CHAPTER 2

CONTENTS OF THE PROJECT

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2-1 Objectives of the Project

Fisheries in St. Lucia are characterized by remarkable seasonal changes in production, some 70% of the annual catch occurring during the high season of January to June. During the high season fish production exceeds the capacities of the existing storage facilities in Castries and fish prices go down when the maximum capacity is reached. Fishermen thus suspend their fishing from time to time during the high season, leading to the reduction of their income.

Vieux Fort, the project site, is the largest fishing base in the country with the annual landings of 357 tons (1996 statistics), but at present there are no adequate facilities to deal with large amounts of fish landings. In this context, the Government of St. Lucia requested a grant aid on Construction of Vieux Fort Fishery Complex to the Government of Japan.

The objectives of the Project are:

a) To increase fish production by increasing the efficiency of fishing and construct a fishery complex containing fish port and market facilities in Vieux Fort to improve the quality of fish and procure a stable supply of fish consumers.

b) To improve fish storage and marketing systems through the improvement of relevant facilities in order to reduce the gaps in supply and demand of fish and minimize price differences between the high and the low season.

With these background and objectives, the layout, the optimum structure and the scope of the complex facilities have been designed and alternative plans also prepared. Both governments agreed to the assistance components which are indicated below.

(1) Basic Facilities

a) Breakwaters
b) Landing Wharves
c) Slipway

(2) Functional Facilities

a) Administration Office Building
b) Cold Storage
c) Chilled Room
d) Fish Handling Shed
e) Quick Freezers

f) Ice Making Plant and Ice Storage
g) Fuel Station
h) Fish market
i) Locker Rooms
j) Workshops
k) Retail Shops of Goodwill Fisheries Cooperative
l) Toilets and Shower Rooms
m) Canteen
n) FRP Boats, Fishing Gears and Insulated Trucks

2-2 Basic Concept of the Project

This Project aims at developing Vieux Fort as the base for fishing, storage and distribution of fish in the South District. The basic concepts and major activities of the Project are as follows.

(a) Activities will be consistent with the objectives of the Fishery Development Plan;
(b) Improvement of fishing efficiency to increase fish production;
(c) Improving the safety of boats in navigation channels and mooring basins;
(d) Preserving the freshness of fish and increase fish prices;
(e) Preventing water pollution in the fishing port caused by fish processing;
(f) Preventing the siltation in navigation channels and mooring basins caused by littoral drift;
(g) Establishment of an adequate system for the management and operation of the Fishery Complex;
(h) Convenience of town residents and environmental aspects will be fully taken into account in the preparation of layout plans for Complex facilities;
(i) Need, priority and cost-effectiveness will be important factors to determine the optimum levels of the scale and location of facilities;

Currently, 118 fishing boats are registered in Vieux Fort. Upon the completion of the complex, a larger number of boats are expected to bring fish from neighboring districts to Vieux Fort. Vieux Fort may turn into a center for collection and distribution of fish in the south district. The Project aims at improving the efficiency of fish landing and preparations for fishing trips. The improved distribution system would guarantee a stable supply of fish to consumers. Thus, the socio-economic status in the south may be improved. In the course of preparation of the plan for Vieux Fort Fishery Comnplex, local customs and traditional practices as well as the experience learnt from the construction of the Dennery Fishing Port will be fully taken into account.

2-2-1 Examination of the Requested Facilities

(1) Selection of Project Site

The project site shown in Figure- 2.2.1 was proposed and accepted by the Government of St. Lucia. The site will be established by reclaiming part of Vieux Fort Bay and allow the fishing industry to continue to develop. The fishery complex is located in the vicinity of Vieux Fort downtown and will play an important role for the development of the fishing industry in the south. In the integrated development project currently envisaged, the Government intends to build three zones, i.e. marine, residential and commercial, on the western part of the Bay. On the eastern part of the Bay the commercial port was already built and the present project, or marine zone, has been proposed to be established next to the commercial port.

(2) Examination of the Content of the Request

On the basis of the consultation with the Government of St. Lucia and the findings of the Study team, it was stressed that an urgent action would be required for implementing the project. The main components of the project are as follows.

1) Breakwaters

Vieux Fort District faces the ocean and is directly exposed to the impacts of strong waves and hurricanes. There is an urgent need for strengthening shore facilities to ensure the safe navigation and mooring of fishing boats.

FRP boats are generally anchored offshore at the distance of 30 - 100m from the beach and fishermen have a difficult access to the beach. It is necessary to build breakwaters to enable them to moor the boat to the breakwater. The field survey revealed that fishermen return to the port from time to time late at night. It is necessary to install navigation lights at the tip of breakwaters for the safe entry to the port.

2) Landing Wharf

The landing wharf is one of the most important facilities to be built by the project together with breakwaters. Fish are normally landed by fishermen who carry baskets from the boats anchored off the shore. Once the wharf is built, fishing boats can berth the wharf for direct unloading, which will increase the efficiency.

It was also noted that not only the fishing boats of Vieux Fort but also those of Laborie, Choiseul, and Soufriere would land fish on the complex.

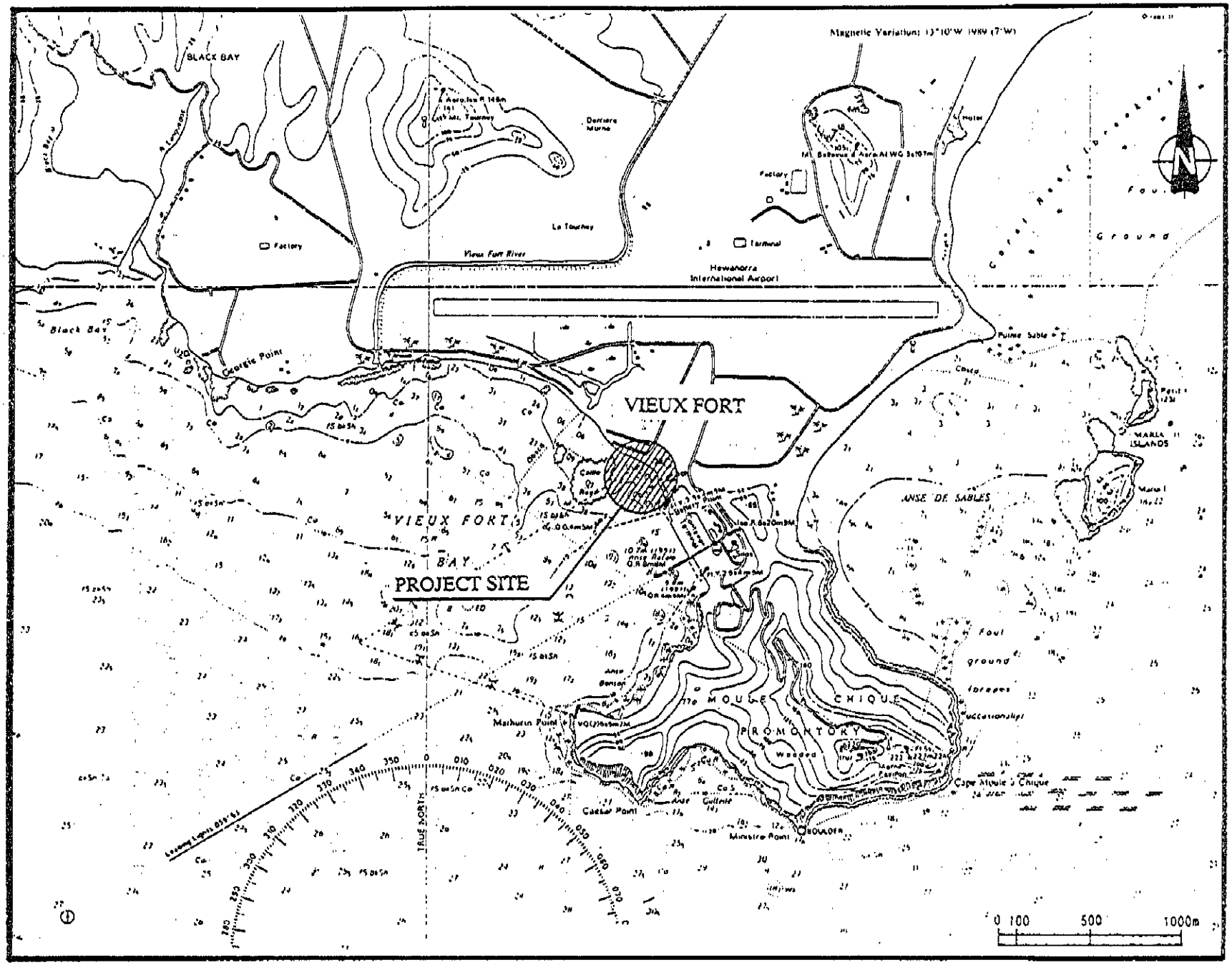


Figure-2.2.1 Project site

3) Slipway

Wooden canoes are to be pulled up on the beach after returning from fishing trips and thus a slipway is required. This will help to increase the calmness of water in the port. A hand-operated winch will be installed instead of electric ones.

4) Fuel Supply Station

It was agreed that a local petroleum company would build a fuel supply depot. The Project will offer a piece of land for building the depot within the reclaimed site.

5) Administration Office

An administration office will be built to accommodate a number of agencies and organizations which will be involved in the operation of market facilities, port management and operation. The office will have a conference room to be utilized for conducting training course, seminars by extension officers and JICA experts and also fishermen's assembly meetings by Goodwill Fishermen's Cooperative Society.

6) Fish Handling Shed

The major functions of this facility are to carry out sorting, cleaning and weighing, packaging of fish right after fish are landed.

7) Fish Market

Fish are sold on the roadsides by fish vendors and fishermen. From a hygienic point of view, it is necessary to build a fish market within the complex premise. Also, the transfer of street fish stalls will help to decrease the congestion of the town traffic.

8) Ice Making/Storage Facility

Ice used in Vieux Fort today is brought from Laborie as there is no ice making plant in the city. Ice is mainly used by fish vendors to transport fish to Castries. The field survey disclosed that sufficient quantities of ice were not available to meet the demand and there was a need to build an ice plant.

9) Cold Storage

There is a need to build cold storage facilities to store surplus fish during the high season in order to solve problems on excessive production to ensure a stable supply of fish to the market throughout the year. This would also help to stabilize the price of fish. Fishermen will gain benefits for this arrangement. The existing cold storage in Castries is not efficiently used since the fish stored earlier stay till the end of the season since

fish are piled one after the other. To solve this problem, fork lifts and fish pallets will be used in the new complex so that fish may be smoothly rotated to supply quality fish to consumers. Besides, the capacity of a cold storage could be designed smaller when fork lifts and fish pallets are used as compared with a bulk storage system.

10) Chilled Room

The purpose of a chilled room is to preserve the freshness of fish and temporarily to store surplus fish which cannot be sent to freezing and processing immediately. Although provision of a chilled room was requested by the Government of St. Lucia, it was considered that the anti-room of the cold storage could play this function. Therefore, it was decided that provision of the chilled room will not be included in the Project.

11) Quick Freezer

There is a need to apply a quick freezing system when fish are stored in the cold storage to maintain the quality of fish. It is indispensable to use the quick freezer together with cold storage.

12) Work Shop

It is necessary to have a workshop to repair fishing boats and outboard engines, which are currently repaired on the beach without adequate machinery and tools. In order to extend the durability and the life of the equipment and to enhance the efficiency of fishing operations.

13) Cooperative Retail Shop

The Goodwill Fishermen's Cooperative sell fishing gear and materials to its members at its shop. A new cooperative retail shop will be built within the complex premise to continue the same service for the members.

14) Toilet and Shower Room

The toilet/shower rooms will be provided within the premise of the complex.

15) Locker Room

Fishermen currently use their own sheds built on the beach to store their gear and equipment. These sheds will be replaced by gear lockers to be built within the complex. New facilities would provide fishermen with benefits in respect of storage capacity and safety.

16) Fishing Boats and Gear

The project will provide five FRP boats of 28-30 ft equipped with two engines of 75 HP. This would give additional impetus to local fishermen's effort to expand the

scale of vessels. So far a total of 77 FRP boats have been provided to the country under the Japanese assistance programmes. Besides there has been a sharp increase in the number of FRP boats built by local fishermen (the total number of FRP boat reached 257 in 1994: 328 in 1996). This has greatly contributed to the modernization of the fishery industry in the country. Major future issues includes the following.

a) Exploitation of tuna fishing grounds in the southeastern waters of the country; securing boats to be used for tuna fishing as well as training for fishermen.

b) Preservation of freshness and quality of fish; awareness building and training for fishermen and fish vendors on fish handling and quality control.

c) Development of Goodwill Fishermen's Cooperative; to increase the membership of young fishermen; to improve the financial standing through training on Cooperative management. Management of boat operations will be undertaken by the Cooperative under the supervision of the DOF.

17) Insulated Trucks, etc.

Whilst FMC currently owns three insulated trucks, additional insulated trucks need to be provided to meet the future need to transport fish from Dennery to Micoud.

18) Other Facilities

a) Water tank

Water tanks with an adequate capacity will be built to supply water for the operation of market halls, quick freezers, cold storage, ice making machine, fish handling shed, processing plants, etc. during the breakdown of the water system.

b) Generator

A generator is needed to allow cold storage and ice making plants to work during power failure.

c) Canteen

A canteen will be built for use by fishermen, fish vendors and other customers.

2-2-2 Basic Direction of Fishing Port Construction

In formulating the Project, the following problems currently faced by the Vieux Fort District must be solved first.

a) Inefficient fishing operations due to the lack of adequate fishing port facilities

b) Limit in fishing operations due to the unavailability of a fish marketing system

The layout plan for the facilities will be proposed by considering their relations with the urban district and the flow of fish catch. As for future management and operation of Vieux Fort Fishery Complex, an appropriate system will be proposed by considering the organization, the fee system, and the management cost.

2-3 Basic Design

2-3-1 Design Concept

(1) Design Standards

Since the Government of St. Lucia does not have any standards for designing the structure of fishing ports, the standard regulation for building fishing ports in Japan will be applied. For buildings, reference will be made to the Caribbean Building Code (CUBIC).

(2) Concepts for designing Basic Facilities

The Project will reclaim the coastal area in Vieux Fort and protect the reclaimed land by outer facilities such as breakwaters. According to the grain size analysis (Appendix-8), the reclamation materials were considered to be suitable.

The following factors will be taken into account in planning the reclamation of the coastal areas.

a) In the project site, the calmness in the port against waves from the Atlantic is to be preserved. Since the port is open to the south and west, it may receive high waves during hurricane. The breakwaters will be positioned in such a way that the calmness in the port may be maintained at the time of high waves.

b) As the source of littoral drift probably lies in the western side of the site, the breakwaters will be placed in a way to prevent the siltation in the entrance and inside of the port.

c) The Landing wharf and slipway will be designed by taking into account the customary movement of fishing boats.

d) A seismic design will be made to resist earthquakes.

e) Proper consideration will be given to the natural conditions and local environments in relation to construction work.

f) The height of the reclaimed land will be determined by considering the height at the edge of the town area.

g) Structures with good economical and engineering features will be selected by considering natural conditions such as soil conditions.

(3) Basic Design Concept for Fish Marketing Facilities

The basic design concepts for fish marketing facilities are discussed below.

a) The structure of the foundation on the uneven subsidence will be designed by considering the soil conditions of the existing ground as the facilities will be built on the reclaimed land. The results of the study on the foundation of buildings are shown in Appendix-8.

b) The marketing facilities will have a proper scale based on the result of surveys on fish production, marketing and consumption trends.

c) A seismic design will be made resist earthquakes.

d) Proper considerations will be given to the natural conditions and local environments in relation to construction work. As the facilities will be located close to the town areas, it is important to establish the harmony with the surrounding scenery .

e) An appropriate layout will be drawn by taking into consideration the flow of fish, people and vehicles as well as the harmony with the existing urban areas.

f) The design will allow the smooth operation of equipment and machinery housed in the complex facilities.

(4) Basic Policy for Equipment such as Fishing Boats and Gear

The Japan's past grant aid assistance program for fishing boats has contributed to the modernization of fishery in St. Lucia. There is an additional need for providing fishing boats and gear to accelerate the development of offshore fisheries.

The previous section discussed the objectives and justifications for providing fishing boats and gear.

2-3-2 Layout Plan

(1) Basic facilities

The basic facilities of the fishing port consist of the breakwater, landing wharf, slipway and revetment.

(2) Functional facilities on land

The land facilities to be built in the project site are summarized below according to their functions.

a) Facility for administration and management

Administration office building : Office, conference room and other utilities

b) Facilities for marine product storage and distribution

Cold storage building : Cold storage, quick freezer, processing room, etc.

Ice making plant

Fish handling shed

Fish market

c) Facilities for fishermen

Locker room

Workshop and Cooperative retail shop

Fuel station

Toilet and shower room

Canteen

(3) Layout Plan

1) Layout of Basic Facilities

The concepts and functions of the basic facilities are discussed below.

a) Layout of breakwater

Breakwaters will be positioned to effectively shield hurricane waves and prevent the siltation in the port which may be caused by littoral drifts. The predominant direction of coastal littoral drifts is from the west. The east side will not be affected by littoral drifts as the channel for the commercial port was dredged as deep as -10 m. The main breakwater will therefore be constructed on the western side to shield waves from South to West at the time of hurricane to keep the calmness in the port and to prevent the effect of littoral drift on the west side.

b) Layout of wharf

As the predominant wind is in the easterly direction, the landing wharf will be positioned with its face-line extending from east to west. This layout will allow boats to moor in parallel with the predominant wind direction.

The lay-by wharf will be constructed by using a part of the breakwater (the longitudinal portion), which is parallel to the predominant wind direction.

c) Slipway

The slipway will have the same face line with the wharf.

2) Layout of Functional Facilities

The layout of functional land facilities has been selected by taking fully into account the flow of fish and people as well as the need of users. The functions of these facilities are discussed below.

a) Fish handling shed

The shed will be built right behind the landing wharf to ensure the efficient unloading and the preservation of freshness of fish.

b) Cold storage facility

Freezing and cold storage facilities will be built right behind the fish handling shed.

c) Ice making facility(ice making machine and storage)

The ice making plant will be located near the cold storage to facilitate the smooth supply of ice to boats and cold storage (fishes need to be stored at low temperate during processing).

d) Fish market

The fish market will be located near the Vieux Fort town because of the convenience of consumers.

e) Administration office

The office will house DOF and FMC. In order to optimize their functions, the office will be located near the cold storage and the fish handling shed.

f) Locker room and cooperative retail shop

These facilities will be built near the slipway and the landing wharf for the convenience of fishermen.

g) Others

Facilities such as the water tank, power substation, lavatory, access road, lighting facilities, drainage, parking lot, etc. will be conveniently located by taking into account the access to other facilities.

Figures- 2.3.1 and 2.3.2 show the layouts of these facilities which are zoned according to the functions. Figure-2.3.1 shows the slipway placed in the east of the port, while Figure -2.3.2 in the west of the port. The position of the slipway subsequently affects the position of other facilities. Figure-2.3.3 shows that the path of fish flow corresponds to Figure-2.3.2.

Taking into account the flow of fish and people as well as the location of the city center, the fish market should be located at the center of the site to establish direct connection with the town roads. Fishermen facilities can be best situated in the east of the port. Figure- 2.3.1 is considered better than Figure-2.3.2 from a functional point of view. Figure-2.3.4 shows the basic layout plan.

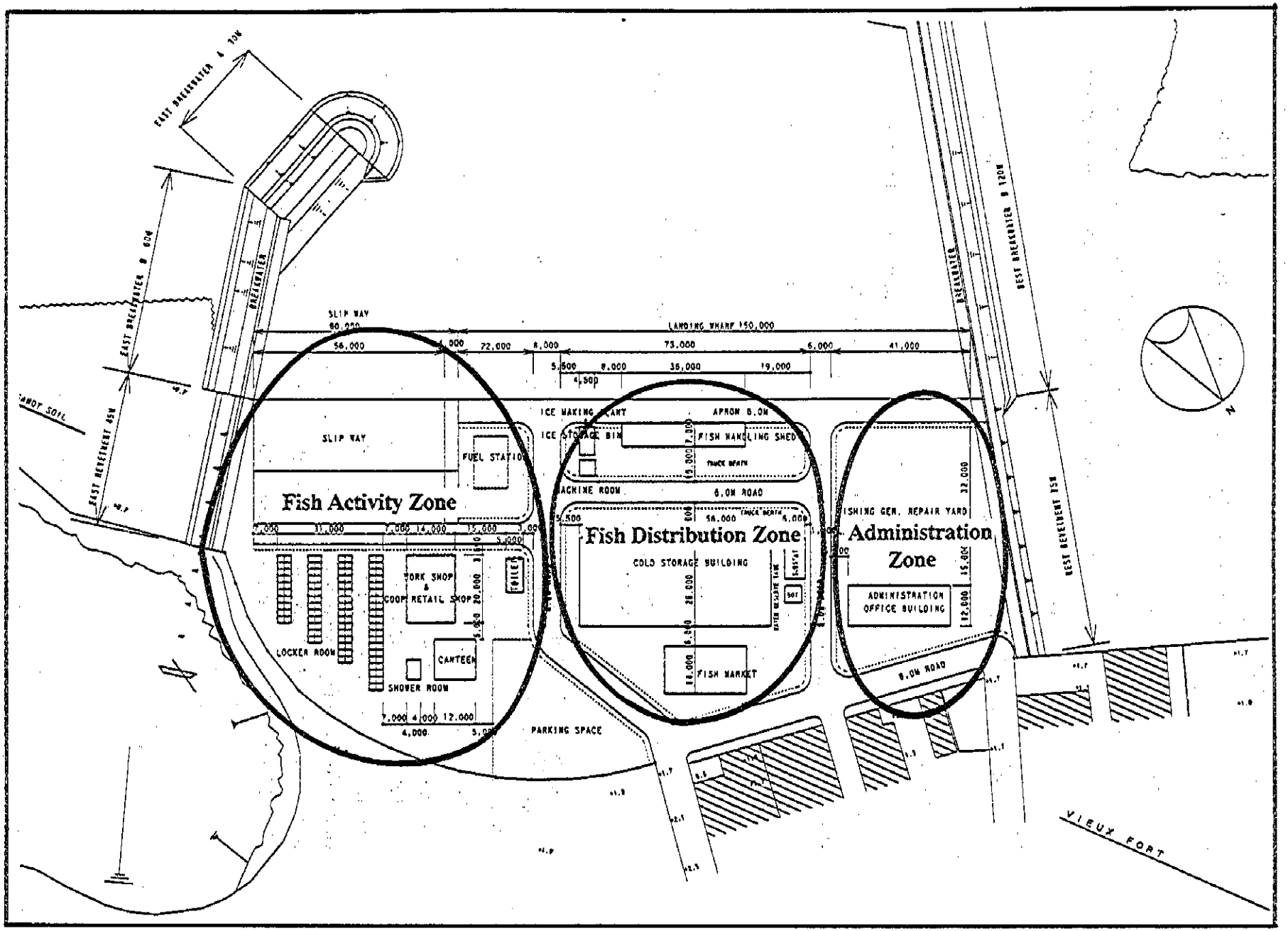


Figure-2.3.1 Zoning of functional facilities (Alternative plan-1)

