National Directorate of Fisheries
Ministry of Agriculture and Fisheries
Republic of Mozambique

# BASIC DESIGN STUDY REPORT
# ON THE PROJECT
# FOR
# REHABILITATION OF MAPUTO FISHING PORT
# IN
# THE REPUBLIC OF MOZAMBIQUE

**FEBRUARY 1999**



**JAPAN INTERNATIONAL COOPERATION AGENCY**
**PACIFIC CONSULTANTS INTERNATIONAL**

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# Preface

In response to a request from the Government of the Republic of Mozambique, the Government of Japan decided to conduct a basic design study on the Project for Rehabilitation of Maputo Fishing Port and entrusted the study to the Japan International Cooperation Agency (JICA).

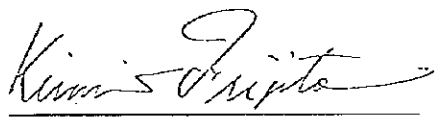
JICA sent to Mozambique a study team from August 1 to September 5, 1998.

The team held discussion with the officials concerned of the Government of Mozambique, and conducted a field study at the study area. After the team returned to Japan, further studies were made. Then, a mission was sent to Mozambique in order to discuss a draft basic design, and as this result, the present report was finalized.

I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between our two countries.

I wish to express my sincere appreciation to the officials concerned of the Government of the Republic of Mozambique for their close cooperation extends to the teams.

February, 1999



Kimio Fujita
President
Japan International Cooperation Agency

February, 1999

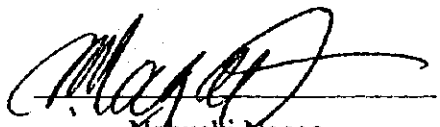
Letter of Transmittal

We are pleased to submit to you the basic design study report on the Project for Rehabilitation of Maputo Fishing Port in the Republic of Mozambique.

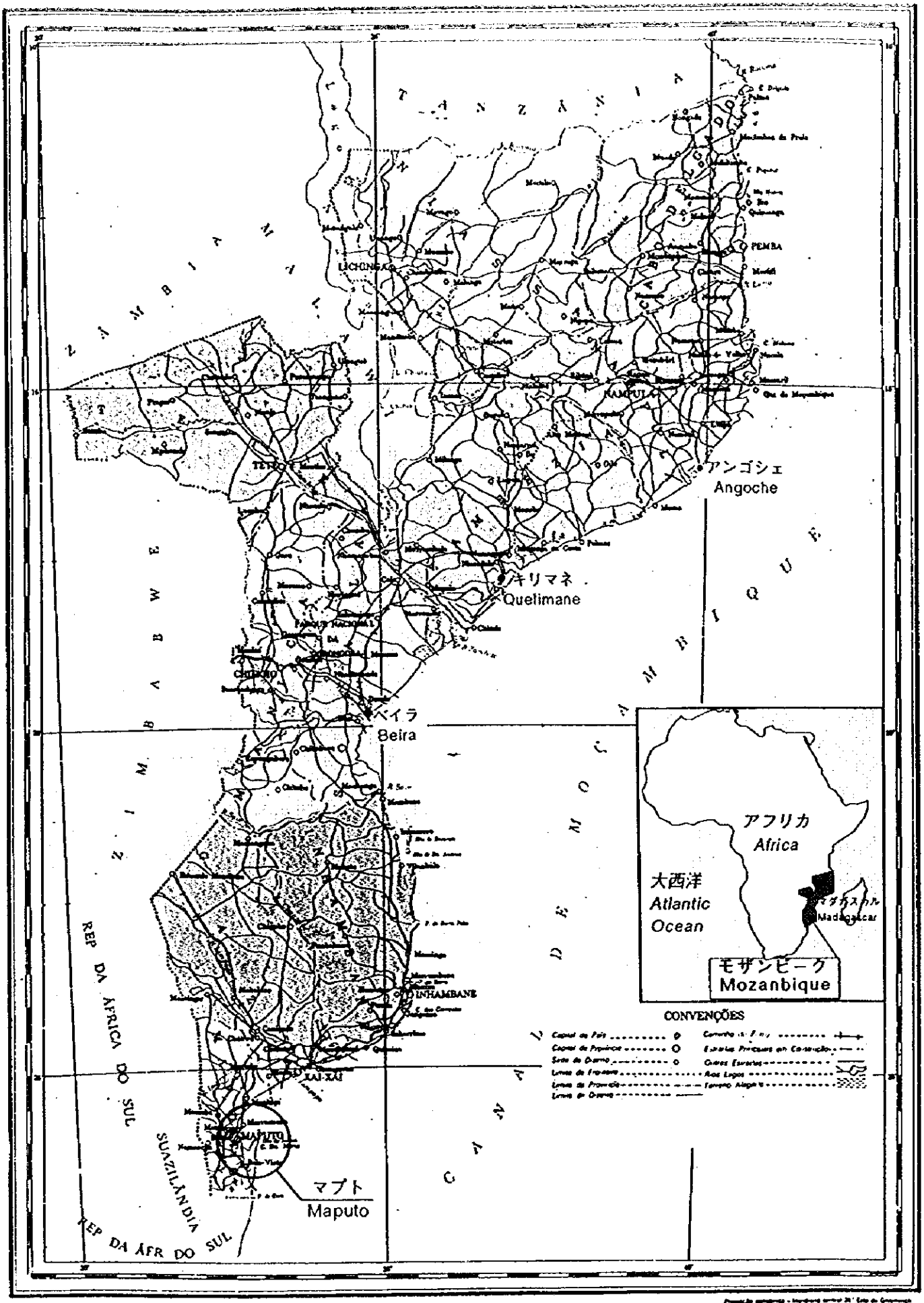
This study was conducted by Pacific Consultants International, under a contract to JICA, during the period from July 24 1998 to February 1, 1999. In conducting the study, we have examined the feasibility and rationale of the project with due consideration to the present situation of Mozambique and formulated the most appropriate basic design for the project under Japan's grant aid scheme.

Finally, we hope that this report will contribute to further promotion of the project.

Very truly yours,



Nobuaki Nagao
Project Manager,
Basic design study team on
The Project for Rehabilitation of
Maputo Fishing Port in the
Republic of Mozambique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INHAMBANE
LUI-XU
マプト
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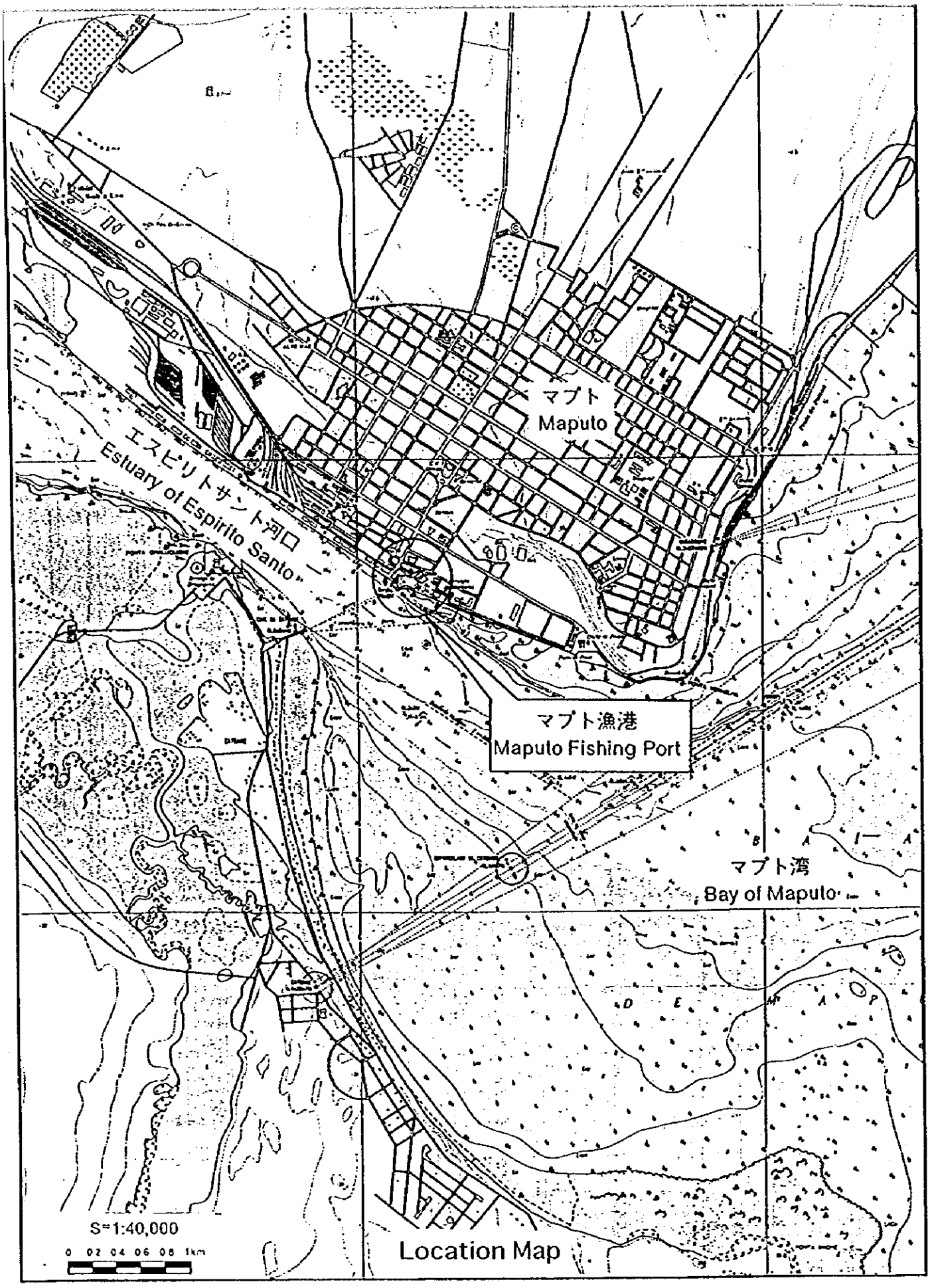
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Maputo
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Estuary of Espirito Santo
マプト漁港
Maputo Fishing Port
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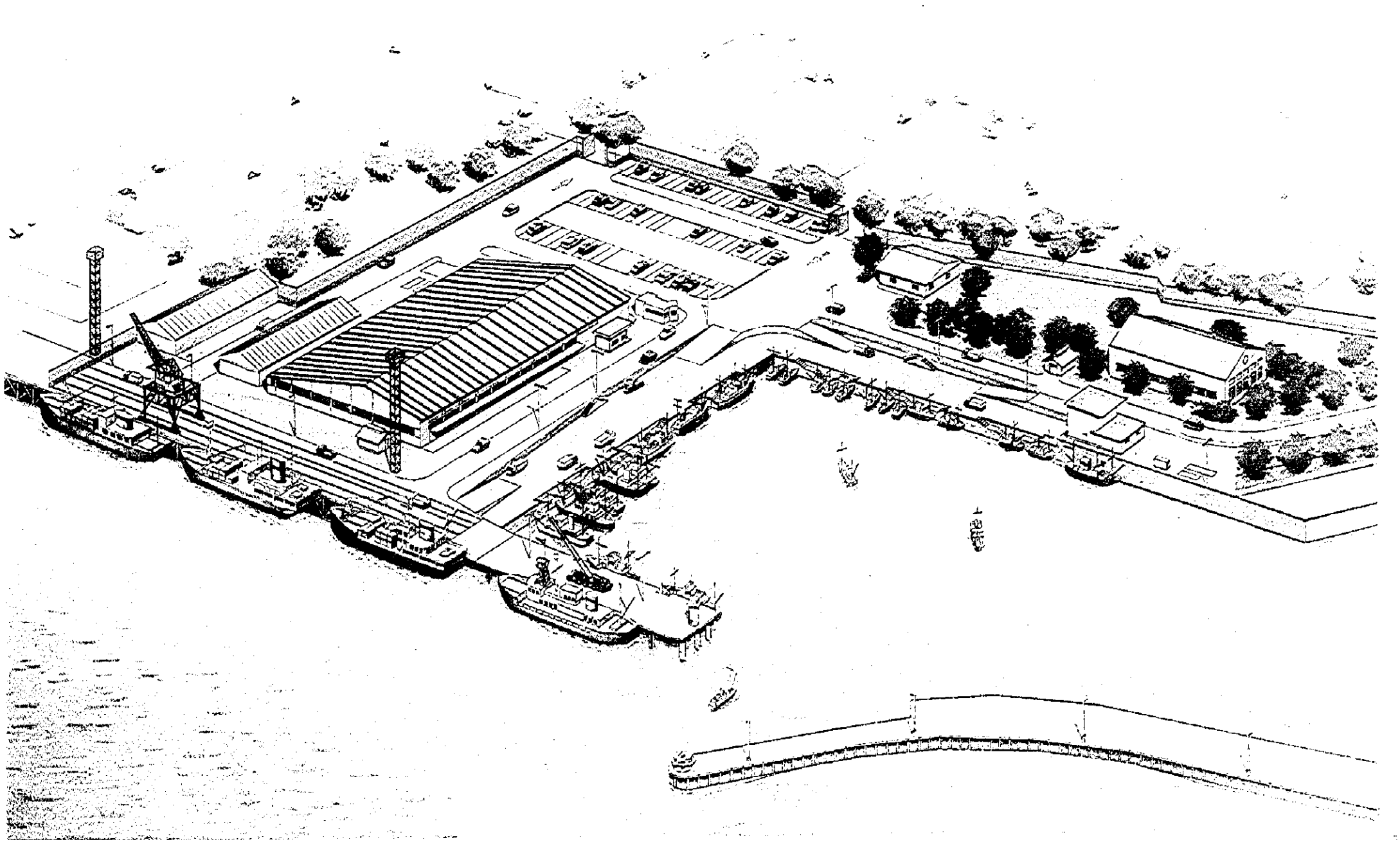
Location Map



Abbreviations

| | |
|---|---|
| CETA | Public Construction Corporation of Mozambique |
| CFM | Empresa Nacional de Portos e Caminhos de Ferro de Moçambique E.E. |
| DNP | Direcção Nacional de Pescas |
| EMODRAGA | Empresa Moçambicana de Dragagens |
| EU | European Union |
| INAHINA | Instituto Nacional de Hidrografia e Navegação |
| LEM | Laboratório de Engenharia de Moçambique |
| PPM | Porto de Pesca de Maputo |
| SAFMAR | Maritime Administration Agency of Mozambique |
| SABS | South African Bureau of Standards |
| SOMONAV | Public Corporation of Ship Yard by the joint-venture between Mozambique and South Africa |
| UNHCR | United Nations High Commissioner for Refugees |

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Appendices

# CHAPTER 1 BACKGROUND OF THE PROJECT

## 1-1 Background of the Project

Mozambique is located on the east coast of the African Continent, longitude 30° 12'- 40° 51'E and latitude 10° 27'- 26° 52'S, and is bordering north on Tanzania, west on Malawi, Zambia, Zimbabwe and South Africa, south on Swaziland. The land area is 799,380 km$^2$, twice as large as that of Japan. Mozambique has the coastline of 2,515 km long and the continental shelf of approximately 70,000 km$^2$ in the 200 nautical miles Exclusive Economic Zone (EEZ).

The population of the nation is about 17,880,000 as of 1996 and the capital Maputo has a population of about 1,090,000. There is a wide range variations of regional climate due to the longitudinal differences of the land from north to south and the elevation differences from east to west, and in Maputo the average temperature is 25.5℃ and monthly average precipitation is 111.6 mm/month in summer (rainy season; November – March) and 21.0℃ and 29.0 mm/month in winter (dry season; April – October) respectively (the average in 1961 – 1990).

Mozambique is one of the least less developed countries (LLDC) and its GDP per capita stays at USD 125 (as of 1997). The international trade balance of the nation shows the big excess of imports (USD 802 million) over exports (USD 226 million) as of 1996. The major items of the exports are in the order of prawns, cashew nuts, coconuts, cotton and copra, and the export of prawns occupies the share of 40% (USD 90 million), the top position by far above all, and contributes to the domestic economy of the nation.

Mozambique is blessed with many good fishing grounds and abounds in marine resources; the northern offshore area is the rich fishing ground of migratory fishes such as tunas, bonitos, etc; the surface fishes such as sardines and horse mackerels and the bottom fishes such as prawns and rosefishes are abundant on the continental shelf offshore along the coast line; the southern part of the Madagascar Strait is the rich fishing ground of the surface fishes such as tunas and the bottom fished such as lobsters, crabs and rosefishes. Fishing boats are gathering from the deep-sea fishery countries seeking tunas and bonitos, and not only the local fishing boats but also the foreign fishing boats are operating through establishment of joint venture in the offshore fishing grounds.

The gross amount of the fishery catch in 1996 was about 35,000 tons, of which the portion

of prawns was about 8,300 tons. It is considered that the 60 -- 80% of the potential resources of prawns are already utilized but the total utilization of the whole marine resources still remains at the level of 10 – 15%.

The 90% of catches of prawns are caught and exported by the large-scale fishing enterprises of joint ventures, while the 80% of catches of common fishes are caught by the local small-scale fishers and are distributed in the domestic market. But the volume of the fish catches has not yet reached to the level to meet domestic demand and the shortage is supplemented by the import from foreign countries. Meanwhile, the bottom fishes as well as prawns are being exported to the neighboring countries such as South Africa and Zimbabwe to obtain foreign currency in recent years and are showing good growth.

The Government of Mozambique has recognized the fishing industry as one of the important sources to obtain foreign currency and to supplement the national food demand. And the Government also recognized the improvement of infrastructures of the major fishing bases of Maputo, Beira and Quelimane as the national prime project to achieve supply of fish catches to the Mozambican nationals, improvement of lives of fishing people, improvement of productivity of fishing industry and growth of export in the fishery sector.

