# CHAPTER 3

# CHAPTER 3 Outline of the Project

## 3.1 Objective

The Kirinda Fisheries Harbour was completed in 1985. However, due to the harbour siltation caused by sand drift, the Harbour became malfunction after one year.

From the results of the Technical Study, in SW monsoon season the sand drift volume is estimated to be more than a hundred thousands $m^3$, and in NE monsoon season it is estimated to reach thousands of $m^3$. Furthermore, it was clarified that the sand causing the siltation problems comes mainly

a. from the Harbour mouth
b. through the breakwater
c. over the breakwater

The objective of this study is therefore to propose the suitable countermeasures against siltation, and for a practical maintenance and an administrative system. The plan of the facilities in this study is based on the proposed countermeasures in the Technical Study.

## 3.2 Study and Examination of the Request

### 3.2.1 Necessity and Justification of the Plan

The requested plan is considered to include the Harbour rehabilitation based on the results of the Technical Study and it is expected to recover the functions of the harbour. The functions of the requested principal items are summarized as follows:

(1) Groyne (at the Krinda Point)

* Length: 200 m, Crown height: +4.0 m

* Function: to change the direction of the main sand drift to offshore from the South West direction in the SW monsoon

season.

(2) Main Breakwater

* Extension length: 200 m, Crown height: +4.5 m

* Function: to prevent sand drift into the harbour, and to secure calmness in the harbour.

(3) Improvement of the existing breakwater

* Length for improvement: 100 m, Crest elevation: +4.0 m

* Function: to prevent sand movement overtopping and passing through the breakwater.

(4) Sub-breakwater

* Length: 230 m, Crest elevation: +3.0 m

* Function: to prevent sand movement into the harbour from NE direction.

Due to the results of the Technical Study which recommended the facilities mentioned above as the countermeasures against harbour siltation, a maximum quantity of dredging sand by CFHC in the Kirinda Fisheries Harbour was estimated to be 10,000 $m^3$ a year. In this study, the expected dredging sand volume of the Harbour by a existing dredger is also evaluated to be about 10,000 $m^3$ with consideration of the actual experience of dredgers belonging to CFHC. Furthermore, the effects by the investment of the Project including maintenance and administration of the Harbour on socio-economic condition in the southern region are evaluated for some alternatives in Chapter 5. Consequently the plan requested by the Government of Sri Lanka results in the most appropriate plan.

The proposed project as mentioned above is expected to achieve the following targets:

(1) Contribution to the development and settlement plans in the southern area, on the following three points

* Effect on the promotion of settlement by creating employment opportunities

* Forming a foundation for well economic activities

* Establishment of a protein supply base of inexpensive and fresh fish to the hinterland

(2) Contribution to the nation through an effective utilization of the fishing resources, as mentioned below:

* Increase of protein consumption of the people and therefore contribute to their health

* Contribution to the state economy by increasing the fish exportation and decreasing its importation

(3) Expansion of fishing activities due to an increase of the fishermen population and of its income caused by the following expected effects

* Introduction of well-equipped fishing boats

* Increase of fishermen's working days by using well-equipped boats which will enable the all year-round fishing activities

* Increase of effective working time for fishermen due to reduction of fishing preparation and unloading times

The necessity of the Harbour is corroborated by the fact that the fish catch in Kirinda is increasing after the completion of the Harbour in spite of its deficiency. More than 20 units of 3.5 GT type fishing boats are always being anchored near the Harbour and most of the fishermen using these boats are living in Kirinda. When the Harbour was opened in 1985, it was said that

about 150 units of 3.5 GT type fishing boats came to the Harbour to unload fish and some fish transporters scrambled for the car parking. Therefore rehabilitation of the Harbour is considerably expected by the people. Further the promotion of export and the acquisition of foreign currencies by utilization of the fishing resources, e.g. lobsters, which are special products around the Kirinda area, are being extended by the private sectors. Therefore, the Harbour will be expected to be developed as one of the fishery bases in the southern region due to an increase of the population hinterland.

### 3.2.2 Examination of Operational Plan

#### (1) Executing and Operation Agency

This project shall be implemented by the Ministry of Fisheries, and its substructure called Aquatic Resources and Ceylon Fishery Harbours Cooperation (CFHC) shall execute the construction and operation works including the maintenance dredging. Table 3-1 shows the budgeted expenditures for the last ten years. These expenditures do not include personal expenses. The annual budget for the Harbour maintenance by dredging is also shown in Table 3-1.

Fig. 3-1 shows the organization of the Ministry of Fisheries and Aquatic Resources.

Fig. 3-2 shows the structure of CFHC for the Harbour operation. The structure is similar to the present one, because the shore facilities will remain the same.

The Points of administration and operation are as follows.

a. Maintenance and operation of the cold storage
b. Maintenance and operation of the store house and the workshops for repair
c. Maintenance and repair of the civil engineering structures
d. Management and operation of all the harbour facilities, office works, etc.