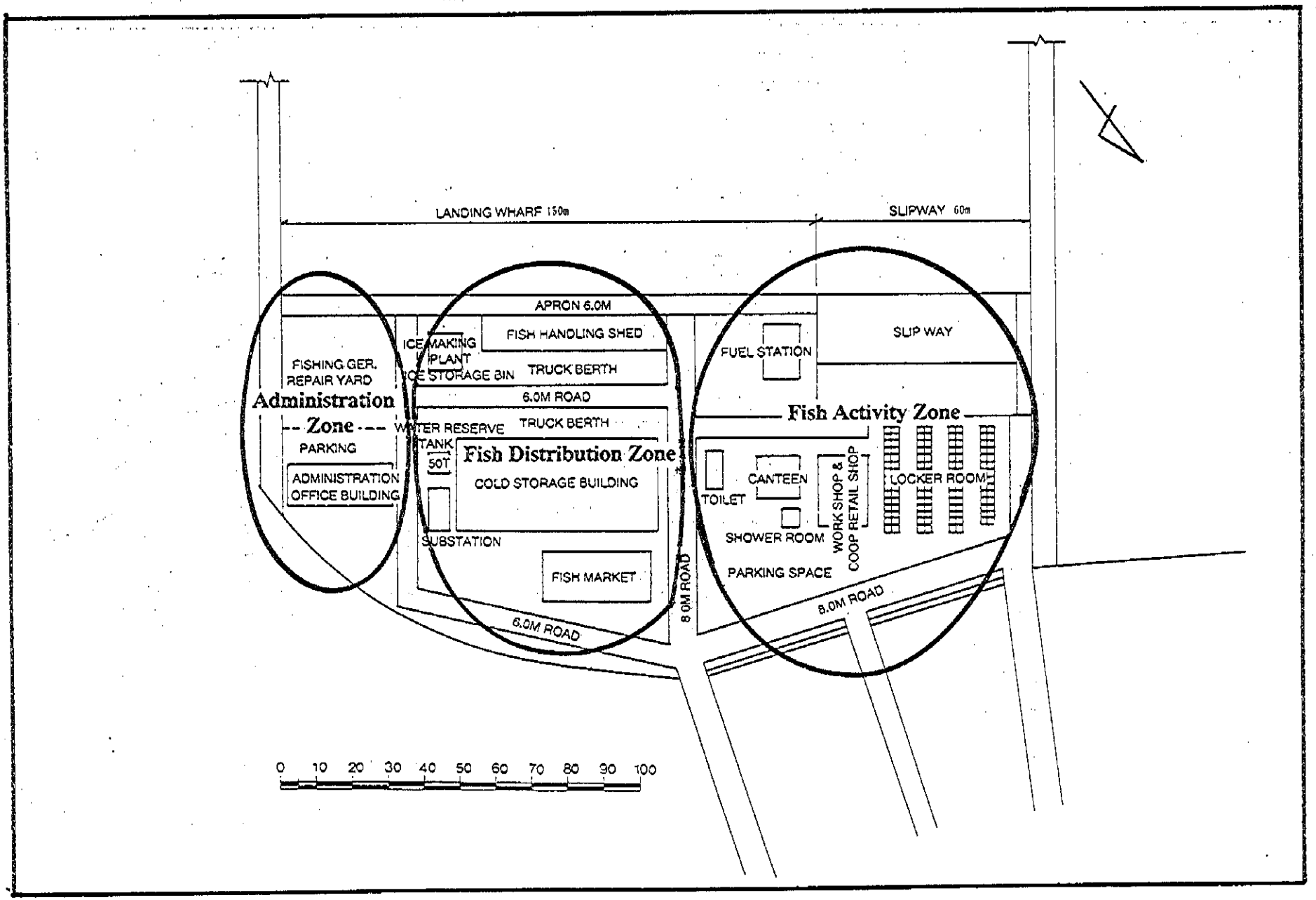


Figure-2.3.2 Zoning of functional facilities (Alternative plan-2)

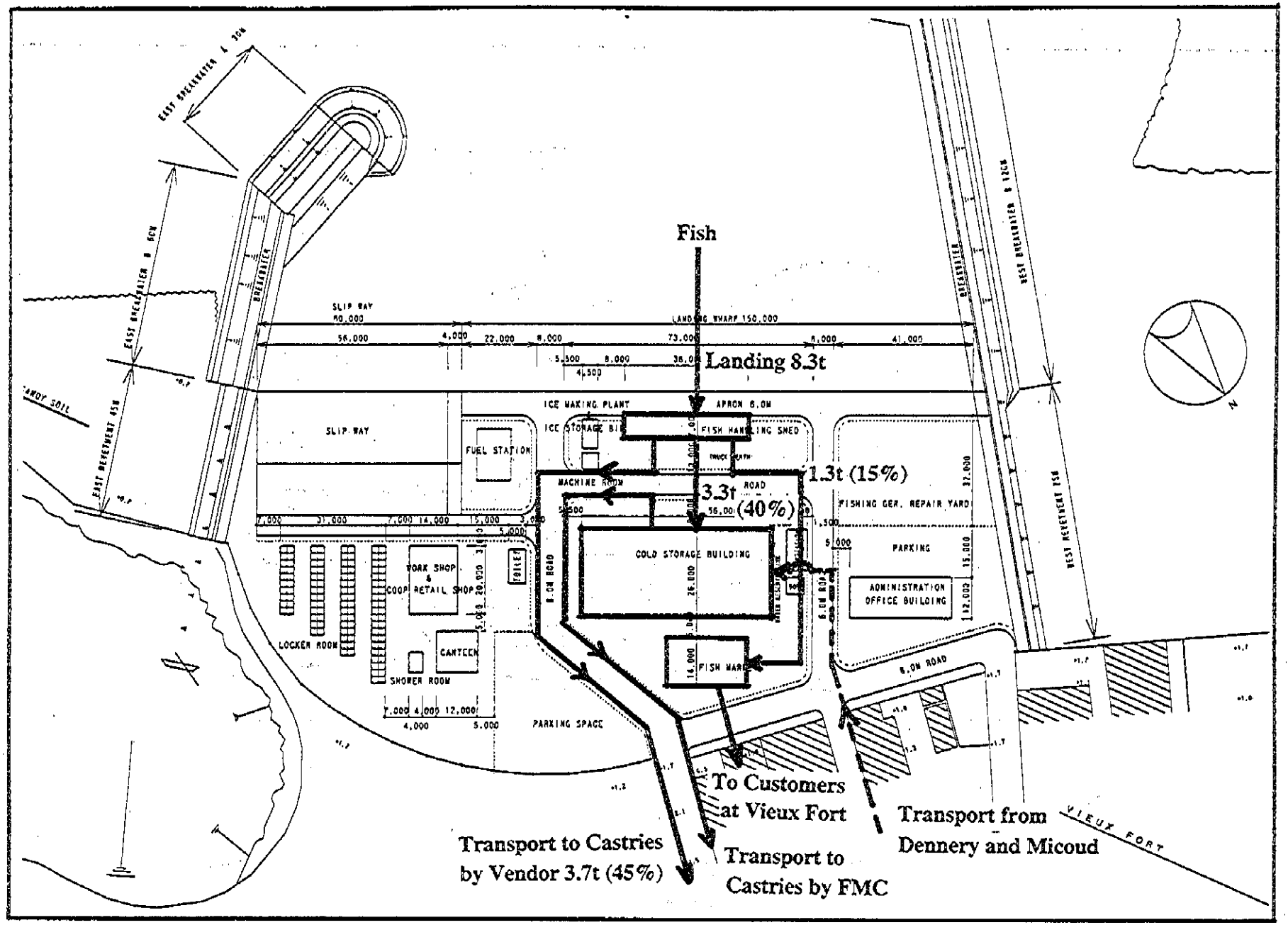


Figure-2.3.3 Path of fish flow (Alternative plan-2)

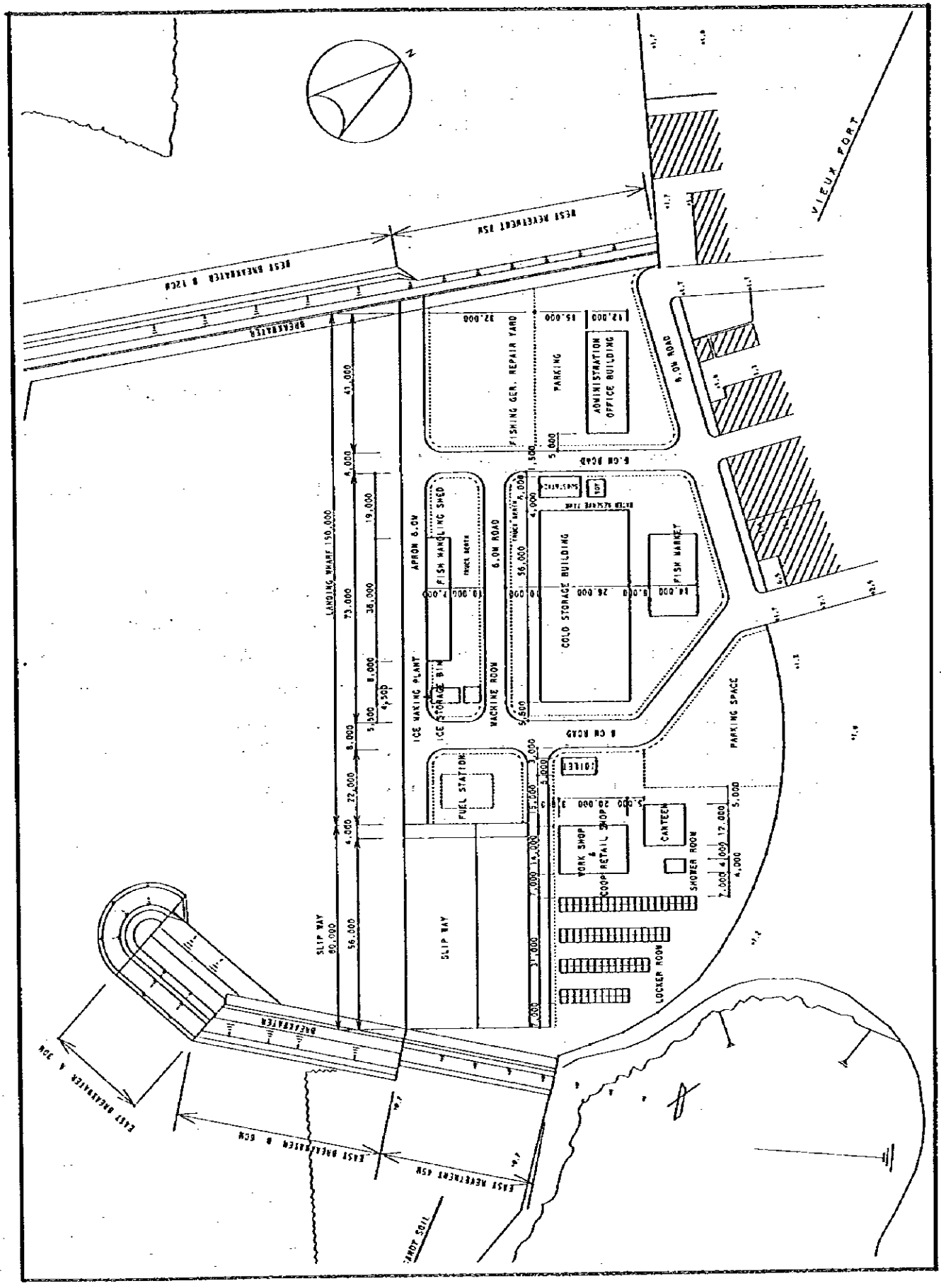


Figure-2.3.4 Basic layout plan

2-3-3 Basic Design of Fishing Port Facilities

(1) Dimensions of Fishing Boat

FRP : Length=7.5m, Width=2.0m, Draft=1.5m

Canoe : Length=6.5m, Width=1.8m, Draft=0.5m

(2) Basic Design for Breakwater and Revetment

1) Breakwater Length

The breakwater length is determined to allow safe anchorage in the port to resist hurricane waves and also to take into account the lay-by wharf length on the back of the breakwater.

Standard calmness in the port:

The wave height which allows boats to moor safely at the lay-by wharf

H = 0.4 m

Design wave with a return period of 30 years

(Handbook of Fishing Port Plan; the National Federation of Fishing Ports, Japan)

The port is opened to the southwest direction. The calculation of calmness in the port (Appendix-8) indicates that the breakwater layout as shown in Figure-2.3.5 is necessary. According to the wave deformation calculation (Appendix-7), the wave height and direction at the port-mouth are to be 2.95 m and S 27.7° W respectively. The West Breakwater is to be 290 m long and the East Breakwater 60 m long.

The face line of the West Breakwater (B) and the West Revetment has been adjusted to the face line of the road as designed by the Vieux Fort Integrated Development Project of the Government of St. Lucia.

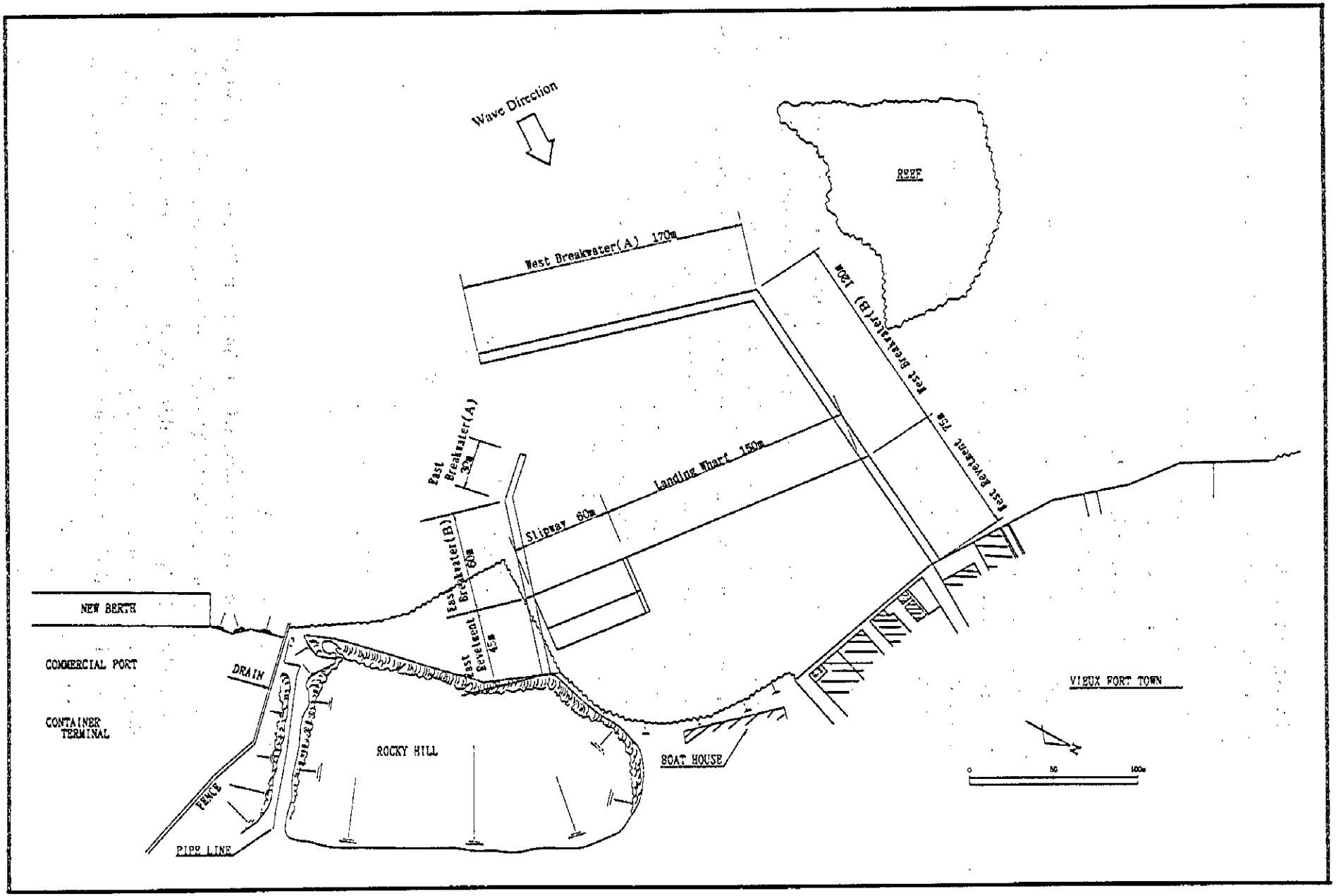


Figure-2.3.5 General layout plan for breakwaters

2) **Lay-by Wharf Length**

The length of the lay-by wharf is to be determined by considering the number (70) of FRP boats based in Vieux Fort.

Necessary length of Lay-by wharf (L) :

L =N×(B+ extra width)

=70×2.0×(1+0.5)= 210 m

N: Number of boats B: Boat width

Instead of constructing a lay-by wharf separately, the longitudinal portions(B) of both the East and the West Breakwaters will be used for constructing the lay-by wharf on them. The length of the lay-by wharf which can actually be used for the mooring of boats is only 180m long, being shorter than the required length (210m) by 30m. To cover this shortage, part of the landing wharf will be used.

3) **Cross Section**

From cost effectiveness, engineering and functional points of view, a rubble mound structure will be adopted for the construction of breakwaters and revetments. Rubble stones will be taken from a quarry located at about 8 km north of the project site. The rubble mound breakwater will be effective to decrease wave reflections from the breakwater trunk, and thus minimize influences on nearby beaches, ensure safe navigation of boats and improve the calmness in the port.

As a rubble stone of more than 1 ton in weight is not available, armor concrete blocks will be used for the front part of the breakwater.

(a) Design Conditions

Offshore Wave : Wave Height, Ho = 6.3 m

Wave Period, T = 10.0 sec

Wave Direction, S~W

Tide : H.W.L. +0.43 m

L.W.L. +0.12 m

C.D.L. +0.00 m

(b) Calculation of Design Wave

The design deep-water wave (Ho= 6.3m, T= 10.0 sec) becomes most critical when the wave direction is SW. The effects of wave deformations in the case of SW is shown in Appendix-8. On this basis, the location where the height of the design wave has to be determined was identified as shown in Appendix 8 (encircled). The design waves calculated for the breakwaters and the revetment are shown in Table-2.3.1.

Table-2.3.1 Design wave height

Section	Design wave height(m)
West Breakwater(A)	3.8
West Breakwater(B)	1.5
East Breakwater(A)	3.5
East Breakwater(B)	2.4
West Revetment	1.2
East Revetment	0.6

(c) Sectional Dimensions

The breakwater and revetment crown heights were determined based on the design wave height and should be able to prevent overtopping. In determining the dimensions, consideration should also given to engineering efficiency for the end-on system.

Crown height = design wave height x 1.0 + H.W.L. + allowance for construction efficiency

However, the crown height of West and East Breakwaters (B) is determined by the following formula since boats berth the breakwaters facing the port.

Crown height = design wave height x 1.25 + H.W.L.

The crown width of rubble stone mounds shall be 6.0 m by considering the work efficiency for transporting and placing rubble stones on the breakwaters and the width of armor concrete blocks.

(d) Required Weight of Armor Stone and Armor Concrete Block

The weight required for armor stones and armor concrete blocks is calculated by applying the Hudson's formula.

$$W = \frac{\gamma \times H^3}{Kd \times \cot \alpha \times (\gamma - w)^3}$$

W : weight of armor stone, and armor concrete block (t)

γ : specific gravity of materials
(stone:2.6 t/m^3,concrete:2.3 t/m^3)

w : specific gravity of sea water(1.03 t/m^3)

α : angle of slope(cot α=4/3)

H : design wave height (m)

Kd : stability constant of armor stone and armor concrete blocks
(stones:Kd=2.1, blocks: Kd=20)

Table-2.3.2 shows dimensions of the breakwaters and revetments.

Table-2.3.2 Dimensions of breakwater and revetment

Section	Crown height(m)	Crown width(m) *1)	Weight of armour concrete block(t)	Weight of armour stone(t)
West breakwater(A)	4.0	4.0	4.0	—
West breakwater(B)	2.3	1.8	—	1.0
East breakwater(A)	3.6	3.1	2.0	—
East breakwater(B)	3.6	3.1	2.0	—
West revetment	2.3	1.8	—	1.0
East revetment	2.3	1.8	—	1.0

Note *1) Crown width for armor stones or armor concrete blocks

(e) Cross section of breakwaters

Figures-2.3.6 and 2.3.7 shows the standard sections of East and West Breakwaters (A).

(f) Cross section of the lay-by wharf

As the port sides of the East and West Breakwaters (B) are used as the lay-by wharf, concrete blocks will be used on the port side of the breakwaters. The section is shown in Figures-2.3.8 and 2.3.9.

(g) Cross sections of the revetments

The reclamation height of the east and west revetments adjacent to the breakwaters shall be +2.3 m by considering the crown height of the breakwaters and of the existing seawalls (+1.7m). Figure-2.3.10 shows the standard section views.

(h) Auxiliary facilities

Solar type navigation lights will be installed at the tips of the west and east breakwaters to ensure the safety of boats arriving at and departing from the port at night. Their specifications are given below.

Visible distances : 3 miles
Flashing intervals : 4 seconds
Type of light : light emitting diode
Color of light : green and red

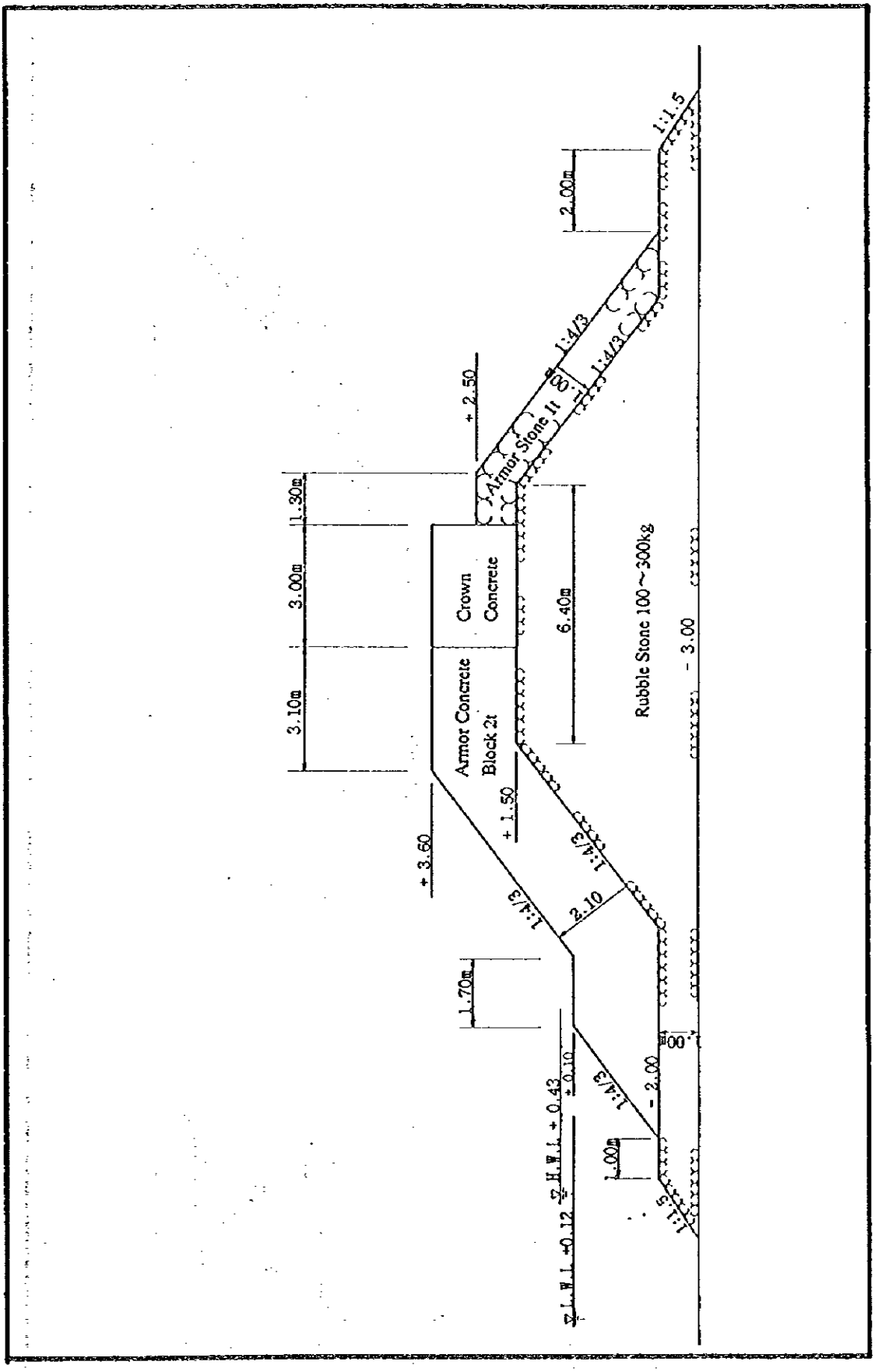


Figure-2.3.6 Cross section of East Breakwater (A)