Maputo Fishing Port, the objective of this project study, is an excavated harbour constructed about 85 years before and has functioned as an important distribution base of marine products for the metropolitan area. But the fishery infrastructures as well as port facilities have already been timeworn severely and many troubles have been seen in the series of fishing activities in the port. Furthermore, the part of the harbour revetment was collapsed during the maintenance dredging of the harbour basin conducted by EMODRAGA in 1997 and the accident required an urgent countermeasure to prevent the danger to the operation of the harbour.

Under the above-mentioned situation, the Government of Mozambique made an improvement plan of Maputo Fishing Port to rehabilitate and improve the function of the port and requested the Grant Aid to the plan from the Government of Japan.

## 1-2 Components of the Project

The aim of the request of the Grant Aid was the rehabilitation and improvement of the functions of Maputo Fishing Port and the components of the project are as follows.

The item "rehabilitation of cold storage" was not included in the original request. The item was proposed as the urgent additional request by the Government of Mozambique when the study team visited the site for the field investigation and the study team recognized the urgency and necessity of it. The recognized priority of each component of the project is shown in the following table.

| | Components of the Project | Priority | |
|---|---|---|---|
| | | A | B |
| 1 | Demolition and Construction of Quaywall and Revetment | ○ | |
| 2 | Installation of Floating Pier | | ○ |
| 3 | Rehabilitation of the existing Piled Wharf | ○ | |
| 4 | Demolition and Construction of Ice Making Plant Building | ○ | |
| 5 | Construction of Administration Building with Social Center | | ○ |
| 6 | Procurement of Crane | | ○ |
| 7 | Procurement of Fork Lift Trucks | | ○ |
| 8 | Rehabilitation of Cold Storage | ○ | |

# CHAPTER 2 CONTENTS OF THE PROJECT

## 2-1 Objectives of the Project

The Government of Mozambique envisions the local fishing industry to develop into a large industry as large scale as ones of foreign capital in a long term. The main users of Maputo Fishing Port are the medium-size fishing boats. Since this port is the only fishing port equipped with port facilities in the southern part of Mozambique, it is impossible to exclude the large-size fishing boats which are giving the largest fish catches, exports and foreign currencies from the objective vessel. Meanwhile, it is also required to take the convenience of the small-size fishing boats into account that have no other berthing facility than Maputo.

In the above-mentioned background, this Project is aiming to recover and improve the functions as the marketing center of marine products in the metropolitan area by rehabilitating and expanding the deteriorated existing facilities of Maputo Fishing Port and is also aiming to improve the situation of fish distribution in the Maputo area.

## 2-2 Basic Concept of the Project

### 2-2-1 Requested and Accepted Project Components

In order to improve the function of deteriorated existing facilities of Maputo Fishing Port, the Government of Mozambique has requested to the Government of Japan to rehabilitate or construct the following facilities and to install or supply the following equipment. For the requirement, the necessity and suitability of the requirements were studied in the Basic Design Study and the conclusions were summarized in Table2.2.1.

Table2.2.1 Requested Project Components

| | |
|---|---|
| 1 | Demolition and Construction of Quaywall and Revetment |
| 2 | Installation of Floating Pier |
| 3 | Rehabilitation of the existing Piled Wharf |
| 4 | Demolition and Construction of Ice Making Plant Building |
| 5 | Construction of Administration Building with Social Center |
| 6 | Procurement of Crane |
| 7 | Procurement of Fork Lift Trucks |
| 8 | Rehabilitation of Cold Storage |

(1) Rehabilitation of Piled Wharf (Demolish and new Construction or Repair)

In this fishing port, there is a piled wharf (184m long) facing to the Espirito Santo River, which was constructed in 1912 and utilized for the mooring of industrial fishing vessels. The part of 114m in length is a piled wharf type structure backed by land and the remaining part of 70m in length is jetty type structure locating between the river and artificial harbour basin.

The both types of structures has passed 85 years after construction and many concrete members have cracked and are in the condition that they can not stand against the utilization for long period in future. Therefore, it is requested to rehabilitate or demolish and newly construct these facilities.

However, it requires a grate deal of cost to demolish the structures completely and construct a new structure. Based on the field survey on the magnitude of deterioration of both structures, the piled wharf type portion, nevertheless there are cracks and torn off on many diagonal members, is not in a condition that structure will collapse in a few years. Meanwhile, the jetty type portion, in which members are not only cracked or torn off but also lacked in full length in some positions, is under severe conditions due to frequent collisions with vessels. Considering the restriction of available fund amount, therefore, the piled wharf type portion is kept as it is in this opportunity and it is judged that only the jetty type portion will be completely demolished and replaced by new structure.

In order to mitigate the deterioration on the piled wharf type portion, there is an alternative method to repair mainly on the cracked and torn-off spots only, but it is difficult to guarantee its soundness and durability since no detailed drawings are available and the embedded length of piles can not be confirmed. Furthermore, considering that the repair cost will require some 60% of that for new construction, it is judged that the best way is to demolish the existing facility completely and construct new one for the guaranteed service life of 50 years after the sufficient fund become available.

Beside this, in case of the construction of new jetty, the alignment has been proposed to be shifted initially so that the tip of jetty to be parallel with the tip of breakwater of SAFMAR in order to reduce the sedimentation of river bed-load into the artificial basin. However, this concept was abandoned finally because it is difficult to evaluate the effectiveness of the realignment work without availability of the necessary engineering data such as discharge of river water, volume of bed load, grain size analysis of suspended materials and so on.

(2) Demolition and Construction of Quaywall and Revetment

The existing fishing port has an artificial basin along the large river and the basin is surrounded by the quay wall and revetment of 230m long in total. The existing structures were constructed in 1912. The portion of 50m long was constructed as a quaywall with a water depth of 0m to about – 3m and the remaining portion of 180m long was built as a revetment with a water depth of 0m. The most part of revetment has collapsed last year during the maintenance dredging work and that caused difficulty in port operation for boat mooring and cargo handling of semi-industrial and artisanal fishing boats in the basin.
Around Maputo City at present, Maputo Fishing Port is the only fishing port having the facilities for mooring, cargo handling, ice and water supply, etc. Therefore, the activities in Maputo Fishing Port is very busy now and all kind of fishing vessels such as industrial boats, semi-industrial boats and artisanal boats are mooring and handling cargoes using the facilities in and out of the artificial basin. The basin has a water area of more than 1 ha, but not wide enough for the demand. Meanwhile, there are few artisanal fishing boats now using the Maputo Fishing Port, but there are more than 200 artisanal fishing boats in the several fishermen villages around this fishing port, and it is clearly expected that the calling of these fishing boats at this port will increase when this rehabilitation project is realized.

Judging from the above situations, it is necessary and appropriate to construct a new quaywall for full length around the basin in this opportunity to repair the collapsed revetment, instead of the existing quaywall with revetment, for the semi-industrial fishing boats and artisanal fishing boats.

(3) Floating Pier

The floating pier in case of existence of a large tidal range (approx. 3.5m) like in this site, is very useful facility for the mooring and cargo handling operation of fishing boats, but on the contrary, in the area where sedimentation occurs considerably like in this basin, the floating pier will disturb the workability of maintenance dredging and there is possibility to damage the function of floating pier due to insufficient maintenance dredging works. Therefore, the problem against the large tidal range is solved by applying the counter measures of lowering the crown height of quay wall and providing the steps on the parapet of quaywall as many as possible.

Judging from the field survey and actual port operation data, even if the floating pier is omitted, the mooring facility for artisanal boats will be sufficient for the demand in future

by converting the structure from the existing revetment to a new quaywall.

(4) New Ice Making Plant

The existing ice making plant is located on the pier type jetty. The plant consists of 2 ice making machines made in 1977 and the machines are the type of making ice at inner surface of double wall pipes and tearing off the ice by using the hot gas at few minutes intervals. One machine is out of order already and the ice making productivity is about 1 ton/hour at present.

According to the monthly sales data of Maputo Fishing Port, 2,071 tons/year (Average 172 ton/month) of ice were sold for fishing boats and market, and 248 ton/month (Average 8 ton/day) in the busiest month of March in 1997. The loading volume of ice is 150 kg/sail/boat for artisanal boats and 1,000 kg/sail/boat for semi-industrial boats in average. The industrial boats have own refrigeration equipment and load ice rarely.

According to the interview survey, nevertheless the necessity of use of ice is well understood, the use by artisanal boats is realized at about 50% due to insufficient supply capacity and the semi-industrial boats are also not loading enough ice for sailing period and also due to higher temperature of ice, the quality of catch in early time of sailing period is difficult to keep well.

As explained above, the necessity of replacement of the existing ice making plant by the new one is judged as very high because of the following reasons:

1) the existing ice making plant has not been satisfying the demand,
2) the whole facility has been deteriorated already,
3) the existing plant must be replaced from the jetty during rehabilitation works,
4) the supply of ice shall be maintained during the rehabilitation of the jetty,
5) the present ice production system is considered very dangerous because of strong percussion at every few minutes to the ice making panels.

The plate ice used currently is considered as the most suitable type of ice from the view point of objective fishes and fishing operation pattern, and the ice storage room which can store the ice for 2 to 3 days of production is considered necessary.

(5) Construction of Administration Building with Social Center

The present administration office of the fishing port is actually located in the refrigeration

building and the office has neither windows nor enough space and is in poor working conditions. Therefore, an administration office should be built independently from the refrigeration building. Meanwhile, the urgent necessity is not recognized for the social center for fishermen, but the toilets for public use are insufficient. Thus, it is suitable to build two public toilet booths independently from the administration building.

Besides, the building in the territory of fishing port and now used by the fishing companies (SURPESCA and GAMBEIRA) is under the jurisdiction of the public fishery corporation (EMOPESCA) which is directly controlled by the Ministry of Agriculture and Fishery and out of the jurisdiction of PPM. Therefore, this building is impossible to divert for the administration office of PPM.

(6) Procurement of Crane

At present, one (1) rail mounted gantry crane of hoisting capacity of 3.5 tons is working on the piled wharf. This crane is very old, made in 1912, but still being used for cargo handling of industrial fishing vessels. Generally, the industrial fishing vessels are equipped with boat gears but the gears have not enough boom length during low tide and the most vessels are handling marine catch, fishing goods and other supplies using this rail mounted gantry crane. However, the crane running area is limited only a half-length of whole piled wharf and the existing crane cannot cover the remaining area of the port.

In addition to the above, there is no crane which can cover the basin side and the semi-industrial fishing boats should move to the industrial fishing boat berth where they need the crane. Judging from these situations, it is necessary to procure one (1) crane. In that case, the procurement of a mobile crane is recommendable since only one (1) crane can applicable for industrial and semi-industrial fishing boats.

(7) Procurement of Forklift Trucks

Forklift trucks in this port are, in general, used for the transportation between wharves to cold storage and between the cold storage to delivery trucks. At present, PPM owned one electric driven forklift truck of 1.5 ton capacity (made in 1982) and one diesel engine forklift truck of 3.5 ton capacity (made in 1973) but both two are out of order now and the operation is continued barely by borrowing one electric driven forklift truck from CFM. The both of two forklift trucks of PPM are already expired its service life (about 6 years in general) substantially and are in the time for renewal.

Therefore, it is judged that in stead of the existing broken down forklift trucks, the same capacity and same number of forklift trucks should be introduced for smooth fish handling.

(8) Rehabilitation of Cold Storage

The Mozambican side has requested to add the project component of rehabilitation of cold storage, which was not included in the original requirements, as the highest priority component. It was explained that the refrigerating capacity of cold storage had become insufficient drastically after the application for grant aid was submitted.

In the existing cold storage, there are 3 refrigerated rooms of 150-ton storage capacity each, 2 cold storage rooms of 200 ton storage capacity each and one (1) ice making room but only 3 freezing rooms are in operation. As for the refrigeration machines, 4 units of compressors, 2 receivers for low and middle pressure and one (1) ammonia storage tank of GRASSO (made in 1977) are installed. Among them, 2 units of compressors are already broken and remaining 2 units are operable but with 50% of its capacity. And the middle pressure receiver is also broken of its circulation motor and pump, and is filled some extent by the oil mixed with ammonia. Furthermore, the cooling units in freezing rooms are not equipped with outlet of the mixed oil and the capacity has been reduced considerably, and the temperature in the freezing rooms can be maintained only up to -15°C during winter season and -10°C during summer season. Therefore, with an epidemic of cholera occurred in Mozambique in the beginning of this year as the turning point, the import ban for marine products was applied by EU and is continued till now.

It is the urgent need for Mozambique to reopen the export of marine product that is the main export commodity of country to the EU. In order to achieve this, the rehabilitation of freezing rooms is necessary to be able to maintain the temperature less than -18°C of the EU Standard.

The insufficiency of capacity of freezing rooms is due to the deterioration of machines manufactured 20 years ago, and the drastic rehabilitation or renewal of machines is inevitable. However, the machine manufacturer GRASSO had stopped their production in 1985 and the procurement of spare parts is impossible, and the rehabilitation of the existing system is technically difficult and costly.

In conclusion, it is judged as the best way to introduce a new system to the 2 chilled rooms which are not used at present and upgrade to the freezing rooms which can maintain the

room temperature of -18°C of EU Standard or lower.

### 2-2-2 Objective Usage of Facilities and Equipment

The functions of facilities, equipment and objective usage of this Project are as shown below (Table2.2.2).

Table 2.2.2 Functions of Facilities and Equipment

| Function | Facility / Equipment | Planned Usage |
|---|---|---|
| 1. Unloading of Catch and Mooring of Boats | 1) Pier | River side: Industrial fishing boats<br>Bay side : Semi-industrial fishing boats |
| | 2) Wharf in bay | West side : Semi-industrial fishing boats<br>North side : Artisanal fishing boats |
| 2. Storage and Distribution of Catch | 1) Ice Making / Storage Plant | Semi-industrial fishing boats<br>Artisanal fishing boats |
| | 2) Cold Storage | Industrial fishing boats<br>Semi-industrial fishing boats<br>Artisanal fishing boats |
| 3. Improvement of Port Operation Conditions | 1) Administration Office | Fishing Port staff |
| | 2) Crane | Industrial fishing boats<br>Semi-industrial fishing boats |
| | 3) Forklift Trucks | Industrial fishing boats<br>Semi-industrial fishing boats |

### 2-2-3 Objective Fishing Boats, Forecast of Fish Catch and Distribution Volume

#### (1) Objective Fishing Boats

The registered fishing boats in the Maputo Province are 135 industrial fishing boats, 85 semi-industrial fishing boats and 483 artisanal fishing boats. However, the number of actually working fishing boats in Maputo Fishing Port as the mother port are about 30 industrial boats (5 prawn trawlers, 25 other boats), about 33 semi-industrial boats (17 shrimp trawlers, 16 other boats) and about 20 artisanal fishing boats.

It is estimated that the number of industrial and semi-industrial fishing boats will be kept unchanged before and after the implementation of this Project. But as for the artisanal fishing boats there are more than 200 boats in the fishermen villages in the vicinity of Maputo Fishing Port. Therefore, after the improvement of wharves in Maputo Fishing Port by this Project, it is expected that many artisanal fishing boats will call at this port

because the most of the fishes caught by artisanal fishing boats are sold and consumed in the Maputo City, and no fishing port infrastructures are provided in those fishermen villages. However, Maputo Fishing Port has a limited waterfront area and only 40 additional boats equivalent to 50% of total number of boats in Catembe and Matola fishermen villages are planned to utilize in this port for unloading of catch and preparation of sailing out for fishing.

The explanation for the assumption that additional 40 artisanal fishing boats belong to the fishermen villages in the vicinity will be accepted after the implementation of this Project is described as follows (refer to Figure2.2.1).

(Catembe)
Based on the survey results, the number of artisanal fishing boats belong to Catembe fishermen village is about 30 boats at present and about 20% of catch is sold at local markets and remaining 80% of catch is delivered by ferry boats to the markets in the Maputo City through brokers.

The Maputo Fishing Port is situated between their fishing grounds and Catembe village and some fishermen have the opinion that when wharves in Maputo Fishing Port is improved, the most of 80% of catch will be dealt with brokers directly at Maputo Fishing Port. And most fishing boats are expecting to sail out fishing and loading catch through Maputo Fishing Port.

In this Project, therefore, it is assumed that 50% (15 boats) out of above 80% will unload their catch directly at Maputo fishing port for the moment, considering that the change of distribution system needs a certain period of time.

(Matola)
Based on the field survey of Matola fishermen village, the number of artisanal fishing boats belong to this village is about 50 and some 30% of catch are sold in the local markets and remaining 70% are send to the markets in Maputo city through brokers.

The Maputo fishing port is situated between Matola fishermen village and the fishing grounds, same as the Catembe fishermen village, and it was the brokers' opinion that about 70% of artisanal fishing boats will unload the catch at Maputo fishing port if unloading berths for artisanal fishing boats are provided in Maputo Fishing Port.

In this Project, it was assumed that the only 50% (25 boats) out of 70% will directly

In this Project, it was assumed that the only 50% (25 boats) out of 70% will directly unload the catch at the Maputo fishing port.

(Costa do Sol)

The area around Costa do Sol fishermen village and Macaneta fishermen village is the most large fishermen community in the vicinity of Maputo city and there are more than 100 artisanal fishing boats in operation. The local fish market here is very prosperous and the people in Maputo City come to this fish market directly for shopping. Therefore, some 50% of catch are sold at this local market and the remaining about 50% of catch are delivered by brokers to the markets in Maputo city by road.