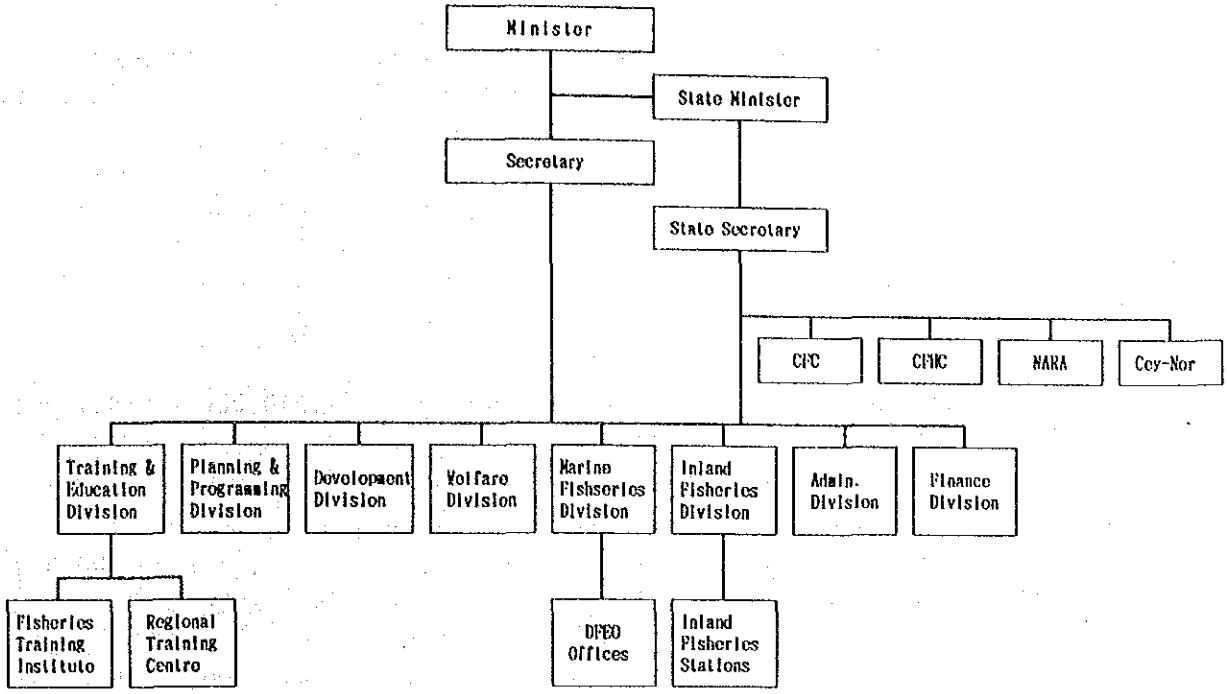



**Fig. 3-1 Organization of the Ministry of Fisheries and Aquatic Resources**

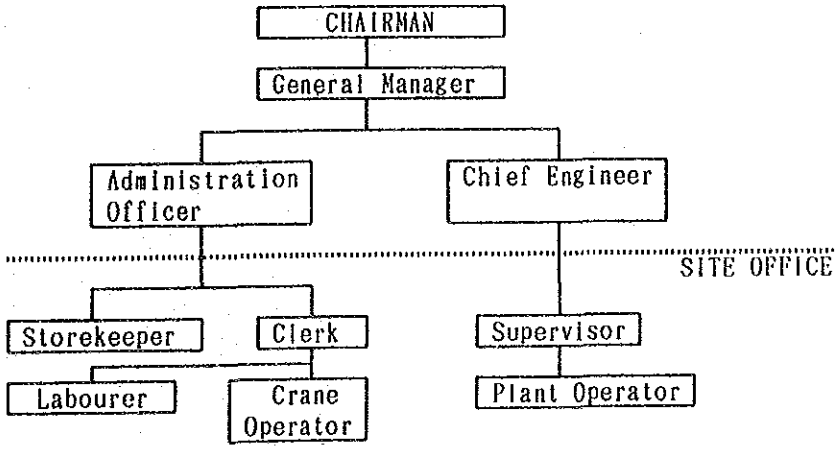



**Fig. 3-2 Administrative and Operational Structure for the Harbour by CFHC**

**Table 3-1 Annual Budget for Maintenance of the Harbour Facilities** (unit : Rs.)

| Year | Budget by Harbours | | Budget for Maintenance | | Total |
|---|---|---|---|---|---|
| 1990 | Beruwala | 1,640,050 | Pokirissa | 825,000 | |
| | Tangalla | 162,000 | Ruhunuputha | 415,000 | |
| | Galle | 915,000 | | | |
| | subtotal | 2,717,050 | subtotal | 1,240,000 | 3,957,050 |
| 1989 | Galle | 300,000 | | | |
| | Kirinda | 2,900,000 | | | |
| | Wellamankara | 400,000 | | | |
| | subtotal | 3,600,000 | | | 3,600,000 |
| 1988 | Wellamankara | 500,000 | Maintenance | 1,470,000 | |
| | Galle | 1,000,000 | & Repairs | | |
| | subtotal | 1,500,000 | subtotal | 1,470,000 | 2,970,000 |
| 1987 | | | Pokirissa | 750,000 | |
| | | | Kawaiya | 250,000 | |
| | | | Mutublla | 100,000 | |
| | | | subtotal | 1,100,000 | 1,100,000 |
| 1986 | Wellamankara | 3,000,000 | | | |
| | Tangalla | 250,000 | | | |
| | Galle | 750,000 | | | |
| | subtotal | 4,000,000 | | | 4,000,000 |
| 1985 | data unknown | | | | |
| 1984 | Beruwala | 1,500,000 | Repair of | 100,000 | |
| | Wellamankara | 2,000,000 | Dredgers | | |
| | Tangalla | 500,000 | | | |
| | subtotal | 4,000,000 | subtotal | 100,000 | 4,100,000 |
| 1983 | | | Repair of | 500,000 | |
| | | | Dredgers | | |
| | | | Fuel | 300,000 | |
| | | | subtotal | 800,000 | 800,000 |
| 1982 | Beruwala | 1,000,000 | Repair of | 600,000 | |
| | Myliddy | 2,000,000 | Dredgers | | |
| | subtotal | 3,000,000 | subtotal | 600,000 | 3,600,000 |
| 1981 | Beruwala | 1,000,000 | Repair of | 2,200,000 | |
| | Chilaw | 150,000 | Dredgers | | |
| | subtotal | 1,150,000 | subtotal | 2,200,000 | 3,350,000 |

(2) Examination of the Harbour Maintenance by Dredging

The Harbour maintenance by dredging is supposed to be conducted using one of the dredgers belonging to CFHC, which at present are

a. Pokirissa : Grab Type/presented by Japan in 1966
b. Ruhunuputha : Grab Type/presented by Japan in 1989
c. Kawaiya : Pump Type/presented by the Netherlands in 1980

Considering that Pokirissa is obsolete and its dredging capacity is 15,000 $m^3$/year at most, and that Kawaiya is almost fixed in Beruwala Harbour, Ruhunuputha, which dredging capacity is about 350 - 400 $m^3$/day, is recommended to be used for the Harbour maintenance by dredging.

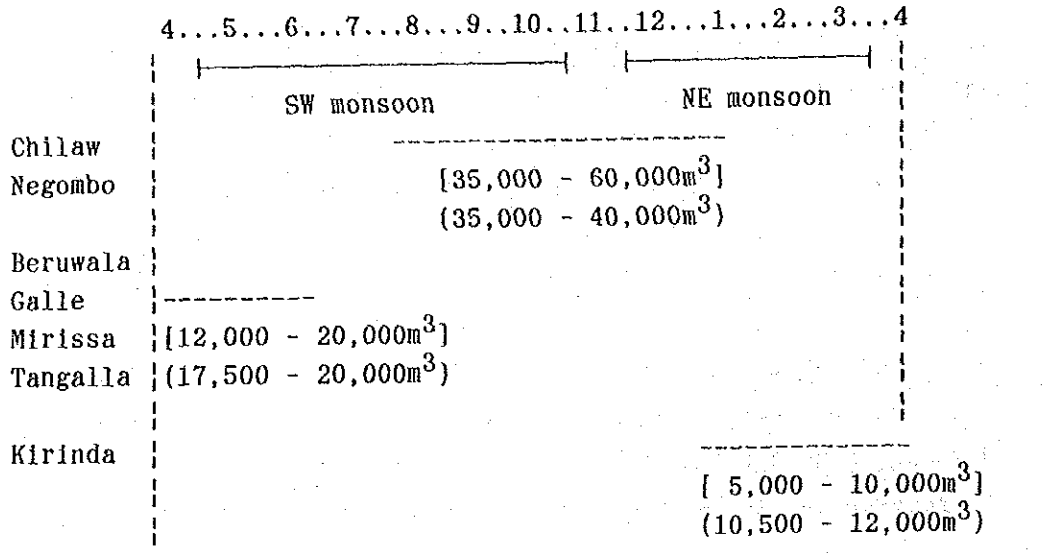
The necessary volume of yearly dredging the sedimentation season in the typical harbours are considered as shown in Table 3-2.

From these situations, a schedule for yearly dredging, as indicated in Fig. 3-3, is proposed.

**Table 3-2 Necessary Dredging Volume in Typical Harbour**

| Harbour | Necessary Dredging Volume($m^3$/year) | Sedimentation Season |
|---|---|---|
| Chilaw | 30,000 - 50,000 | Sep. - Oct. |
| Negombo | 5,000 - 10,000 | ditto |
| Beruwala | 3,000 - 5,000 | Apr. - June |
| Galle | 3,000 - 5,000 | ditto |
| Mirissa | 3,000 - 5,000 | ditto |
| Tangalla | 3,000 - 5,000 | ditto |
| Kirinda | 5,000 - 10,000 | Feb. - Apr. |

**Fig. 3-3 Schedule for Dredging**




[] : Necessary dredging volume
() : Capable dredging volume by dredgers

3.2.3 Present Conditions of Existing Functional Facilities

Services of the Kirinda Harbour were rendered to the local fishermen in June 1985 and a number of 3.5-GT-type fishing boats increased to reach about 112 units of its peak in August 1985, when the berthage income showed Rs 15,590. With increasing sand deposits in the harbour, however, a number of calls of fishing vessels decreased to be nil in 1986 and C.F.H.C were obliged to terminate its operation in February 1987.

During the period of the Harbour operation, freezing and cold storage facilities were not used because of lacking enough period for their utilization due to progress of the sand deposits, and because of requiring no facilities with such functions due to under-development of fish distribution system.

The functional facilities are almost maintained in good conditions despite termination of the harbour operation. The harbour equipment such as a mobile crane, electric pumps, etc. is stored in the Galle harbour, the operational body of which administrates the Kirinda harbour too. The cold

storage and freezing facilities are timely maintained by an engineer from C.F.H.C.

No defects of the machines for freezing and cold storage facilities are not found due to inside installation of the equipment and a stand-by generator is confirmed to operate in good conditions.

It is deemed natural that the functional facilities as mentioned above were not fully utilized during the Harbour operation period. There remains an under-developed fish distribution system that facilities for keeping freshness are served only for fish distributed to Colombo and other inland cities and for fish products for exports. If demands for inboard cold storage facilities are recognized for conserving freshness of fish with increasing fishing days per trip, cold storage and freezing facilities in the harbour will be utilized efficiently. However, such efficient utilization of the above facilities needs further time because conservation or improvement of fish freshness is required with equipping cold storage rooms in small fishing boats with inboard engines. Since consumers are expected to realize necessity of freshness of fish as to be sanitary affairs, a fish distribution system will be necessarily improved with introducing refrigerator trucks and freezer showcases at retail shops.

It is impressed that fishermen in Kirinda feel the necessity of inboard cold storerooms and that, therefore, the existing functional facilities will be sufficiently utilized in a near future.

