 | 67,288 | 237,177 | | 126,713 | 540,798 |
| 2003 | 26,415 | 68,886 | 245,499 | | 126,757 | 550,801 |
| 2004 | 26,721 | 70,300 | 255,132 | | 131,087 | 566,484 |

5.10.5 Investment Costs

(1) Initial investment costs

Initial investment costs of the Short-Term Plan are estimated in Section 5-7. These are summarized in Table 5-10-10.

Table 5-10-10 Initial Investment

(thousand FMG/y)

| 1994 | 1995 | 1996 | 1997 | 1998 | Total |
|---|---|---|---|---|---|
| 3,036,217 | 15,339,657 | 20,223,850 | 9,039,716 | 1,155,008 | 48,794,448 |

1 US$ = 1,860 FMG

(2) Renewal investment costs

The facilities and equipment will be renewed based on their service lives which are as follows:

Rehabilitated quay : 20 years
Light marker : 15 years
Fence and gate : 15 years

5.10.6 Operating Expense

The annual operating expenses are assumed as follows;

(1) Personnel cost

The annual personnel costs are estimated based on the organization proposed in section 5.8.3 and existing pay scales.
Personnel costs and number of workers are shown in Table 5-10-11.

Table 5-10-11 Personnel Cost

| Sections | Persons | Personnel C. (thousand FMG/y) |
|---|---|---|
| General Manager | 1 | 2,889 |
| Sub General Manager | 1 | 2,349 |
| Technical Manager | 1 | 1,931 |
| General Affairs Dept. | 8 | 11,532 |
| Port Operation Dept. | 3 | 4,645 |
| Technical Dept. | 1 | 1,634 |
| Total | 15 | 24,980 |

(2) Administration

Administration cost is 60 % of personnel costs based on the past condition.

(3) Maintenance and repair

The annual maintenance and repair costs for port facilities are calculated as 1% of the original investment coat.

The operating expenses/year during the project life are shown in Table 5-10-12.

Table 5-10-12 Operation Expense

(thousand FMG/y)

| Personal | Administration | Maintenance and repair | Total |
|---|---|---|---|
| 24,980 | 14,988 | 437,072 | 477,040 |