Maputo fishing port is situated farther than these fishermen villages from the fishing ground, and the distance between these fishermen villages to Maputo City is only about 30 minutes by car. From these conditions, it was assumed in this Project that the artisanal fishing boats in Costa do Sol and Macaneta fishermen villages will unload catch in these villages continuously and will not use Maputo fishing port.

There are no infrastructures of fishing port at all in Costa do Sol and the unloading operation of catch and sailing out for fishing can be done only at the high tide. Therefore, if unloading berths and supply berths are prepared in Maputo fishing port, there is a possibility that some artisanal fishing boats will unload in Maputo fishing port but such possibility was not considered in this Project for safety.

From the above reasons, the number of artisanal fishing boats in vicinity which will use Maputo Fishing Port, is planned to be 40 boats in total, 15 boats from Catembe fishermen village and 25 boats from Matola fishermen village. The above explanation is illustrated in Figure2.2.1.

The maximum and average sizes of these design objective vessels are indicated in Table 2.2.3. And the average operation patterns of the design objective vessels are summarized as shown in Table2.2.4.

Table2.2.3 Design Objective Vessel Size

Unit: meter

| Boat Type | Maximum Boat Size | | | Average Boat Size | | |
|---|---|---|---|---|---|---|
| | Length | Width | Draft | Length | Width | Draft |
| Industrial Fishing Vessel | 55 | 9.4 | 5.0 | 40 | 8.0 | 4.5 |
| Semi-industrial Fishing Boat (Prawn Trawler) | 15 | 4.1 | 2.0 | 12 | 3.2 | 1.3 |
| Semi-industrial Fishing Boat (Other Fishing Boat) | 20 | 5.0 | 2.5 | 17 | 5.0 | 2.0 |
| Artisanal Fishing Boats | 10 | 2.6 | 1.6 | 7 | 2.5 | 0.7 |

Table2.2.4 Operation Patterns of Design Objective Vessels per Year

Unit: day

| Boat Type | Number of Boats | Sailing | Unload-ing & Supply | Repair | Closed Season | Waiting | In Port | Out Port |
|---|---|---|---|---|---|---|---|---|
| Industrial Boat (Prawn) | 5 | 240 | 50 | (30) | 60 | 15 | 65 ~ 95 | 0 ~ 30 |
| Industrial Boat (Other Fish) | 25 | 264 | 55 | 30 | 0 | 16 | 71 | 30 |
| Semi-Industrial (Prawn) | 17 | 200 | 50 | (30) | 60 | 55 | 135 | 30 |
| Semi-industrial (Other Fish) | 16 | 210 | 70 | 30 | 0 | 55 | 125 | 30 |
| Artisanal Boat (Mother port) | 20 | 200 | 50 | 30* | 0 | 85 | 165 | 0 |
| Artisanal Boat (Village boat) | 40 | 200 | 50 | 30 | 0 | 85 | 50 | 115 |

Note: 1. Repair (30) of prawn boats are done in the closed season.
2. The repair other than 30* of artisanal boats is done at the outside boatyard.
3. A half number of industrial shrimp boats return to the mother country during the closing season.
4. The artisanal boats belong to surrounding villages are not stay in the port except for unloading and supply operation.

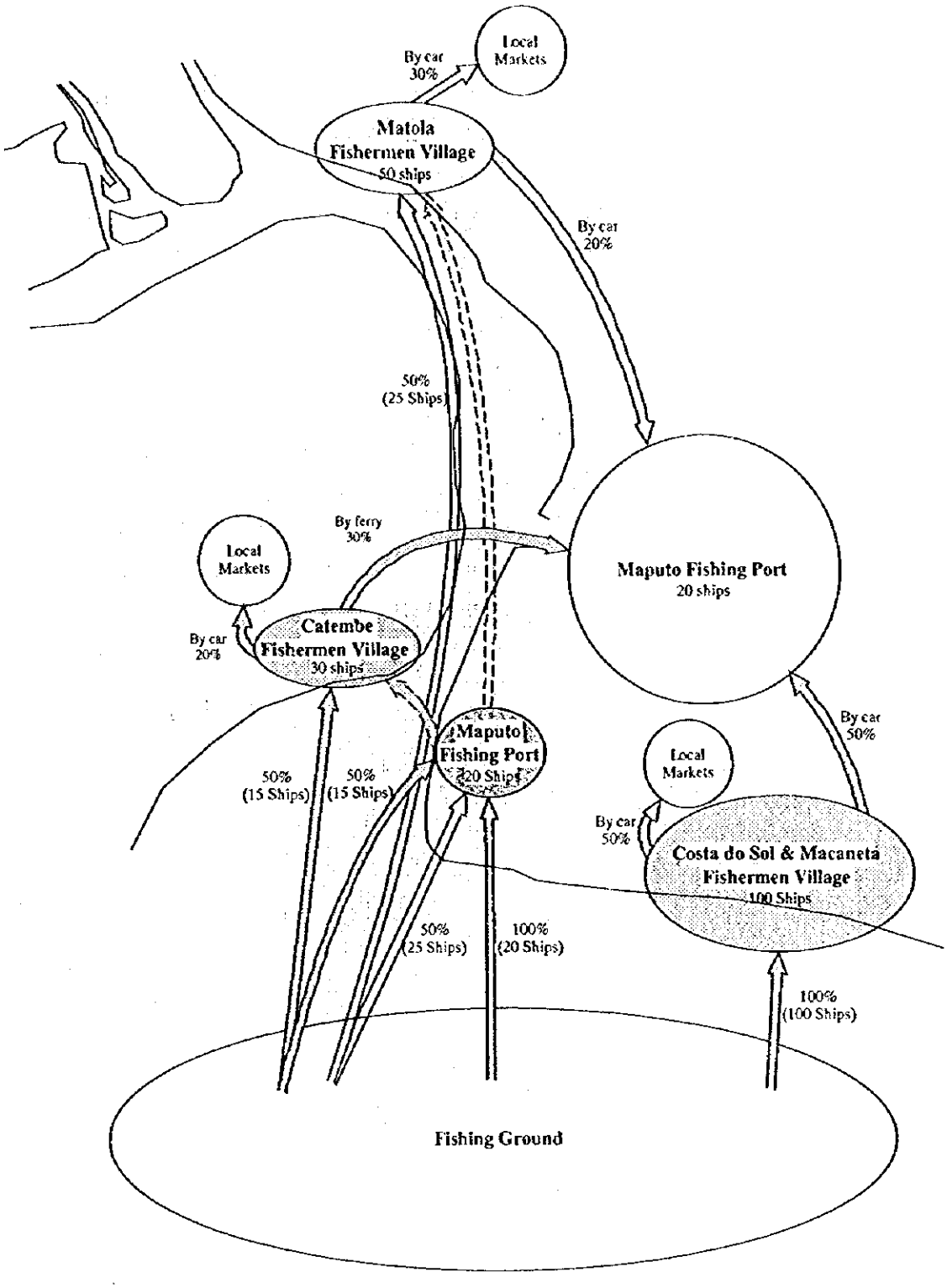


Figure2.2.1 Unloading and Distribution of Catch by the Artisanal Fishing Boats

(2) Planned Annual Catch

According to the fishery statistics of Mozambique, the catch of the Maputo Province is presented by the type of boats and by the species of fish. In Maputo Province there is only one fishing port of Maputo Fishing Port and can accept industrial and semi-industrial fishing boats for unloading catch and mooring boats. Therefore, the catch by industrial and semi-industrial boats in Maputo province is considered as that in Maputo Fishing Port.

As for the catch by artisanal fishing boats, the national fishery statistics are scarcely grasped the actual volume. According to the past statistics, the trace of effort to grasp the catch until around 1993 is seen but judging from the total number and average catch of artisanal fishing boats in the province, the statistic figures would not mean the total catch of the province but, according to the opinion of the staff member of Maputo Fishing Port, it would be regarded as the unloaded volume of artisanal fishing boats in Maputo Fishing Port. Therefore, the catch of artisanal fishing boats in the Maputo province may be regarded as the catch of Maputo fishing port. Table2.2.5 shows the catch of the Maputo province (Maputo Fishing Port).

Table2.2.5 Catch of Maputo Province (Maputo Fishing Port)

(Unit: ton)

| Boat Type / Species of Fish | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 5 Years Average |
|---|---|---|---|---|---|---|---|---|---|
| Industrial Fishing Boat | | | | | | | | | 1992–1996 |
| Prawn | 4,300 | 3,850 | 1,523 | 887 | 698 | 1,013 | 901 | 833 | 850 |
| Fish | 9,229 | 8,179 | 8,040 | 5,262 | 2,261 | 1,734 | 1,790 | 3,166 | 3,240 |
| Sub-total | 13,529 | 12,044 | 9,572 | 6,149 | 2,959 | 2,747 | 2,691 | 3,999 | 4,090 |
| Semi-industrial Fishing Boat | | | | | | | | | 1992–1996 |
| Prawn | 4 | 36 | 135 | 133 | 185 | 108 | 65 | 177 | 134 |
| Fish | 25 | 135 | 488 | 524 | 923 | 758 | 584 | 812 | 720 |
| Fresh-water Fish | - | - | - | - | 689 | 250 | 423 | 388 | (350) |
| Sub-total | 29 | 171 | 623 | 657 | 1,797 | 1,116 | 1,072 | 1,377 | 854 |
| Artisanal Fishing Boat | | | | | | | | | 1089–1993 |
| Prawn | 42 | 87 | 53 | 53 | 181 | 11 | 3 | - | 87 |
| Fish | 770 | 419 | 167 | 79 | 187 | 9 | 1 | - | 324 |
| Sub-total | 812 | 506 | 220 | 132 | 368 | 20 | 4 | - | 411 |
| Total | 14,370 | 12,721 | 10,415 | 6,938 | 5,124 | 4,790 | 4,767 | 5,376 | 5,355 |

As shown in the above table, the present annual catch by the fishing boats calling at Maputo Fishing Port are 4,090 tons by industrial fishing boats, 854 tons except fresh-water fish by semi-industrial fishing boats and 411 tons by artisanal fishing boats, thus 5,355 tons in total.

When this fishing port is rehabilitated by this Project, as mentioned above the number of artisanal fishing boats will increase from 20 boats to 60 boats and the catch of artisanal boats will also increase to 1,200 ton per year. Therefore, after rehabilitation the total catch of Maputo fishing port is estimated at 6,144 tons per year.

(3) Planned Annual Distribution Volume of Marine Products

At present, because of insufficient temperature control of the cold storage of Maputo Fishing Port due to deterioration, the prawns and quality fishes caught by industrial fishing boats are exported not through the cold storage of this fishing port but through other port like the ports in South Africa.

The catch of semi-industrial fishing boats, despite insufficient mooring facilities, is unloaded all in this fishing port since no other facilities around here. On the other hand, the use of this fishing port by artisanal fishing boats are restricted because of insufficient mooring facilities in this port and insufficient supply of ice due to deterioration of the existing ice making plant, etc., and only some 20 boats out of more than 200 boats of artisanal fishing boats around Maputo fishing port are now using this fishing port. The catch of remaining artisanal boats is unloaded at beach near the fishermen villages where no port facility is provided, and distributed to the markets in Maputo city by car or by ferry under the condition of fresh fish or dried fish.

When mooring facilities and an ice making plant for the artisanal fishing boats are provided by this Project, it is expected that the throughput of catch by the artisanal fishing boats will be 3 times of present volume and the volume of catch which use the cold storage will also increase at 2 times of present volume. Once the cold storage is rehabilitated and the temperature control is improved, at least 50% of the prawns and quality fishes of industrial fishing vessels are expected to be exported through the cold storage of this fishing port.

Therefore, the annual unloading volume through mooring facilities of 3,533 tons and the annual storage volume in the cold storage of 3,106 tons at present in Maputo fishing port will increase to 5,233 tons and 4,217 tons respectively when the fishing port facilities and equipment are rehabilitated by this Project.

The present fish distribution flow through Maputo Fishing Port is summarized in Figure2.2.2.

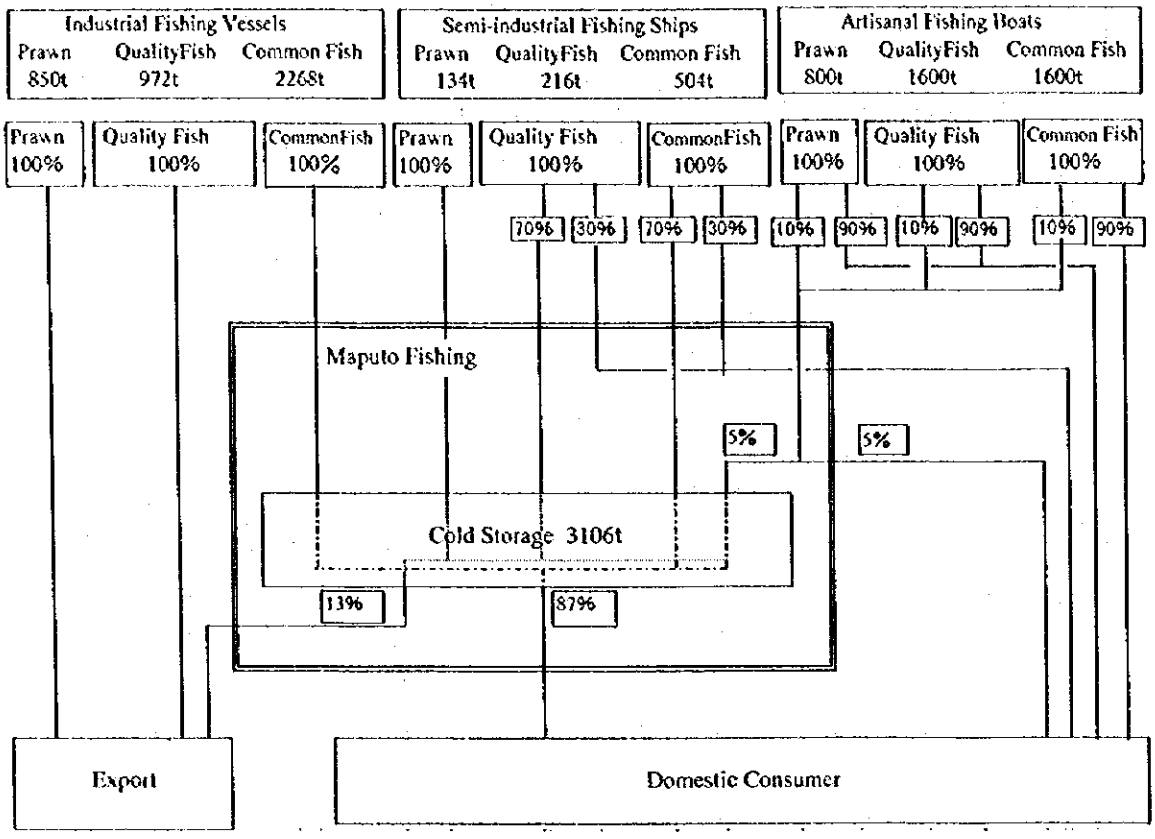


Figure2.2.2 Flowchart of Actual Fish Distribution in Maputo (Present Condition)

## 2-2-4 Basic Concept

Based on the above study, the basic concept of this Project is to improve the productivity of the Maputo Fishing Port and to expand the mooring facility for the artisanal fishing boats. In order to realize the basic concept it is proposed to implement the rehabilitation of mooring facilities, construction of new ice making plant, rehabilitation of cold storage, construction of a new administration building, a guards house and two public toilets, installation of water supply, fuel supply and electricity supply system, preparation of drainage and sanitary facilities, and to supply the equipment such as a truck crane and two forklift trucks.

## 2-3 Basic Design

### 2-3-1 Design Concept

(1) Basic considerations and conditions

1-1) Alignment of piled jetty considering sedimentation, calmness of harbour and erosion of jetty foundation

The Maputo Fishing Port is subject to sedimentation problem affected by sediment transport due to river flow and/or coastal process in the estuary of Espirito Santo. Once the plan to change alignment of the piled jetty to be projected against the river flow obliquely for the purpose of control and restraint of sedimentation of the harbour is proposed as one of the effective countermeasures.

But it is evaluated that the change of alignment has demerit to cause worsening of calmness of harbour due to incident sea wave or ship wave from the harbour entrance and/or to cause erosion of riverbed at around the jetty foundations during the river flood. And since the information of the river discharge, sediment transport of the river and/or the grain size of the suspended solid are not available and the quantitative evaluation of the effects of the countermeasure is considered impossible, finally it is determined that the rehabilitation of the structure of piled jetty is to be made on the basis of the present configuration of the existing wharf structure without any change in its alignment.

1-2) Interchange of water in harbour

The existing structure of piled jetty is provided with wave-sheltering wall in the level of intertidal zone under the deck, and the structure type of existing jetty is seen as an open type having a capability of water interchange between the harbour basin and the river. The construction of completely sheltered type of jetty structure such as gravity type, for example, would obstruct the water interchange and inevitably worsen the water quality of the harbour, which is polluted by the discharge of untreated sewage and spilt oil from fishing boats presently. Therefore, special considerations are paid for these problems in the planning of port facilities and utilities in technical point of view.

1-3) High tidal range and considerations for small boat berthing

The tidal range at the Maputo Fishing Port is over 3 m. In such condition, floating pier that

can follow water level changes would have merit to accommodate small sized boats for berthing and unloading fish catches, while the port needs periodical maintenance dredging of the harbour. It is considered rather difficult to dredge neatly in the harbour basin under the floating piers, and it is also expected that the structural instability would occur when pontoons touch the bottom in low tide condition. Therefore the floating pier is concluded not suitable to employ for the rehabilitation project of Maputo Fishing Port.

Instead of floating pier, it is recommended to provide lower crown height and connecting steps along the face of quaywall to accommodate small size boats. Meanwhile, new piled jetty structure is to be planned to lower its crown height from present +6.0 m to +5.0 m so as to accommodate industrial and/or semi-industrial fishing boats properly.