To meet the above circumstances, C.F.H.C. is recommended to conduct regular maintenance and operation of these facilities and to overhaul the machinery of the facilities on the occasion of reopening the Harbour services.

### 3.2.4 Evaluation of Size and Capacity of Facilities

#### (1) Landing Facilities

1) Wharf

The length of the existing wharf in the Kirinda Harbour is 150 m, extension of which is not covered in the Project. It is confirmed whether or not an estimated number of fishing boats in a future as shown

below be moored in the harbour.

3.5-GT-type boat : 90 units
FRP & traditional boat: 130 units

Fish will be unloaded in around 20 minutes following present unloading system, which will result in recognition of sufficient size of the wharf. The conditions are reminded that all fishing boats be moored lengthwise, that time for supplying fuel and water be minimized, and that unloading time be shared into two times a day to produce efficient unloading time.

2) Beaches

With improvement of the harbour facilities in addition to construction of the sub-breakwater, calm waters in front of beaches will be secured and they will provide efficient unloading places for 150 traditional fishing boats along the beaches.

(2) Idling facilities

The estimated units of 90 fishing boats of 3.5-GT type will be sufficiently moored in the waters secured by improvement of the harbour facilities with providing temporary mooring waters in front of the harbour.

(3) Yard for future expansion

The sand beach inside the harbour plays a role to reduce wave agitation in the harbour and it will also create a yard for future expansion of the existing wharf with constructing a 100 m wharf, a type of which shall be an absorb-wave-agitation type such as a steel-pipe-pile structure. The beach between the existing and the new sub-breakwater will play a same role in a future if necessary.

(4) Freezing and Cold Storage Facilities

Future catches unloaded in the Kirinda Harbour is estimated in the Chapter 6, which is applied to evaluate the capacity of the said facilities. The daily fish catches unloaded in the harbour is summarized as follows:

| | | |
|---|---|---|
| Catch by 3.5 GT fishing boats | : | 9,000 kg/day |
| Catch by FRP fishing boats | : | 2,400 kg/day |
| Catch by canoes | : | 1,440 kg/day |
| Catch by Canoes | : | 1,225 kg/day |
| Total | : | 14,065 kg/day |

With applying the above catches and several conditions for a fish distribution system in a future, the capacities of captioned facilities are evaluated as below:

1) Freezer

Daily consumption of ice: 4.4 tons (less than 5 tons of the existing capacity)

2) Cold storage Facility

6.75 tons as maximum fish stored (less than 10 tons of the existing capacity)

It is concluded that the capacities of the freezer and cold storage facility will meet the future demands. It is recommended that the latter will be used for conserving freshness of fish landed except normal auction time and that the freezer will be provided for valuable catches such as lobsters and shrimps.

## 3.3 Project Description

### 3.3.1 Location and Conditions of Project Site

(1) Plan of Facilities

The conditions of the planned facilities are shown in Table 3-3 and Fig. 4-1 shows their locations.

(2) Quarry Site

The planned facilities will be made of rubble stones. These stones will be quarried out from Binkeramahela located about 25 km northward of Kirinda.

### 3.3.2 Outline of Facilities

Table 3-4 shows the outline of the scope of the facilities.

**Table 3-4 Scope of Facilities**

| Facilities | Length | Crest Elevation |
|---|---|---|
| Groyne | 200 m | + 4.0 m |
| Extension of Main-breakwater | 200 m | + 4.5 m |
| Improvement of Main-breakwater | 100 m | + 4.0 m |
| Sub-breakwater | 230 m | + 3.5 m |

**Table 3-3 Conditions of Planned Facilities**

| Facilities | Conditions |
|---|---|
| Groyne | It is planned to locate the groyne at the channel between the Kirinda Point and the rocks exposed to the sea. The length of the Groyne will be 200 m. The detailed bathymetric data around it have not been obtained because of the critical sea conditions at the channel. The limits of the planning water depth of the Groyne are considered to be from 2 to 5 m. A temporary approach road of 600 m length will be constructed for the construction works of the Groyne. |
| Extension of Main-breakwater | The Main-breakwater of 200 m length will be extended.<br>The foundation of the breakwater is sandy and the limits of the planning water depth will be from 3 to 6.5 m. Although the sea bottom which depth is more than 6 m will be stable, in the shallower area the depth of sea bottom will vary according to the monsoon seasons. |
| Improvement of Main-breakwater | The crest elevation of the existing Main-breakwater, 100 m back from the head, will be raised up to +4.0 m above L.W.L.. |
| Sub-breakwater | It will be located at about 350 m to the east of the existing sub-breakwater. The limits of the planning water depth will be from 2 to 5.5 m. The location of the shoreline nearby the new Sub-breakwater will be shifted seaward about 60 to 80 m in the NE monsoon season after the SW monsoon season. A temporary approach road of about 600 m length will be constructed. |

### 3.3.3 Operation and Maintenance Plan

Aspects of the operation and maintenance of the Harbour are as follows:

(1) Operation and maintenance of the fishery harbour facilities
   a. Maintenance and repair of the breakwaters
   b. Maintenance and operation of the freezing and cold storage room
   c. Management and maintenance of the offices and the workshops

(2) Maintenance by Dredging
   a. Dredging by a grab type dredger
   b. Sounding around the Harbour to obtain the sea bottom configuration and determine the required dredging

Works of item (1) will be carried out by CFHC, forming the operational structure shown in Fig. 3-2. The dredger which belongs to CFHC will be used for the maintenance by dredging. Sounding will be conducted by a survey team which is organized by CFHC.

Particularly works of item (2) are most important and indispensable to maintain the harbour functioning.

From the results of the annual budget of CFHC, the annual expenses for the operation and maintenance of the Harbour will be estimated as shown in Table 3-5 under the following conditions:

   a. Amount of yearly dredging volume is 10,000 $m^3$.
   b. Unit price of the dredging is Rs. 100/$m^3$.
   c. The period of the dredging work is about one month in NE monsoon season.
   d. Sounding is carried out twice a year.

**Table 3-5 Tentative Annual Expenses for the Harbour Maintenance** (Rs.)

| | |
|---|---|
| Total Expenses for the Maintenance of the Facilities | 1,520,000 |
| Breakwaters | 750,000 |
| Freezing and Cold room | 10,000 |
| Office and Workshops | 10,000 |
| Personal Expenses | 365,000 |
| Electric Charges | 385,000 |
| Total Expenses of the Maintenance Dredging | 1,480,000 |
| Dredging | 1,000,000 |
| Sounding | 480,000 |
| Total Expenses | 3,000,000 |

# CHAPTER 4

# CHAPTER 4 BASIC DESIGN

## 4.1 Design Policy

In the basic design of this rehabilitation plan, the following basic policies are taken into consideration.

1. The facilities should be planned to be sufficiently functional against the attacking waves and sediment siltation.
2. The influence on environment around the project site should be considered.
3. Utilization of local manpower and materials should be maximized for the activation of the local economy, considering the local technical skill level.
4. The period of the construction works will be 24 months.

## 4.2 Study and Examination of the Design Criteria

### 4.2.1 Design Criteria

In this study, the 'Technical Standards for Fishery Harbour Facilities in Japan (1990)' shall be applied in the design of the planned structures. The basic design will be carried out on the basis of the design conditions and method designated in the Technical Study.

### 4.2.2 Tide

The tide level for the structural design is as follows:

H.W.L.= D.L. + 0.50 m

### 4.2.3 Design Wave

From the Technical Study, the design waves for each planned facilities are as shown in Table 4-1.

**Table 4-1 Design Wave**

| Structure | Water Depth (m) | Design Wave Period(s) | Wave Height(m) |
|---|---|---|---|
| Main Breakwater | 5.0 | 10.0 | 4.0 |
| | 6.0 | 10.0 | 4.8 |
| | 6.5 | 10.0 | 5.0* |
| New Sub-breakwater | 2.0 | 10.0 | 2.0 |
| | 3.0 | 10.0 | 2.7 |
| | 4.0 | 10.0 | 3.4 |
| | 5.0 | 10.0 | 4.1* |
| New Groyne | 5.0 | 10.0 | 3.7 |

* at the breakwater head

## 4.3 Basic Plan

### 4.3.1 Site and Layout Plan

The layout plan is shown in Fig. 4-1; this was proposed in the Technical Study to minimize siltation.