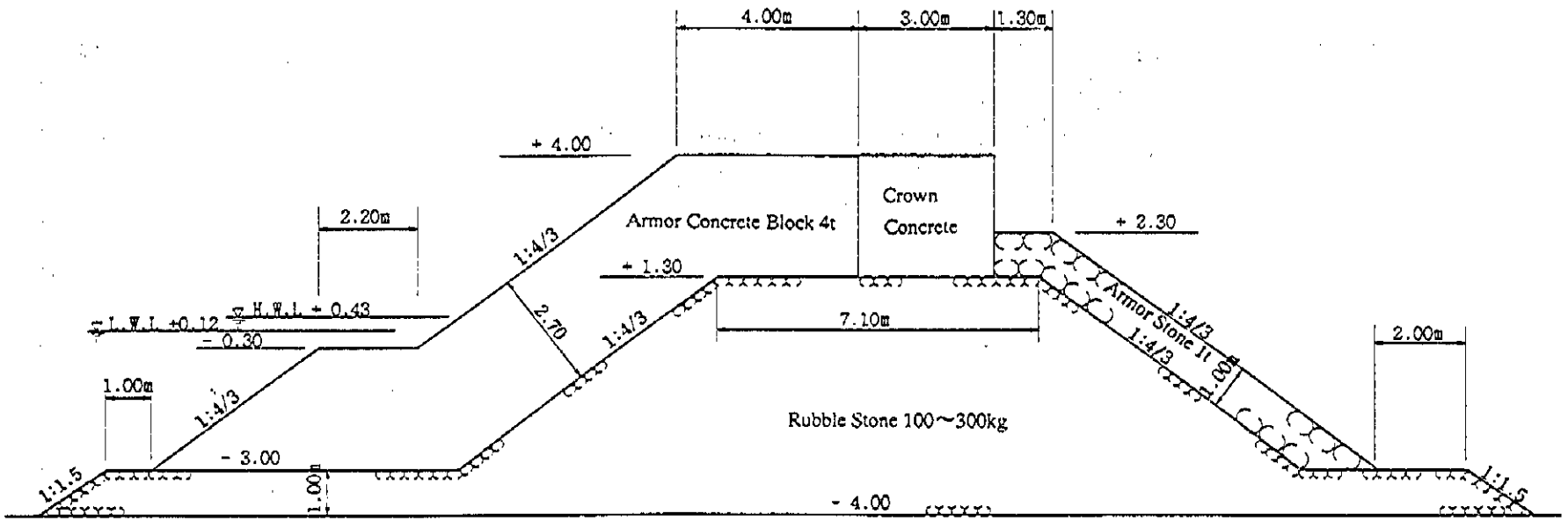


Figure-2.3.7 Cross section of West Breakwater (A)

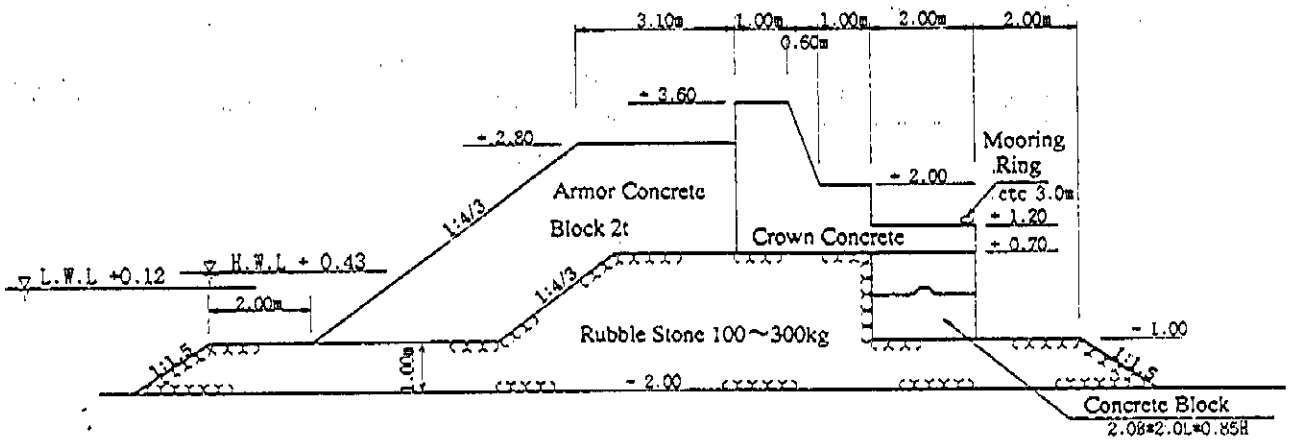


Figure-2.3.8 Cross section of East Breakwater (B)

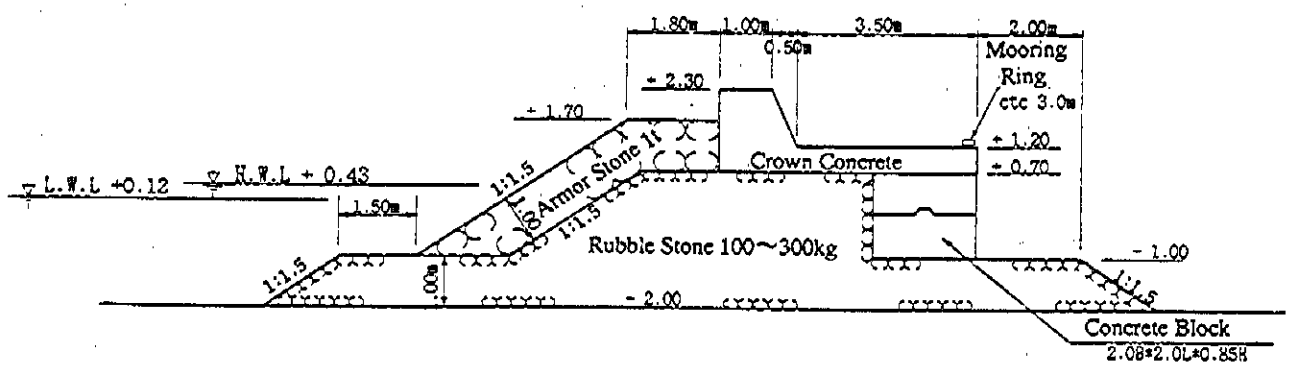


Figure-2.3.9 Cross section of West Breakwater (B)

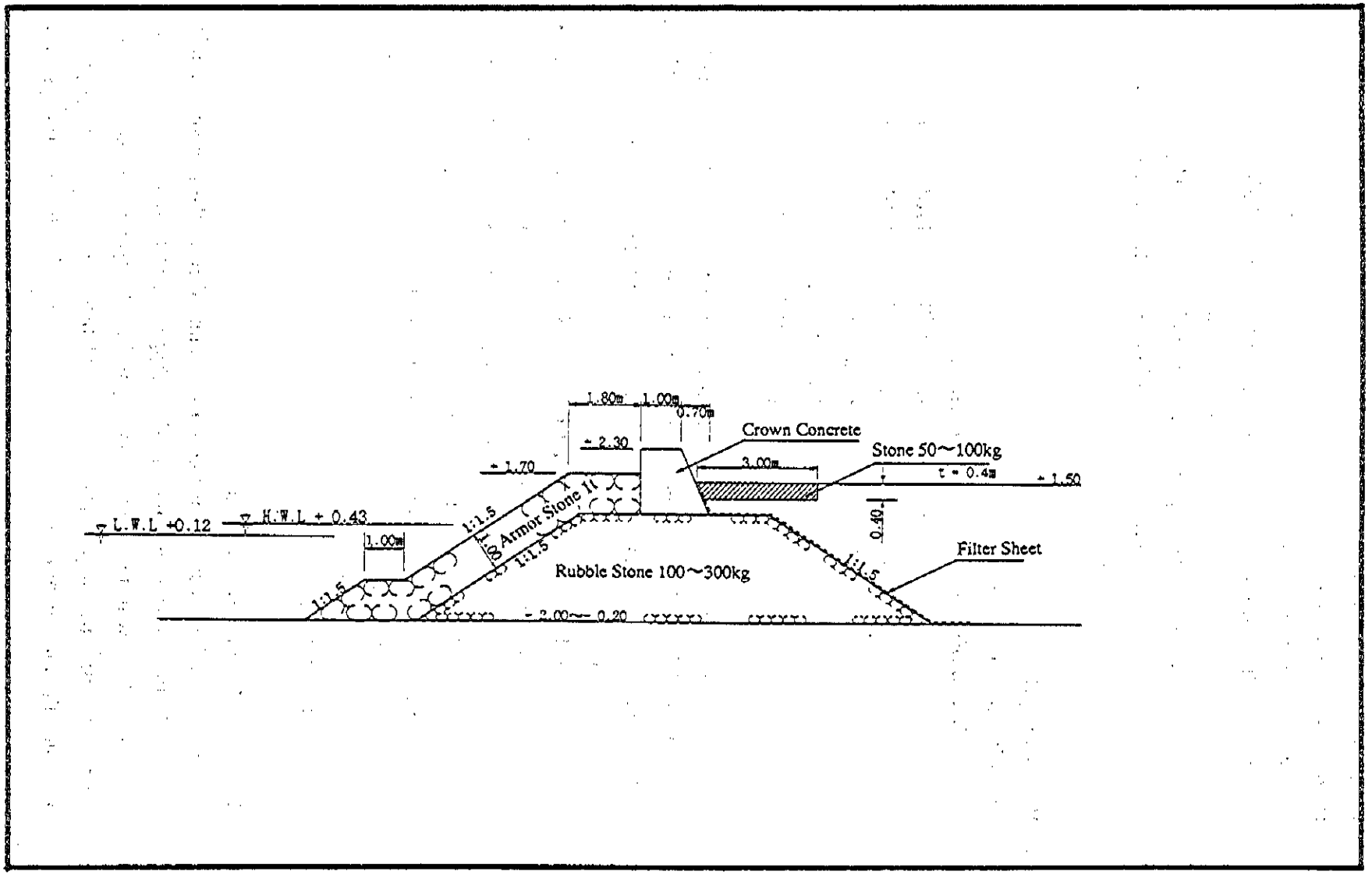


Figure-2.3.10 Cross section of East and West Revetments

(3) Basic Design of Landing Wharf

1) Dimensions and Structure

The dimensions and the structure of the landing wharf shall satisfy the following.

Structural dimensions: The dimensions will secure the stability of structure under the conditions of the design.

Type of Structure : The type of structure will be determined by considering local construction conditions, cost effectiveness and engineering efficiency.

2) Wharf Length

(a) Conditions for calculation

a) Number of fishing boats to use the wharf

Vieux Fort	118 boats	(canoe: 48、	FRP : 70)
Laborie	48	(canoe: 27、	FRP : 21)
Shoiseul	64	(canoe: 57、	FRP : 7)
Soufriere	109	(canoe: 48、	FRP : 61)
Total	339	(canoe:180、	FRP : 159)

The interview survey for fishermen revealed that not only the fishing boats of Vieux Fort but also those of Laborie, Choiseul and Soufriere on the Caribbean Sea will use the port for landing the catch. The number of fishing boats of the above four fishing villages are 339.

It can well be conceived that all these boats, except for those based in Vieux Fort, will not land their entire fish catches on Vieux Fort since part of their catches are to be offered to local consumption of their communities. It has been estimated that about 50% of boats from Laborie, Choiseul and Soufriere will land their fish at Vieux Fort, thus the number of design boats has been set at 229.

Canoe : 114 boats
FRP : 115 boats
Total 229 boats

b) Fishing boat operational rates

The operational days of fishing boats estimated from the fuel supply in Vieux Fort in 1996 and 1997 are presented in Appendix-8. During the high season of January to June with the peak of fishing in March, operational days exceeded on average by 50% per month. The daily rate of fishing trips in March (Appendix-8) indicates the maximum of 77%. The average ratios for the top 10 days in March

were 70% for 1996 and 71.2% for 1997. The length of the wharf has been determined on the assumption that the operational ratio of boats is 70% which is the average of 10 days in March.

c) Turnover of the wharf

The time required for unloading catch ; 20 minutes per boat (berthing: 5 minutes, unloading: 10 minutes, leading the wharf: 5 minutes) and the rotation of unloading is three times per hour

Landing hours are estimated to be three hours from 2 o'clock to 5 o'clock based on the interview survey and the local landing records. The Project assumes that boats will enter the port with adequate intervals during the three hours and there will not be any congestion during landing hours.

(b) Number(N) and Length(L) of Berth Required

Length of canoe : 6.5 m
Length of FRP boats : 7.2 m
Ratio of the number of canoe and FRP = 1 : 1
N=229 boats x 0.70/ (3 times x 3 hours) = 18 berth
L = 9 berth x 7.2 m x 1.15 + 9 berth x 6.5 m x 1.15 = 143 m

From the above, the wharf length L is set at 150 meters including the junction at both ends of the wharf.

3) Dimensions of the Wharf

a) Crown height

The crown height of the landing wharf and lay-by wharf is determined using mean dimensions of fishing boats. As shown in Table 2.3.3, the wharf crown height is determined by measuring the gross tonnage (GT) of the design boats and tidal differences.

Table-2.3.3 Crown height of landing wharf (above H.W.L.)

Tidal range	Size of fishing boat (GT)			
(H.W.L.−L.W.L.)	0~20	20~150	150~500	500 以上
0~1.0 m	0.7 m	1.0 m	1.3 m	1.5 m
1.0~1.5 m	0.7 m	1.0 m	1.2 m	1.4 m
1.5~2.0 m	0.6 m	0.9 m	1.1 m	1.3 m

The gross tonnage of an average design boat is 3GT and the tidal differences about 0.3 meter.

Crown height of landing wharf = H.W.L. + 0.70 m = 0.43 m + 0.70 m
= +1.20 m

b) Water depth

The design water depth for wharf is obtained by adding an allowance to the maximum draft of an FRP boat.

Landing wharf : -2.0 m

4) Apron width

The fish handling shed will be located behind the landing wharf and all the fish landed are to be carried into the shed by pallets and carts. A sufficient space (6.0m) needs to be procured for pallets and carts and for their maneuver in the apron of the landing wharf.

Apron width at landing wharf : 6.0 m

5) Auxiliary Facilities

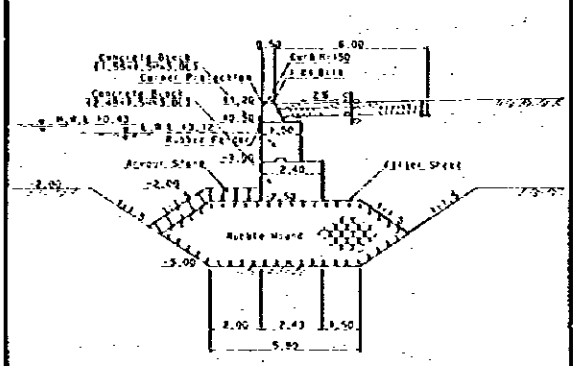
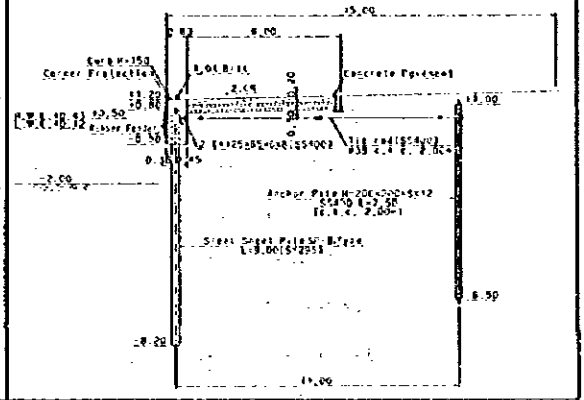
Fenders will be erected in front of the wharf and concrete curbs at the edge of the apron, and mooring posts on the crown surface.

6) Design Cross Section

Considering that the landing wharf is the main facility of the Project, a comparative section design has been prepared for determining the type of the structure. The layer ranging from 4 to 7m below the seabed consists of soft silty sand whose N value was less than 5, whereas the lower part consisted of the solid sand layer whose N value was more than 20. The design section for the project site was either the gravity type using concrete blocks piled on the rubble stones in place of the soft layer, or the sheet pile structure wherein piles and sheet piles were driven into the seabed. Comparison was made of the gravity type, the sheet pile type in respect of the efficiency in engineering, construction and cost effectiveness. Table-2.3.4 shows the result. It has been decided that the sheet pile type wisll be adopted.

Type 1 : Concrete Block Type
Type 2 : Steel Sheet Pile Type

Table-2.3.4 Comparison of structure type for landing wharf

Structure Type	Concrete Block Type	Steel Sheet Pile Type
Standard Section Water depth -2.0m		
Advantage	*Simple and easy work items composed. *Small amount of in-situ concrete casting. *Easy procurement of construction material obtained domestically.	*Simple and easy work items composed. *Small amount of in-situ concrete casting. *Small amount of excavation for wharf construction. *On-land construction available. *Easy procurement of construction machinery.
Disadvantage	*Differential settlement of quay body expected due to consolidation of soft soil sub-layer. *More volume of excavation required for installation of concrete quay block, because of artificially excavated fishing port in land. *Construction machinery of larger capability required for concrete block handling. *Quality control of concrete block required under severe weather condition. *Larger construction yard necessary for concrete block construction. Under water work necessary for excavation and installation of sand replacement and concrete blocks.	*Steel sheet pile and other relevant steel products expected to be imported, because of some difficulty in availability of special steel products in local. *Corrosion of steel products taking into consideration.
Construction Period	*Longer construction period due to excavation for quay construction, replacement of sand foundation, casting/curing concrete blocks and procurement of materials	*Shorter construction period due to simple work items, no underwater works and less excavation amount for quay construction
Cost ratio of construction	1.2	1.0
Evaluation		Selected

(a) Design Condition

Wharf design conditions are as below.

Crown Height of wharf	: +1.2 m
Design Water Depth	: - 2.0 m
Tide	: H.W.L. + 0.43 m
	L.W.L. + 0.12 m
Wave, Current	: No effect
Surcharge of Landing wharf	: 1.0 t/m^2 (normal): 0.50 t/m^2 (earthquakes)
Design boat	: 3GT Type, Length 7.5 m, Draft 1.5 m
Berthing velocity	: Not considered
Tractive force	: Not considered
Design seismic force	: Kh = 0.1 (air) , Kh' =0.2 (water)
Subsoil condition	: Sand layer
Material	
Rubble backing and filling stone	: Internal friction $\phi = 30^{\circ}$
	:Wall friction angle $\phi = 15^{\circ}$
Foundation rubble	: Internal friction $\phi = 40^{\circ}$
Specific weight	
Reinforced concrete	: 2.45 t/m^3(air), 1.42 t/m^3(water)
Plane concrete	: 2.30 t/m^3(air), 1.27 t/m^3(water)
Rubble backing,filling stone	: 1.80 t/m^3(air), 1.00 t/m^3(water)
Sea water	: 1.03 t/m^3(air)

(b) Type of Structure

The structure of the landing wharf was determined as follows on the basis of the analysis of the sections of two types of structure.

Landing wharf (-2.0m) : Sheet pile type

Figure-2.3.11 shows the standard section view of the wharf.

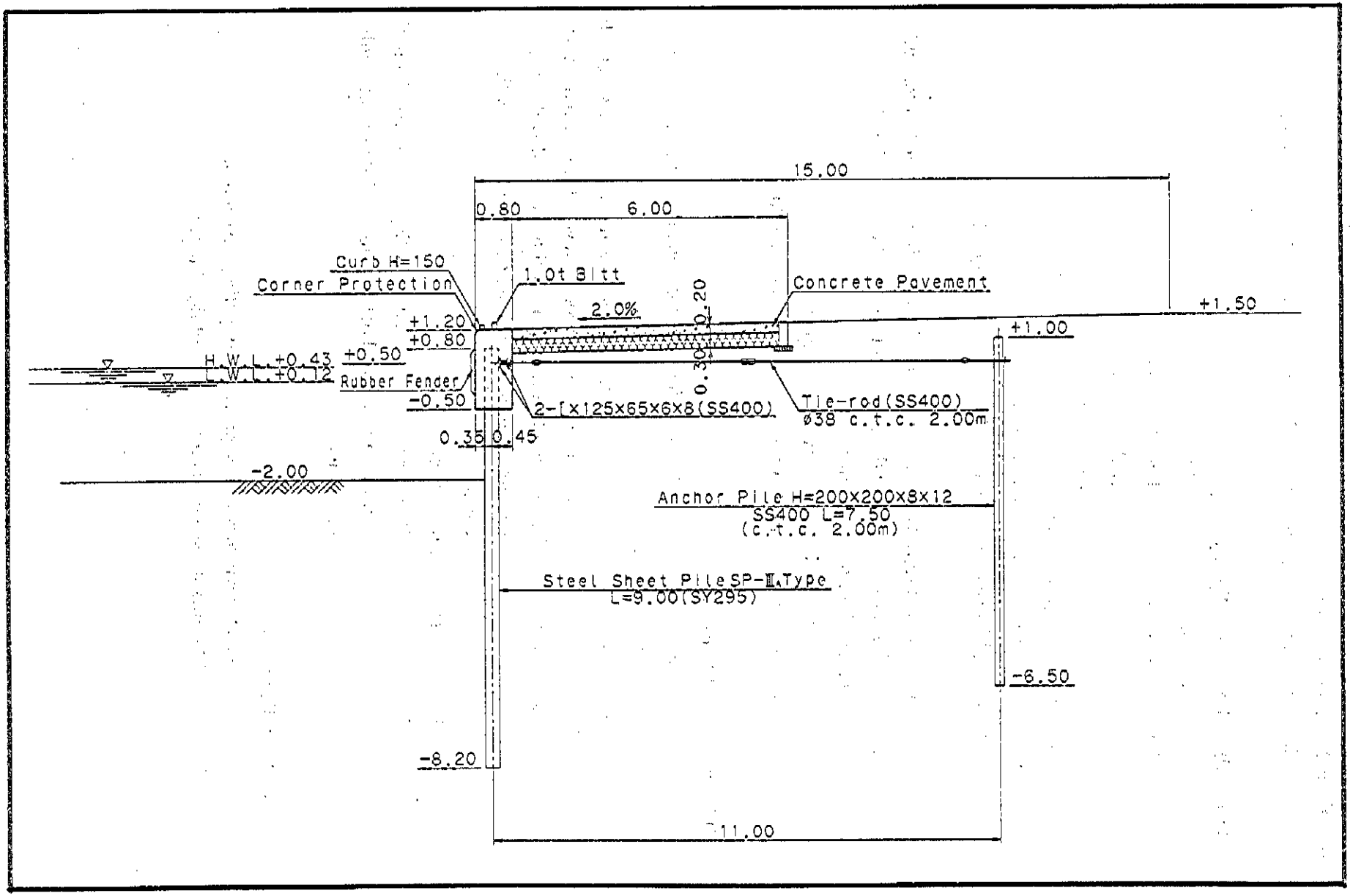


Figure-2.3.11 Standard section of Wharf

(4) Basic Design of Slipway

The design boat for the slipway shall be canoes registered at Vieux Fort.

1) Width and Area for Slipway

Number of canoe : 48

Dimension of canoe : Length = 6.5 m

Width = 1.8 m

Draft = 0.5 m

Interval between boats = 0.5 m

Canoes will stay in two longitudinal rows.

Width = (48 boats ÷ 2) x 1.8 m + (48 ÷ 2 + 1) x 0.5 m = 56 m

The width of the slipway shall be 56 m. For hull repair, a path of 4 m for pulling up canoes will be provided so that the entire width of the slipway will be 60 m.

Area required for the boat yard:

Depth: 6.5m x 2 boats + allowance = 15.0 m.

Boat yard area = (6.5 m x 2 canoes + 2.0 m) x 60 m = 900 m^2

2) Dimensions of Slipway

Toe depth	: Draft 0.5 m + allowance for water depth 0.5 m = - 1.0 m
Slipway gradient	: 1:8
Tip finish	: The tip of slipway will be covered with steel sheet piles instead of concrete blocks to prevent the tip from sinking.
Slope finish	: The portion below H.W.L. will be covered with pre-cast concrete and that above the surface of water with in-situ concrete.
Boat yard area	: In-situ concrete
Others	: Bars made of composite plastic will be fixed on the slipway at an interval of 0.8 m to facilitate smooth pulling up of canoes .

3) Auxiliary Facilities

Two hand-operated winches will be provided for pulling up canoes.

Figure-2.3.12 shows the standard cross section of the slipway.