1-4) Considerations for neighboring facilities

The principal aim of the Project is to rehabilitate the facilities and functions of the fishing port, and there exist the present structures such as retaining walls, revetments as well as buildings adjacent to the pier and quaywalls to be rehabilitated. In designing new port facilities and planning construction method, therefore, utmost considerations must be paid in order to avoid unnecessary disturbance onto these existing structures during the construction stage.

1-5) Considerations for maintenance dredging

Since this grant aid program was requested because of the collapse of the old revetment due to over dredging in the harbour, the waterfront facilities should be designed in a definite way to be able to avoid unnecessary instability of structure due to possible over-dredging.

1-6) Considerations for maintenance of civil structures

Designing civil structures is to be carried out in considering suitable use of construction materials which are able to be procured in or around Mozambique and would facilitate maintenance works in future. While, in case of using steel materials for structural members exposed to seawater, serviceability in life type of structure should be kept by providing necessary thickness or anti-corrosion measures.

1-7) Buildings and utilities

In the Southern Mozambique area where the Project site is located, openings of walls are not provided on the northern side of building due to strong sunshine of the area. And for the reason that the buildings are to be located in the Port area, the construction materials should be employed to avoid damages by the briny air.

The Project site is located in the Southern Mozambique area where occurrence of hazardous earthquake is very rare. According to the Design Standard established in the era of Portuguese rule, the B-zone where the Maputo area belongs to is defined as to have medium level of earthquake risk and structural designs shall take into account the effect of seismic force considering horizontal seismic intensity coefficient as $k_h = 0.05$.

(2) Consideration for social conditions

Since the Maputo Fishing Port is the only one fishing port with well-equipped infrastructures in the Maputo metropolitan area, the rehabilitation project will include as the design objective vessel size of planning not only the industrial and/or semi-industrial fishing boats but also the small size fishing boats of artisanal fishing people which unload their fish-catches in this fishing port presently.

There exists no room for extension of harbour basin in this port area when the number of semi-industrial fishing boats to increase in the future. In the case, it is considered that other fishing port facilities should be installed for small fishing boats in another location and the Maputo Fishing Port would become a specialized one for the semi-industrial fishing boats.

(3) Background of construction industry

The time is ripe in Mozambique for the post civil-war rehabilitation, and the investments for construction projects, in particular, private investment for housing development, have become vital in recent years. The situation is proved by the fact that the growth rate of GDP of the construction sector in the fiscal year of 1997 has recorded 16% increase compared with the previous year. The investment in the construction sector is expected to grow more vital accompanied by the implementation of the major projects such as the Maputo Corridor Project.

3-1) Applicable codes and standards relating to construction project

The contract code, "Programas de Concurso Tipo e Cadernos de Encargos Tipo para as Empreitadas de Obras Públicas (1979)", issued in Lisbon in the era of Portuguese rule is

still valid as the authorized Conditions of Contract for Construction of Public Works in the Republic of Mozambique. But it is said that the ODA projects by the foreign countries will not always be controlled by this code.

As to technical specifications, there exist the standards and/or specifications concerning concrete structures, steel structures and so on issued in 1960s – 70s, the era of Portuguese rule. But it is considered unsuitable to apply those standards to the Project due to the differences from the current methods of design and/or quality of construction materials.

It is expected that most of the construction materials are to be procured from South Africa, and in that case the standards of SABS (South African Bureau of Standards) will be adopted. Therefore, Basic Design will be carried out, referring to those standards and specifications, based upon the current standards of design and construction of Japan paying attention to the source of procurement of materials.

3-2) Local contractors and consultants

There exist a few Government-owned construction companies such as CETA (Mozambican public corporation of construction) and/or EMODRAGA (Mozambican public corporation of Dredging), while several local private companies in Mozambique mainly deal with the smaller scale construction such as housing building and/or road pavement.

In many cases of multilateral and/or bilateral ODA projects, the construction companies of foreign capital, i.e., South African based, Portuguese based and Italian based, occupy the positions of main contractors and the local companies have been engaged in the projects as subcontractors. Since those foreign-based companies steadily hold some hundreds or thousands of local workers (including unskilled labours), they can be satisfactorily adopted as the subcontractors of the Japanese contractor for the Project.

Meanwhile, there exist the Government-owned, South African based and/or Portuguese based consulting companies in Mozambique. Concerning the ODA projects in the Port of Maputo (including fishing port), CFM deals with the planning and design works hiring foreign consultants.

LEM (Mozambican Engineering Laboratory) executes the construction-related research and experimental works, such as subsoil investigation, concrete test and so on, as an official research institute.

(4) Consideration for utilization of local contractor and local materials/equipment

4-1) Local contractors

The large-scale, civil works are executed as the project of foreign private investment or ODA and carried out mainly by the foreign-based companies as contractor and local companies as subcontractors.

CETA, EMODRAGA (government owned companies in Mozambique) and other foreign based companies, which have branch offices in Maputo, have experiences of maritime civil works, and they can be satisfactorily adopted as the subcontractors of the Japanese contractor.

4-2) Procurement of local materials/equipment

According to the contract documents of the similar types of construction works and the cost quotations of construction materials and equipment estimated by local and/or South African companies, there are only limited kind of materials available in the Mozambican market except for cement, aggregates, stones, timber and so on. In case that procurement volume is small, the basic construction materials are available in the market. Considering the required volume and period, the plan of procurement should be considered weighing advantages of procurement from the third countries such as South Africa and or from Japan.

In order to avoid the risk of exchange quotations fluctuation and to secure the accuracy of cost estimates, the estimation of the Project cost in the portion of local procurement in the Basic Design stage will be carried out in US dollars.

4-3) Tariff

Basically tariffs on imported materials/equipment are to be exempted, but actually the executive agency of the Project, i.e., DNP, has the duty to pay tariff to the Ministry of Finance. The Study Team confirmed, in the visit for discussion on the draft basic design in December 1998, that this Project was authorized in the Government's investment program, Plano Trienal de Investimento Público (1999 – 2001), and that the necessary measures for exemption of tariffs and duties are to be taken.

(5) Consideration for manageability of operating agency

Maintenance Division of PPM is in charge of the maintenance works of facilities and equipment of the Maputo Fishing Port. Maintenance Division consists of 13 members and has two sections of Mechanical and Maintenance. All the managers of these sections are the persons of highly educated in specialty fields. Present organization of the division is as follows. Since the operation of refrigerating system must be maintained throughout nights and days, two of 6 staff members of Mechanical Section work in three shifts and keep operation of refrigerator.

| | | |
|---|---|---|
| * Mechanical Section : | Chief (Mechanician) 1, | Electrical Engineer 1, Mechanical Engineers 5 |
| * Maintenance Section : | Chief (Electrician) 1, | Electrical Engineers 2, Welder 1, Mason 1. |

The expenses of the maintenance from 1992 to 1997 are shown in Table2.3.1. Most of the spare parts and consumables are purchased from foreign countries and the amount of maintenance expense is in declining with the peak in 1995.

Table2.3.1 Expenses for Maintenance at PPM

(Unit : 1,000 Meticais)

| Items /Year | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 |
|---|---|---|---|---|---|---|
| Spare Parts | 19,998 | 12,163 | 33,656 | 124,420 | 52,903 | 43,280 |
| Ammonia | 15,770 | 33,147 | 61,013 | 72,823 | - | 87,741 |
| Fixing Facilities | 51,324 | 28,126 | 21,123 | 94,852 | - | - |
| Fixing Equipment | 15,625 | 121,431 | 149,943 | 356,549 | 95,127 | 99,666 |
| Total (in 1,000 Meticais) | 102,718 | 194,866 | 265,735 | 648,644 | 148,030 | 230,687 |
| Total (in US$) | 37,459 | 37,200 | 40,555 | 60,193 | 13,106 | 19,880 |

The present organization and system are appraised as satisfactory for management and maintenance of facilities to be introduced by the Project, and the maintenance program is considered on the basis of this appraisal.

(6) Consideration for grade of facilities and equipment

6-1) Port facilities

a) Piled wharves

Cracks and scale of surface concrete are observed on the concrete pillars, beams and

diagonal braces, especially on the front members of those, of the piled wharves. But the present condition does not mean immediate collapse of the structure and the wharves are possible to be used for more several years. Since the year of construction was 1912 and old enough, neither the detail drawings of the structures nor the records of piling are available. Therefore, it is judged that the partial repairing of wharf structure cannot secure the strength and/or life time of the structure.

The concrete spraying method was adopted in the rehabilitation works of the piled wharves of the neighboring commercial port aiming simply to stop the spreading of corrosion of reinforcing steel bars. But the long term durability of structure is not assured by this method in spite of its rather high cost. In order to secure the semi-permanent durability of the wharf structure, to scrap existing structure and to build new structure are in crucial necessity. The scrap-and-build way in rehabilitation of the piled wharves is considered very expensive, and no fixing or improvement is executed regarding the piled wharves in the Rehabilitation project of Maputo Fishing Port. And the complete way of rehabilitation is expected to be planned in another occasion in the future.

b) Piled jetty

This part of wharves, piled jetty of 60 m in length, has been more damaged than the neighboring piled wharves, and the present structures should be completely removed and newly constructed in the same location in this rehabilitation project. The surface elevation of the newly built jetty is to be lowered by 1 m to +5.0 m considering the convenience of loading/unloading of berthing fishing boats. Once the plan to change alignment of the piled jetty to be projected against the river flow obliquely for the purpose of control and restraint of sedimentation of the harbour is proposed as one of the effective countermeasures. It is, however, not recommended to adopt this idea because of the lack of sufficient hydraulic information to discuss the effectiveness of the changed alignment.

c) Quaywall

Quaywall of 220 m in length is planned as the structure of anchored steel sheet pile walls with the apron of 10 m in width, elevation of +4.2 m and design depth of –2.5 m. In addition appropriate number of steps are to be installed on the front face of the quaywall considering the convenience of loading/unloading of smaller fishing boats.

d) Harbour basin

The harbour basin is required to be dredged up to –2.5 m in depth, and the SAFMAR-side limit of the dredging area is to be defined as the water area that is necessary for maneuvering of the middle-size fishing boats to depart from waiting quaywall.

6-2) Buildings

The resolution of the present situation that administration functions are packed in the refrigeration building and the improvement of insulation and sealing functions of cold storage are required for the basic design of buildings.

Public toilets are not provided sufficiently and it is considered difficult to keep good sanitary conditions in the fishing port area. To resolve this situation, two public toilets are planned to be provided.

The ice-making plant, presently on the piled jetty to be demolished and renewed, is planned to be relocated and renewed.

6-3) Utilities

a) Electric installation

Lighting is planned to be installed for the safety operation in the night time working in the fishing port. And electric power supply facilities for fishing boats are planned to be installed at the several points along the wharf.

b) Water supply

To cope with the present low pressure of water supply in the fishing port area and the water cut-off, water reservoir is planned to be installed to prevent ice-making plant from troubles.

c) Sanitary arrangement

Septic tanks are planned to be installed newly for treatment of sewage from the buildings and public toilets. The outlet of waste water from the city sewerage is planned to be relocated from the inner harbour to the river front along the wharf.

6-4) Procurement of equipment

Refrigeration equipment for the improvement of the cold storage and new ice-making plant for the replacement of the timeworn old equipment are planned to be installed to satisfy the current demands. A mobile crane truck and forklift trucks for loading/unloading are planned to be procured for the replacement of existing old equipment with same capacities.

(7) Construction period

The construction period for the Project is planned to be divided into two terms giving the highest priority to the urgent rehabilitation of the collapsed revetments in the harbour and the improvement of the cold storage to satisfy the EU standards and demands and in order to upgrade the activity of the fishing port completely.

In the first term the construction of quays (Type B and C; refer to Figure2.3.1) for the replacement of collapsed revetment is to be executed with partial dredging of the harbour basin, related utilities such as lighting, water supply and sewage system. Then in the second term all the other components of the Project, i.e., the construction of quay (Type A), the demolition and renewal of piled jetty, the construction of ice-making plant, the improvement of cold storage rooms, the construction of administration building, the installation of utilities and the procurement of a mobile crane truck and forklift trucks are planned to be executed.

## 2-3-2 Design Conditions and Criteria

### (1) Design Conditions

#### 1-1) Natural Conditions

a) Tides

| | | |
|---|---|---|
| Flood Level | HHWL | +4.20 m |
| High Water Spring | HWL | +3.55 m |
| Mean Water Level | MSL | +2.00 m |
| Low Water Spring | LWL | +0.46 m |
| Port Datum Level | DL | ±0.00 m |

b) Wave (Height, Period, Direction) $H_{1/3}$=0.5m, 2~3 sec, SSE

c) Sub Soil Conditions

| | |
|---|---|
| At Wharf | Surface Layer : Mud (N=0~1) |
| | Second Layer : Clay (N=15) |
| | Bearing Layer : Gravel (N=30) |
| At River side Quaywall (Type A) | Surface Layer : Mud (N=0~1) |
| | Second Layer : Clay (N=15) |
| At Port Inner side Quaywall (Type B+C) | Surface Layer : Sand (N=15) |

d) Seismic Coefficient $k_h$=0.05

e) Design Wind Velocity 50 m/s (storm)

f) Maximum River Velocity 1.0 m/s (flood)

#### 1-2) Design Conditions for Use

a) Design Objective Vessels

| | | |
|---|---|---|
| Industrial Fishing Boat | 500 GT | ( L=55m, B=9.4m, d=5.0m) (length, breadth, draught) |
| Semi-industrial Fishing Boat | 50 GT | ( L=20m, B=5.0m, d=2.5m) |
| Artisanal Fishing Boat | 4 GT | (L=10m, B=2.6m, d=1.6m) |

b) Planned Water Depth

| | |
|---|---|
| Wharf outside port | -5.5m |
| Wharf inside port & Quaywall | -2.5m |

c) Design Water Depth

| | |
|---|---|
| Wharf outside port | -6.0m |
| Wharf inside port & Quaywall | -3.0m (without foot protection) |

d) Elevation of Facilities

| | |
|---|---|
| Existing Wharf at face-line | Approx. +5.8m |
| New Wharf to be constructed | +5.0m |
| Quaywall (existing ground inside port) | Approx. +5.7m |
| Quaywall at face-line | +4.2m |
| Lowest Landing of Quaywall Steps | +1.2m |

| | |
|---|---|
| e) Live Load (Wharf Deck & Quaywall) | 1.0 tf/m$^2$ |
| f) Dead Load | Considering Ice Making Plant |
| g) Vehicle Load | 25 ton lifting capacity truck crane |
| h) Life Span | 50 years |

(2) Design Standards for Civil Structures

Except for Portuguese technical standards issued in '60s to '70s, Mozambique's own technical design code of practice or materials standards is currently unavailable. Besides, most of construction materials are basically imported from South Africa of which standard are based on the South African Bureau of Standard (SABS). Therefore, in considering these standards, basic design for the port facilities is carried out on the basis of the following design and construction standards or JIS (Japanese Industrial Standard) which are deemed to be equivalent to the code of practice or standards commonly used in Mozambique.

| | |
|---|---|
| Standard Design Method for Fishing Port Facilities (1990), | Japan Fishing Port Association |
| Standard Specification for Concrete (1996), | Japan Society of Civil Engineers |
| Japanese Industrial Standard, | Japanese Standards Association |
| Asphalt Pavement Manual (1992), | Japan Road Association |
| Technical Standard for Port Facilities (1989), | The Japan Port & Harbour Association |

(3) Design Standards for Buildings and Utilities

The Japanese building code and standard are employed for design of buildings. Regarding

building materials, SABS standards and JIS standards are adopted properly.

The Japanese standards are adopted properly for design of plumbing installations, sanitary services, air-conditioning, freezing and ice making facilities. The Mozambican standards will be adopted for design of electrical services.

(4) Other design conditions

The miscellaneous design conditions are to be based upon Japanese Building Code and are set as follows.

a) Wind pressure: Wind pressure effecting to building varies with shape and height of building and is calculated using following formula:

Wind pressure (P) = Wind Speed (q) x Pressure Coefficient (c)

where q: wind speed $q = 60\sqrt{h}$ ,
h: height from ground level in meter,

b) Seismic load: Horizontal seismic coefficient is defined as $k_h = 0.05$.

c) Main materials
Concrete: $F_c = 250 kg/cm^2$ (compressive strength of 4 weeks test piece)
Reinforcing Bar: SABS920

## 2-3-3 Basic Design

### (1) Site and Layout Plan

#### 1-1) Present status of the Site

The Maputo Fishing Port is located in the center of the city facing waterfront of the Estuary of Espirito Santo and is neighboring to the commercial port on the upper-stream side and SAFMAR (the Maritime Administration) on the down-stream side. There is a harbour basin of 200 meters in length and 100 meters in width between the fishing port and SAFMAR, and the portion of the basin of 120 meters in length and 100 meters in width belongs to the fishing port area and the other belong to SAFMAR.

There arranged on the east side a breakwater of 115 meters in extent and on the west side a piled jetty of 70 meters in extent facing water front of the river. The piled jetty is provided for berthing of the industrial fishing boats and is always crowded with double or triple berthing of those fishing boats.

In the harbour basin, the inner side of the piled jetty is used as a supply berth and landing berth for the semi-industrial fishing boats and is crowded with double or triple berthing of those fishing boats. The quay of 30meters in extent next to north side of the piled jetty is used as waiting and landing berth and the semi-industrial fishing boats are berthing square to face line. A ferry boat is anchoring in front of the revetment neighboring SAFMAR and is used as a floating pontoon for artisanal fishing boats to berth.

It is considered inconvenient for vessels to load/unload because those wharves highly rise to the height of +5.8 m in elevation in spite of the low elevation of Low Water Spring of +0.5 m.