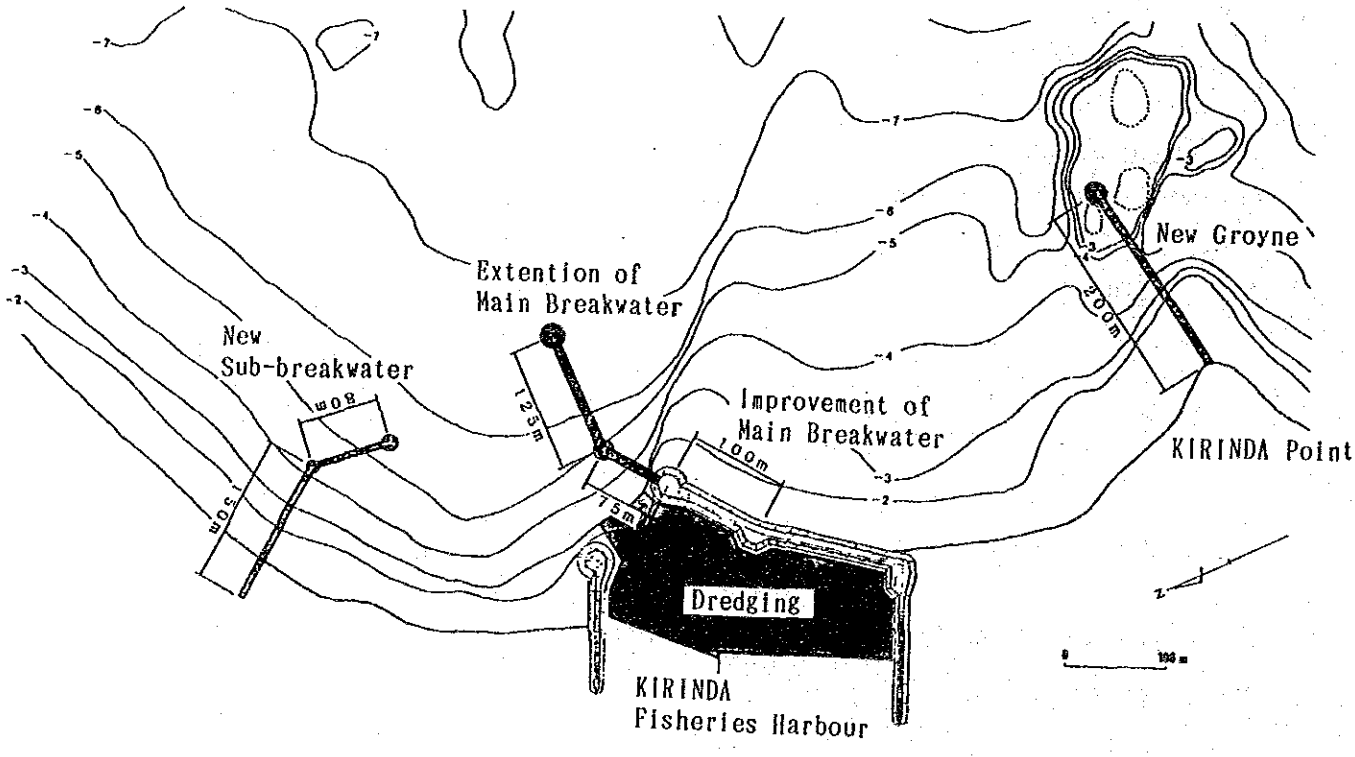



**Fig.4-1 Layout Plan**

4.3.2 Structure of Planning Facilities

As in the existing facilities, a rubble mound breakwater will be adopted as the design structure because of the simplicity of its execution and the easy handling of the materials. A typical rubble mound breakwater consists of three layers, primary and secondary cover layers and core layer, as shown in Fig. 4-2.

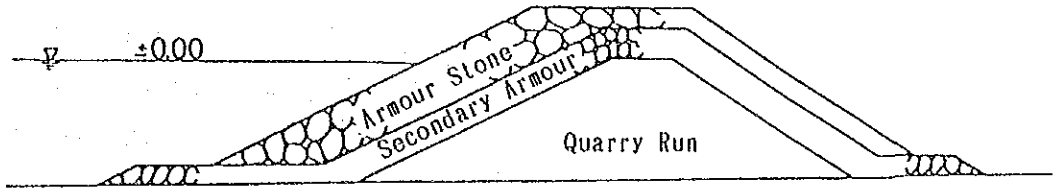



**Fig. 4-2 Structure of Breakwater**

4.3.3 Dimension of Planning Facilities

(1) Crest Elevation

According to the 'Technical Standards for Fishery Harbour Facilities in Japan (1990)', the standard crest elevation can be determined from the following equation

$$R_L = 1.0\ H \qquad (4\text{-}1)$$

where $R_L$ : Crest elevation (m)
$H$ : Significant wave height at the structure (m)

By using this equation, the standard crest elevations at the planned points are calculated and obtained as shown in Table 4-2.

However regarding the Main Breakwater, it was concluded, from the model test of the sand overtopping, that its crest elevation should be +4.5 m above the L.W.L..

For the New Sub-breakwater, it was assumed that its north side can be filled up with sand in the NE monsoon, up to +3.0 m, and some wave overtopping can be permitted. A crest elevation of +3.0 m shall therefore be suitable as the design crest elevation of the New Sub-breakwater.

The crest elevation of the Groyne was examined by applying stability tests and resulted to be +4.0 m.

The design crest elevations of these structures are shown in Table 4-2.

**Table 4-2 Design Crest Elevation**

| Structure | Water Depth(m) | Design Wave Height(m) | Standard Crest Elevation(m) | Design Crest Elevation(m) |
|---|---|---|---|---|
| Main Breakwater | 5.0 | 4.0 | +4.5 | +4.5 |
| | 6.0 | 4.8 | +5.3 | +4.5 |
| | 6.5 | 5.0 | +5.5 | +5.0* |
| New Sub-breakwater | 2.0 | 2.0 | +2.5 | +3.0 |
| | 3.0 | 2.7 | +3.2 | +3.0 |
| | 4.0 | 3.4 | +3.9 | +3.0 |
| | 5.0 | 4.1 | +4.6 | +3.5* |

* at the breakwater head

(2) Crest Width

In the Technical Study the crest widths of the planned structures were set as shown in Table 4-3, under the consideration of the capacity of the construction of the available equipments.

**Table 4-3 Crest Width**

| Structure | Standard Crest Width |
|---|---|
| Main Breakwater | 10.0 m |
| New Sub-breakwater | 6.0 - 8.0 m |
| Groyne | 8.0 - 10.0 m |

(3) Weight of Armour Stones

Necessary weights for the primary cover layers calculated by the Hudson formula Eq. (4-2), are shown in Table 4-4. At the present conditions, there will be difficulty to obtain and manage quarry stones of more than 10 ton. The stabilities for those sections which might need more than 10 ton, as calculated from the Hudson formula, were confirmed by conducting 2-D stability tests in the Technical Study. The design weights of primary cover layers are also shown in Table 4-4.

The size of the armour stones which should be placed at less than 5 m deep in the Main Breakwater is the same as that of the existing Main Breakwater head.

Furthermore, considering the increase of the incident wave heights, due to the complicated sea bottom configuration in front of the Kirinda Point, the armour stones for the Groyne are adopted to be heavier than those obtained by applying Eq. (4-2) .

$$W = rw^3H^3/(KDcot(a)(r-w)^3) \qquad (4\text{-}2)$$

where
- W : Weight (ton)
- KD : Stability coefficient (KD=3.2 was used)
- a : Angle of structure slope measured from horizontal in degrees (cot(a)=2 was used)
- w : unit weight of sea water (ton/$m^3$)
- r : unit weight of armour stone (ton/$m^3$)
- H : Design wave height at the structure site (m)

**Table 4-4 Design Weight of Primary Cover Layer**

| Structure | Water Depth(m) | Design Wave Height(m) | Calculated Weight(ton) | Design Weigh (ton) |
|---|---|---|---|---|
| Main Breakwater | 5.0 | 4.0 | 6.8 | 6 - 8 |
| | 6.0 | 4.8 | 11.8 | 8 - 10 |
| | 6.5 | 5.0 | 13.3 | 8 - 10 |
| New Sub-breakwater | 2.0 | 2.0 | 0.9 | 1.5 - 3 |
| | 3.0 | 2.7 | 2.5 | 1.5 - 3 |
| | 4.0 | 3.4 | 4.2 | 3 - 5 |
| | 5.0 | 4.1 | 7.3 | 6 - 8 |
| Groyne | 3.0 | 2.7 | 2.5 | 3 - 5 |
| | 4.0 | 3.4 | 4.2 | 5 - 7 |
| | 5.0 | 4.1 | 7.3 | 8 - 10 |

### 4.3.4 Basic Design Drawings

The design drawings of rehabilitation works are listed below.