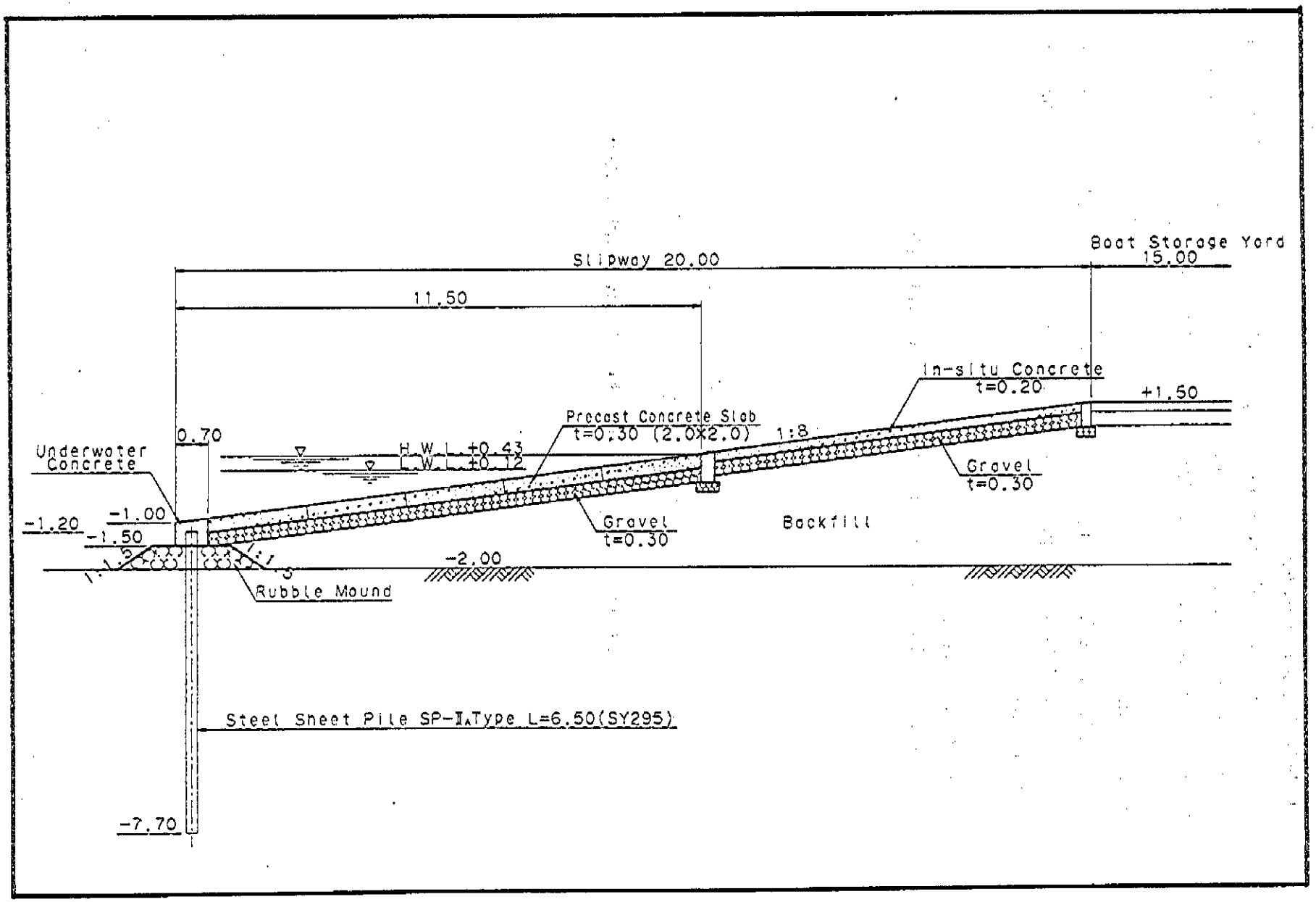


Figure-2.3.12 Standard section of slipway

(5) Basic Design of In-port Road

In-port roads will be designed to facilitate smooth flows of goods and people within the complex premise. As the fishing port will be constructed in front of the center of Vieux Fort City, the road must be conveniently connected with the network of city transportation.

1) Lane Width

The lane for vehicles will have the width of 8.0 m which will be connecting to the city roads of 8.0 m wide. In-port roads will be 3.0 m wide for one way and 6.0 m wide for two ways.

2) Design Cross Section

Figure-2.3.13 shows the structure of roads paved with asphalt.

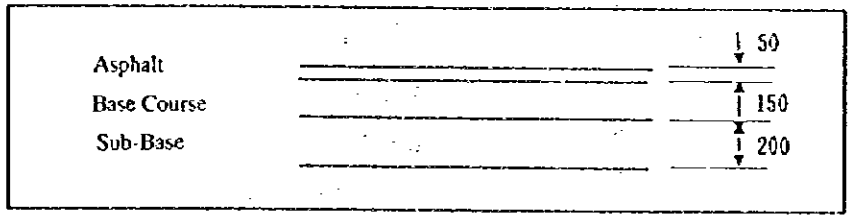


Figure-2.3.13 Structure of roads paved with asphalt.

2-3-4 Basic Design of Functional Facilities

(1) Cold Storage Facilities

1) Capacity

(a) Estimates for fish catch

In St. Lucia, the fishing season is distinctly divided into two; the high season (January to June) and the low season (July to December). Table-2.3.5 shows the annual catch in 1995 and 1996 (DOF statistics). However, actual landings are estimated to be much higher than those of DOF statistics. Attempt was made to estimate actual landings of the country on the basis of interviews for fishermen and fish vendors at major fishing bases. Also the records of fuel supply to fishing boats were examined to estimate the operational days of fishermen throughout the year to reinforce the results of the interview analysis. Table-2.3.6 shows the estimated landings according to the landing sites.

Table-2.3.5 Fish landings by sites (statistics)

(unit: t)

Fishing Site	1995	1996
Anse-laraye	19.51	19.17
Canaries	80.79	93.02
Castries	59.82	100.08
Choiseul	120.01	159.21
Dennery	227.89	313.17
Grosislet	42.14	109.12
Laborie	42.22	37.54
Micoud	59.76	61.02
Soufriere	132.65	52.42
Vieux Fort	154.00	357.62
Other		13.08
Total	983	1,315.45

Source: DOF

Table-2.3.6 Actual landings estimated by sites

Sites	Annual landings by Statistics Report (t)	No of boats (boats)	Operational rate assuming per VF is 100 (%)	Landings (Jan-Jun) (t)	Landings (July-Dec) (t)	Total (t)
Anse-laraye	19.17	43	14.7	32	10	42
Canaries	93.02	29	105.8	155	48	203
Castries	100.08	137	24.1	167	51	218
Choiseul	159.21	64	82.1	266	82	348
Dennery	313.17	58	178.2	523	160	684
Grosislet	109.12	81	44.5	182	56	238
Laborie	37.51	48	25.8	63	19	82
Micoud	61.02	27	74.6	102	31	133
Soufriere	52.42	109	15.9	88	27	114
Vieux Fort	357.62	118	100	597	183	780
Other	13.08	0	0.0	0	0	0
Total	1,315.45	714		2,176	667	2,842

(b) Import of Marine Products

As St. Lucia depends heavily on tourism, so-called gourmet marine products (smoked salmon, prawns, cods, scallops, etc) are imported for tourists by FMC. The imports averaged 125 tons per year during 1992 to 1996 as shown in Table-2.3.7.

Table-2.3.7 Imported marine products by FMC

(unit: t)

Year	Imported volume
1992	134
1993	98
1994	139
1995	101
1996	153
Total	625

Source: FMC

(c) Selection of Capacity of Cold Storage Facilities

On the basis of fish production as estimated by the Study team and the volume of fish purchased by FMC, the required capacity of cold storage facilities has been determined. Since FMC handles both domestic catches and the imported fish, the imports of frozen fish were also taken into account. The existing capacity of the cold stores in Castries provided by grant aid programmes by Canada and Japan is also taken into account. Since it is likely that there will be two flows of fish catches, one to Castries and another to Vieux Fort (the new facilities), the capacity must be determined by considering the role of each facility. The problem in St. Lucia is the lack of cold stores during the high season, resulting in surplus fish which can not be accommodated by cold stores. The question is how much more fish can be caught during the high season without spoiling them.

In setting the capacity, the landings and imports during the high season (January-June) and the sales by FMC and the capacity of the existing facilities were taken into consideration.

a) Volumes Handled by FMC

FMC aims at realizing a stable purchase of fish from fishermen and a stable supply of fish to consumers. The current level of quantities (25%) handled by FMC is expected to increase to 40% when the new facilities are completed. The volume to be handled by FMC in future during the high season is estimated as follows.

Fish catch for first half	2,175 t x 0.4	=	870 t
Imported fish for first half	120 t ÷ 2	=	60 t
Total		=	930 t

b) Sales by FMC

(i) Sale of Domestic Catches

The sale of fish by national vessels amounted to 408 tons in 1996 and 330 tons in the first half (January - August) of 1997, the average monthly sale being 40 tons. As the volume handled by FMC is expected to increase by 1.6 times or from 25% to 40%, a total of 64 tons (40 tons x 1.6 = 64 tons) will be purchased by FMC. The monthly purchase has been estimated to be 60 tons.

(ii) Sale of Imported Fish

Annual imports : 120 t

Monthly sales : 120 t ÷ 12 = 10 t

Total sales of fish : 60 t (domestic) + 10t (import) =70 t/month

Sales in the first half of the year : 70 t x 6 months = 420 t

(iii) Capacity of Existing Cold Storage Facilities

The capacities of the existing facilities of FMC are shown in Table-2.3.8.

The capacity of these facilities totals 198 tons with the concentration to Castries. The container type system developed locally is already obsolete and will not be installed by the present project. The facilities in areas other than Castries are limited in capacity and could function only as temporary storage for local consumption. Thus, the capacity of the new facilities will be as follows.

Table-2.3.8 Storage capacity of existing cold storage facilities

Place	Capacity (t)	Quick freezer (t)
Castries	70	2.7
Castries	18	
Castries	10	
Castries	100	2.7
Laborie	(9)	
Dennery	(9)	
Anse-Laraye	(9)	
Total	198	5.4

(iv) Capacity of Cold Storage Facility

*Volume landed and handled (January-June) : 870 t

*Volume imported and handled (January-June) : 60 t

*Volume sold by FMC (January-June) : 870 t + 60 t = 930 t

*Sales by FMC (January-June) : 60 t/month (domestic landing),
10 t/month (import)
: (60 + 10) x 6 = 420 t

*Stocks (January-June) : 930t - 420t = 510 t

*Capacity required = stock - capacity of existing facilities
= 510 t - 180 t = 330 t

330 tons of cold storage capacity will be required. Fork lifts will be used together with pallets. Ample space will be required for the use of fork lifts and pallets, which will be 250 tons. As for the balance of 80 tons (i.e. 330-250), if the space of cold stores is used effectively, the proposed capacity of 250 tons will be able to accommodate the extra quantity of 80 tons of fish.

2) Methods of Storage

Methods of storing fish are classified into by hand (bulk), by racks and by pallets. In the existing facility in Castries, fish are stored by hand in an inefficient manner, requiring work in a cold place for an extended period of time. Fish placed in the bottom remains un-rotaited and dried up, and are deformed and damaged by the weight of fish placed on top, and the quality inevitably deteriorates. This system is suitable only for small quantities of inexpensive fish.

The rack system keeps fish on the racks built inside the facility. As they are handled by hand, it is time consuming but damage to the fish is relatively small and the cold air circulation is good. It is used for storing small amounts of comparatively expensive fish.

The pallet system keeps fish in various sized pallets. As pallets are used in bringing in and taking out fish, work can be prompt and decrease burdens on workers. However, it requires cargo handling machines such as electric fork lift for handling, requiring an extra space for operating the machines. While it is not suitable for small scale cold storage facilities, it is most efficient for large scale ones. Since the facility planned by the Project has a relatively large capacity of 250 tons and handles large volumes of long and weighty fishes such as dolphins, king fish and tunas, the pallet system is considered most suitable.

The pallets used in the Project will have the following configurations, which are used commonly in Japan.

Pallet for storage : 2,250 mm(L) x 1,250 mm(W) x 1,260 mm(H)

For large bodied fishes such as dolphins, king fish and tunas.

Capacity : approx. 1 ton

3) Area and Height for Cold Storage Facilities

(a) Storage space

Capacity : 250 t

Number of pallets : 250 pallets

Number of tiers for pallets : 3 tiers

Number of pallets/tier : 250 ÷ 3 = 84 pallets

Allowance between pallets : 10 cm in front and back,
20 cm to left and right

Floor area : 84 x [(1,250+10)x(2,250+20)] = 240 m^2

In addition to the effective floor area, the areas required for operation of fork lifts and installation of unit coolers are needed, making the total area to 315 m^2.

Height of ceiling : 1.2 m (height of pallet) x 3 tiers = 3.6 m
3.6 m + allowance for 1 tier (about 1.4 m) = 5 m

(b) Ante-room

The ante-room is used as a buffer to prevent room temperature from rising due to the incoming-air at the time of transferring fish in and out of the chamber. In principle, the area which allows operation of fork lift is enough, but the Project will use part of the space for the purpose of storing ice and therefore the floor space of 45 m^2 will be required.

The total floor area of the cold storage facilities will be as follows.

Cold storage space (315 m^2) + ante-room (45 m^2) = 390 m^2 (15 m x 26 m)

4) Heat Insulation

(a) Wall and ceiling

Assembly type heat insulation panels will be used for the walls and ceilings from the viewpoint of uniform heat insuration, cost-effectiveness and work hours.

Specifications for the panel: with ribs

a) Wall, Ceiling, and Partition

Type of Panel	: Prefabricated insulation panel
Ceiling Panel	: Flat surface type
(outside) surface material	: 0.4mm thickness color-coated galvanized iron sheet
b) Wall Panel	: Keystone Corrugate Type
(Inside) surface material	: 0.45mm thickness color-coated galvanized iron sheet
c) Partition Panel	: Keystone Corrugate type
(both sides) surface material	: 0.45mm thickness color coated galvanized iron sheet
d) Core	: injected rigid polyurethane form,
Heat conductivity	: 0.018 kcal / mhc.

(b) Floor Insulation

Structure Insulation	: steel reinforced concrete
Material	: Styrofoam board
Heat conductivity	: 0.032 kcal / mhc

Insert Styrofoam between upper and lower water proof asphalt sheets, then apply with the wearing fl. concrete. Also the underground basement should be mounted with the PVC pipe for ventilation.

(c) Doors

Insulation Door	: Electrically powered sliding door
Surface Material	: stainless steel sheet 0.5mm thickness
Core	: injected rigid polyurethane foam complete with the Air curtain (Auto-start, stop control)

5) Specification of Cold Storage

Storing Volume	: 250 ton for frozen fish
Room Temperature	:-25℃
Heat insulation	: Ceiling, Wall and partition panel
Injected rigid polyurethane form	
Thickness	: Approx. 100mm
Floor	: Styrofoam board 150mm Thickness

Refrigeration

Compressor Unit

Type	: Tow stage Reciprocating and Multi-cylinder open type
Capacity	: Approx. 38,000kcal/hr At condensing temperature +40℃ Evaporative temperature -35℃
Motor	: 410V, 50Hz, 37kw

(2) Quick Freezer

When fish are transferred directly to the cold storage, the freshness of fish cannot be preserved because of a slow process of freezing. Also if the fish with the normal temperature are placed in the cold rooms, the inside temperature will rise. Therefore, a quick freezer is needed to preserve the freshness of fish and control the temperature of the cold room. Fish will be frozen by quick freezing machines prior to the transfer the cold storage rooms.

1) Capacity

The capacity has been determined examining the amount of fish to be handled daily by FMC out of the daily catch landed at Vieux Fort during the high season.

Volume handled daily by FMC

1,117 t (landings: Jan-June) x 0.4 (FMC purchase) ÷6 months ÷ 25 days = 3 t

The above volumes (1,117 tons) have been obtained by adding the Vieux Fort landings to the amount anticipated to be brought from Dennery and Micoud (it was assumed that 50% of catches landed at each site) (refer to Table -2.3.5). There might be some days when the entire catch from these ports will be brought to Vieux Fort if the storage capacities in Castries are full. The freezing capacity at Vieux Fort is thus set at 4 tons/day allowing 1 ton as reserve.

As fishing boats return to the port at different hours of the day, freezing operations must be carried out at two chambers to preserve the fish quality and to imporve cost-effectiveness. Therefore, the freezing apparatus will be installed in two chambers and freezing is performed on a first-come-first-served basis.

Freezing capacity/chamber : 4 t÷2 chambers = 2 t/chamber

A freezing equipment with the capacity of 2 tons/day will be installed in two chambers respectively.

2) Freezing System/Method

a) Freezing system

There are a number of freezing systems, i.e. contact system, blast system and brine immersion system. The demerits of contact and brine immersion systems are that the machinery used by these systems are complex; salt must be used; manual operation is required; and maintenance and repair are difficult. It has been decided that the blast system will be used for the Project.

b) Freezing method

Freezing racks on which fish will be placed will be manually operated.

The dimensions of the rack are as follows.

1.2 m x 0.9 m x 1.9 m = 2.052 m^3

The major species to be frozen include dolphin, tuna and king fish.

(The rack is of the same size to that used in Castries)

3) Space needed

For freezing racks : 12 racks/chamber

The floor area of the freezing chamber will be 13 m^2 (i.e. 1.2m x 0.9m x 12 sets = 13 m^2). When the space for coolers, circulation chamber and space between racks are added, the total area will become 49 m^2 (7.0 m x 7.0 m = 49 m^2 /chamber).

4) Heat insulation material

The structure of walls, ceilings and floors are the same with that of the cold storage room. Heat proof doors to which a defrosting heater to prevent freezing is installed will be operated manually.

5) Specifications for Blast Freezing Equipment

Production Capacity	: 2,000 kg/room (2 rooms)
Freezing period	: approx. 20 hours
Freezing temperature	: -18℃
Final room temperature	: -25℃
Heat insulation	: Ceiling, Wall, and partition panel injected rigid polyurethane form type approx. 125mm thickness.
Floor	: Styrofoam board 200mm thickness

Refrigeration

Compressor Unit	
Type	: Tow stage reciprocating and Multi-cylinder open type
Capacity	: approx. 21,000 kcal/hr
Condensing temperature	: +40 C
Evaporative temperature	: -45℃
Motor	: 415V, 50Hz, 30kw
Quantity	: 2 sets

(3) Ice Making/Storage Facility

1) Ice making machine

Ice is indispensable for preserving the freshness of fish. Because of the limited supply of ice, there are many fishing boats which do not carry ice and their catch are usually not fresh enough.

In Castries, Laborie, Dennery and Anse-Laraye there are ice making plants provided by Canadian and Japanese grant aid assistance programmes, but their ice making capacity is limited to cover the local demand. An ice making plant and cold storage facilities will be provided by the Project to supply ice to fishing boats and fish vendors at all times.

(a) Ice Making Capacity

Ice supply will be supplied to fishing boats and fish vendors. The ice requirements have been estimated on the basis of the amount of fish to be handled by fishermen, vendors and retailers.

a) Supply to fishing boats

Ice will be provided to fishing boats based in Vieux Fort.

(i) During the high season

About 38 kg of ice, equivalent to 1/2 of the average catch per ship per day .

(ii) Number of fishing boats based in Vieux Fort: 118

Supply to boats/day = 118 x 38 kg/boat = 4,500 kg

b) Supply to local vendors

There are five fish vendors and several retailers in Vieux Fort. It is assumed that they handle about 60% of the catch landed there, their requirement is calculated as follows.

(i) Purchase by local vendors during the high season

1,117 t (fish landings at Vieux Fort from January to June) x 0.6 (ratio of vendors' purchase) = 670 t

(ii) Daily purchase by vendors

670 t (from January to June) ÷ 6 month ÷ 30 days = 3,700 kg

c) Daily capacity required for ice machine

4,500 kg + 3,700 kg = 8,000 kg = 8 t

The daily capacity of the machine provided by the Project will be 8 tons which will be produced by two sets of machine (each has a 4 tons capacity). Since the catch will drastically decrease during the low season, ice consumption will inevitably decrease. In order to save the cost only one machine will be operated during the low season.

(b) Characteristics of Ice

Ice is roughly classified into block ice, flake ice and plate ice depending on the shape of ice. Plate ice will be produced by the Project as the scale of machine is small and thus maintenance and control are easy.

2) Ice Storage Room

The purpose of the ice storage room is to make it possible to constantly supply ice.

The ice making machine has a daily capacity of 8 tons and the capacity of the ice storage room could be twice as large as the ice making capacity, being 16 tons. The storage room will be made of pre-fabricated material with effective heat insulation. It should maintain the inside temperature at -5°c by installing a compact freezer.

(4) Water Supply

1) Requirement for Water

(a) Ice making plant

The ice making plant is expected to consume large quantities of water, 1.5 times greater than the standard quantity required for ice making in Japan. Quantities of water to be supplied to the ice making plant will therefore be 1.5 times higher than the ice making capacity.

Ice plant : 8 t x 1.5 = 12 t

(b) Administration Office, Etc.

The DOF and FMC will use the Administration Office for management and operation of the fishery complex. The cold storage facilities will be operated by FMC employees and the work shop by the Goodwill Fishermen's Cooperative.

The requirement of clean water is estimated to be 1 lit/person/day. Table-2.3.9 shows the water required for the Administration Office and other facilities in the Complex.

Table-2.3.9 Water requirements to the administration building

Users	Number of persons	Water per person	Quantity of water
DOF	7	100 ltr/人	700 ltr
FMC	16	100 ltr/人	1,600 ltr
Participants of lectures	40 (half day)	50 ltr/人	2,000 ltr
Coop	5	100 ltr/人	500 ltr
Total	68		4,800 ltr

Approximately 4.8 tons of water will be consumed.

(c) Fishing Boats

Table-2.3.10 shows the water required for fishing boats and canoes.

Table-2.3.10 Water supply to fishing boat

User	Num. of days/voyage	Crew	Water supply/boat	Num. of in coming boats	Total
FRP	1 day	3	30 ltr	70	2,100ltr
canoe	1 day	3	30 ltr	48	1,440ltr
Total					3,540ltr

As shown in the table, the water required is about 3.5 tons for day.

(d) Fish Handling Shed and Processing Plant

The water required for cleaning fish at the fish handling shed and the processing plant is estimated to be 8 tons since water equal to the quantity of fish caught a day.

(e) Cold Storage, etc.

Water required for defrosting cold storage rooms, quick freezers, etc. is estimated to be 10 ton/day. As water evaporation is estimated to be 10 ton/day, 20 ton/day of water is needed for the operation of these facilities.

(f) Shower Room for Fishermen

As about 40 people are expected to use the shower requiring 20 liter of water per person of water per day, 0.8 tons of water is considered necessary a day.

40 persons x 0.02 t = 0.8 t

2) Water Tank

(a) Tank Capacity

Daily water requirements are as follows.

Ice making plant	:	2 .0t
Administration office	:	4.8 t
Fishing boats	:	3.5 t
Cold storage	:	20.0 t
Fish handling shed	:	8.0 t
Shower room	:	0.8 t

Required water supply=49.1 t≒50 t

City water will be supplied to the Project site by means of small pipeline branches (diameter; 75 mm) stemmed from the main pipeline (diameter; 100 mm) buried along the road, with a length of about 50 m from the site. For efficient ice

making and water drainage, water supply must be carried out smoothly. Ordinary pipelines used for city water supply are not suitable. Since water supply may be discontinued if power failure occurs, a water tank with the capacity of 50 tons will be built in the Complex.

(b) Specifications of Water Tank

Specifications of the water tank are as follows.

Capacity	: 50 t
Number	: one
Type	: FRP type
Dimension	: 5.0m (L) x 5.0m (W) x 2.0m (H)
Attached equipment	: Ladder (inside, outside)

(c)Water Supply from Tanks

Water will be supplied by pumping from the water tank installed in the project site.

(5) Water Discharge Systems

Since there is no sewage system near the project site, the waste water must be treated within the site. Discharge of contaminated water is to be planned in view of environmental protection in the port. Rainwater and waste water from the administration building will be discharged to outside the port through U-shaped ditches and underground drain pipes.

The waste water drained from the fish handling shed containing fish guts and garbage will first pass a garbage screening pit before it is discharged to the sea via a settling tank.

(6) Electrical Installations

1) Main feeder wiring

The main feeder wiring is located underground between the distribution board at the substation and each distribution board of the complex facilities. The electricity to be supplied will be of 3-phase, 4 wires, 415V/240V, and 50 Hz. The incoming cables to conform to power consumption required for the port facilities are connected to the breaker in the substation at the site. The installation of the incoming cabling and its connection to the breaker will be the responsibility of the Government of St. Lucia. Emergency generators (capacity 250 KVA) will be installed to continue power supply to the cold storage, quick freezers and ice plant.

2) Lighting fixture

In order to ensure the safe and smooth arrival/departure of vessels and preparation for fishing trips and also for the security purpose, eight electric poles (luminocity = 400 W/lamp) will be erected on the apron with an interval of 30 m. Also for the security reasons, the pole (250 W/lamp) will be erected along the in-port roads.

(7) Other facilities

1) Fire extinguishing facilities and seawater pumps

Two hydrants will be provided at the project site to extinguish fires onboard.

2) Fuel supply facilities

Fuel supply facilities will be installed by a local oil company.

The area of 10 m x 15m = 150 m^2 will be provided in the reclaimed area to accommodate the following facilities.

Gas tank (8,000 gallons) : one
Diesel oil tank (4,000 gallons) : one
Oil pumping system

3) Plumbing and garbage facilities

In St. Lucia, municipal governments are responsible for periodical garbage collection by trucks. Garbage containers will be placed in the port to be collected by the Vieux Fort municipal trucks.

2-3-5 Basic Design of the Building Facilities

(1) Design Conditions.