There is about 1 *ha* land area in the fishing port area between the commercial port and the harbour basin. The refrigeration building occupies about 3,500m$^2$ of the center of the land area and most of the miscellaneous utility facilities are located in this area. The on-land activities of the fishing port are concentrated in this area. There is another 1 *ha* lot of the fishing port next to north end of the harbour basin, and there exists only a 600m$^2$ building of the public fisheries corporation in this area and the remaining area is used for the fuel supply facility and the open storage yard of materials/equipment. There is 0.4 *ha* lot, which is used as a public parking lot, between those two areas, and is planned to be incorporated into the area under the fishing port administration.

The on-land access to the fishing port is well developed and no problem is raised presently. The supply systems of electricity and water from the city area to the fishing port too are well developed, though the most of utility facilities have been already timeworn.

1-2) Basic layout plan of port facilities

The general layout plan of the fishing port is shown in Figure2.3.1.

The 1 *ha* lot between the commercial port and the harbour basin is to be exclusively used for the activities of the fishing port such as loading/unloading and storage of fishery products as it is.

Since the present layout of road in the fishing port is considered inappropriate for the vehicle traffic flow, the new outward-flow road is planned as one-way system along the boundary of the commercial port to secure the smooth flow of the automobiles.

Concerning another 1 *ha* lot at the north end of the harbour basin, the portion of 20 meters width along the shoreline is planned to be used for the purpose of loading/unloading of fishery products and road construction, and remaining portion is to be used as the zone of buildings.

The 0.4 *ha* lot which is newly incorporated into the fishing port area is used as the parking lot presently and is planned to be used as the wholesale market of fishery products in the stage that auction trades become common in the Maputo area in future.

Along the shoreline, the wharves facing the river front is planned to be used exclusively for berthing of industrial fishing boats. The back of the piled jetty and the west side quay of the harbour, where sedimentation is estimated comparatively small and is near to the harbour entrance and advantageous for boat operation, is planned to be used for berthing of semi-industrial fishing boat. One berth at the north end of the harbour basin neighboring SAFMAR area is planned to be used as supply berth for semi-industrial and artisanal fishing boats, and remaining extent of quay is to be used as the berth for artisanal fishing boats.

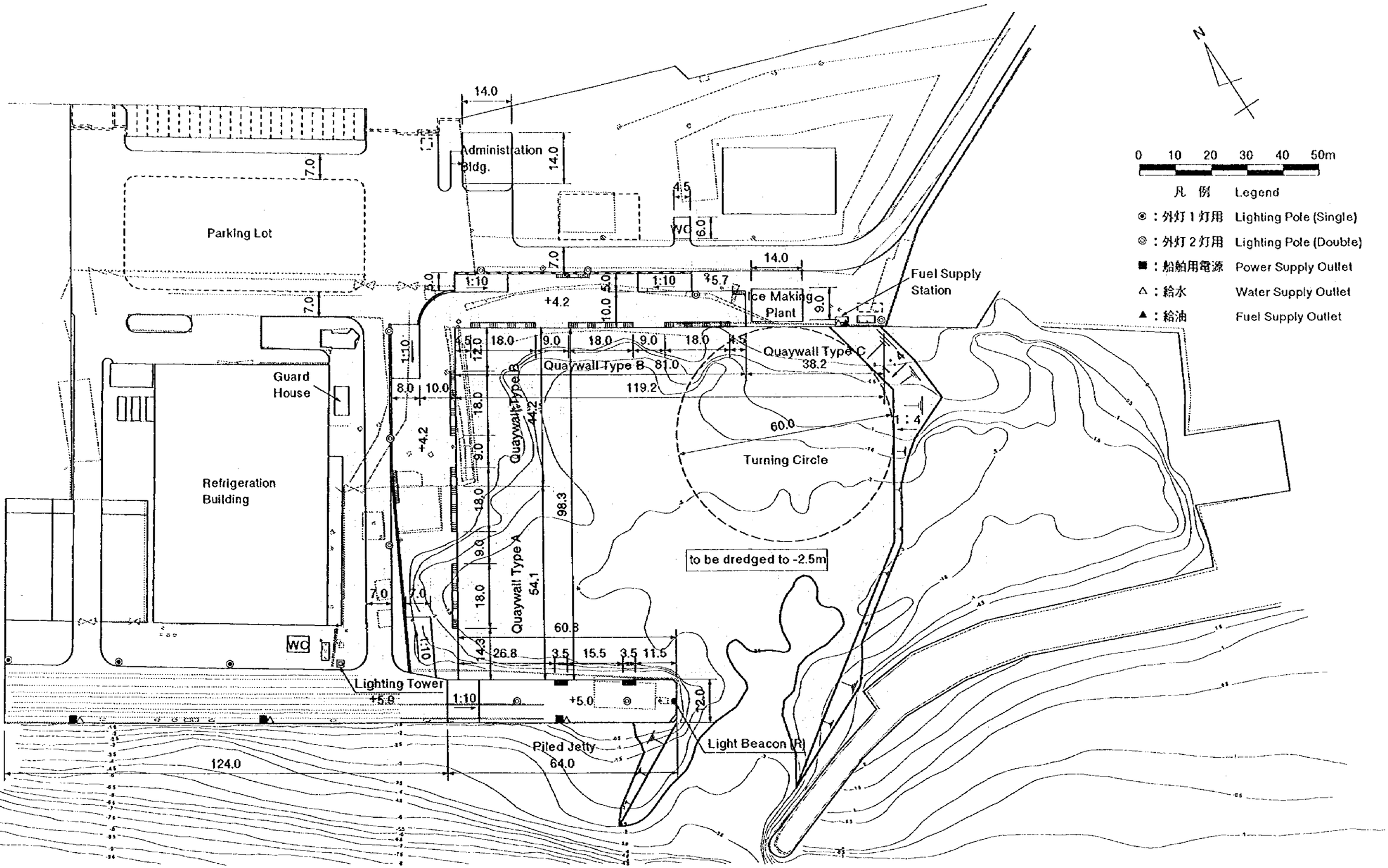


Figure2.3.1 Maputo Fishing Port Layout Plan (S=1:1,000)

(2) Basic plan of port facilities

2-1) Dimensions of berthing facilities

Dimensions of port facilities are studied based upon the following considerations:

① All the industrial, semi-industrial and artisanal fishing boat are included in the design objective vessels of the fishing port.

② Length of the berthing facility for industrial fishing boats, though it is considered insufficient presently, is planned not to be extended due to the absolute shortage of the berth length for semi-industrial and artisanal fishing boats. The piled jetty, the part of which is used for berthing of industrial fishing boats and is severely damaged and timeworn, is to be demolished and renewed.

③ The promotion of semi-industrial fisheries productivity is the key factor for the growth of commercial fisheries of Mozambique, and semi-industrial fishing boats are the vessel type growing in number of use in the Maputo fishing port. Therefore, the main portion of the quay length in the harbour basin is provided for berthing of semi-industrial fishing boats.

④ Though there working over 200 artisanal fishing boats in and around the Maputo area, only about 20 boats are using the Maputo fishing port due to the shortage of serviceable facilities. Since there is no fishing port with berthing facilities other than Maputo, based on the study in the section 2-2-2 (1), Objective Fishing Boats, the new quay for berthing of artisanal fishing boats is planned to be built in the Project and to accommodate more 40 artisanal fishing boats.

Based upon the above-mentioned considerations, the required dimensions of wharves and quays for design objective vessels (refer to Table2.2.4) are summarized as in Table2.3.1.

The Berth Layout Plan is shown in Figure2.3.2.

Table2.3.1 Berthing Sufficiency Rate

| Type of Fishing Boat | Berth Classification | Required Length (m) | Planned Length (m) | Rate of Sufficiency (%) | Remarks |
|---|---|---|---|---|---|
| Industrial<br>L=40m<br>B=8.0m<br>d=4.5m | Landing | 16.1 | 184=46m x 4 berths (70m : newly constructed) | 58 | Excess is accommodated by double berthing. |
| | Waiting | 289 | | | |
| | Supply | 16.1 | | | |
| Semi-industrial (prawn)<br>L=12m<br>B=3.2m<br>d=1.3m | Landing | 42.8 | 41.4=13.8m x 3 berths | 97 | Landing excess is accommodated by square berthing to cope with congestion in the peak time. |
| | Waiting | 30.2 | 24.0=4.8m x 5 berths | 79 | |
| Semi-industrial (fish)<br>L=17m<br>B=5.0m<br>d=2.0m | Landing | 19.6 | 20.0=20m x 1 berth | 100 | |
| | Waiting | 65.5 | 54.2=19.6m x 2 berths + 7.5m x 2 berths | 83 | |
| Artisanal<br>L=7.0m<br>B=2.5m<br>d=0.7m | Landing | 44.4 | 40.5=8.1m x 5 berths | 91 | Landing excess is accommodated by square berthing to cope with congestion in the peak time. |
| | Waiting | 54.4 | 37.5=3.75m x 10 berths | 69 | |
| Semi-industrial (prawn) | Supply | 4.0<br>0.29 berth | 23=23m x 1 berth | 110 | Time extension is considered to cope with congestion in the peak time. |
| Semi-industrial (fish) | | 1.8<br>0.10 berth | | | |
| Artisanal | | 8.4<br>0.52 berth* | | | |

Notes: 1. The annual averaged frequency of fishing boat calls is employed to calculate the required berth length.

2. The sufficient Rate of supply berth is described with the number of berths of semi-industrial fishing boats, and the following conversion rate is adopted: 1 berth for semi-industrial is equivalent to 2 berths for artisanal.

3. Planned length does not include the length of root portion.

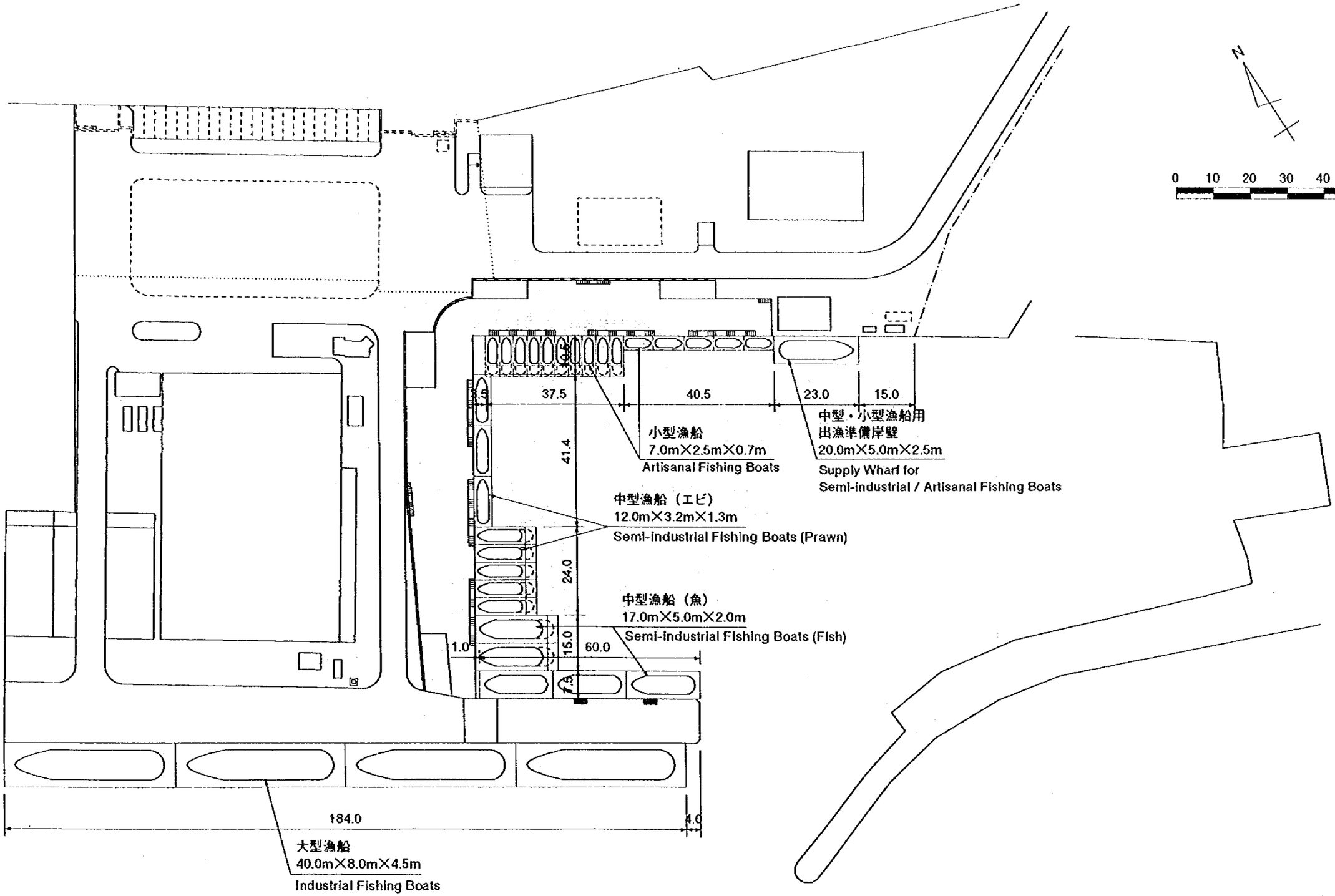


Figure2.3.2 Berth Layout Plan (S=1:1,000)

2-2) Piled jetty

Three types of structures for the new piled jetty is comparatively studied concerning structural advantages, construction cost and workability among alternatives as follows:

Alternative I : Vertical steel pipe piled wharf with shelter wall under the deck
Alternative II : Batter steel pipe piled wharf with shelter wall under the deck
Alternative III : Composite structure of vertical steel piped wharf and steel sheet pile double walls

As a result of study, Alternative I of vertical piled wharf with shelter wall is considered as the best solution as shown in Table2.3.2.

2-3) Quaywall

Quaywalls inside the harbour are designed to have sufficient water depth to accommodate semi-industrial and artisanal fishing boats even at low tide. The applicable type of structure is studied considering subsoil conditions at the site and other affecting factors for design. A series of steps are planned along the face line of quaywall so as to provide landing aprons as lower as possible for easy loading/unloading operation. The height of quay wall along face-line is set forth to be +4.2 m above the datum which would be suitable level for quaywall for receiving small boats with provision of on-land retaining walls behind the quay to sustain the existing ground level of about +5.7m.

Utmost utilization of locally available materials is considered with a view to easier maintenance.

According to the subsoil investigation, a subsoil profile in the fishing port of Maputo shows remarkable change from on-land to river side direction and very soft mud deposit is developed at and around the existing wharf structure. Therefore, designed quaywall structure is divided into two types, i.e., Type A for riverside portion of about 50 m along quaywall of the north to south direction and Type B+C quaywall of remaining land side portion following Type A and behind the port basin in east-west direction. A comparative study of structure is made for the following three types of structure which are selected among applicable construction method of structure.

[Quaywall - Type A]
Alternative I : Gravity type of wall by cellular concrete blocks
Alternative II : Anchored steel sheet pile walls
Alternative III: Steel sheet pile walls with pile supported deck

[Quaywall - Type B+C]

Alternative I : Gravity type of wall by concrete blocks

Alternative II : Gravity type of wall by cellular concrete blocks

Alternative III: Anchored steel sheet pile walls

As the result of study, anchored steel sheet pile walls both for quaywalls Type A and Type B+C are selected as the most suitable type of structure from the technical and economical points of view as shown in the following tables (Table2.3.3 and Table2.3.4).