Fig. 4-3 Location of Kirinda
Fig. 4-4 Layout Plan
Fig. 4-5 Standard Cross-section of Main-breakwater
Fig. 4-6 Standard Cross-section of Groyne
Fig. 4-7 Standard Cross-section of Sub-breakwater

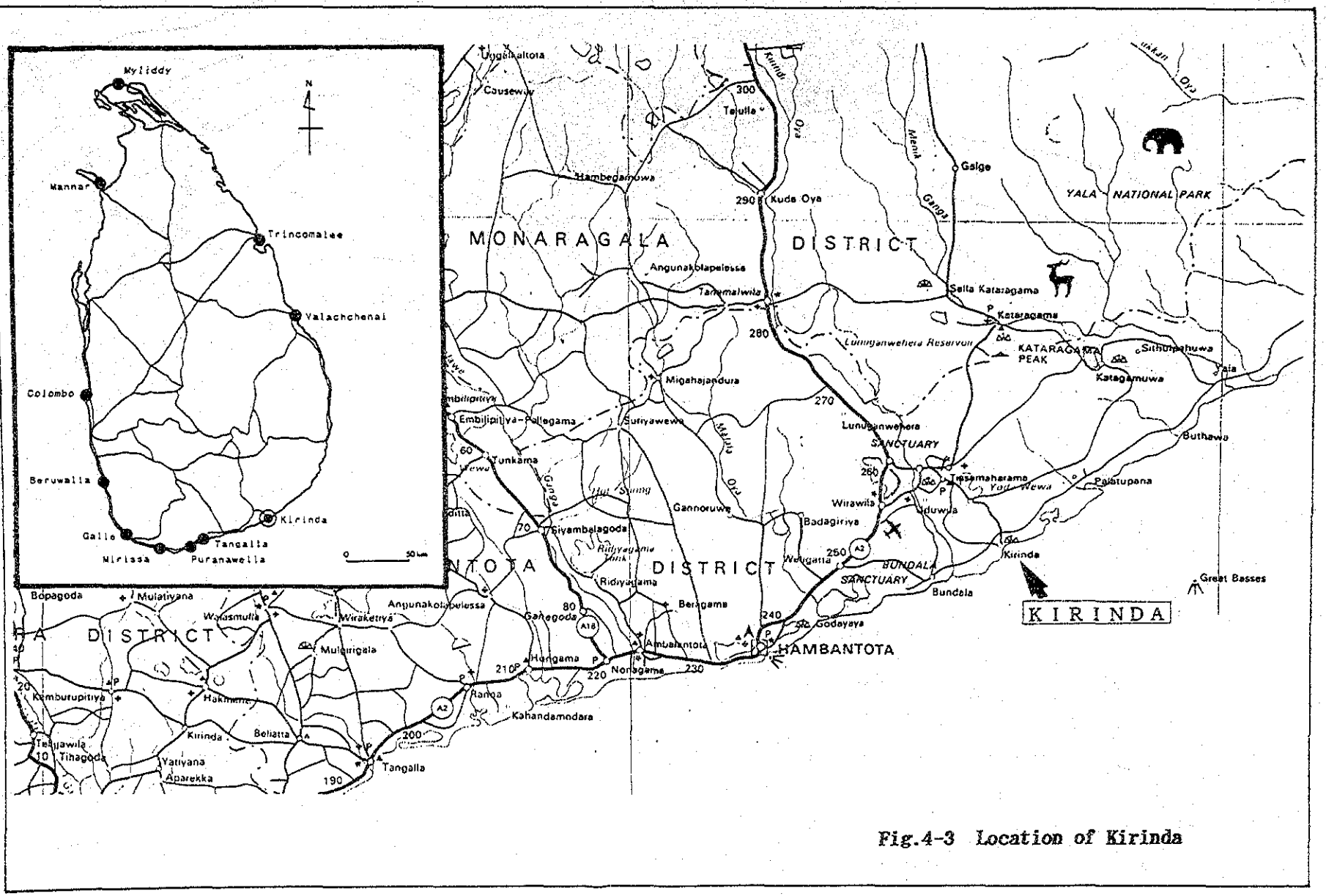



Fig.4-3 Location of Kirinda

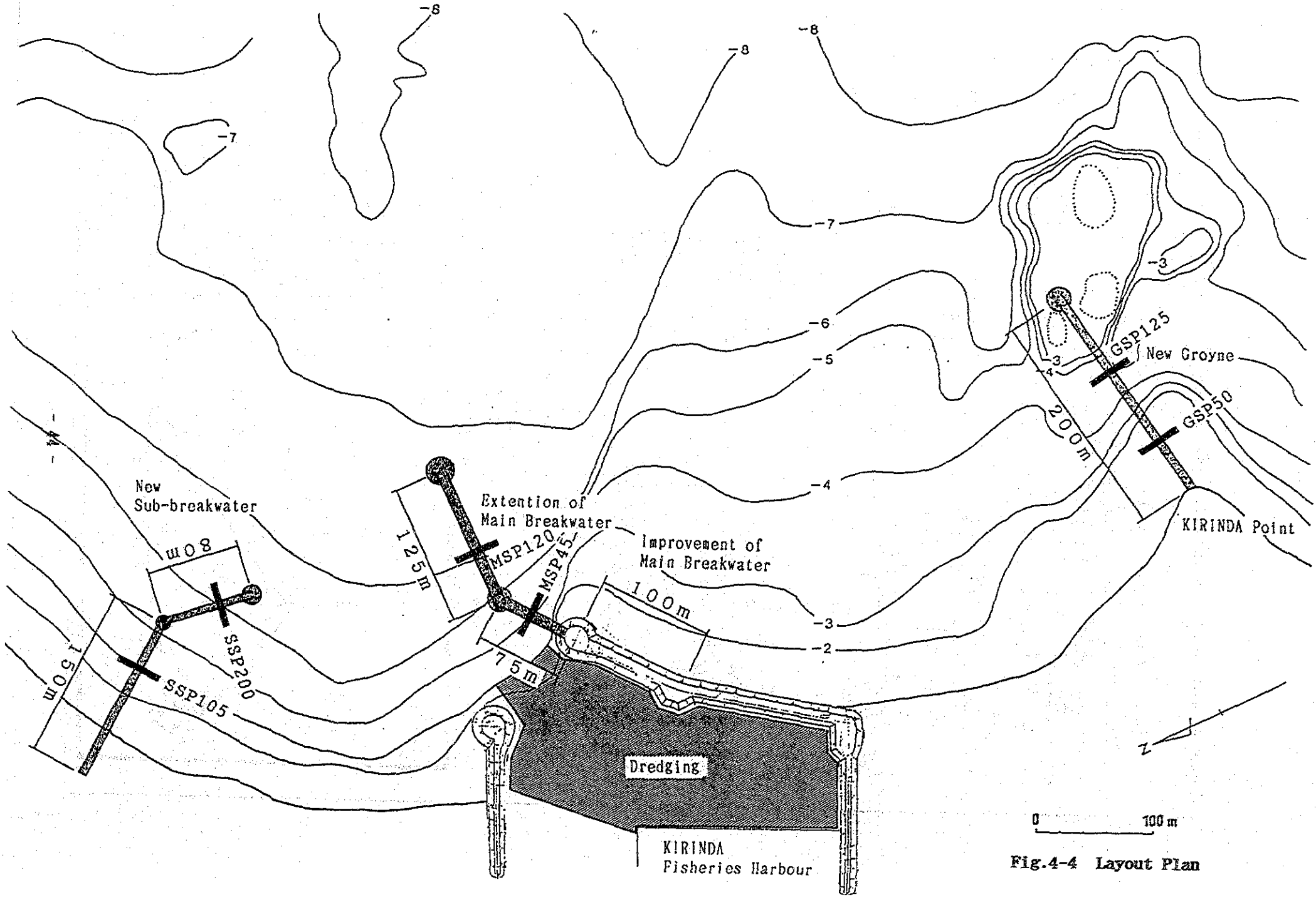



**Fig.4-4 Layout Plan**

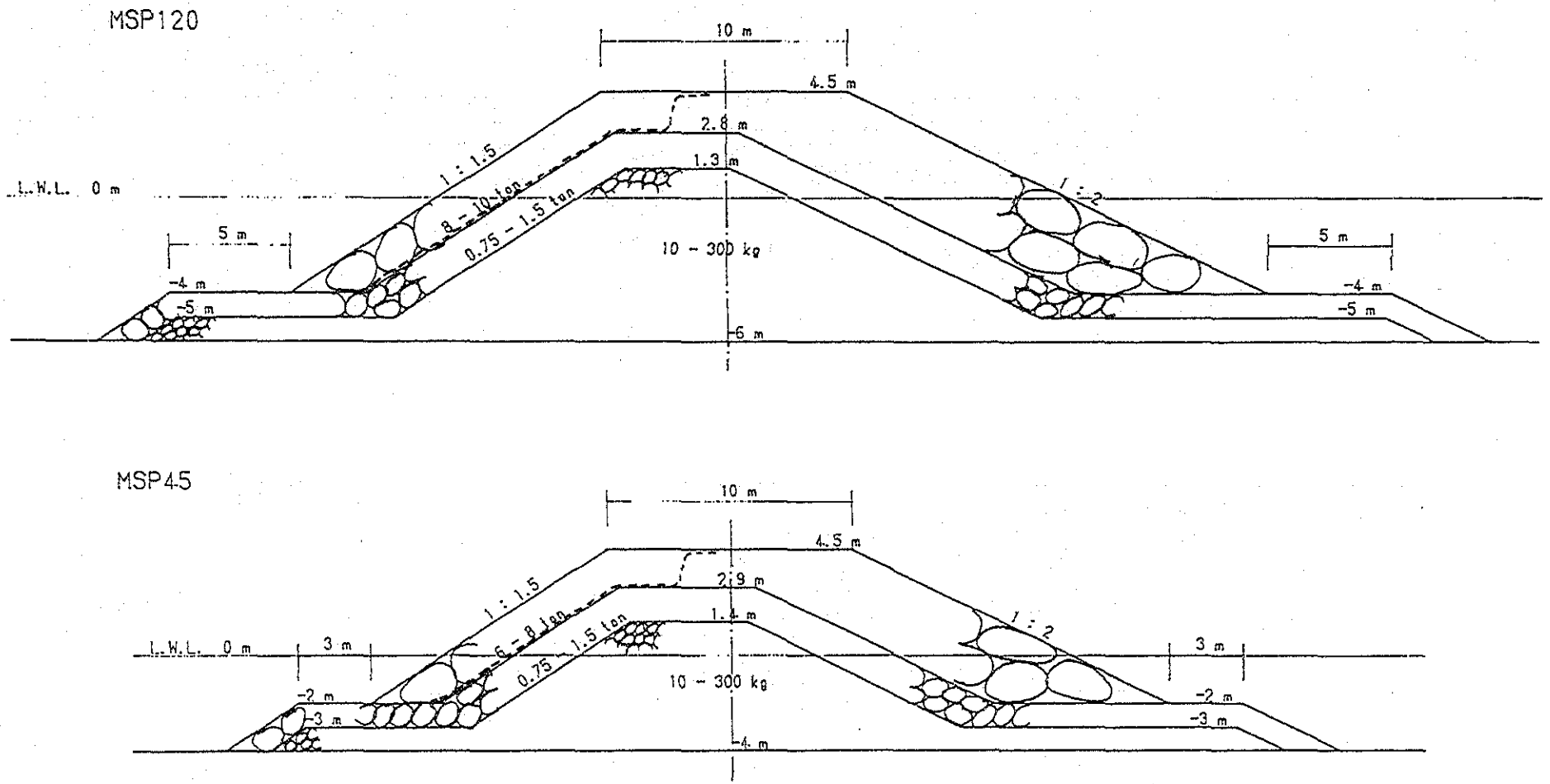



**Fig.4-5 Standard Cross-section of Main-breakwater**

---- Sand Guard Mat

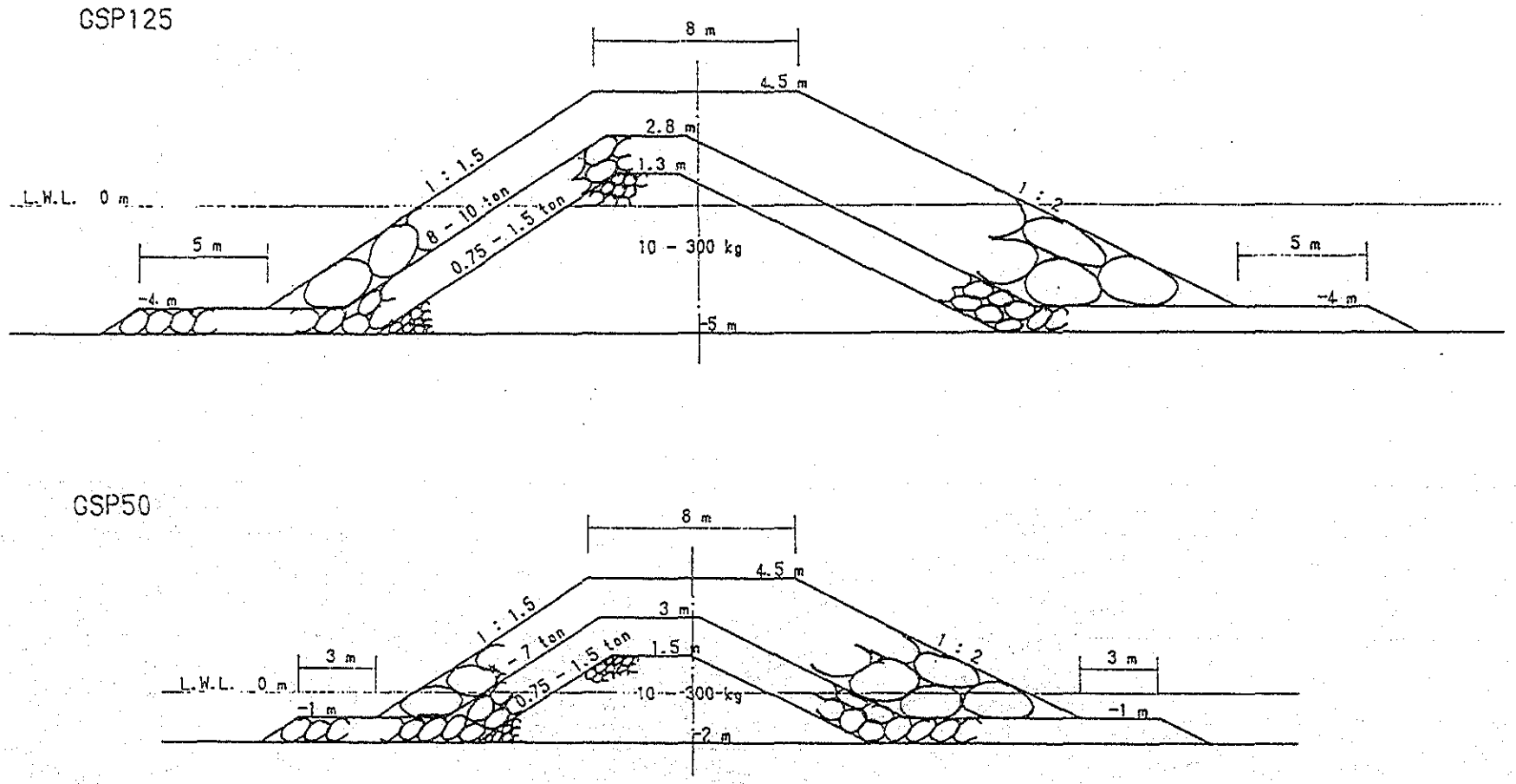



**Fig.4-6 Standard Cross-section of Groyne**

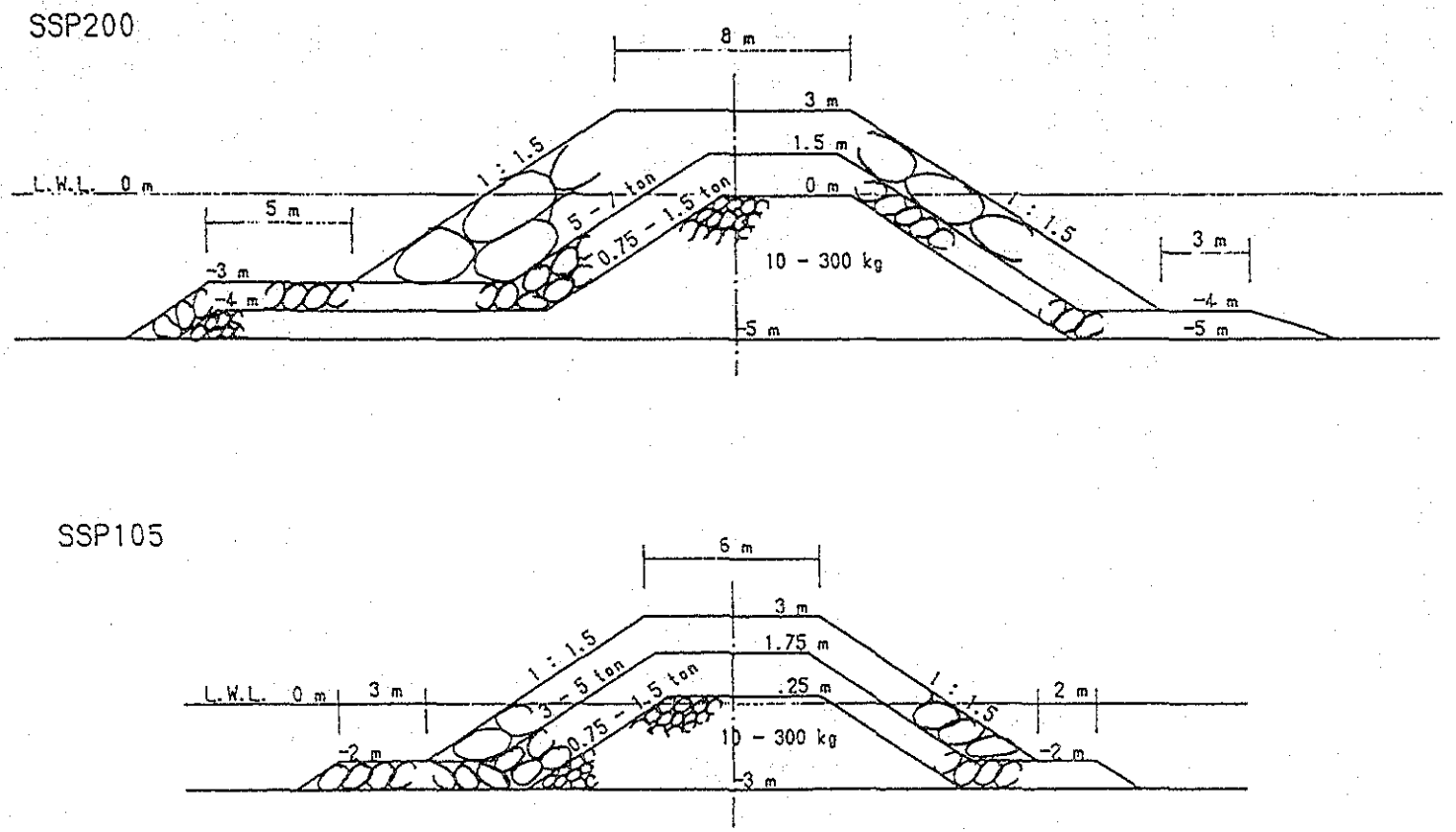



Fig.4-7 Standard Cross-section of Sub-breakwater

## 4.4 Implementation Plan

### 4.4.1 Construction Conditions

Local conditions have been examined through field surveys in Sri Lanka, these are as follows:

(1) Construction Materials

1) Stones
The quarry site in Binkemahela which is located at about 25 km from the Harbour, contains a lot of granite and it is possible to obtain 10 ton class armour stones as a maximum. This quarry belongs to the Government of Sri Lanka and rocks from this place were already used in the previous Harbour construction.

2) Cement and Concrete
Although importation of 40 kg cement bags are available in the Country, concrete delivery service is available only in Colombo area. Therefore production of site mixed concrete at the project site will be necessary.

3) Gasoline and Light Oil
Gasoline and light oil are available at Kirinda.

4) Dynamite
Dynamite is available in Colombo. Careful control and observation of the Government Regulation in storing and handling dynamite will be required.

(2) Labour

Labourers such as carpenters, iron workers, truck drivers, bulldozer operators, etc. are available in Sri Lanka, however, skilled operators for large capacity cranes, masons and divers are not. Therefore these operators must be employed from foreign countries.

(3) Construction Equipment

Equipment for drilling , selecting and gathering of rocks, dumping and placing of rocks, etc. are necessary for this project. From the investigation on the availability of machinery in Sri Lanka, it is clear that machinery for earth work, road construction and small cranes are available at local companies, but large capacity cranes are not. Nevertheless, the machinery is not in sufficiently reliable conditions and it will be difficult to rent them for a long term.

(4) Standards on Construction