Design Conditions must conform to the following:

Ambient Temperature	: 21℃ to 31℃
Humidity	: 75 % or higher
Wind load, Wind speed	: Prevailing direction E
	Average Wind Speed 10 to 14 knots
	Maximum Wind Speed 50 knots
Precipitation	: 1,400 mm/year
Power Supply	: 415 Volts, 3 phase, 50 Hz
	240 Volts, 1 phase, 50 Hz
Applicable Standard	: The standard employed for designing the facilities for this project primarily conforms to the standards adopted in St. Lucia. However, the structural analysis is based on the Japanese standards.

(2) Administration Office Building

1) Plan Description

The Administration Office Building is designed to be used by i) the employees of DOF who maintain and control the port, ii) employees of FMC, who administer the fish storage and distribution system, and iii) fishermen who attend short courses conducted by JICA experts and DOF.

(a) Number of people anticipated using the facility

a) Office

(i) Fishery Department personnel:

General Manager	1 person
Port Management Employee	2 persons (serve concurrently as fishing supervisors)
Clerks for supportive tasks	2 persons
Watchmen	2 persons

(ii) FMC Personnel:

General Manager	1 person
Fish Market Retail Manager	1 person
Procurement Manager	1 person
Accountant	2 persons
Reception	1 person (serves concurrently)

b) Conference Room

Short courses will be conducted by JICA experts and DOF, which will be attended by about 30 to 60 participants. The room will have the capacity of accommodating 40 persons.

(b) Required Area

a) Office	
Fishery Department personnel	:5 pers. x 8 m^2/pers. = 40 m^2
FMC	:5 pers. x 8 m^2/pers. = 40 m^2
b) Conference Room	: 40 pers. x 3 m^2/pers. =120m^2
c) Toilet	:30 m^2 (Men : 2 toilets and 3 urinals: 20m^2, Women: 2 toilets: 10m^2)
d) Pantry	: 20 m^2
e) Storage	:20 m^2
f) Watchman's Room	: 25 m^2 (for two watchmen, nap space available)
g) Reception	:15 m^2
h) Corridor	:30 m^2
TOTAL	360m^2

2) Structural Description

a) Foundation

Spread Foundation

b) Structural Skeleton

Reinforced Concrete rigid frame structure

c) Roof

Reinforced Concrete Slab

3) Other Descriptions

a) Roofs

Sanded waterproof membrane on Concrete Slab

b) External Claddings

Concrete blocks with plaster substrate and paint finish.

c) Openings

Since the site is located adjacent to the ocean, the materials to be used must be resistant against such environmental conditions. Windows with louvers are needed for adequate ventilation during the summer season. Lattices are needed outside the windows for security reasons.

d) Internal Finishes

Walls: Concrete blocks with either i) plaster substrate and paint finish, or ii) lumber studs with gypsum board finish.

e) Floor

Vinyl Tiles on the steel trowel finished concrete

4) M/E Description

a) Water Supply

Water will be supplied by pumping from the water tank installed in the project site.

b) Sanitary Equipment

Men's toilet	Toilets	2 pcs.
	Urinals	3 pcs.
	Wash Basin	3 pc.
	Storage	1 No.
	Ventilation Fan	1 No.
Women's toilet	Toilets	2 pcs.
	Wash Basin	3 pc.
	Ventilation Fan	1 No.

c) Pantry

Install sink, faucet, boiler for hot water

d) Lighting

Fluorescent lights will be used for lighting and must conform to the following intensity of illumination.

Offices, conference room, waiting rooms : 400 lux

Pantry, toilet, corridors : 60 lux

e) Air-conditioner

Locally available Split type air-conditioner (5000 kcal/hr) will be installed in each office room.

(3) Fish Handling Shed

Fish are sorted, washed, and scaled at the shed. It must be located adjacent to the landing wharf, and it has an awning overhead.

1) Required Areas (S)

The area required for the Fish Handling Shed has been determined on the basis of the average amount of fish landed per day during March, the peak season.

Amount to be landed (N) : 8.3 tons per day
Fish Captured : Bonito and Tuna. The area coefficient for these species is assumed as P=0.6.
Number of turnovers (R) : The operational turnovers are estimated as twice a day.
Weight of fish per nominal area (A): 27 kg/m^2

The required area can be calculated according to the following formula:
Required Area =N / (R x A x P) = 8,300 / (2 x 27 x 0.6) = 256 m^2
The configuration of the area will be rectangular.
7m x 36 m= 252 m^2

2) Structural Description

a) Foundation

Pile Foundation

b) Structural Skeleton

Reinforced Concrete rigid frame structure

c) Roof

Reinforced Concrete Slab

d) Floor

Concrete with steel trowel finish

3) M&E and other Facilities

Electrical: Illumination facilities of 300 lux are required for work.

(4) Ice Making Plant and Ice Storage Bin

An Ice Making Plant and Ice Storage Bin (approx. 38m^2) will be built near the landing wharf .

Structural Description:

a) Foundation

Pile Foundation

b) Structural Skeleton

Reinforced Concrete rigid frame structure

c) Roof

Reinforced Concrete Slab

d) Wall

Concrete block with plaster substrate and paint finish

e) Floor

Concrete with steel trowel finish

(5) Cold Storage Building

1) Plan

The Cold Storage Building needs an adequate space, not only to install a cold storage and a quick freezer, but for area where fish can be sorted and processed, the area for machinery, and the space where forklifts and baskets can be stored.

The following is a list of the required areas.

Cold storage	: Capacity 250 tons, include ante-room 390 m^2
Quick freezer	: Capacity 2 tons/day, 2 Nos, 120m^2
Machinery Room	: 150 m^2
Handling Space	: 270 m^2
Washing Space	: 180 m^2
Basket Storage	: 48 m^2
Cutting Room	: 36 m^2
Work Shop	: 42 m^2
Staff Room	: 50 m^2
Temporary Storage for Frozen Fish	: 39 m^2
Others such as Corridors	: 131m^2
Total	1,456 m^2

Thus, the Cold Storage Building will be 26 m x 56 m (1,456m^2).

2) Structural Description

a) Foundation

Pile Foundation

b) Structural Skeleton

Reinforced Concrete rigid frame structure

c) Roof

Structural Steel beams with metal folded plate roof.

3) Other Descriptions

a) External Claddings

Concrete blocks with plaster substrate and paint finish.

b) Openings

Since the site is located adjacent to the ocean, the materials used must be resistant to environmental conditions. Windows with louvers are needed for adequate ventilation during the summer season. Lattices are needed outside the windows for security reasons.

c) Internal Finishes

Walls: Concrete blocks with plaster substrate and paint finish.

d) Floor

Concrete slab with steel trowel finish

4) M/E Description

a) Water Supply

Water will be pumped from the water tank installed in the project site.

(6) Fish Market

In Vieux Fort, fish are usually sold on the roadsides, creating problems on sanitation and traffic congestion. A fishing market will be built in the Complex to solve these problems.

1) Required Area

The size of each unit will be 5m x 6m = 30 m^2. 1unit has 2 compartments.

There will be 8 units.

The required area for Fish Market is : 8 units x 30 m^2 = 240 m^2

4m width aisle x 30 m = 120 m^2

The total of these two areas will be 360 m^2, which is 14m x 24 m in a rectangular shape.

The Fish Market will be covered with a roof to block the direct sun light.

2) Structural Description

a) Foundation

Spread Foundation

b) Structural Skeleton

Reinforced Concrete rigid frame structure (without walls)

c) Roof

Reinforced Concrete Slab

d) Floor

Concrete slab with steel trowel finish

3) M/E Description

a) Water Supply

Water will be pumped from the water tank installed within the project site.

(7) Work shop and Coop Retail Shop

This building consists of a work shop for the repair of fishing boats/engines, a cooperative retail shop, and Goodwill Fishermen's Cooperative office.

1) Required area

a) Work shop

The workshop will be used for the maintenance and repair of boats, engines, gear and equipment. Also spare parts will be stored therein.

Boat maintenance space : Space required for one 22 feet class boat with working space. 12m x 5m = 60m^2

Engine repairing Space : Space required for four 75 PH engines. Repairing space of 3m x 3m = 9m^2 per engine Considering the spaces for pathways, the water tank for test operation, and shelves for repair tools, an area of 9m x 12m = 108m^2 is necessary.

b) Coop retail shop

Currently 5 staff are working at the retail shop of the Goodwill Fishermen's Cooperative.

Office Room:	Coop Manager	1 per.
	Oil Supplier	2 pers.
	Retail for fishing gear	2 pers.
	Total	5 pers.

Retail Shop for Fishing Gear: The same size as the existing Retail Shop. (Storage and Retail Counter inclusive)

Office Room: 5 pers x 8m ^{2}/per = 40 m^2

Retail Shop for Fishing Gear = 72 m^2

Work Shop: 60m^2 + 108 m^2 = 168m^2

Total 280m^2 (14m x 20m)

2) Structural Description

a) Foundation

Spread Foundation

b) Structural Skeleton

Reinforced Concrete rigid frame structure (without walls)

c) Roof

Reinforced Concrete Slab

d) Floor

Concrete slab with steel trowel finish

3) Other Descriptions

a) External Claddings

Concrete blocks with plaster substrate and paint finish.

b) Openings

Since the site is located adjacent to the ocean, materials used must be resistant to environment (conditions). Windows with louvers are needed for adequate ventilation during the summer season. Lattices are needed outside the windows for security reasons.

c) Internal Finishes

Walls: Concrete blocks with plaster substrate and paint finish.

d) Floor

Concrete slab with steel trowel finish

(8) Locker Room

1) Required Area

A storage Locker Room capable of handling 118 boats in Vieux Fort.

Space for one Locker Room 2m x 2m = $4m^2$

$4m^2$ x 118 = 472 m^2

2) Structural Description

a) Foundation

Spread Foundation

b) Structural Skeleton

Concrete Block Structure

c) Roof

Reinforced Concrete Slab

d) Floor

Concrete slab with steel trowel finish

(9) Toilet

The toilet will be used by fishermen (approx. 350 pers.), employees of FMC (10 pers), employee of Cooperative (5 pers.), and local consumers. The required area will be 50m^2 (10m x 5.0 m).

The following sanitary equipment are needed:

Men	: 2 toilets, 6 urinals, 3 wash basins.
Women	: 4 toilets, 3 wash basins.

The structural description is as follows:

Foundation	: Spread Foundation
Structural Skeleton	: Concrete Block Structure

A Septic Tank will be installed.

(10) Shower Room

A Shower Room of 24 m^2 is required.

8 shower units are necessary.

The structural descriptions are as follows:

Foundation	: Spread Foundation
Structural Skeleton	: Concrete Block Structure

(11) Canteen

A canteen will be built in the Complex for use by fishermen and local people. An areas of 140 m^2 will be allocated for building a canteen.

The structural description is as follows:

Foundation	: Spread Foundation
Structural Skeleton	: Reinforced Concrete rigid frame structure (without walls)
Floor	: Concrete slab with steel trowel finish

(12) Sub-Station

The Sub-Station will be built for receiving power from the local power stations.

The required area for the sub-station is 72m^2 (12.0m x 6.0m), and it has the following structural descriptions:

Foundation	: Spread Foundation
Structural Skeleton	: Reinforced Concrete rigid frame structure (without walls)
Floor	: Concrete with steel trowel finish

2-3-6 Fishing Boat, Fishing Gear and Other Equipment

(1) Scale of fishing boat

Fishing boats must have sufficient space for work and rest for 5 crew who will be at sea for 2-3 days. Sufficient space for fish hold and fuel tank will also be required. A FRP boat should be at least 28-30 feet long and a total of 5 boats will be provided by the Project.

1) Structure of fishing boat

Fundamentally the shape of the boat must be suitable for a high speed navigation and overcoming high waves. Tuna fishing will be operated by hand operating reels without any mechanical equipment. There is a need to protect fishermen from the heat and rainfalls during the fishing trips, for which a shelter will be required. The boat will be of :approximately 10m in length, 2.5m in breadth ,1.4m in depth, 3 GRT, fish holding capacity of approximately 3 tons.

2) Equipment

A boat needs to be equipped with the following equipment.

a) Outboard engine
Capacity: 75 HP x 2

b) Anchor: Type, 40kgs weight with crow
Quantity: 1 pc.

c) Anchor rope: Type, 20mm diameter of Kremona, 400m length
Quantity: 1 pc.

d) Mooring rope: Type, 20mm diameter of Kremona, 20m length
Quantity: 2 pcs.

e) Safety Equipment for Navigation
- Compact GPS Navigator : 1 pc.
- Life Jacket : 5 sets

(2) Fishing Gears

Types and quantities of fishing gears to be provided are shown in Appendix-9. These gears will be used not only for tuna fishing, but also for trawling, gill net fishing, Payao fishing and so forth.

2-3-7 Basic Design Drawing

(1) Outline of Basic Facilities

Outline of the Basic facilities planned for Vieux Fort Fishery Complex is shown in Table-2.3.11, 2.3.12.

Table-2.3.11 Contents of Basic Facilities (Phase-1)

Name of Facilities	Scale	Outline
1. Reclamation	approx. 43,000 m^3	Rubble Mound Type
2. West Breakwater (A)	170 m	ditto
(B)	120 m	ditto
3. East Breakwater (A)	30 m	ditto
(B)	60 m	ditto
4.West Revetment	75 m	ditto
East Revetment	45 m	ditto
5. Landing Wharf (-2m depth)	150 m	Steel Sheet Pile Type
6. Slipway	60 m	

Table-2.3.12 Contents of Basic Facilities (Phase-2)

Name of Facilities	Scale	Outline
1. Concrete Pavement		
Apron for wharf	approx. 900 m²	150m x 6m
Boats Storage	approx. 900 m²	60m x 15m
2. Administration Office Bld.	360 m²	12m x 30m
3. Cold Storage Bld.	1,456 m²	26m x 56m
4. Fish Handling Shed	256 m²	7m x 36m
5. Fish Market	336 m²	14m x 24m
6.Workshop & Coop Retail Shop	280 m²	14m x 20m
7. Locker Room	472 m²	118 rooms
8. Toilet	50 m²	5m x 10m
9. Shower Room	24 m²	4m x 6m
10.Canteen	144 m²	12m x 12m
11.Sub-Station	72 m²	6m x 12m
12.Ice Making & Ice Storage Bld.	approx. 38 m²	4.5m x 8.4m
13.Water Tank	50 tons	
14.Cold Storage Facilities		
Cold Storage	250 tons	
Quick Freezer	2 ton/day x 2	
15.In-port Road	approx. 455m	Asphalt Pavement

(2) Outline of Equipment

Outline of the equipment planned for Vieux Fort Fishery Complex is shown in Table-2.3.13.

Table-2.3.13 Contents of Equipment (Phase-2)

Name of Equipment	Specifications	Quantity
1.Fishing Boats with outboard engine (75HP x 2)	Martinique type (FRP 30 feet type)	5 Nos.
2.Fishing Gear	Tuna long-line, Trolling, Surface gill net, Payao	1 Ls.
3.Fork Lift	2 tons	1 No.
4.Fish Pallets	2,150 x 1,250 x 1,260 mm	270 Nos.
5.Ice Making Machine	4 ton/day	2 Nos.
6.Ice Storage	16 tons	
7.Equipment for Fish Processing and Fish Handling Shed	Electric fish scale, Band saw, etc.	1 Ls.
8.Equipment for Work Shop	Tool for outboard engine , etc.	1 Ls.
9.Insulated Truck	4 ton	1 No.
10.Generator	250 KVA	1 No.

(3) Basic Design Drawings

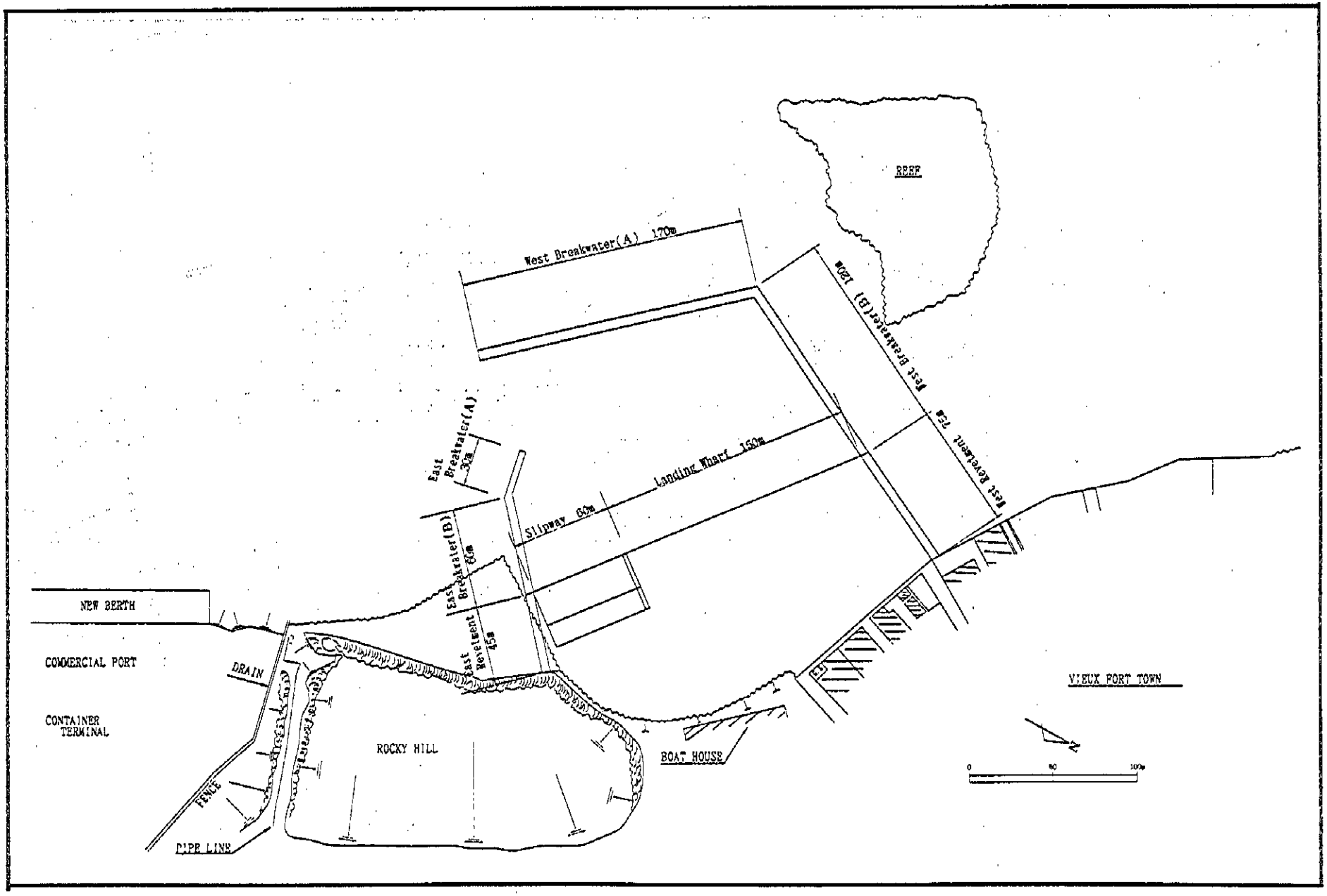


Fig.-2.3.14 Location Plan

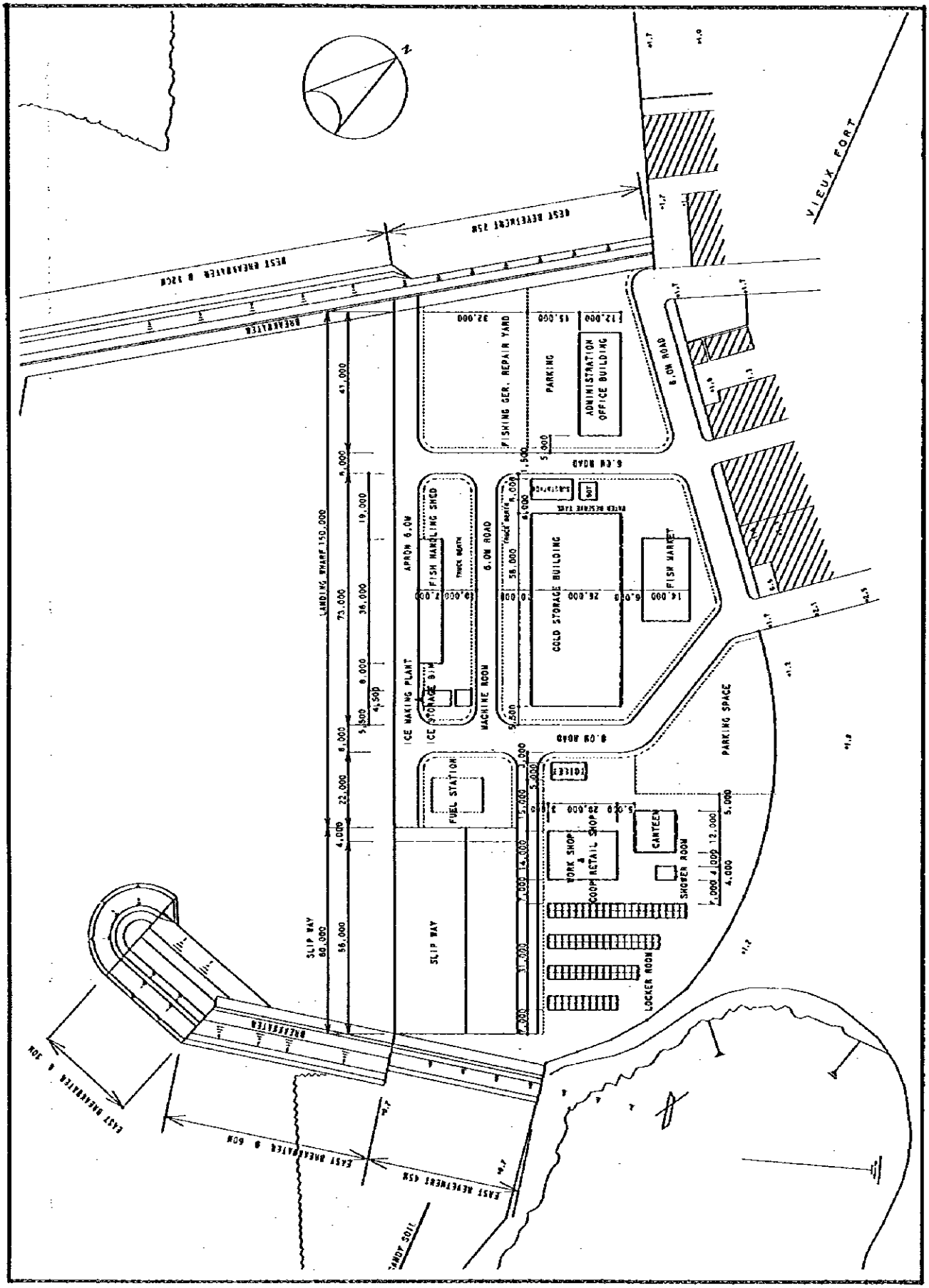
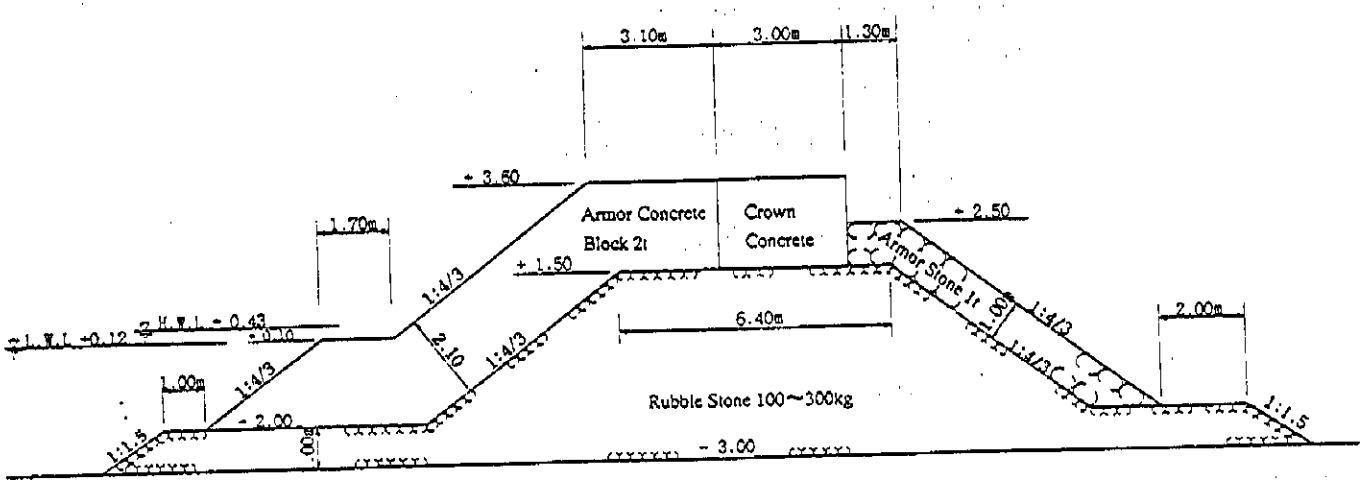