Table2.3.2 Comparison of Solutions for Piled Jetty Structures

| Alternative | Solution-I | | Solution-II | | Solution-III | |
|---|---|---|---|---|---|---|
| | Vertical Steel Pipe Pile Wharf with Shelter Wall | | Batter Steel Pipe Pile Wharf with Shelter Wall | | Piled Deck in combination with Double Wall | |
| Structural Concept | Framed superstructure is adopted in order to reduce bending moment on vertical pile, considering very weak subsoil condition. Framed superstructure will also facilitate installation of docking fenders in suitable level for receiving small size boats | | Cappled pile foundation system is adopted to resist horizontal load to wharf structure in oder to minimize bending moment on the piles and displacement of wharf block. Fender bed is installed in a block with superstructure | | Vertical loads are supported by piled deck while horizontal load by double wall so as to minimize the total load on double walls. Double wall eliminate additional installation shelter wall | |
| Particulars | ○ | Easiness in installing fender system | ○ | Easiness in installing fender system | ○ | Easiness in installing fender system |
| | △ | Large size foundation piles in need because occurrence of large magunitude of bending | △ | Smaller size of pile is sufficient and minimal horizontal displacement of wharf block | △ | Double wall is needed tobe filled with good materials to have enough shear resistance |
| | △ | Work idling in need for concrete work and treatment | △ | Work idling in need for concrete work and treatment | ○ | No need to provide shelter wall |
| Structural Stability | ○ | High structural stability of fender system fixed to superstructure | ○ | excellency in horizontal stability. restrain horizontal desplacement owing to batter piles | ○ | Excellency in horizontal stability owing to its rigidness. |
| | △ | Anti-corrosion measure in absolutely need. Having a downside in occurrence large magnitude of bending moment and horizontal displacement of deck. Shelter wall in need to install additionally | △ | Anti-corrosion measure in absolutely need.Shelter wall in need to install additionally | △ | Mud subsoil inside the double wall to be removed and replaced by good quarity of soils or stones. Anti-corrosion measure in absolutely need. |
| Construction | ○ | Easiness in vertical piling work | ○ | Easiness in construction except for batter pile driving works | ○ | Easiness in vertical and sheet pile construction |
| | △ | Large size foundation piles driving in need. There is time loss due to idling for pile top treatment and concrete works at low tide | △ | Required batter pile driving machine with pile leader.There is time loss due to idling for pile top treatment and concrete works at low tide | △ | Accuracy in construction is much required. Execution of several sequence of works |
| Cost (ratio of cost) | medium | | high | | highest | |
| | 1.00 | | 1.11 | | 1.40 | |
| Evaluation | ◎ | | ○ | | △ | |

Table2.3.3 Comparison of Solutions for Quay Wall Structures (Quay Wall - Type A)

| Alternative | | Solution-I | | Solution-II | | Solution-III |
|---|---|---|---|---|---|---|
| | | Gravity Type Wall by Cellular Blocks | | Anchored Steel Sheet Wall | | Deck withSteel Sheet Pile Walls and Piles |
| Structural Concept | | Gravity Type Wall by Cellur Blocks are installed on the rubble mound base with weak mud original subsoil replacement by sandy soils. Wall top concrete is provided steps to facilitate accommodation of small size boat at low tide. | | Steel sheet pile wall is adoped considering very weak and soft subsoils. Coping concrete at the top of wall is provided steps to facilitate accommodation of small size boat at low tide and therefor is supported by pile foundation. | | Steel sheet pile wall is adoped considering very weak and soft subsoils. Deck concrete with steps to facilitate accommodation of small size boat at low tide is supported by pile foundation to sustain vertical. |
| Particulars | ○ | Subsoils are replaced to sustain vertical weight of gravity wall | ○ | Structural stability relying on horizontal resistance of anchor behind the wall | ○ | Structural stability relying on horizontal resistance of batter piles |
| | △ | Work idling in need for in-situ concrete work | △ | Work idling in need for in-situ concrete and installation of tie rods | △ | Work idling in need for in-situ concrete work and pile top treatment |
| | | | | | | |
| Structural Stability | ○ | High stability in horizontal resistance relying on own weight of gravity wall | ○ | Excellency in stability for settlement owning to light weight of sheet pile wall and suppoting by foundation piles | ○ | Excellency in stability owing to foundation piles supported on bearing layer |
| | △ | Full precausion needed in stability of base mound and possible settlement in particular. Accuracy in installing cellur blocks is required to maintain the stability. | △ | Full precausion needed in stability for lateral resistance of sheet pile anchore walls. | △ | Deck concrete become heavy due to additional weight of soils loaded on the deck |
| Construction | ○ | Easiness in on-land fabricationof cellular block and setting at site | ○ | Easiness in pile construction. No need of subsoil replacement | ○ | Easiness in pile construction. No need of subsoil replacement |
| | △ | Large scale subsoil replacement in need. Required utmost precaution for maintaining stability of existing facilities during construction. Relatively large crane is needed for block installation. | △ | A sequence of work divided into many work items. There is time loss due to idling for pile top treatment and concrete works at low tide | △ | A sequence of work is time spending due to many work items. There is time loss due to idling for pile top treatment and concrete works at low tide |
| Cost (ratio of cost) | | high<br>1. 33 | | medium<br>1.00 | | highest<br>2.29 |
| Evaluation | | △ | | ◎ | | ○ |

Table2.3.4 Comparison of Solution for Quay Wall Structures (Quay Wall - Type B+C)

| Alternative | Solution-I | | Solution-II | | Solution-III | |
|---|---|---|---|---|---|---|
| | Gravity Type Wall by Concrete Blocks | | Gravity type Wall by Cellular Blocks | | Anchored Steel Sheet Pile Walls | |
| Structural Concept | Gravity Type Wall by Concrete Blocks are installed on the rubble mound base. Wall top concrete is provided steps to facilitate accommodation of small size boat at low tide. | | Gravity Type Wall by Cellular Blocks are installed on the rubble mound base. Wall top concrete is provided steps to facilitate accommodation of small size boat at low tide. | | Steel sheet pile wall is adoped in order to resist horizontal earth pressure. Coping concrete with steps is provided to facilitate accommodation of small size boat at low tide. | |
| Particulars | ○ | This type of wall is suitable to dense or stiff subsoils because of heavy own weight | △ | Uncertainty of stability of cellular blocks, toe pressure of upper block in particular | ○ | Structural stability relying on horizontal resistance of anchor wall |
| | △ | Work idling in need for in-situ concrete work | △ | Work idling in need for in-situ concrete work | △ | Work idling in need for in-situ concrete work and tie rod installation |
| | | | | | | |
| Structural Stability | ○ | High stability in horizontal resistance relying on own weight of gravity wall | ○ | Relatively light weight structure owning to stone filling inside cellular blocks | ○ | Excellency in stability owing to foundation piles supported on bearing layer |
| | △ | Full precausion needed in stability of base mound and possible settlement in particular. | △ | Full precausion needed in stability of base mound and possible settlement in particular. | △ | Full precausion needed in horizontal resistance of anchor wall. |
| Construction | ○ | Easiness in on-land fabricationof concrete block and setting at site | ○ | Easiness in pile construction. No need of large size crane as required for Alternative A | ○ | Easiness in pile construction |
| | △ | Relatively large size of crane is needed for block installation. | △ | Time spending work required for installation of cellular blocks to maintaining accuracy of setting. | △ | A sequence of work is time spending due to many work items. There is time loss due to idling for tie rod installation and concrete works at low tide |
| Cost | highest | | medium | | lowest | |
| (ratio of cost) | 1. 63 | | 1.42 | | 1.00 | |
| Evaluation | ○ | | ○ | | ◎ | |

(3) Plan of ice making plant

3-1) Determination of ice making capacity

The existing ice making plant was installed with the capacity of 48 tons/day during 1977 to 1982, however, now the ice supply for fishing boats are insufficient, because the production capacity has been dropped to some 13 tons/day, the quality of ice is poor and mechanical troubles occur frequently. From the reasons that the facility has passed 20 years from installation and has been deteriorated considerably and the pier on which the ice plant is situated is planned to be demolished and newly constructed, the existing ice making plant is also required to be demolished and newly constructed. It is noted that current industrial fishing boats are equipped with own freezing system and ice supply is no longer needed, and thus the ice making capacity of 48 tons/day is not necessary anymore.

Therefore, the capacities of ice making machine and ice storage are to be determined for the semi-industrial and artisanal fishing ships which need ice supply.

The breakdown of catch by the semi-industrial and artisanal fishing boats after rehabilitation of Maputo Fishing Port is presented in Table2.3.5. As known from this table, the fishing season in Maputo is 10 months in a year, between March and December. Of 10 months, 6 months from March to May and August to October is the most active fishing period and 73% of annual catch is captured within those 6 months.

## Table2.3.5 Monthly Catch by Semi-industrial and Artisanal Fishing Ships

( Unit : Ton )

| | Month | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC | Total | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| District | Fishing Boat/Fish | | | | | | | | | | | | | | |
| Country | Industrial Fishing Boats | 271 | 296 | 2092 | 3054 | 2188 | 1387 | 1284 | 1338 | 1312 | 1268 | 861 | 926 | 16277 | Fishery Statistics in 1996 |
| | Prawn Catch | 203 | 213 | 1267 | 1194 | 1194 | 940 | 788 | 715 | 689 | 583 | 480 | 547 | 8813 | Ditto |
| | Prawn Monthly Ratio (%) | 2.3 | 2.4 | 14.4 | 13.5 | 13.5 | 10.7 | 8.9 | 8.1 | 7.8 | 6.6 | 5.4 | 6.2 | 100 | Actual Monthly Catch Ratio |
| | Other Fish Catch | 68 | 83 | 825 | 1860 | 994 | 447 | 496 | 623 | 623 | 685 | 381 | 379 | 7464 | Fishery Statistics in 1996 |
| | Other Fish Monthly Ratio (%) | 0.9 | 1.1 | 11.1 | 24.9 | 13.3 | 6.0 | 6.6 | 8.3 | 8.3 | 9.2 | 5.1 | 5.1 | 100 | Actual Monthly Catch Ratio |
| | | | | | | | | | | | | | | | |
| Maputo | Semi-industrial Fishing Ship | | | | | | | | | | | | | | |
| | Prawns | 3 | 3 | 19 | 18 | 18 | 14 | 12 | 11 | 10 | 9 | 7 | 8 | 134 | |
| | Quality Fishes | 2 | 2 | 24 | 54 | 29 | 13 | 14 | 18 | 18 | 20 | 11 | 11 | 216 | 30% of Fish Catch |
| | Common Fishes | 5 | 6 | 56 | 126 | 67 | 30 | 33 | 42 | 42 | 46 | 26 | 26 | 504 | 70% of Fish Catch |
| | | | | | | | | | | | | | | | |
| | Artisanal Fishing Ships | | | | | | | | | | | | | 1233 | |
| | Prawns | 6 | 6 | 38 | 35 | 35 | 28 | 23 | 21 | 20 | 17 | 14 | 16 | 261 | 22% of Total Catch |
| | Quality Fishes | 4 | 5 | 54 | 121 | 65 | 29 | 32 | 41 | 41 | 45 | 25 | 25 | 486 | 50% of Fish Catch |
| | Common Fishes | 4 | 5 | 54 | 121 | 65 | 29 | 32 | 41 | 41 | 45 | 25 | 25 | 486 | 50% of Fish Catch |
| | | | | | | | | | | | | | | | |
| | Catch by Semi-industrial & Artisan | 25 | 28 | 244 | 475 | 279 | 143 | 148 | 173 | 172 | 181 | 108 | 110 | 2087 | |
| | Monthly Catch Ratio (%) | 1 | 1 | 12 | 23 | 13 | 7 | 7 | 8 | 8 | 9 | 5 | 5 | 100 | |
| | Active Fishing Period of 6 Months | | | 12 | 23 | 13 | | | 8 | 8 | 9 | | | 73.1 | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |

Note:

1 The monthly catch of Maputo was estimated using the monthly catch ratio of country, since the pattern of fishing activities are similar and the fishing closing season of January and February are same in all districts of country.

2 The catch by the semi-industrial fishing ships in Maputo were obtained as an average from the fishery statistics of past 5 years.

3 For the catch by the artisanal fishing ships, the 5 yeras average between 1989 and 1993 was adopted because the those years data are new and most reliable.

3-2) Ice Consumption for Fishing Boats

The catch mentioned above is captured by semi-industrial prawn trawlers (17 boats, 200 sails/year/boat), other semi-industrial fishing boats (16 boats, 35 sails/year/boat) and artisanal fishing boats (60 boats, 200 sails/year/boat), and the catches by a sail/year and by ship type are summarized in Table2.3.6. Based on the interview at the site, the semi-industrial prawn trawlers will capture the fishes, which volume is usually about 2 times of prawns, in addition to the prawns and this fact is used as one of basic conditions.

Table 2.3.6 Catch by Sail and by Ship Type

| ① | ② Annual Catch (ton) | | | ③ | ④ | ⑤ Catch/Ship (kg) |
|---|---|---|---|---|---|---|
| Ship Type | Prawn | Quality Fish | Common Fish | Nr. of Ships | Nr. of Sails/Yr. | =②×1000 ÷③÷④ |
| Semi-industrial Prawn Trawler | 134 | | | 17 | 200 | 40 |
| | | 80.4 | | | | 24 |
| | | | 187.6 | | | 55 |
| Other Semi-industrial Fishing Ship | 0 | | | 16 | 35 | 0 |
| | | 135.6 | | | | 242 |
| | | | 316.4 | | | 565 |
| Sub-total | 134 | 216 | 504 | | | |
| Artisanal Fishing Boats | 261 | | | 60 | 200 | 22 |
| | | 486 | | | | 40 |
| | | | 486 | | | 40 |
| Sub-total | 261 | 486 | 486 | | | |

The required volume of ice (selling price: 1,000 Meticais/kg) in Maputo is usually 2 times for prawns which market price (25,000~200,000 Meticais/kg) is high, 1.5 times for quality fishes (40,000~50,000 Meticais/kg) and 1 time for common fishes (10,000~35,000 Meticais/kg). The required volume of ice, in view of the average for all kinds of fishes, is equivalent to 1.36 times of catch in weight.

Incidentally, the ice volume supplied to the fishing boats for past 3 years from the existing ice making plant of Maputo Fishing Port was 1.46 times of catch. This fact means that the fishing boats were usually sailed out with the ice more than needed expecting the catch more than average.

Therefore, the loading quantities of ice for each boat and for each sail are calculated as shown in Table2.3.7.

Table2.3.7 Loading Volume of Ice for Boats by Boat Type

| Boat Type | Kind of Fish | Catch (kg/boat) | Ice Ratio (times) | Loading Volume of Ice (kg/boat) |
|---|---|---|---|---|
| Semi-industrial Prawn Trawler | Prawn | 40 | 2.0 | 80 |
| | Quality Fish | 24 | 1.5 | 36 |
| | Common Fish | 55 | 1.0 | 55 |
| | | | Total | **171** |
| Other Semi-industrial Fishing Boat | Prawn | 0 | 2.0 | 0 |
| | Quality Fish | 242 | 1.5 | 363 |
| | Common Fish | 565 | 1.0 | 565 |
| | | | Total | **928** |
| Artisanal Fishing Boat | Prawn | 22 | 2.0 | 44 |
| | Quality Fish | 40 | 1.5 | 60 |
| | Common Fish | 40 | 1.0 | 40 |
| | | | Total | **144** |

Table2.3.8 Ice Consumption Volume for Fishing

| Ship Type | | Nr. of Boats | Sails/Year | Loading Volume of Ice (kg/boat) | Annual Ice Consumption (ton/year) |
|---|---|---|---|---|---|
| Semi-industrial Fishing Ship | Prawn | 17 | 200 | 171 | 581 |
| | Fish | 16 | 35 | 928 | 520 |
| Artisanal Boat | Fish | 60 | 200 | 144 | 1,728 |
| Total | | | | | 2,829 |

While, the most active fishing period of Maputo is, as described in Table2.3.6 clearly, the 6 months of March, April, May, August, September and October and 73% of annual catch is captured within these months, and the ice consumption for fishing in the most active fishing period is estimated as follow.

Ice for Fishing : 2,829 tons x 73% ÷ 6 = 344 tons/month

3-3) Ice Consumption Volume for distribution

The ice volume required for maintaining the freshness of catch during the distribution is calculated based on the catch during the most active fishing period of March to May and August to October. According to the opinion of fishery operators at the site for the ice volume for distribution of the catch, nevertheless it is not realized satisfactorily now because of the restriction of ice supply capacity, the ice is required at 2 times of volume of prawns which is very expensive, 0.7 times of volume of high value fishes and 0.2 time of volume of ordinary fishes.

Therefore, when the new ice making plant is provided by this Project, the ice for distribution of catch during the most active fishing period of 6 months will be as follow derived from Table2.3.9:

Ice for Distribution : 1,024 tons ÷ 6 months = 171 tons/month

Table 2.3.9 Required Ice Volume for Distribution ( After Rehabilitation )

(Unit : ton)

| Ship / Fish | Month Q'ty | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC | Total | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | | |
| Semi-industrial Fishing Ships | | | | | | | | | | | | | | | |
| Prawns | Prawn | 3 | 3 | 19 | 18 | 18 | 14 | 12 | 11 | 10 | 9 | 7 | 8 | 134 | Frozen Prawn after processed |
| | Ice | 6 | 6 | 39 | 36 | 36 | 29 | 24 | 22 | 21 | 18 | 15 | 17 | 268 | Volume of Prawns x 2.0 |
| High Value Fishes | Fish | 2 | 2 | 24 | 54 | 29 | 13 | 14 | 18 | 18 | 20 | 11 | 11 | 216 | 30% of Fish Catch |
| | Ice | 1 | 2 | 17 | 38 | 20 | 9 | 10 | 13 | 13 | 14 | 8 | 8 | 151 | Volume of Fishes x 0.7 |
| Other Fishes | Fish | 5 | 6 | 56 | 126 | 67 | 30 | 33 | 42 | 42 | 46 | 26 | 26 | 504 | 70% of Fish Catch |
| | Ice | 1 | 1 | 11 | 25 | 13 | 6 | 7 | 8 | 8 | 9 | 5 | 5 | 101 | Volume of Fishes x 0.2 |
| Artisanal Fishing Ships | | | | | | | | | | | | | | | |
| Prawns | Prawn | 6 | 6 | 38 | 35 | 35 | 28 | 23 | 21 | 20 | 17 | 14 | 16 | 261 | All Catch of Prawns |
| | Ice | 12 | 13 | 75 | 71 | 71 | 56 | 47 | 42 | 41 | 35 | 28 | 32 | 522 | Volume of Prawns x 2.0 |
| High Value Fishes | Fish | 4 | 5 | 54 | 121 | 65 | 29 | 32 | 41 | 41 | 45 | 25 | 25 | 486 | 50% of Fish Catch |
| | Ice | 3 | 4 | 38 | 85 | 45 | 20 | 23 | 28 | 28 | 31 | 17 | 17 | 340 | Volume of Fishes x 0.7 |
| Other Fishes | Fish | 4 | 5 | 54 | 121 | 65 | 29 | 32 | 41 | 41 | 45 | 25 | 25 | 486 | 50% of Fish Catch |
| | Ice | 1 | 1 | 11 | 24 | 13 | 6 | 6 | 8 | 8 | 9 | 5 | 5 | 97 | Volume of Fishes x 0.2 |
| | | | | | | | | | | | | | | | |
| Total | Ice | 24 | 27 | 190 | 279 | 199 | 126 | 116 | 122 | 119 | 116 | 78 | 84 | 1,480 | |
| | Ice | | | 190 | 279 | 199 | | | 122 | 119 | 116 | | | 1,024 | Active Fishing Period of 6 months |

3-4) Capacity of Ice Making Machine

From the above ice volume for fishing and for distribution, the monthly average ice consumption in the most active fishing period is calculated as follows:

| | |
|---|---|
| For Fishing | 344 tons/month |
| For Distribution | 171 tons/month |
| Total | 515 tons/month |

Therefore, assuming that the monthly average operation days is 25 days, the average ice demand per day will be obtained below.