British Standards are used in civil works in the country, but since the Japanese Standards on fishery facilities can be applied, these will be used.

(5) Local Construction Firms

There are many local construction firms with sufficient capacity and experience on road and building construction work.

(6) Notes on Implementation Works

In this project, the main works are quarrying, transportation and placing of stones.

Before the quarrying, the habitants and their houses near the site have to be removed. The storage of dynamite shall be carefully controlled and safety of surroundings shall be assured. The effects on the inhabitants and houses around the road due to the transportation of quarry stones also should be checked occasionally. Further, in the placing of stones, the effects on the sea area around the project site should be observed.

4.4.2 Implementation Method

Facilities for the project and classification of works are as follows:

| Facilities | Main classification of works |
|---|---|
| Extension of Main Breakwater | Quarrying |
| Rehabilitation of Main Breakwater | Stone work |
| Sub-breakwater | Pavement |
| Groyne | Dredging |
| Dredging Inner Harbour | |

Each work item is outlined below.

(1) Quarrying

All rocks for construction of the facilities will be transported from the quarry site in Bogahapelessa. Quality and volume are confirmed to be suitable for the work.

Prior to dynamiting, surface soil in an area of 3,500 sq.mtrs be removed.

Dynamited rocks be selected and collected into several sizes with a bulldozer. Necessary volume of natural rock ground is estimated at 223,000 c.mtrs and 525 c.mtrs of rocks be blasted daily.

Several machinery for loading rocks on dump trucks be employed to meet sizes of rocks. Transportation of rocks from the quarry to the site will be conducted with 50 units of dump trucks. Volume of rocks to be used for the project is 175,000 c. mtrs and rocks of about 350 c.mtrs is daily required for the construction.

(2) Stone work

Rubble rocks filled into nylon-netted baskets be placed for construction of the core of the some part of the breakwater and groyne for preventing dispersion of rubble rocks. These baskets are placed with a crawler crane and other rocks are dumped directly from trucks. Core surfaces in water and above water be leveled by divers and backhoes respectively.

Armour stone be placed and leveled with crawler cranes.