Fig.-2.3.15 Layout Plan

Standard Cross Section of East Breakwater (A)



Standard Cross Section of East Breakwater (B)

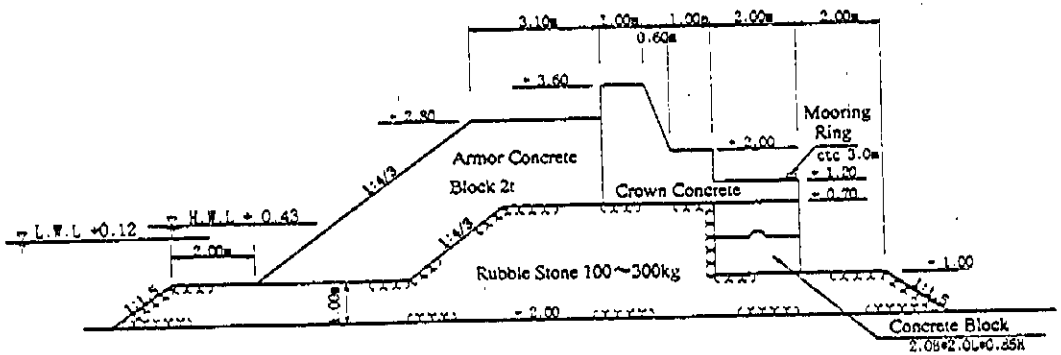


Fig.-2.3.16 Cross Section of East Breakwater

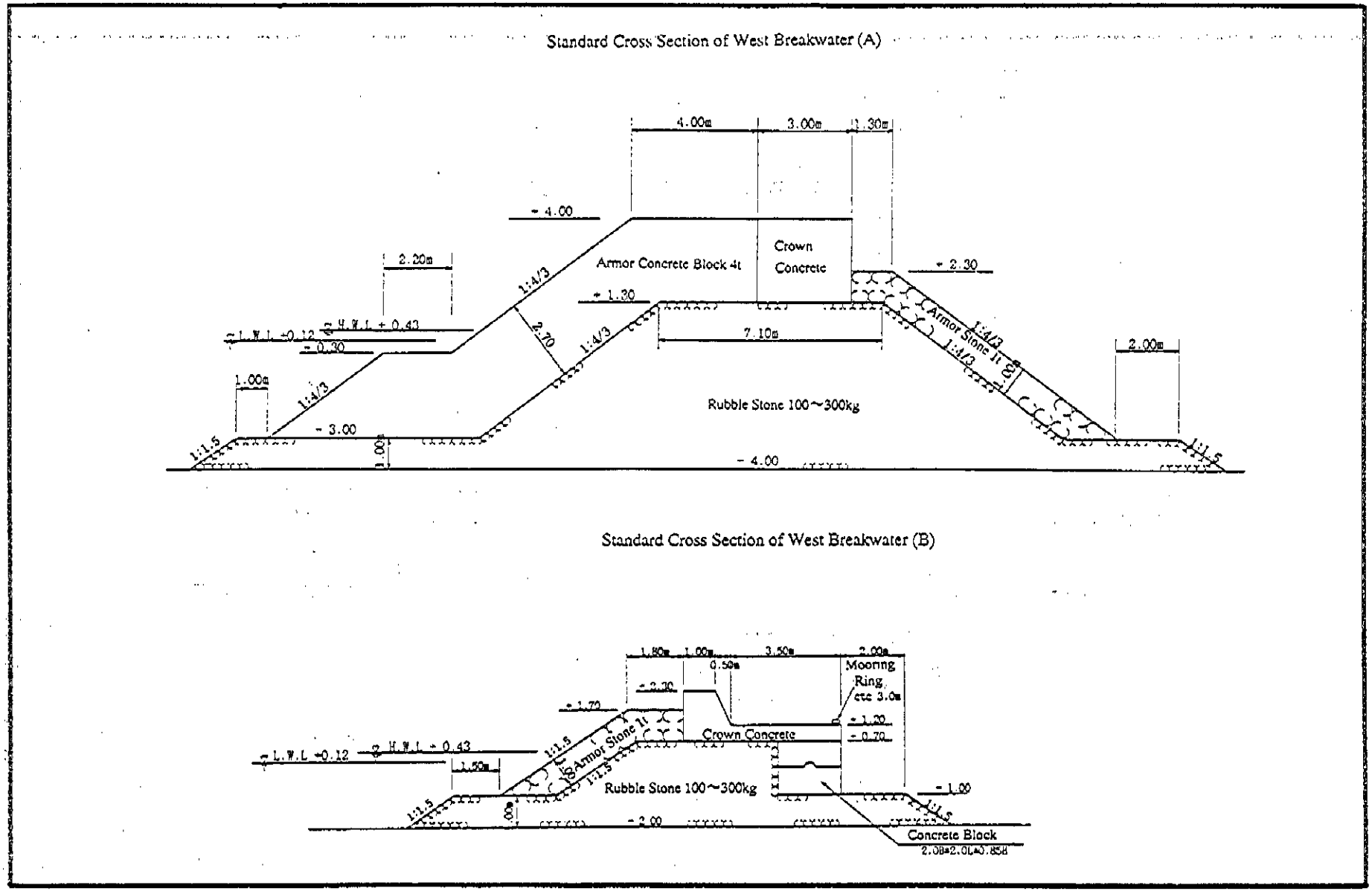


Fig.-2.3.17 Cross Section of West Breakwater

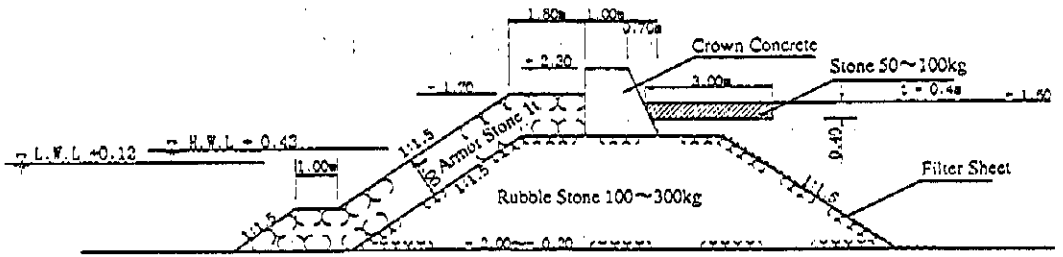


Fig.-2.3.18 Cross Section of East and West Revetment

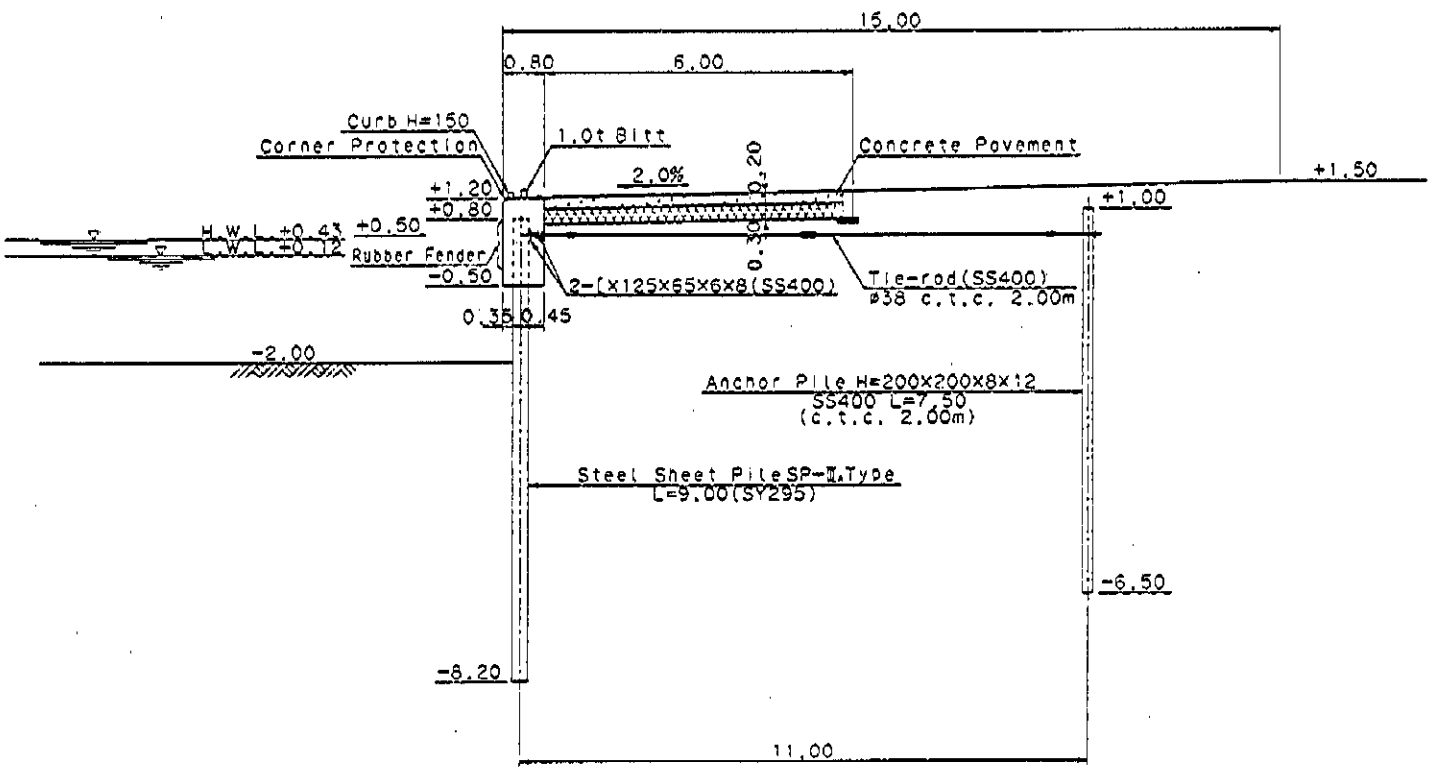


Fig.-2.3.19 Cross Section of Landing Wharf

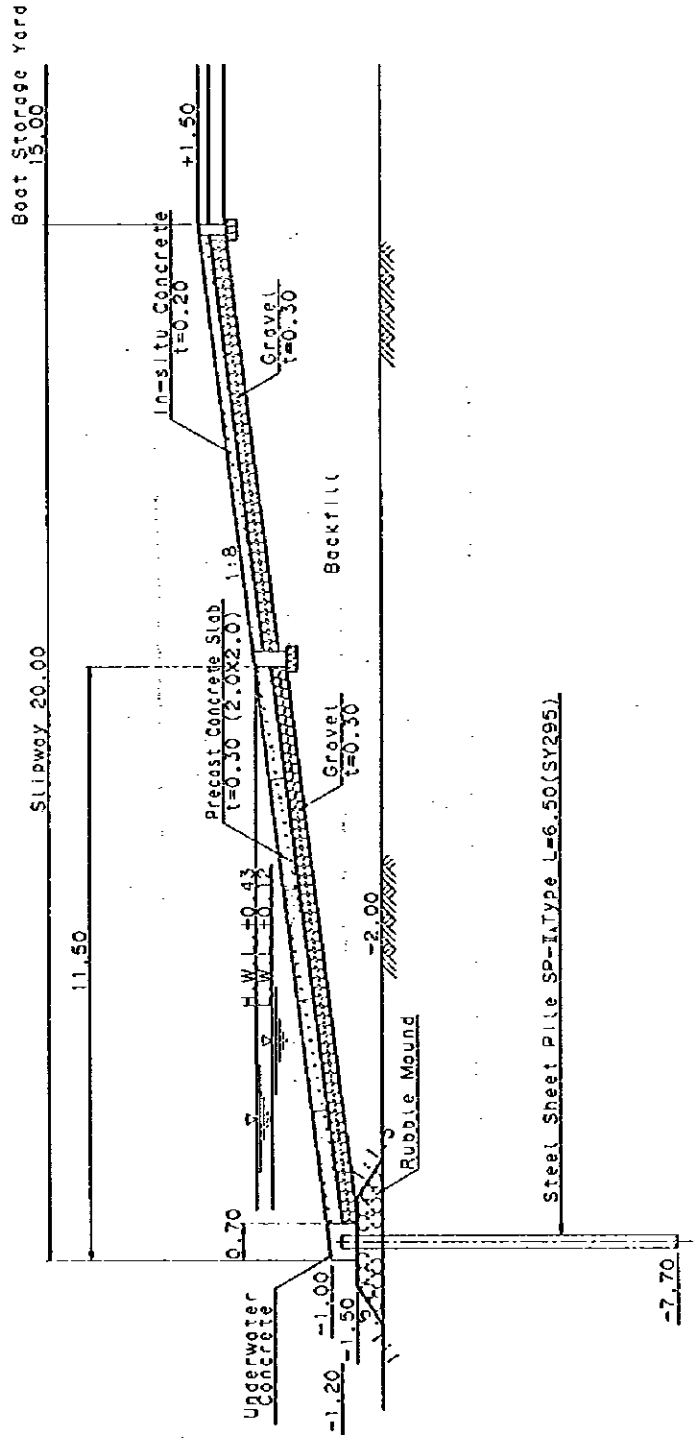
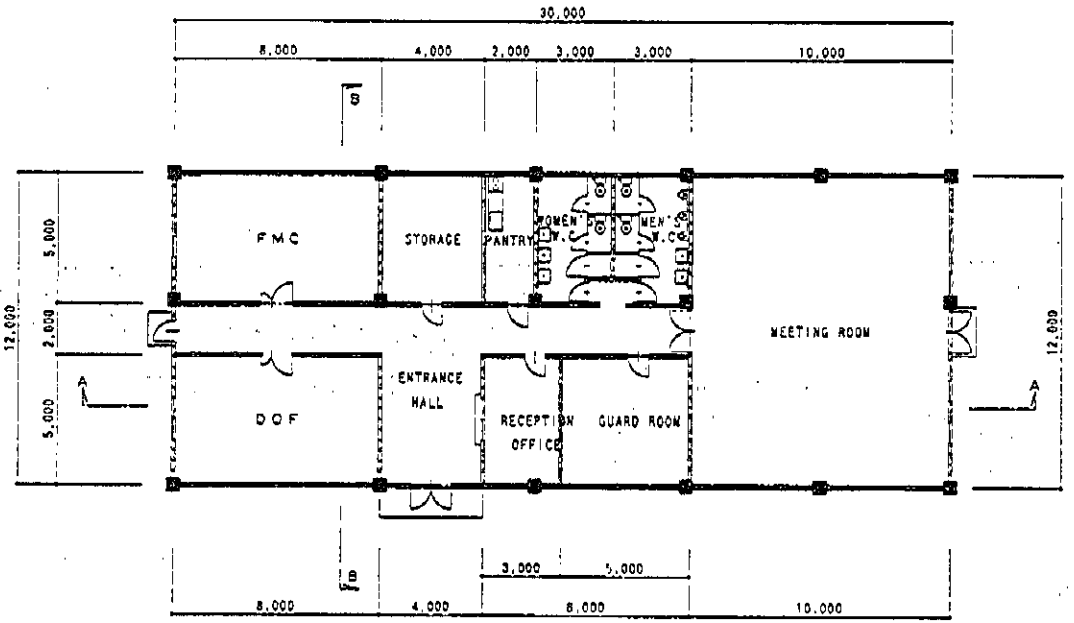