Required Ice Making Capacity = Monthly Average Ice Consumption/ Operation Days

= 515 ÷ 25 = 20.6 tons/day

Based on the above calculation result, the capacity of ice making machine of 20 tons/day will be installed.

3 – 5) Ice Making and Storage Facility

a) Type of Ice

The ice is sold to the fishing boats and brokers and mainly used for maintaining the freshness and controlling the quality of marine products. The types of ice generally used for the fishery are block ice, plate ice, flake ice, etc. Since the melting speed of ice is proportional to the surface area of ice, the preservation time is in order of Block ice > Plate ice > Flake ice from long to short. The characteristics of each ice are presented in Table2.3.10.

Comparing with other types of ice, the block ice requires the facility of large size and many attachments. And the plant cost as well as running cost of this type equipment is most expensive (refer to Table2.3.10). Therefore block ice is not adopted in this Project.

Comparing the plate ice with flake ice, the plate ice making capacity per unit horse power of refrigeration machine is more effective than the flake ice, and the repairing is easy for the plate ice machine if troubled. The most of ice is loaded on ship with ice storage boxes which is suitable for plate ice and the plate ice is suitable for long sailing since it melts slowly. From the above reasons, the plate ice is the most recommendable.

Table 2.3.10 Characteristics of Ice in Type

| Type of Ice | Flake Ice | Plate Ice | Block Ice |
|---|---|---|---|
| Shape/Dimension (mm) | 10 x 15 x 1.2 | 30 x 40 x 15 | 600 x 200 x 800 |
| Ice Making Cycle | Continuous | Approx. 30 min. | 24 to 48 hours |
| Temperature at Ice Making | Approx. - 2°C | 0°C | At storage: - 10°C |
| Melting Speed in Water | Quick | Slow | Slow |
| Fit for Fish Body | Good | Good | Damage on fish |
| Plant Cost | Low | Low | High |
| Handiness of Ice | Easy | Easy | Difficult |
| Suitability to Fish Type | Not suitable to big and medium fishes due to large void between fishes. | Suitable for all type of fish since good contact between fish and ice. | Contact with fish become good after the surface of block ice is melted. |
| Running Cost | 0.5 | 0.5 | 1.0 |
| Maintenance/Check | Adjustment require technical know-how | Adjustment is easy | Adjustment require technical know-how |
| Operation Mode | Automatic operation | Automatic operation | Man power for dehydration, etc. |

b) Refrigerant

The characteristics of refrigerant are presented in Table2.3.11. In order to protect the ozone layer in stratosphere, " Vienna Treaty on the Protection of Ozone Layer" was agreed at the convention in Vienna in March 1985 and " Montreal Protocol on the materials destroying the ozone layer" was adopted in July 1987. The targets for control are not referred to all freon but to 5 kinds of freon ( Freon-11, Freon-12, Freon-113, Freon-114, Freon-115) of long life in the atmosphere which are called as "Specific Freon Gas".

The freon-22 is decomposed in air more easily than the specific freon and was not subject to the control for the protection of ozone layer, however, at the convention on the prevention of global warming in March 1995, the freon-22 was included into the subject of control, however, the production and use of freon-22 was allowed until the year 2020. Considering the service life of freezing machine, therefore, there are no practical problems, but in order to make possible for diversion of refrigerant to the new one in case when the cheap and nontoxic refrigerant become practical, this Project will adopt a belt driven type freezing machine.

Table2.3.11 Comparison of Refrigerant for Ice Making

| Refrigerant | Installation Cost | Magnitude of Danger | Freezing Capacity | Character of Erosion | Others |
|---|---|---|---|---|---|
| Ammonia | 1.0 | High Toxicity and Combustibility | Small | Responsive to Copper alloy | High danger and High plant cost |
| Freon-22 | 0.6 – 0.7 | Low danger | Large | Chemically inactive | Low plant cost |

c) Specifications of Ice Making Machine

- Design Criteria

① Air Condition : Maximum Temperature 40°C, Average Humidity 70%
② Electric Power: 3 Phase, 400V, 60Hz
③ Ice Making Capacity : 20 tons/day
④ Type of Ice : Plate Ice
⑤ Refrigerant : Freon-22 (R-22), Direct Swelling Type
⑥ Refrigerant Condensation: Evaporated Condensation Type

- Ice Making Machine

① Type : Full Automation Plate Ice Making Machine
② Capacity & Number : 10 tons/day type, 2 Units
③ Freezing Machine : Reciprocating Open Type Freezing Machine
④ Attachment : Water tank (20ton) with a Pump, Inhaled Gas Radiator, Evaporation Type Condenser, High Pressure Liquid Receiver, Piping Materials

3-6) Capacity of Ice Storage Room

In case of the plate ice, the ice can be stored at most about 5 days and the capacity of ice storage room is generally having capacity to store 1.5 days to 4 days of the ice making capacity. In this Project, the capacity of ice storage room is adopted to be 40 tons for 2 days.

The delivering ice from the storage room is planned to be done by manually. In this case, there is a dead space around the door for the handling works in the ice storage room, and there are dead spaces also at the upper corners of the storage room since the ice is piled up in conical shape, and the effective ice storage volume becomes about 60% of the space of storage room. Therefore, the dimensions of ice storage room is determined as follow:

| | |
|---|---|
| Volume of Ice | $40\ t \div 0.55\ t/m^3 = 72.72\ m^3$ |
| Required Capacity of Storage | $72.72\ m^3 \div 60\% = 121.2\ m^3$ |

Therefore, the dimensions of the ice storage room are determined as follows:

Length: 8.0 m, Width: 7.0 m, Height: 2.2 m, Capacity: 123.2 $m^3$

3-7) Ice Plant Building

The ice plant building will be installed on the apron of quaywall at the inner part of bay and the ice storage room, freezing machine unit, water tank, etc., are arranged on the ground floor and the ice making machines are allocated at the first floor. The structure is of the reinforced concrete from the view point of the maximum utilization of local materials and the high insulation efficiency, and the total floor area is required 196 $m^2$ as shown in the table below.

Table 2.3.12 Required Area for Ice Plant Building

| Building | Room | Base for Area setting | Area ($m^2$) |
|---|---|---|---|
| Ice Making Plant | Machine Room (GL) | Based on machine arrangement | 53.70 |
| | Storage Room (GL) | Based on calculation | 71.15 |
| | Ice Making Room (1F) | Based on machine arrangement | 71.15 |
| Total | | | 196.00 |

(4) Plan of Cold Storage

4-1) Condition of Cold Storage

As mentioned before, in Maputo Fishing Port, 3 freezing rooms of 150 ton capacity each are actually in operation, but the rehabilitation of the existing cold storage is necessary urgently from the following reasons:

(1) The plant has passed about 20 years and has been deteriorated, and the quality control of the stored products is difficult because of insufficient low temperature,
(2) The freezing machine is frequently out of order and the 3 rooms are not functioning well,
(3) The equipment are old-fashioned and difficult to obtain its spare parts now, and
(4) The port as a fishing port of the capital city is acting as the base of import and export of frozen marine products and the demand for use of cold storage is high, nevertheless, the capacity is not satisfied.

The utilization before and after rehabilitation of the existing cold storage is presented in Table2.3.13. At present, because of insufficient temperature due to deterioration of machine and unsteady temperature control due to break-downs of machine, the cold storage is not used for the prawns and quality fishes caught by industrial fishing vessels for export, but the demand will be recovered if rehabilitation is executed by this Project. In

addition to this, the demand for the cold storage will be increased considerably by the catch of artisanal fishing boats due to expansion of quaywall by this Project.

No data of the monthly catch unloaded at the Maputo Fishing Port is available and the annual catch (average for past 5 years) unloaded at Maputo Fishing Port was divided into monthly applying the monthly catch of country, as shown in Table2.3.14. As known clearly from this table, every January and February (the closing season for prawn fishing) are scarcely performed the fishing activity in Mozambique. Therefore, for the planning of cold storage, the 10 months from March until December are regarded as the objective fishing period.

Applying the using conditions presented in Table2.3.15 for the current catch of Maputo Fishing Port, the monthly average fish volume stored in the cold storage at present is assumed to be 373 tons as shown in Table2.3.16.

Meanwhile, the stored volume and utilization ratio of the present cold storage can be calculated from the past revenue records of the existing cold storage as follows:

The basic data for the calculation are as follows:

| | | |
|---|---|---|
| ① Revenue from the cold storage of PPM(1997) | | US$242,000.- |
| ② Cold Storage Fee | Fish : | US$12.50/ton/week |
| | Prawn : | US$19.20/ton/week |
| ③ Available Storage Capacity | 450 tons = 150 tons x 3 rooms | |

The storage volume and utilization ratio are calculated from the above data as follows:

1) Average storage volume

For convenience, the calculation is made using the fee for fish which is the major commodity for storage;

Weekly Storage Revenue: Annual revenue / 52 weeks = US$4,650 / week

Average Storage Volume: Weekly storage revenue / Weekly unit charge

= 4,650 / 12.5 = 372 tons

2) Average Utilization Ratio

Average storage volume / Storage capacity = 372 / 450 = 83%

The above utilization ratio was obtained assuming that all fish is delivered weekly. Actually, all fish is not delivered weekly, therefore, the accurate utilization ratio will be different from 83% but it may be considered that the accurate utilization ratio will not be so much different because the delivery do not made so often like every one day or two days.

4-2) Required Capacity of Cold Storage

The average storage volume (372 tons) calculated from the revenue from the cold storage is very similar to the monthly average fish volume stored in the cold storage (373 tons) calculated previously in Table2.3.16. Therefore, it was regarded as proved that the ratio of high value fishes to other fishes, the storage pattern of each fish, etc., established by the results of field interview and indicated in Table2.3.13 are judged as appropriate.

As explained before, it is very costly to rehabilitate the 3 freezing rooms of 150 ton capacity each which are now in operation with difficulty, and it is the most economical to renovate the 2 chilled rooms ( 230 $m^2$ each) which are now not operated due to poor freezing capacity.

In this case, considering the local condition that there are many small scaled users, the renovation that the 2 chilled rooms are divided into 2 rooms each and made 4 rooms in total, will be carried out at same time. The divided 4 rooms will become the storage capacity of 100 tons each and 400 tons in total (refer to Figure2.3.3).

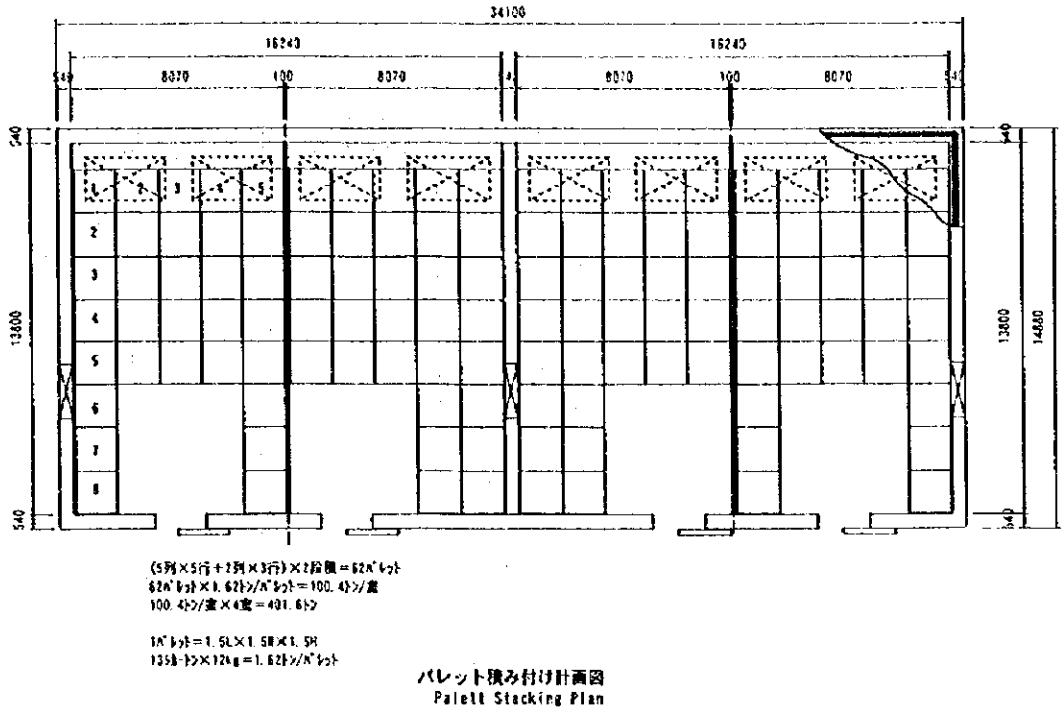


Figure2.3.3 Storage Plan of Pallets

Table2.3.13 Cold Storage Utilization Condition at Present and After Rehabilitation

| Ship Type | Fish Kind | Fish Condition | Cold Storage Use Condition | | Circulation |
|---|---|---|---|---|---|
| | | | Present | Rehabilitated | |
| Industrial Fishing Ships | Prawns | Freezing in ship | Storage temperature of cold storage is high and not used | Store 50% of catch*<br>Store 1month/time | For export |
| | Quality Fishes 30% of catch | Freezing in ship | Storage temperature of cold storage is high and not used | Store 50% of catch*<br>Store 1month/time | For export |
| | Common Fishes 70% of catch | Freezing in ship | All catch stored in cold storage as frozen fishes<br>Store 1month/time | Store 1month/time | Deliver to domestic markets at 1 month intervals |
| Semi-industrial Fishing Ships | Prawns | Unload in fresh Process and freeze on land | All catch stored in cold storage as frozen prawn<br>Store 2month/time | Store all catch<br>Store 2month/time | For export<br>Gather catch for 2 months then export |
| | Quality Fishes 30% of catch | Unload in fresh | 70% of catch stored in cold storage as chilled fish<br>Store 6 days/time | Store 70% of catch<br>Store 6days/time | For export<br>Export weekly as fresh fish |
| | Common Fishes 70% of catch | Unload in fresh | 70% of catch stored in cold storage and frozen slowly<br>Store 1month/time | Store 70% of catch<br>Store 1month/time | Deliver to domestic markets at 1 month intervals |
| Artisanal Fishing Ships | Prawns | Unload in fresh Process and freeze on land | 50% of catch stored in cold storage as frozen prawn<br>Store 2month/time | Ship calls increase 3 times<br>Store 33% of catch<br>Store 2month/time | For export<br>Gather catch for 2 months then export |
| | Quality Fishes 50% of catch | Unload in fresh | 50% of catch stored in cold storage as chilled fish<br>Store 6days/time | Ship calls increase 3 times<br>Store 33% of catch<br>Store 6days/time | For export and domestic use<br>Export or deliver weekly as fresh fish |
| | Common Fishes 50% of catch | Unload in fresh | 50% of catch stored in cold storage and frozen slowly<br>Store 1month/time | Ship calls increase 3 times<br>Store 33% of catch<br>Store 1month/time | Deliver to domestic markets at 1 month intervals |
| Others | Frozen fishes for bait | Unload in frozen | Stored in cold storage | Deliver 20 to 30 tons every month<br>Keep in storage at minimum 50 tons | Deliver 20 to 30 tons every month<br>Minimum storage volume of 50 tons is maintained |

Note: The volume with mark * are established based on the information obtained from 2 industrial fishing companies in Maputo.

## Table2.3.14 Monthly Catch of Country and Maputo District

( Unit : Ton )

| | Month | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC | Total | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| District | Ship/Fish | | | | | | | | | | | | | | |
| Country | Industrial Fishing Ships | 271 | 296 | 2092 | 3054 | 2188 | 1387 | 1284 | 1338 | 1312 | 1268 | 861 | 926 | 16277 | Fishery Statistics in 1996 |
| | Prawn Catch | 203 | 213 | 1267 | 1194 | 1194 | 940 | 788 | 715 | 689 | 583 | 480 | 547 | 8813 | Ditto |
| | Prawn Monthly Ratio (%) | 2.3 | 2.4 | 14.4 | 13.5 | 13.5 | 10.7 | 8.9 | 8.1 | 7.8 | 6.6 | 5.4 | 6.2 | 100 | Actual Monthly Catch Ratio |
| | Other Fish Catch | 68 | 83 | 825 | 1860 | 994 | 447 | 496 | 623 | 623 | 685 | 381 | 379 | 7464 | Fishery Statistics in 1996 |
| | Other Fish Monthly Ratio (%) | 0.9 | 1.1 | 11.1 | 24.9 | 13.3 | 6.0 | 6.6 | 8.3 | 8.3 | 9.2 | 5.1 | 5.1 | 100 | Actual Monthly Catch Ratio |
| | | | | | | | | | | | | | | | |
| Maputo | Industrial Fishing Ships | | | | | | | | | | | | | | |
| | Prawns | 20 | 21 | 122 | 115 | 115 | 91 | 76 | 69 | 66 | 56 | 46 | 53 | 850 | Fishery Statistics in 5 year Average x Ratio of Country |
| | Other Fishes | 30 | 36 | 358 | 807 | 431 | 194 | 215 | 270 | 270 | 297 | 165 | 165 | 3240 | Fishery Statistics in 5 year Average x Ratio of Country |
| | | | | | | | | | | | | | | | |
| | Semi-industrial Fishing Ships | | | | | | | | | | | | | | |
| | Prawns | 3 | 3 | 19 | 18 | 18 | 14 | 12 | 11 | 10 | 9 | 7 | 8 | 134 | Fishery Statistics in 5 year Average x Ratio of Country |
| | Other Fishes | 7 | 8 | 80 | 179 | 96 | 43 | 48 | 60 | 60 | 66 | 37 | 37 | 720 | Fishery Statistics in 5 year Average x Ratio of Country |
| | | | | | | | | | | | | | | | |
| | Artisanal Fishing Ships | | | | | | | | | | | | | 411 | Fishery Statistics in 5 year Average(1989 - 1993) |
| | Prawns | 2 | 2 | 13 | 12 | 12 | 9 | 8 | 7 | 7 | 6 | 5 | 5 | 87 | Fishery Statistics in 5 year Average x Ratio of Country |
| | Other Fishes | 3 | 4 | 36 | 81 | 43 | 19 | 22 | 27 | 27 | 30 | 17 | 16 | 324 | Fishery Statistics in 5 year Average x Ratio of Country |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |

Note:

1 The monthly catch of Maputo was estimated using the monthly catch ratio of country, since the pattern of fishing activities are similar and the fishing closing season of January and February are same in all districts of country.