(3) Pavement

Asphalt pavement with 5 cm in thickness be applied to the top surfaces of all rock structures.

(4) Dredging

In the wake of the construction completion of the breakwater, accumulated sand of 120 thousand c. mtrs in the harbour be dredged. A crawler crane with a grab bucket and a backhoe will be employed for the dredging work. Spoil be spread in the yard specified by the Government.

4.4.3 Construction and Supervisory Plan

(1) Detailed Design

In the detailed design stage, the Japanese consultant who shall be employed by the Government of Sri Lanka will conduct the site survey. Besides, this will prepare the design charts and the tender documents.

The sounding survey will be included in the site survey and together with the offshore wave observation through the construction period will be entrusted to the local consultants.

After the preparation of the tender documents, the consultant shall provide assistance to the client in tendering, reviewing and preparing the detailed work plans.

(2) Supervision on Construction

The consultant shall employ a supervisor for the project site, who shall have experience in harbour construction and siltation problems. The supervisor shall supervise not only the construction works, but also the wave observation and the sounding survey.

Simultaneously, the estimation of the sea bottom deformation by a numerical simulation will be done in Japan on the basis of the results of the wave observation and the sounding survey. The results of the numerical simulation will be applied to verify the construction plan. Furthermore an expert on sand drift shall be dispatched to the project site to study the actual condition of topographical deformation, and to evaluate the numerical simulation results. The Project Manager of the consultant shall confirm the completion of the works, after his

inspection of them at site.

4.4.4 Supervision on Sea Bottom Changes

As mentioned above, it is required to supervise the sea bottom changes during the construction of the coastal structures. Besides, the topographical changes around the Harbour after the construction works shall be analyzed by conducting the topographical surveys during at least five years. Table 4-5 shows the survey items and their contents. The results of these surveys should be reported to the Government of Japan (The example of the report form is shown in Appendix 11).