Fig.-2.3.20 Cross Section of Slipway



PLAN

Fig.-2.3.21 Plan of Administration Office Building

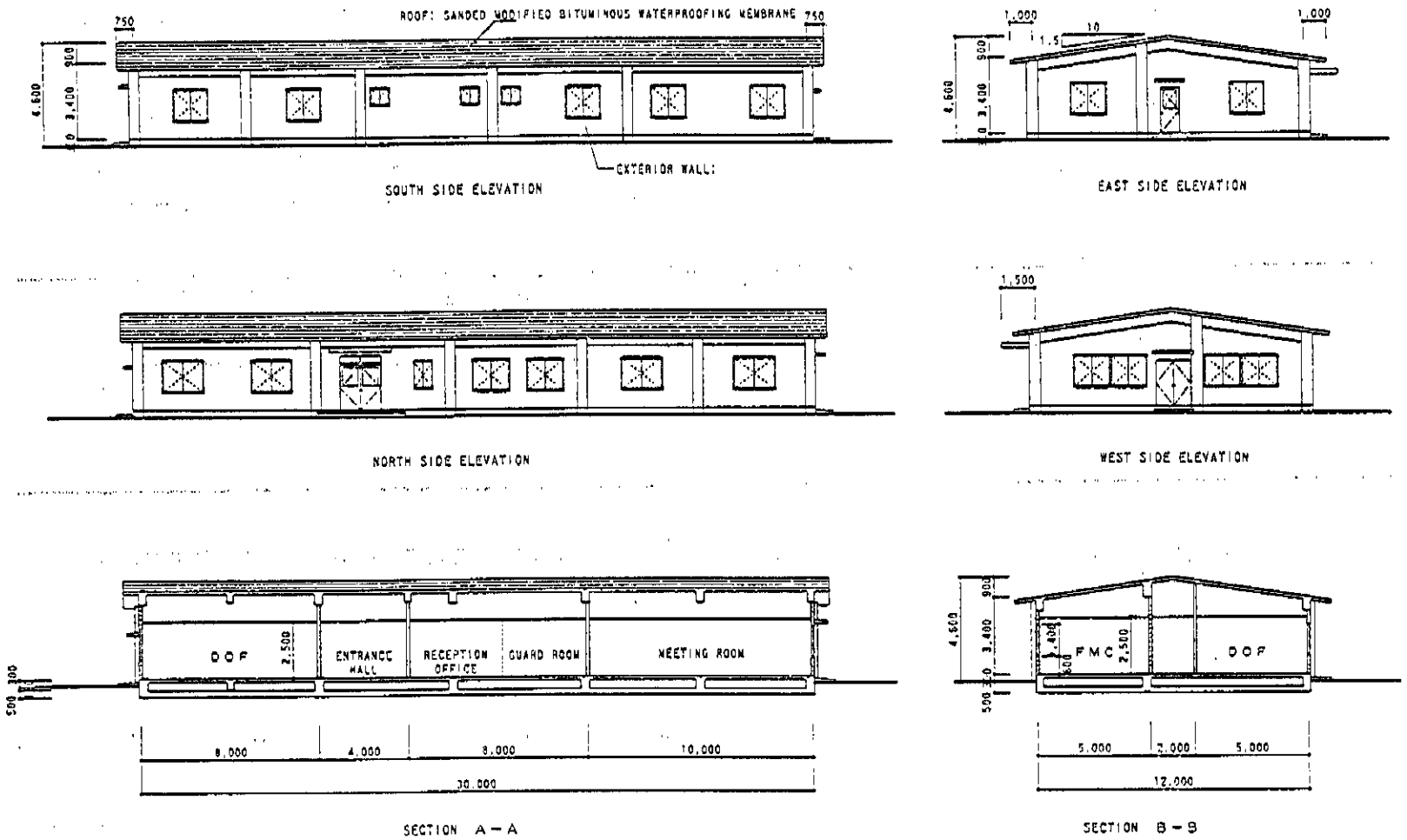


Fig.-2.3.22 Elevation and Section of Administration Office Building

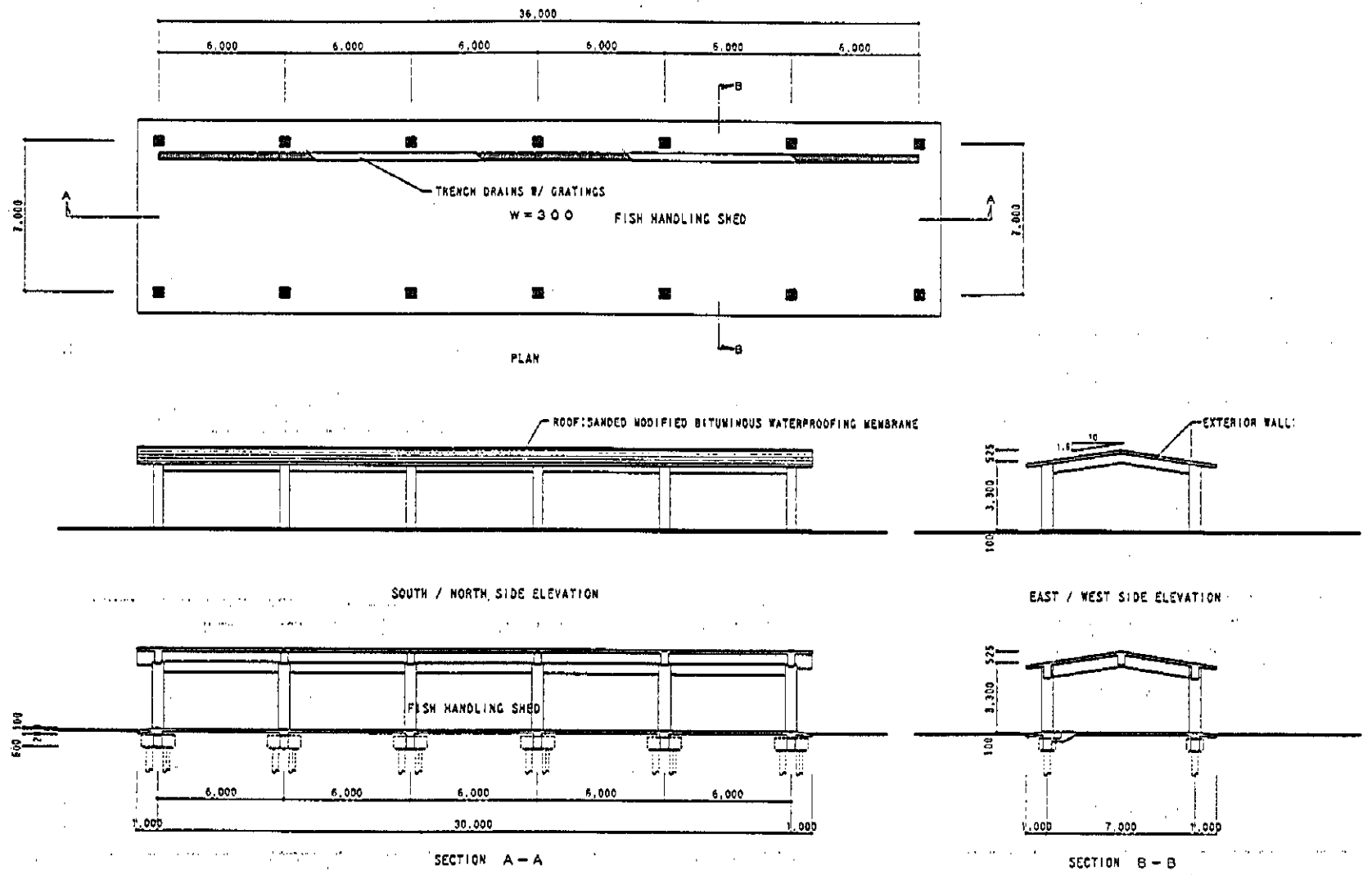


Fig.-2.3.23 Plan, Elevation and Section of Fish Handling Shed

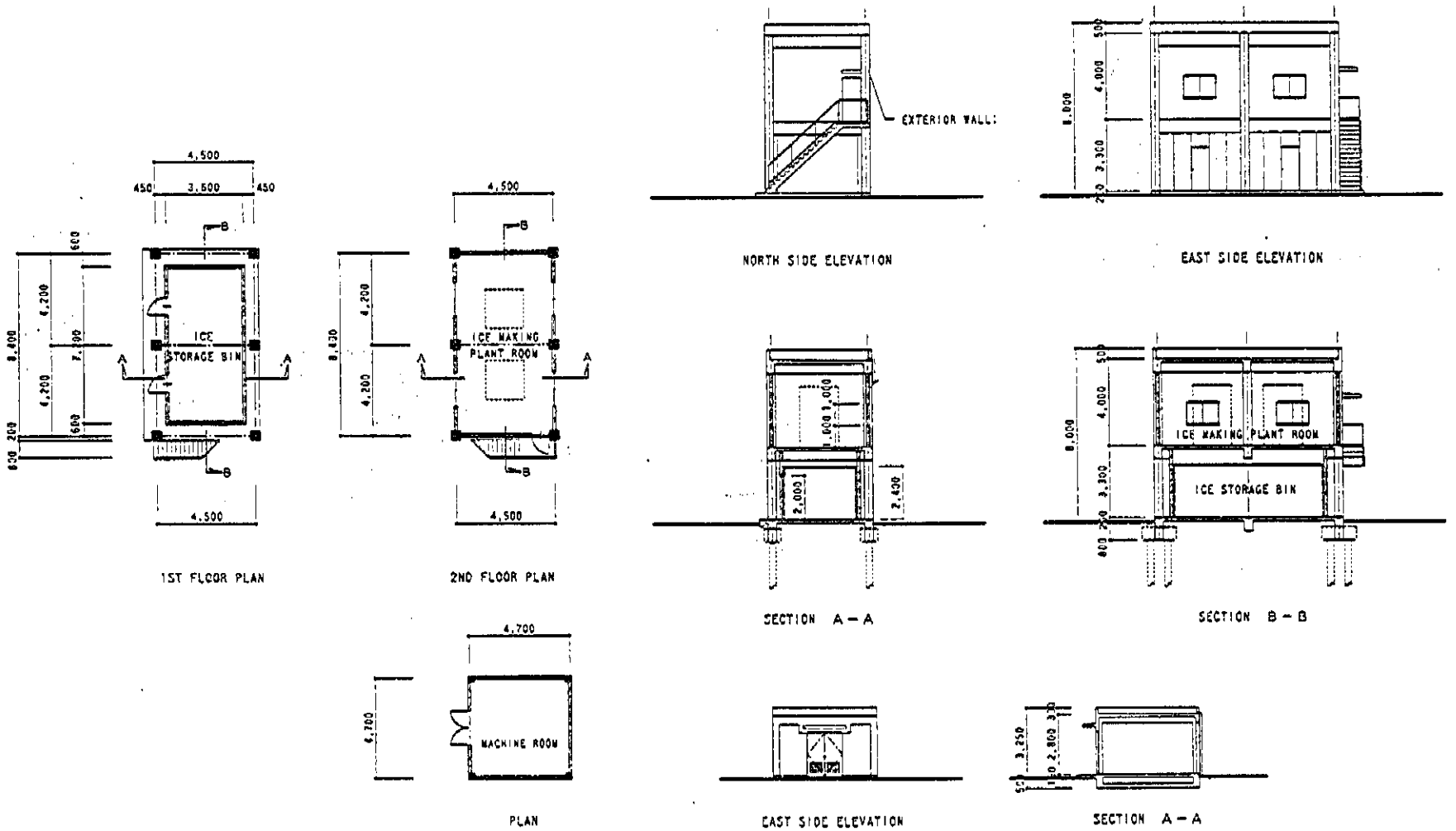
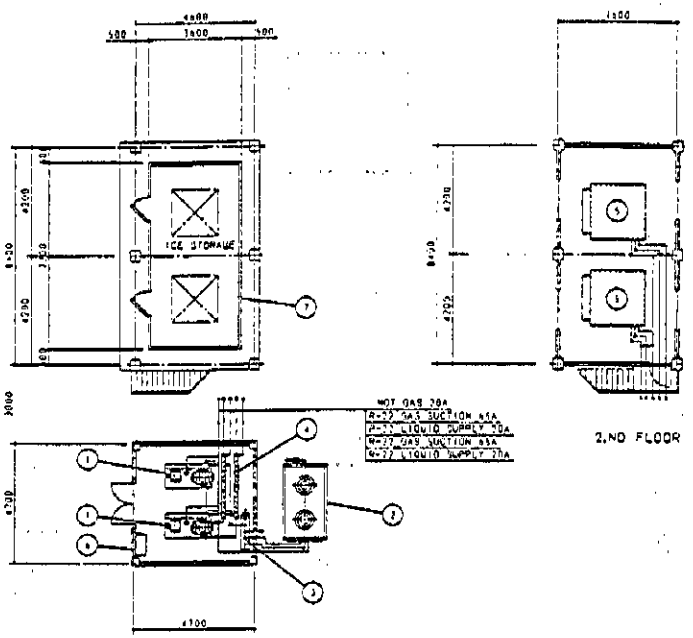


Fig.-2.3.24 Plan, Elevation and Section of Ice-making Plant



NO.	NAME	SPECIFICATION	QTY
1	REFRIGERATION COMPRESSOR UNIT	33000kcal/HR×22kw	2SETS
2	EVAPORATIVE CONDENSER	2V000kcal/HR×2.2kw×0.55kw	1SET
3	R-22 LIQUID RECEIVER	ø318.5×L1500	1SET
4	HEAT EXCHANGER	65A×90A	1SET
5	AUTOMATIC PLATE ICE MACEINE	4 TON/DAY	2SETS
6	CONTROL PANEL		1SET
7	PREFABRICATED ICE STORAGE	L7200×W3600×CH2400	1SET

Fig.-2.3.25 Facility Plan of Ice Making Machine

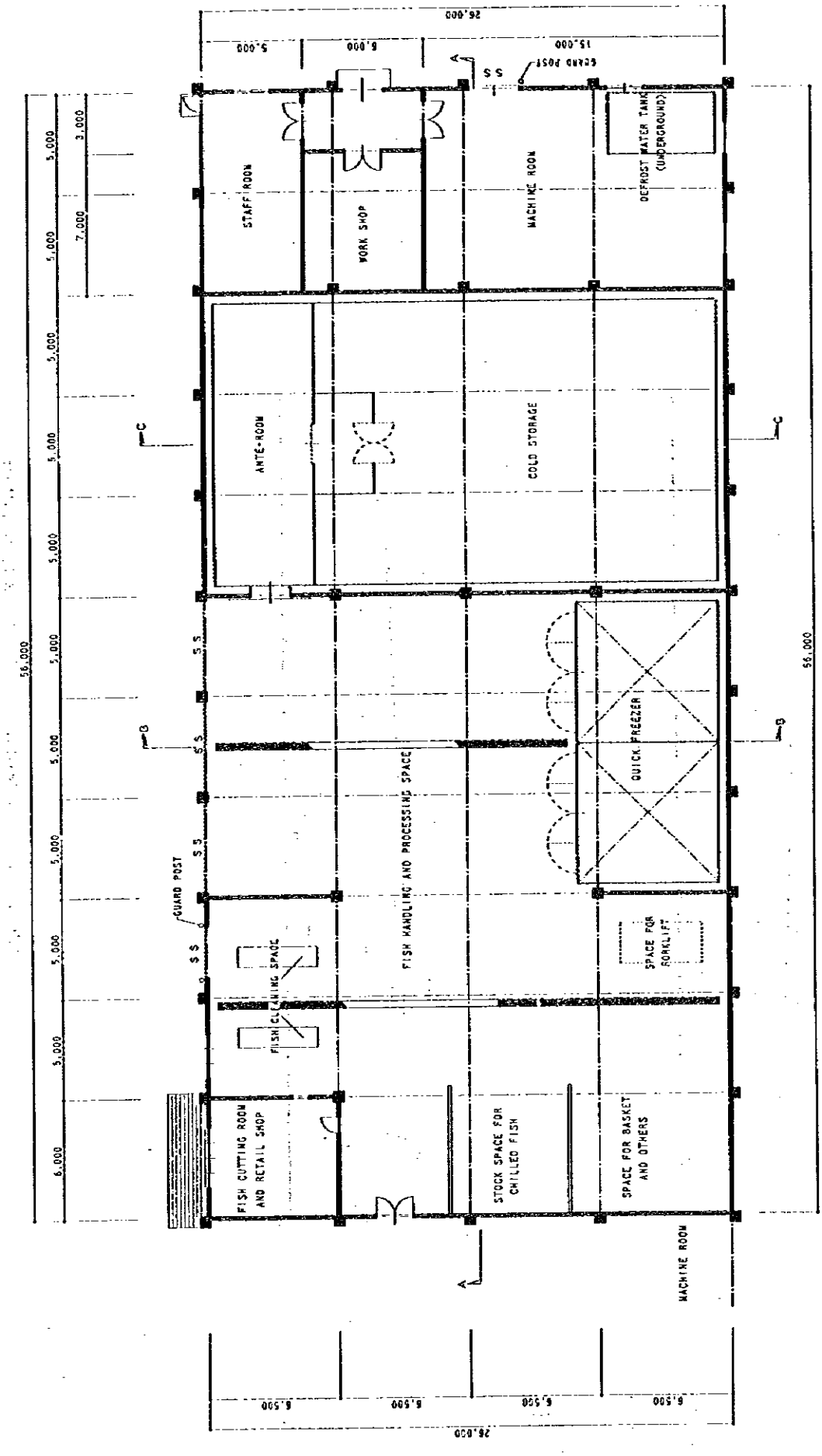
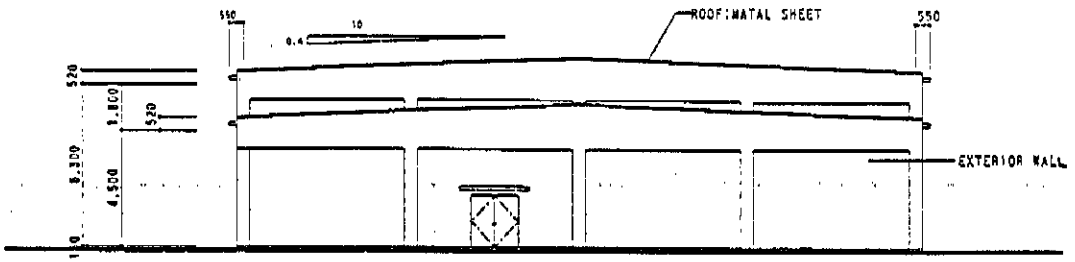
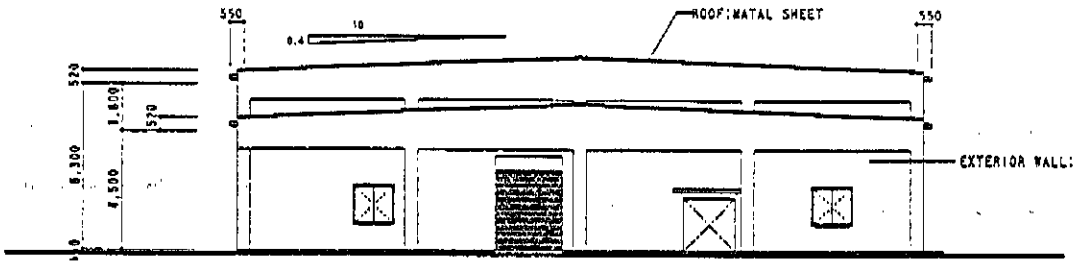


Fig.-2.3.26 Plan of Cold Storage Building



EAST SIDE ELEVATION



WEST SIDE ELEVATION

Fig.-2.3.27 Elevation (1) of Cold Storage Building

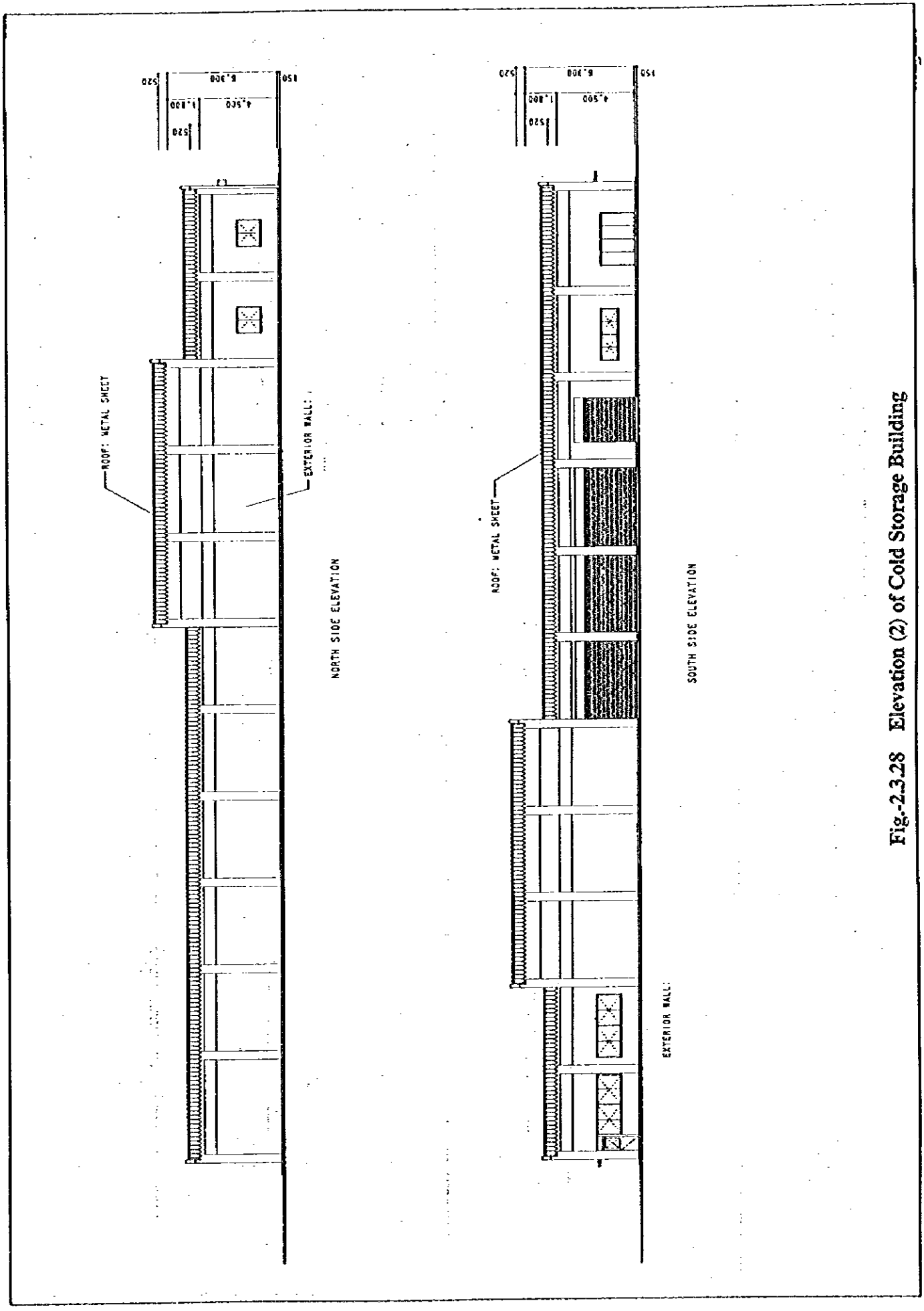


Fig.-2.3.28 Elevation (2) of Cold Storage Building

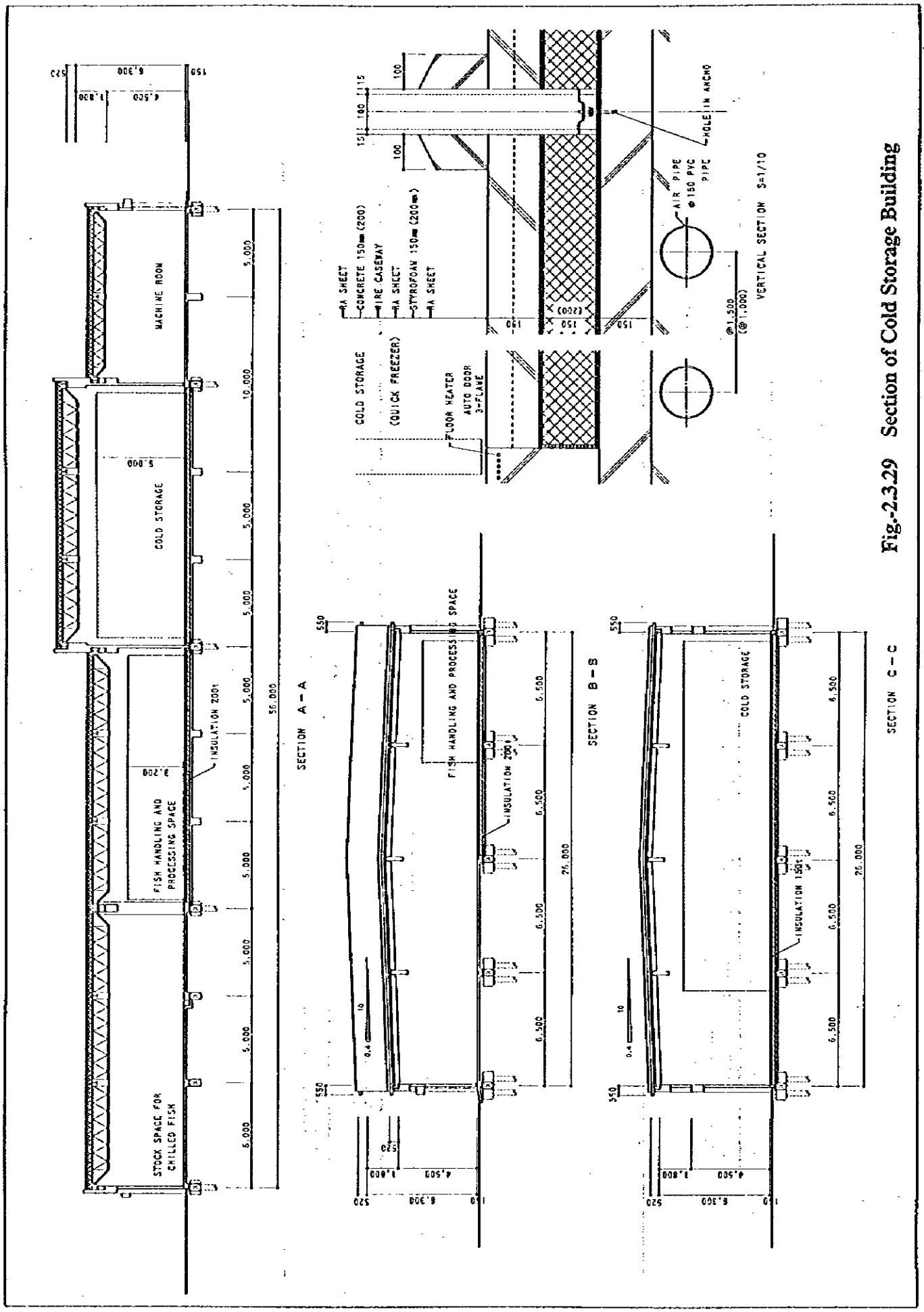
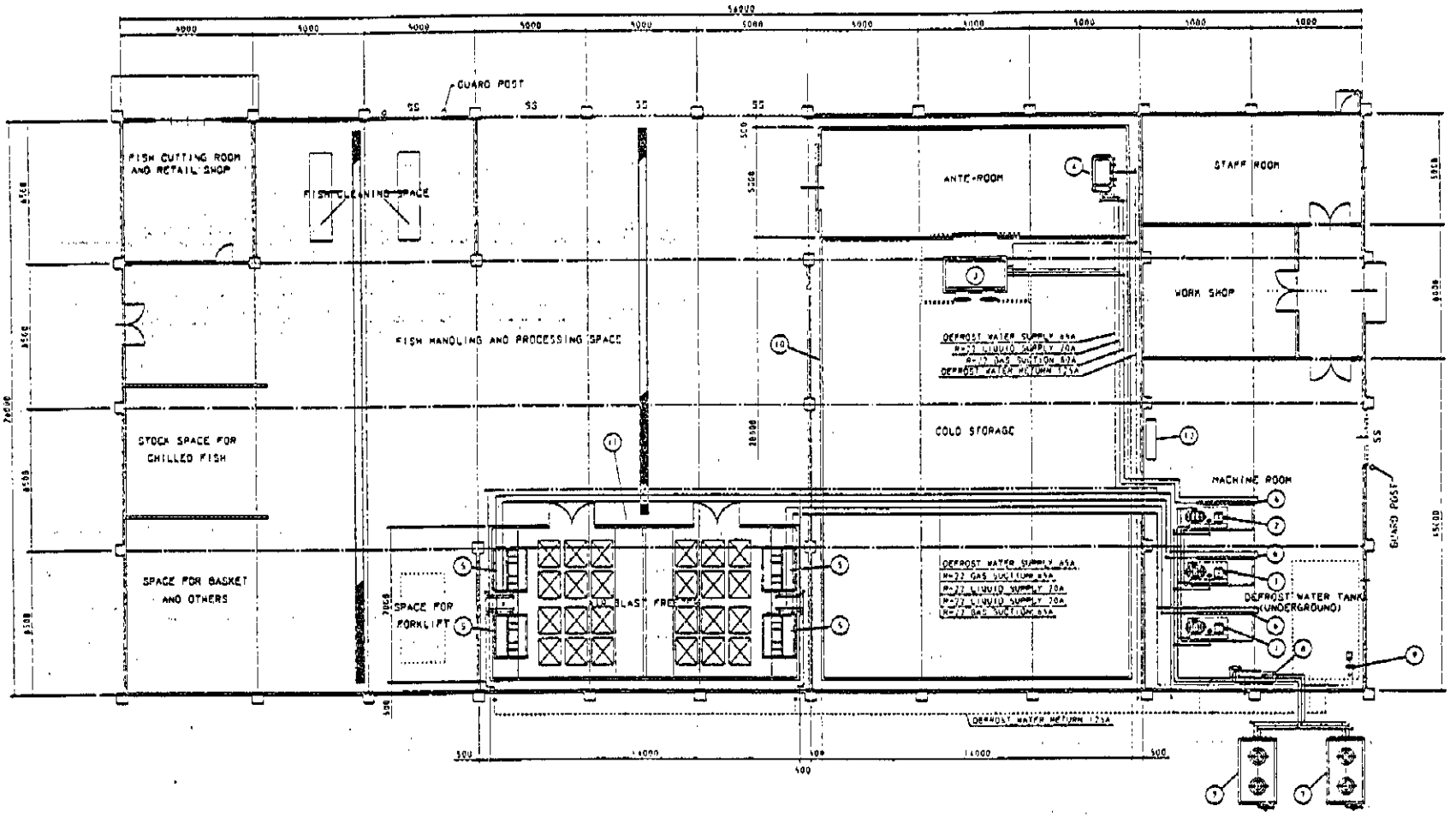
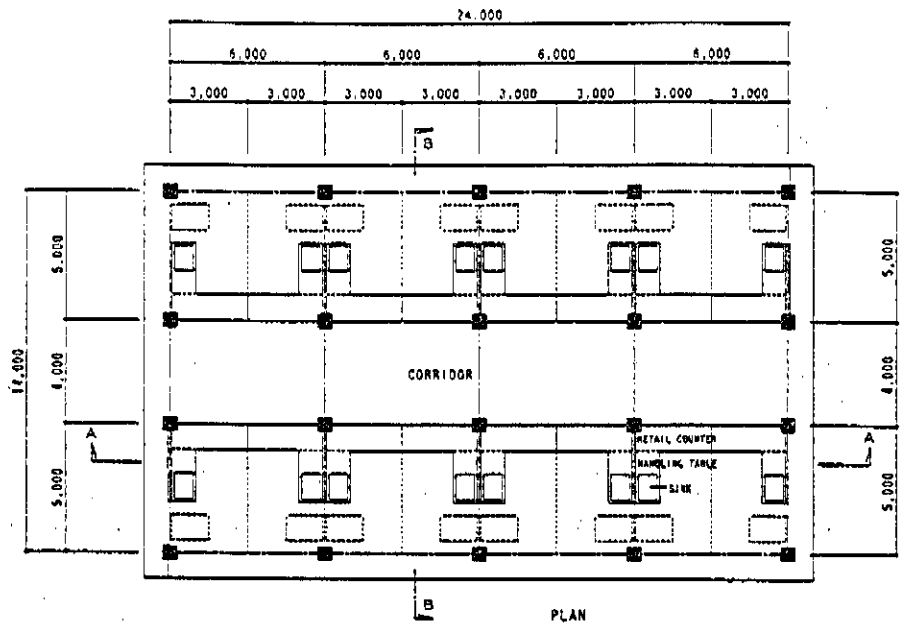


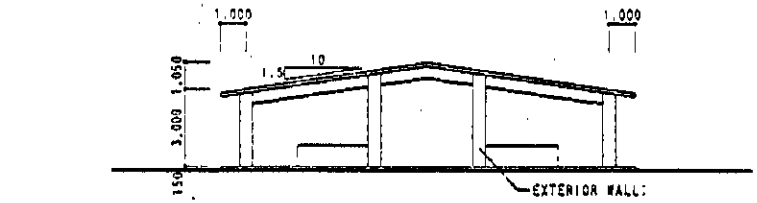
Fig.-2.3.29 Section of Cold Storage Building