2 The catch by the industrial and semi-industrial fishing ships were obtained as an average from the fishery statistics of past 5 years.

3 For the catch by the artisanal fishing ships, the 5 yeras average between 1989 and 1993 was adopted because the those years data are new and most reliable.

Above figures are similar with the figures obtained by the field survey for the operating fishing ships and the catch as shown below.

| | Annual Catch | Shrimps | Other fishes |
|---|---|---|---|
| Catch by Fishery Statistics | 411 ton | 87 ton | 324 ton |
| Catch by Field Survey | 440 ton | 80 ton | 360 ton |

## Table2.3.15 Monthly Catch for Cold Storage (Present)

( Unit : Ton )

| | Month | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC | Total | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| District | Ship / Fish | | | | | | | | | | | | | | |
| Maputo | Industrial Fishing Ships | | | | | | | | | | | | | | |
| | Prawns | | | | | | | | | | | | | 850 | Temperature is high and not stored |
| | High Value Fishes | | | | | | | | | | | | | 972 | (30% of Catch) Same as above |
| | Other Fishes | 21 | 25 | 251 | 565 | 302 | 136 | 151 | 189 | 189 | 206 | 116 | 115 | 2266 | (70% of Catch) Frozen Fishes |
| | | | | | | | | | | | | | | | |
| | Semi-industrial Fishing Ships | | | | | | | | | | | | | | |
| | Prawns | 3 | 3 | 19 | 18 | 18 | 14 | 12 | 11 | 10 | 9 | 7 | 8 | 134 | Frozen Shrimps |
| | High Value Fishes | 2 | 2 | 24 | 54 | 29 | 13 | 14 | 18 | 18 | 20 | 11 | 11 | 216 | (30% of Catch)Chilled Fishes |
| | Other Fishes | 5 | 6 | 56 | 126 | 67 | 30 | 33 | 42 | 42 | 46 | 26 | 26 | 504 | (70% of Catch)Frozen Fishes |
| | | | | | | | | | | | | | | | |
| | Artisanal Fishing Ships | | | | | | | | | | | | | 204 | 50% of Catch is stored |
| | Prawns | 1 | 1 | 6 | 6 | 6 | 5 | 4 | 4 | 3 | 3 | 2 | 3 | 44 | Frozen Prawns |
| | High Value Fishes | 1 | 1 | 9 | 20 | 11 | 5 | 5 | 7 | 7 | 7 | 4 | 4 | 80 | (50% of Catch)Chilled Fishes |
| | Other Fishes | 1 | 1 | 9 | 20 | 11 | 5 | 5 | 7 | 7 | 7 | 4 | 4 | 80 | (50% of Catch)Frozen Fishes |
| | | | | | | | | | | | | | | | |
| | Bait Reservation (Average) | 90 | 70 | 50 | 90 | 70 | 50 | 90 | 70 | 50 | 90 | 70 | 50 | | Frozen Baits |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |

Note:

1 Out of catch in Maputo, only the fishes unloaded at PPM and stored in the cold storage at PPM are considered.

2 Other than the catch, the frozen fishes of bait for the cage fishing are constantly stored now in the cold storage at PPM.

## Table2.3.16 Average Monthly Volume in Cold Storage (present)

( Unit : Ton )

| | Month | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC | Total | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| District | Ship / Fish | | | | | | | | | | | | | | |
| Maputo | Industrial Fishing Ships | | | The average catch for the active fishing period of 10 months is considered. | | | | | | | | | | | |
| | Prawns | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| | Other Fishes | | | 251 | 565 | 302 | 136 | 151 | 189 | 189 | 206 | 116 | 115 | 2220 | (70% of Catch) Frozen Fishes |
| | (Monthly average storage)-(1) | | | Circulate every 1 month : 2,220 / 10 x 1.0 = | | | | | 222 | tons | | | | | Average 1 month storage |
| | | | | | | | | | | | | | | | |
| | Semi-industrial Fishing Ships | | | | | | | | | | | | | | |
| | Prawns | | | 19 | 18 | 18 | 14 | 12 | 11 | 10 | 9 | 7 | 8 | 128 | Frozen Prawns |
| | (Monthly average storage)-(2) | | | Circulate every 2 month : 128 / 10 x 2.0 = | | | | | 26 | tons | | | | | Average 2 month storage |
| | High Value Fishes | | | 17 | 38 | 20 | 9 | 10 | 13 | 13 | 14 | 8 | 8 | 148 | (30% of Catch) Chilled Fish |
| | (Monthly average storage)-(3) | | | Circulate every 6 days : 148 / 10 / 30 x 6.0 = | | | | | 3 | tons | | | | | Average 6 days storage |
| | Other Fishes | | | 39 | 88 | 47 | 21 | 23 | 29 | 29 | 32 | 18 | 18 | 346 | (70% of Catch) Frozen Fishes |
| | (Monthly average storage)-(4) | | | Circulate every 1 month : 346 / 10 x 1.0 = | | | | | 35 | tons | | | | | |
| | | | | | | | | | | | | | | | |
| | Artisanal Fishing Ships | | | | | | | | | | | | | | |
| | Prawns | | | 6 | 6 | 6 | 5 | 4 | 4 | 3 | 3 | 2 | 3 | 42 | Frozen Prawns |
| | (Monthly average storage)-(5) | | | Circulate every 2 month : 42 / 10 x 2.0 = | | | | | 8 | tons | | | | | |
| | High Value Fishes | | | 9 | 20 | 11 | 5 | 5 | 7 | 7 | 7 | 4 | 4 | 79 | (50% of Unloaded Fishes) Chilled Fish |
| | (Monthly average storage)-(6) | | | Circulate every 6 days : 79 / 10 / 30 x 6.0 = | | | | | 2 | tons | | | | | |
| | Other Fishes | | | 9 | 20 | 11 | 5 | 5 | 7 | 7 | 7 | 4 | 4 | 79 | (50% of Unloaded Fishes) Frozen Fish |
| | (Monthly average storage)-(7) | | | Circulate every 1 month : 79 / 10 x 1.0 = | | | | | 8 | tons | | | | | |
| | | | | | | | | | | | | | | | |
| | Bait Reservation (Average) | | | 50 | 90 | 70 | 50 | 90 | 70 | 50 | 90 | 70 | 60 | | Constant Storage of Frozen Bait |
| | (Monthly average storage)-(8) | | | Average volume= | | | | | 70 | tons | | | | | |
| | | | | | | | | | | | | | | | |
| | Total Monthly Average Storage= | (1)+(2)+(3)+(4)+(5)+(6)+(7)+(8)= | | | | | | | 373 | tons | | | | | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |

4 – 3) Specification of Freezing Room

The refrigerant of freon-22 is adopted for the freezing rooms by the same reasons explained in the sub-section of the ice making plant.

a) Design Criteria

① Freezing Capacity : 400 tons of Frozen Fish
② Cold Storage Temperature : – 20℃
③ Refrigerant : Freon – 22 (R-22), Direct swelling type
④ Refrigerant Condensation : Condensation by Evaporation System

b) Specification of Freezing Room

① Floor Area : 460 $m^2$ (4 rooms)
② Insulation : Prefabricated Panel Composition Type
Partition Wall Panel, t=100 mm; Ceiling Panel, t=100mm;
Manual Sliding Door : B=1800mm, H=2200mm, t=150mm, 4 Doors
③ Refrigeration Machine : Open Reciprocation type Refrigeration Machine
④ Accessories : Cooling Unit, Evaporation Type Condenser,
Automatic Defrosting Device, etc.

4 – 4) Modification of the Existing Chilled Rooms

In order to divert the existing chilled rooms, which are not operable now because of deterioration of freezing machines, to the new freezing rooms, in which temperature can be controlled at less than -18°C of EU Standard, the refrigeration machines, doors and the insulation of ceiling will be changed and 2 partition walls will be newly installed.

The existing insulation for floors and walls can be used but the insulation for ceilings are required to be replaced because the insulation material of stylofoam has been saturated by water. The moist insulation ceiling has already lost its function and charging 150 kg/$m^2$ of load to the ceiling, therefore, the existing insulation will be demolished and the new insulation panel of 100 mm thick which can serve for - 20℃ to - 25℃ will be installed.

Accompanied by dividing 2 rooms of 460 $m^2$ into 4 rooms, 3 of 5 door openings will be closed and 2 door openings will be newly provided. The partition walls for dividing the rooms will not have the same insulation capacity with outer walls but will be more simple ones.

In addition to the above, the doors of 4 openings, except for an useless opening located on the existing partition wall to be closed, out of the existing 5 door openings which are lacking air-tightness will be replaced by new one and the rise in temperature caused by leakage of cold air will be protected. All doors are necessary to be changed to the high insulation doors for – 20℃.

(5) Building and utilities

5-1) Administration office building

Administration office of PPM is located in the refrigeration building and their working rooms have no windows facing open air. To improve those situations, a Director's room, an Accountant room, an office room and a meeting room are planned to be newly provided. The required areas of floor spaces are shown in Table2.3.19.

Table2.3.19 Floor Space of Administration Building

| Department | Name of Room | Number of Personnel | Calculation of Basic Floor Space | Designed Floor Space ($m^2$) | Remarks |
|---|---|---|---|---|---|
| Admin. | Director's room | 1 | | 24.00 | Reception |
| Admin. | Reception<br>Storage | 1 | | 10.50<br>7.50 | Waiting space |
| Accounting | Accountant Room | 2 | 2 x 6$m^2$ + Visitor | 24.00 | Waiting space for payer |
| General Affairs | Office Room | 8 | 8 x 4.5$m^2$ + Bookshelf | 42.00 | |
| | Meeting Room | 16 | 16 x 2.0$m^2$ = 32.0 | 32.00 | |
| | Kitchenette | | | 1.50 | |
| | Male Toilet | | | 11.25 | |
| | Female Toilet | | | 6.75 | |
| | Corridor | | | 32.00 | |
| | Entrance | | | 4.50 | |
| Total | | | | 196.00 | |

5-2) Public toilets

The public toilets for the workers in the fishing port are provided presently in the Clock Tower Building for male and female one each. Since many fishing boat crews, port workers, buyers and traders are going in and out the port, it is difficult to keep good sanitary condition in the port. To resolve this situation, two public toilets are planned to be provided; one will be located near the piled jetty and another one will be located near the new ice making plant on the northern quaywall. According to a result of survey in the port,

the proportion of man and woman as port users is seen as about 3:1, therefore, these facilities are planned to be provided in 3:1 proportion for men and women.

The number of port users including fishing boat crews, port workers, buyers and traders is estimated as follows:

| | | | |
|---|---|---|---|
| Fishing boat crews | Industrial | 3.0 boats x 20 persons = | 60 |
| | Semi-industrial | 10.8 boats x 10 person = | 108 |
| | Artisanal | 32.9 boats x 5 person = | 164.5 |
| Port Workers | | | 50 |
| Buyers and Traders | | | 115 |
| | | | 497.5 |

Based upon the above figures, the number of toilet bowls and urinals is estimated as follows:

| | | Toilet Bowls | Urinals | Lavatories |
|---|---|---|---|---|
| Female | 125 persons | 5 | 0 | 5 |
| Male | 375 persons | 5 | 5 | 5 |

However, the number of existing facilities shall be subtracted from the above figures.

5-3) Guard house

The guard house is located presently on the revetment near the boarding steps, and is required to be relocated because of the change of alignment of planned quaywall. The floor space is presently 26.5 $m^2$ and is improved to 32 $m^2$ considering layout of rooms as follows:

Table2.3.20 Floor Space of Guard House

| Department | Name of Room | Number of Personnel | Calculation of Basic Floor Space | Designed Floor Space ($m^2$) |
|---|---|---|---|---|
| Guard House | Watch room | 4 | 4 persons x 4 $m^2$ | 16.00 |
| | Dormitory | 1 | | 16.00 |
| Total | | | | 32.00 |

5-4) Fuel supply

The refueling installation is planned to provide diesel oil and gasoline for fishing boats, and steel oil tanks are to be installed underground. Quantity of refueling (One-day amount) is calculated as follows:

| | | | | |
|---|---|---|---|---|
| Diesel oil: | Semi-industrial (fish) | 1.5 boats x 5,000 L | = | 7,500 L |
| | Semi-industrial(prawn) | 9.3 boats x 400 L | = | 3,720 L |
| | Total | | | 11,220 L |
| Gasoline: | Artisanal | 32.9 boats x 30 L | = | 987 L |

Supply to the oil tanks is considered to be every two days and the tanks are to reserve two-day stock of fuel.

| | | | | |
|---|---|---|---|---|
| Diesel oil tank | 2 days | x 11,220 L | = | 25 kL |
| Gasoline tank | 2 days | x 987 L | = | 2 kL |

5-5) Water Supply

The city water supply in Maputo City shuts down frequently in the dry season. Water for ice making and water supply to fishing boats should be secured to supply water steadily in the port. Therefore, the water tank of $20m^3$ in capacity and pressure device are planned to be installed as a countermeasure to avoid shutdowns of water supply.

5-6) Electrical services

Present electric capacity of the Maputo Fishing Port is 630 KVA and is considered to have sufficient capacity to allow renovation of the cold storage and the ice making plant. However, the shortage of electricity would occur when electricity is provided for lighting with the illumination levels of 20 Lx for night works and electricity supply for fishing boats.

Additional transformer, receive entrance panel and switchboard are to become necessary and are estimated as follows. The existing spare space of receive entrance panel can be used for transformer, so new space for panel will not be required.

| | | | |
|---|---|---|---|
| Lighting Facilities | | | |
| Street Light (Single) 400 W | | 500VA x 3 poles x 1 light | = 1.5 KVA |
| Street Light (Double) 400 W | | 500VA x 16poles x 2 light | = 16.0 KVA |
| Flood Light (4 lights) 400 W | | 500 VA x 4 lights | = 2.0 KVA |
| For Fishing boat | 220V 200A | 25 KVA x 3 | = 75.0 KVA |
| | 380V 100A | 45 KVA x 3 | = 135.0 KVA |
| | | | 229.5 KVA |

The operation rate is assumed as 80%, and 229.5 x 80% = 183.6 KVA, thus a 200 KVA Transformer is planned to be installed.

5-7) Drainage

The city's sewerage pipe (1-meter diameter) has its outlet in the harbour basin and is the main source of pollution of the water inside the harbour. The outlet is planned to be relocated to discharge sewerage directly to the river.

5-8) Sanitary arrangement

The existing three septic tanks in the fishing port area do not have sufficient capacity for treatment of wastewater and sewage from the planned buildings and public toilets. New septic tanks are, therefore, planned to be installed for the newly constructed facilities (administration building and two public toilets).

(6) Loading/unloading equipment

6-1) Crane

A rail mounted quay crane (capacity: 3.5 ton) is operated presently on the piled wharf. Though the manufactured year of the crane is old enough as 1912, the crane is still used for loading/unloading of the industrial fishing boats. Those large size boats have their own ship gears, but the reach becomes shorter during the low tide. So most of the large size fishing boats have to load and unload their fish-catches, supplies and fishing gears by the old crane under the risk that the crane could go out of order every time. The extent of the crane rail covers only half-length of the wharf and installation of rail mounted crane is required to improve in efficient operation for the remaining portion of the wharf.

And there exists no crane to cover the loading and unloading of inner harbour, it is considered appropriate to provide a mobile crane for both the industrial fishing boats and the semi-industrial fishing boats by one equipment.

Concerning the lifting capacity, the nominal 25 tons capacity crane is planned to be installed so that a 3.5 tons cargo can be lifted at 10 meters ahead of out-riggers.

6-2) Forklift trucks

The forklift trucks in the Maputo Fishing Port were generally used for transporting cargoes from wharves to the cold storage and/or from cold storage to forwarding trucks. The fishing port has two forklift trucks presently; one is an electric forklift truck (1.5 tons

capacity; manufactured in 1982) and another one is diesel type (3.5 tons capacity; manufactured in 1973), and both of them are out of order now. An electric forklift truck borrowed from CFM is used currently for a stopgap measure. The both forklift trucks of the fishing port have already exceeded the life of machine and the time of replacement has come.

Therefore, provision of one electric forklift truck (1.5 ton capacity) and one diesel forklift truck (3.5 tons capacity) are planned to provide efficient port operation.

### 2-3-4 Drawings of Basic Design

(1) Maputo Fishing Port Layout Plan
(2) Cross Section of Piled Jetty
(3) Cross Section of Quay Wall (Type A)
Cross Section of Quay Wall (Type B)
Cross Section of Quay Wall (Type C)
Detail of Step Works
(4) Administration Building
(5) Public Toilet; Guard House
(6) Ice Making Plant
(7) Existing Refrigerator Building
Existing Cold Storage Rehabilitation Plan