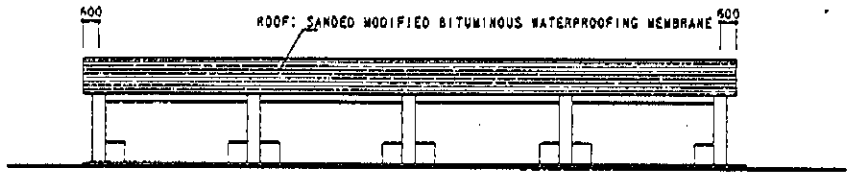


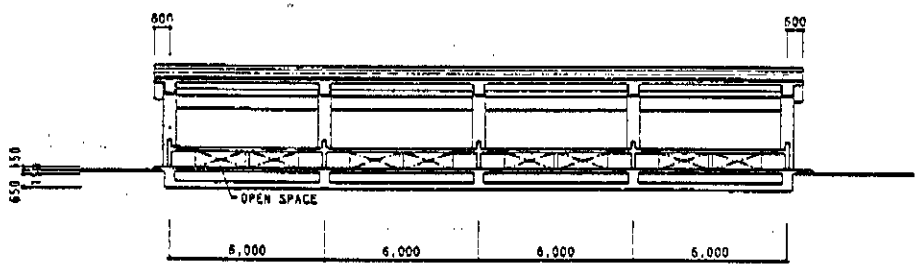
No.	NAME	SPECIFICATION	Q'TY
1	REFRIGERATION COMPRESSOR UNIT FOR COLD STORAGE	38,000kcal/HrX37kw	1SET
2	REFRIGERATION COMPRESSOR UNIT FOR AIR BLAST FREEZING	21,000kcal/HrX30kw	2SETS
3	UNIT COOLER FOR COLD STORAGE	290mmFANØ.2kwx7SETS	1SET
4	UNIT COOLER FOR PREPARATION ROOM	70mmFANØ.4kwx2SETS	1SET
5	UNIT COOLER FOR AIR BLAST FREEZER	170mmFANØ.75kwx7SETS	4SETS
6	HEAT EXCHANGER	65A-90A	1SETS
7	EVAPORATIVE CONDENSER	240,000kcal/HrFAN2.2kw	2SETS
8	R-22 LIQUID RECEIVER	ø508XL7000	1SET
9	DEFROST WATER PUMP	100L/minX2.2kw	1SET
10	PREFABRICATED COLD STORAGE	L24000xW14000xCH5000	1SET
11	PREFABRICATED BLAST FREEZING ROOM	W14000x07000xCH3200	1SET
12	CONTROL PANEL		1SET

Fig.-2.3.30 Facility Plan of Cold Storage and Quick Freezer









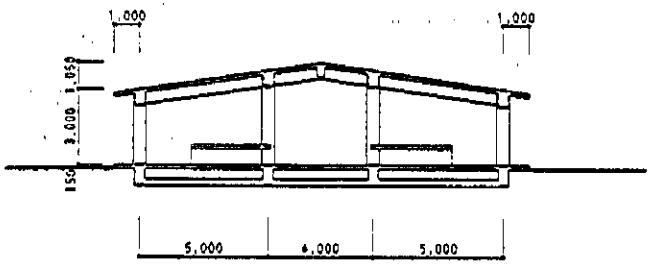


Fig.-2.3.31 Plan, Elevation and Section of Fish Market

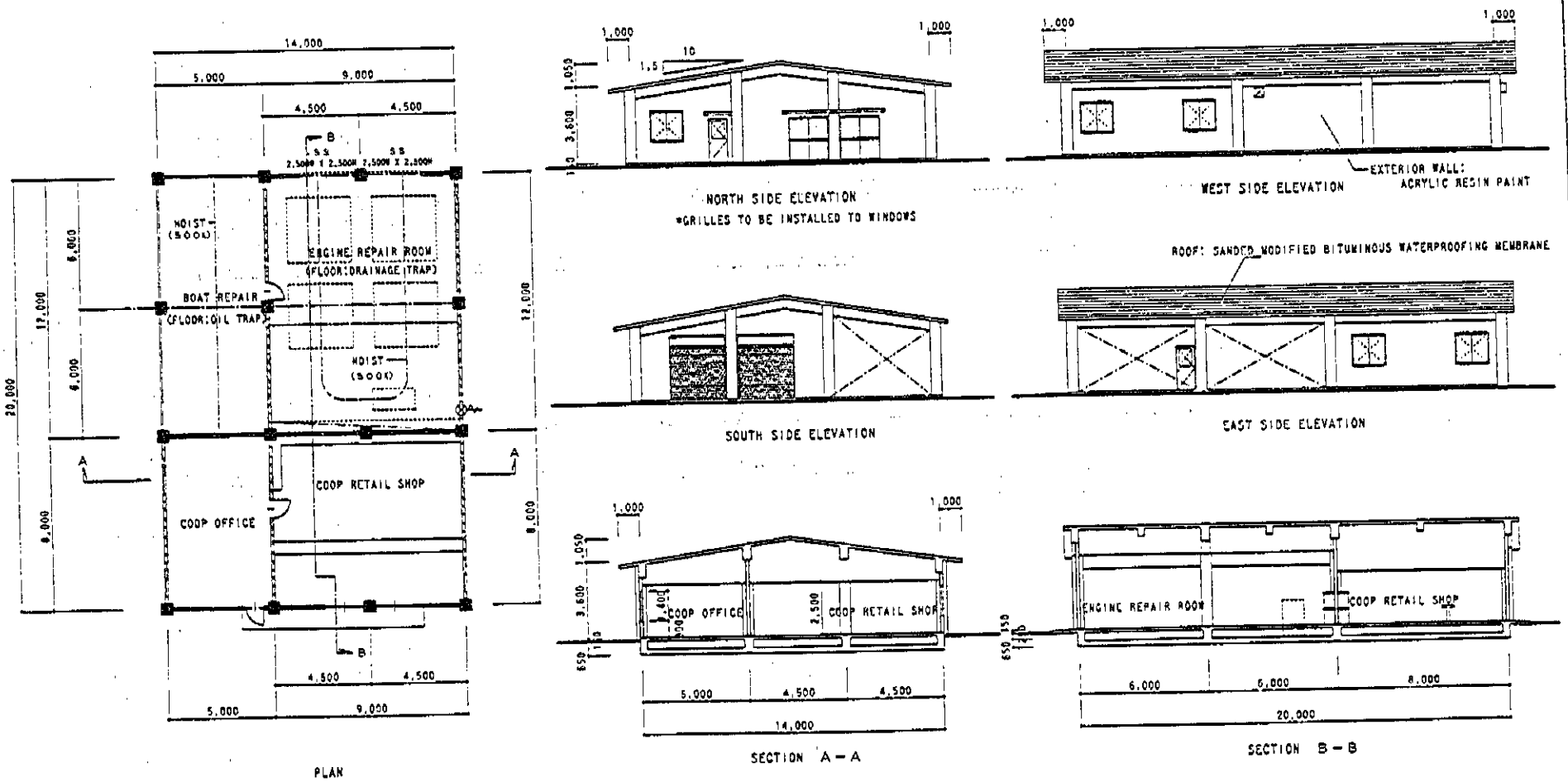
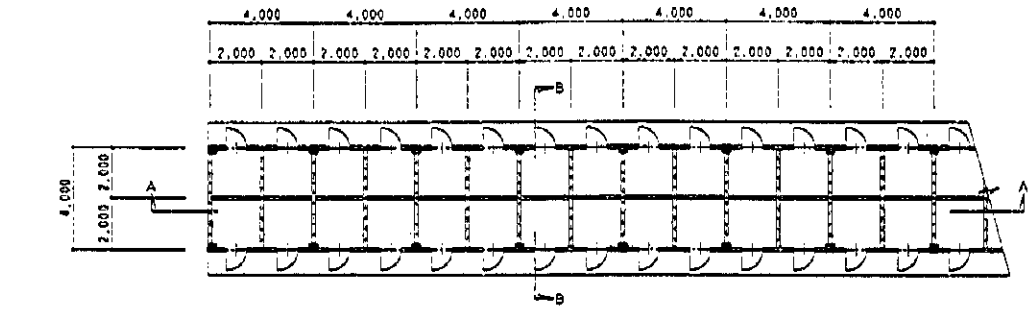
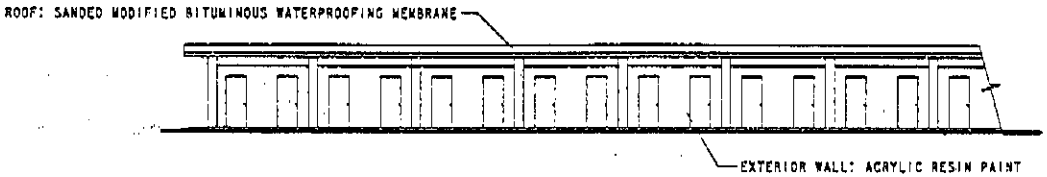


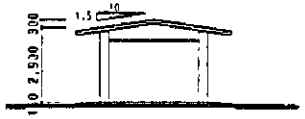
Fig.-2.3.32 Plan, Elevation and Section of Workshop and Coop Retail Shop



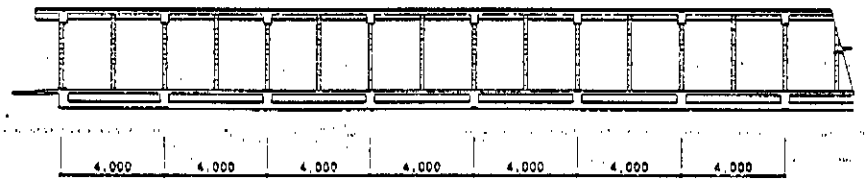
PLAN



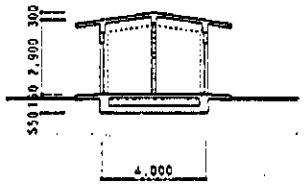
EAST / WEST SIDE ELEVATION



SOUTH / NORTH SIDE ELEVATION



SECTION A – A



SECTION B – B

Fig.-2.3.33 Plan, Elevation and Section of Locker Room

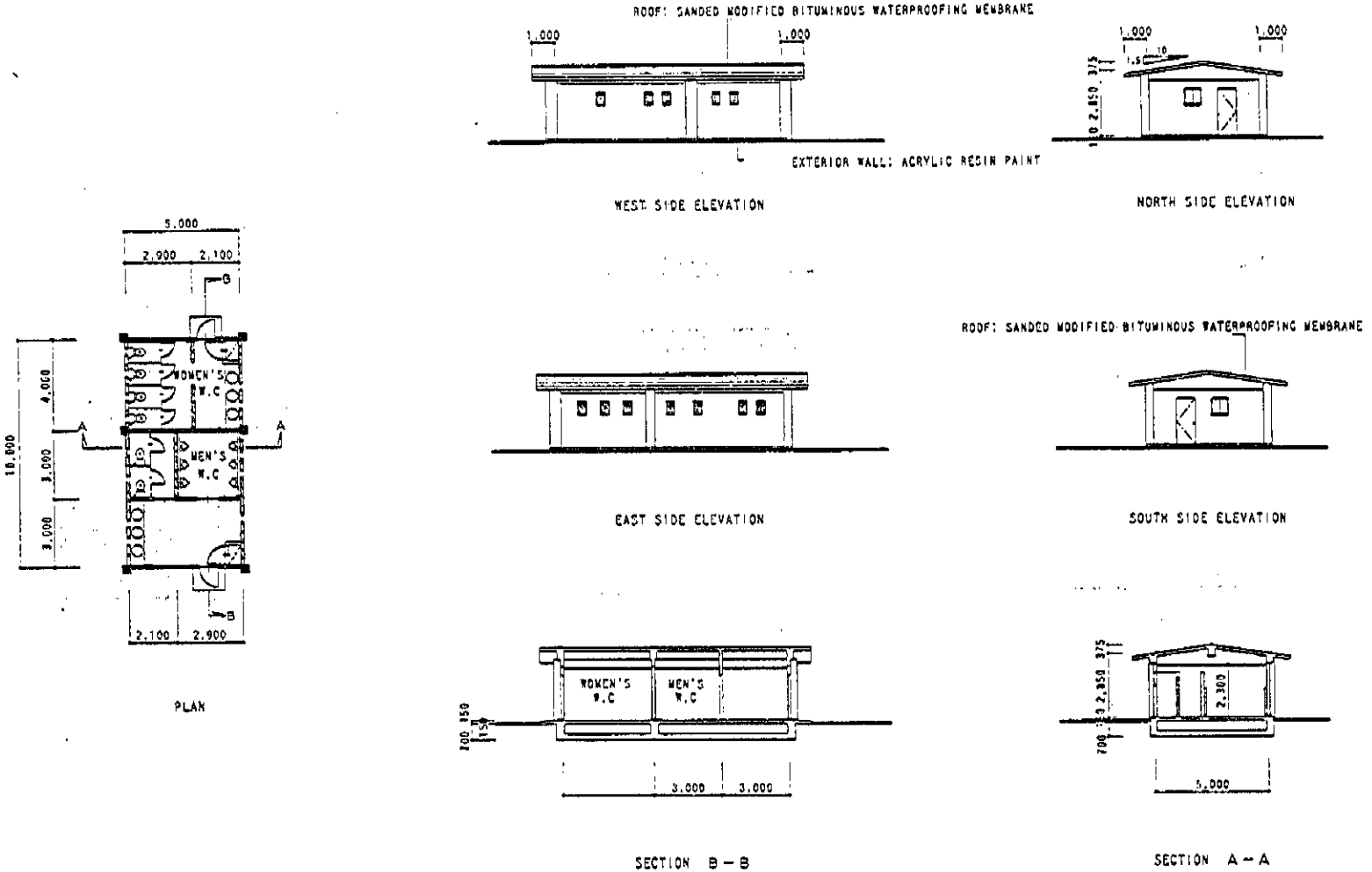


Fig.-2.3.34 Plan, Elevation and Section of Toilet

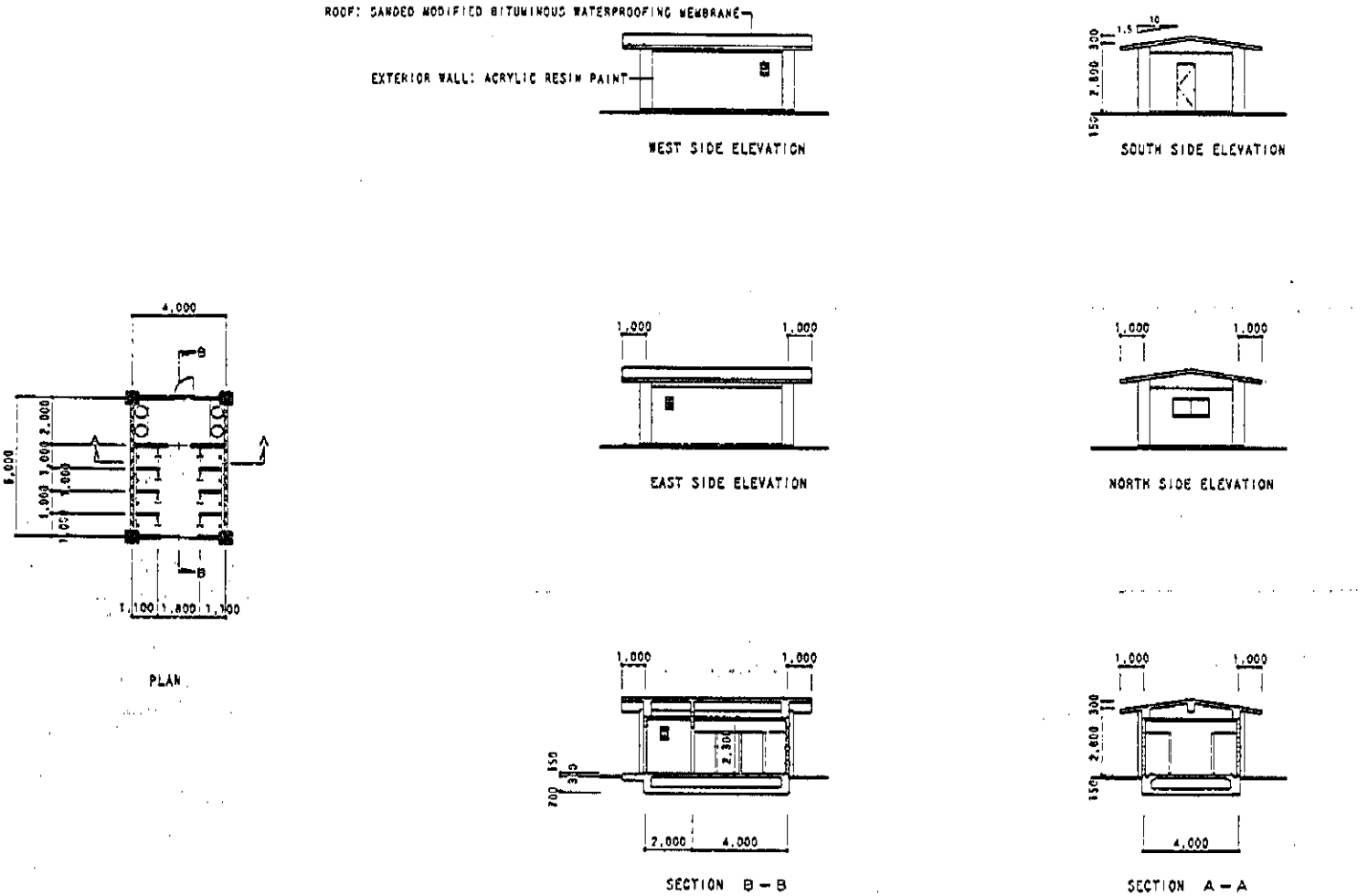
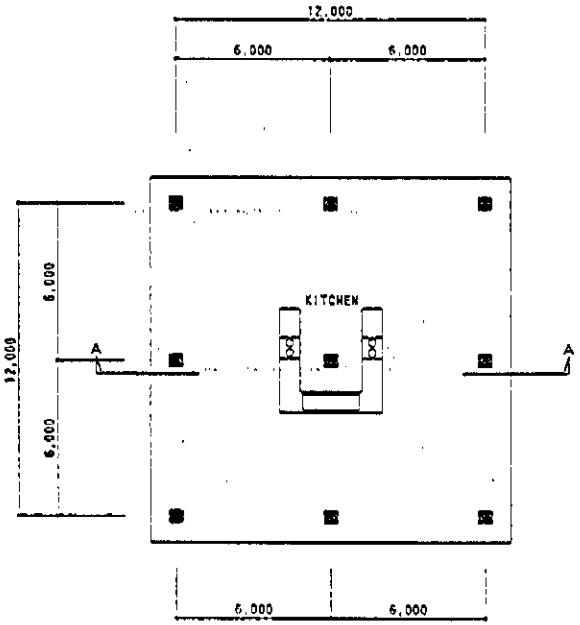
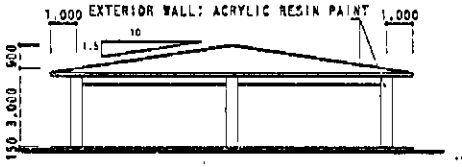


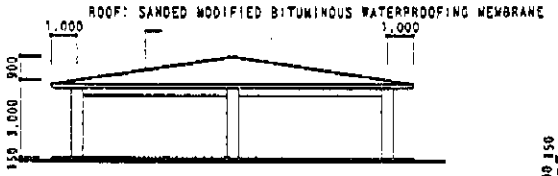
Fig.-2.3.35 Plan, Elevation and Section of Shower Room



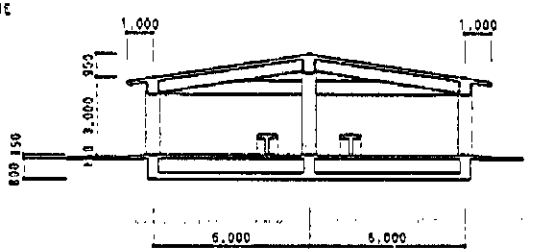
PLAN



SOUTH / NORTH SIDE ELEVATION

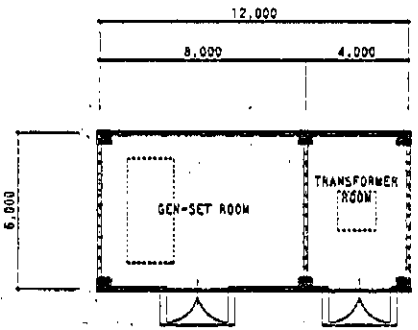


EAST / WEST SIDE ELEVATION

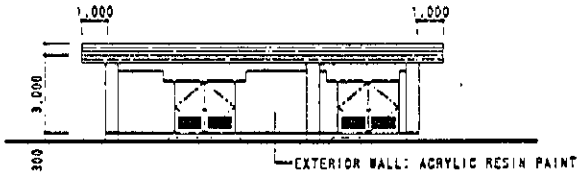


SECTION A – A

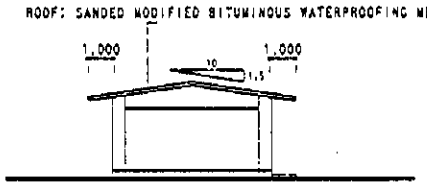
Fig.-2.3.36 Plan, Elevation and Section of Canteen



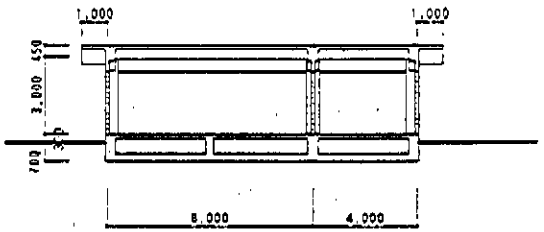
PLAN



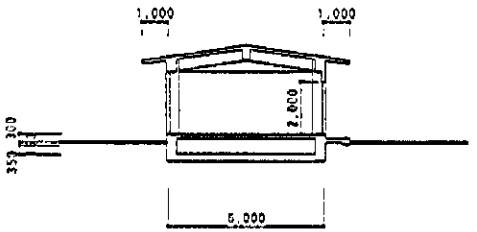
EAST SIDE ELEVATION



NORTH SIDE ELEVATION



SECTION A – A



SECTION B – B

Fig.-2.3.37 Plan, Elevation and Section of Sub-Station

2-3-8 Impact of Breakwater Construction on Nearby Beaches

The impact likely to be given to Vieux Fort Fishery Complex was studied based on the numerical simulations of forecast of 3-Dimensional Bathymetric Deformation.

(1) Forecast of 3-D Simulation for Bathymetric Deformation

A precise quantitative evaluation method has not yet been established because of very complicated phenomena of interactions between sediments and waves. Attempts to reproduce the sedimentation phenomena on a numerical model are being made to simulate bathymetric deformations, as large capacity, high speed computers are now available. This numerical forecasting technique recently has been replaced conventional hydraulic model tests. Bathymetric changes near the port are reproduced by 3-dimensional simulation and the shoaling characteristics near the port is being evaluated.

1) Outline of 3-D simulation for Bathymetric Deformation

The 3-dimensional simulation model will aim to measure the likely bathymetric deformation based on the distribution of the incoming waves and the near shore currents generated by waves for the area. Secondly, bathymetric changes caused by the continuous equation of littoral drifts is calculated. The numerical model consists of three sub-models listed below, and the estimation is usually carried out in these three phases.

a) Estimation of wave field
b) Estimation of nearshore current field
c) Estimation of bathymetric changes

Since the wave and the near shore current field will be changed when bathymetric changes become significant, calculation of the waves and near shore current is recalculated in order to improve the forecasting precision.

2) Forecast of Bathymetric Changes

Waves with a return period of two year (offshore wave height: 1.2m, Wave Period : 4.5 sec) were applied on the simulation model obtained from the sounding survey conducted in August, 1997. The wave directions of S, SW and W were studied.

The result of comparison of the near shore current and the bathymetric changes under the present condition and at the time when the breakwaters is completed are presented in Appendix-8. The result of comparison is as follow.

a) **The present conditions**

The current from the rear of the reef to the southeast direction is predominant because of the reef, and erosions in front of the reef and depositions right behind the reef have been observed. On the west side of damaged wooden piles sediments were seen. The areas of erosion and sedimentation existed near the Vieux Fort Commercial Port.

b) **The conditions after the completion of the breakwaters**

There were no currents from the rear of the reef to the southeastern direction. A weak circulating current was observed on the west side of the project site, however the area of deposition was not existent. After the port is completed, similarly to the present, there might be tendencies of erosion in front of the reef and of depositions on the back of the reef. In the neighborhood of the commercial port, the areas of erosion and sedimentation may appear.

No significant currents nor topographical changes will occur at the mouth and inside of the fishing port, suggesting that there will not be significant currents and bathymetric deformation. Thus, there is no fear that the port will suffer from sedimentation.

(2) Evaluation of Impact by Construction of Facilities

Since the result of 3D simulation for bathymetric changes during stormy weather may be the same as the present and the future and there will not be any significant impact on the neighboring beaches after the completion of facilities in the port. However there is a need for careful monitoring on the deformation of the seabed. Likewise, the effect of coastal structure on the bathymetric changes is an extremely sensitive phenomenon and careful observation of the bathymetric changes should be continued.