**Table 4-5 Surveys for Supervision**

| Survey | | Contents |
|---|---|---|
| Sounding | /Limits | *From 300 m west of the Groyne to 300 m east of Sub-breakwater in the longshore direction<br>*From surf zone to 6 m depth in the vertical direction |
| | /Intervals | *Less than 200 m |
| | /Frequency | *Once in four months during the construction period<br>*More than once a year after the construction works |
| | /Method | *Echo-sounder |
| Shoreline Survey | /Limits | *From 1,000 m west of the Groyne to the Palatupana Point in the longshore direction<br>*From 0.5 m depth to 4 m above the sea in the vertical direction |
| | /Intervals | *Less than 200 m |
| | /Frequency | *Same way with Sounding |
| Wave Observation | /Period | *Same with the construction works |
| | /Frequency | *12 or 6 times a day, for 20 minutes each |
| | /Method | *Buoy type wave gauge |
| Analysis of Waves and Sand Drift | | *On the basis of the results of the above surveys, the sea bottom changes will be expected and the result will be applied to the construction plan. |
| Aerial Photographic Survey | /Method | *During the construction period |
| | /Period | *At the commencement of the work (a)<br>*One year from the commencement<br>*At the completion of the work (b) |
| | | *Drawing of Topographical-maps in (a),(b) |

### 4.4.5 Procurement Plan

(1) Material

Quarry stones are major materials to be used in this project. The quarry site is located at about 25 km from the harbour site. These stones shall be carried by dump-trucks.

Other materials are asphalt and concrete which are imported and shall be available at the project site.

(2) Equipment

The construction equipments available in Sri Lanka are almost superannuated and difficult to rent for a long period. Furthermore large-sized construction equipments are not available. Therefore, Japanese construction equipments shall be mainly used.

### 4.4.6 Implementation Schedule

According to the implementation procedure of the grant aid project assured by the Japanese Government, this project shall proceed as the following procedure.

1) Exchange of official notes between the Governments of Sri Lanka and Japan

2) Selection of a pertinent Japanese consultant company by Sri Lankan Government

3) Detailed design, tender documentation and management for the project by the consultant

4) Execution of construction work under the supervision of the consultant

The works to be carried out by the government of Sri Lanka and Japan are listed in Table 4-6.

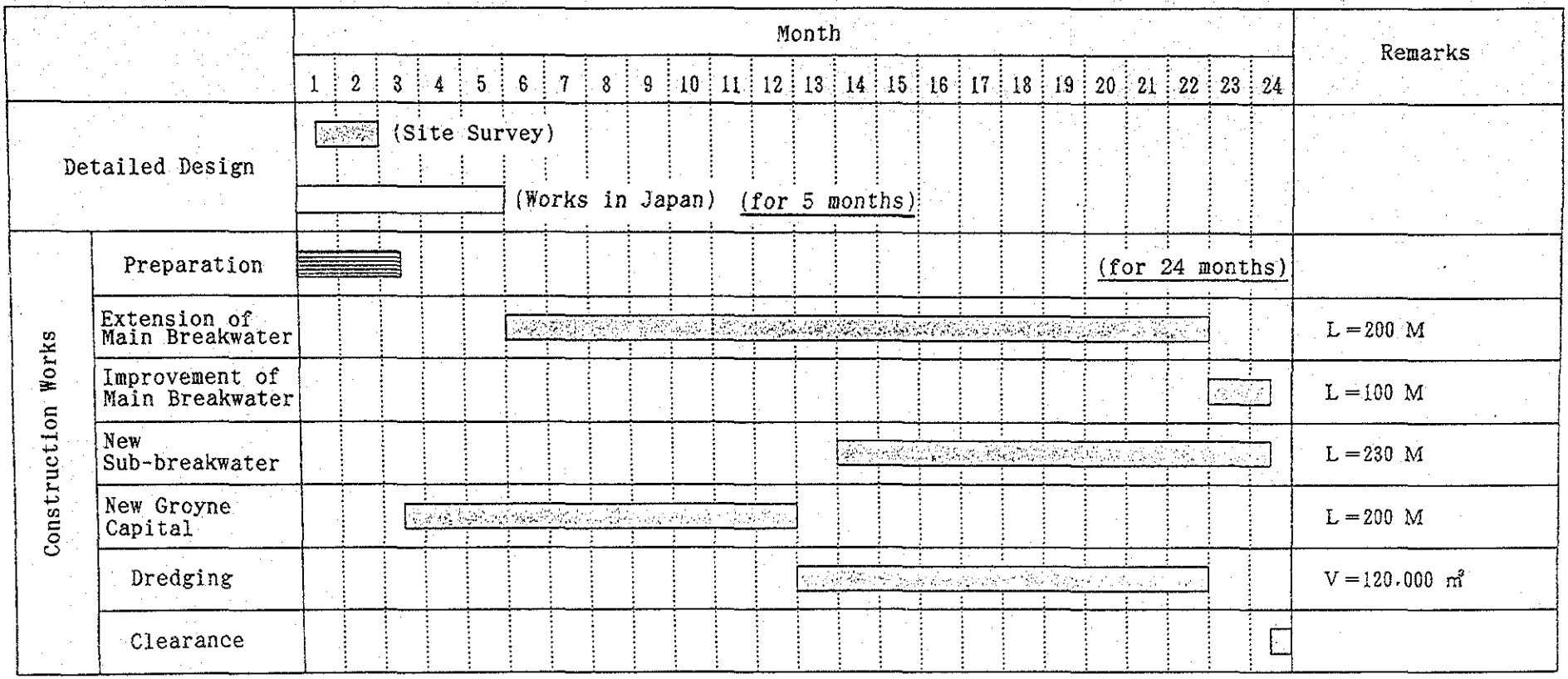
**Table 4-6 Division of Works**

| | |
|---|---|
| Japan | Construction of Groyne 200 m |
| | Extension of Main-breakwater 200 m |
| | Improvement of Main-breakwater 100 m |
| | Inner Harbour dredging |
| | Construction of Sub-breakwater 230 m |
| Sri Lanka | Maintenance and repair of the quarry transportation road for 30 Km length, and construction of turnout area of it |
| | Removal of inhabitants and houses near the quarry site (about 7-10 families) |
| | Exemption from taxation for the construction materials |

Table 4-7 shows the implementation plan. As described in that plan, the construction works will take more than one year, therefore the project have to be divided into some phases to coincide with the Japanese governmental budget system.

After the Detailed Design Study, the construction of the Groyne at Kirinda Point will be commenced at first.

## Table 4-7 Overall Implementation Plan



# CHAPTER 5

# Chapter 5 Project Evaluation and Conclusion

In this chapter, economic evaluation and social effects of the realization of the Project are investigated. Besides, the feasibility of the project and eligibility for a Japanese grant project are evaluated.

## 5.1 Frame of Evaluation

Both economic and financial analysis are investigated after the discussion about the Project effects upon the regional development. Three alternatives mentioned below are examined. The proposed plan in the Technical Study, which is one of the alternatives, was considered to be the most appropriate among them and it is taken up for discussion in this report. The examination of each alternative effects is described in the Appendix.

Alternative Plans

| | |
|---|---|
| Case-1 | Proposed plan in the Technical Study<br>Groyne 200 m length<br>Extension of Main-breakwater 200 m length<br>Sub-breakwater 230 m length<br>Improvement of Main-breakwater 100 m length |
| Case-2 | Reduced plan against Case-1<br>Groyne 200 m length<br>Extension of Main-breakwater 75 m length<br>Improvement of Main-breakwater 100 m length |
| Case-3 | Reduced plan against Case-1<br>Groyne 200 m length<br>Extension of Main-breakwater 75 m length<br>Sub-breakwater 150 m length<br>Improvement of Main-breakwater 100 m length |

The flow chart of evaluation is illustrated in Fig.5-1.

Economic evaluation is a method to judge basically the priority of resources distribution from the view point of national economy, and shall be made based on the economic price translated from market price. Even though

this project consists in the rehabilitation of the existing harbour, more than one cost benefit ratio (B/C) shall be expected. All the alternatives are analyzed by market price.

For financial evaluation, it is required that the business income cover at least the cost of management. At the present stage, the criterion is set such that total income of bodies related to harbour operation, namely CFHC, fishery co-operatives, private sectors, etc., covers the total operating cost of these bodies.

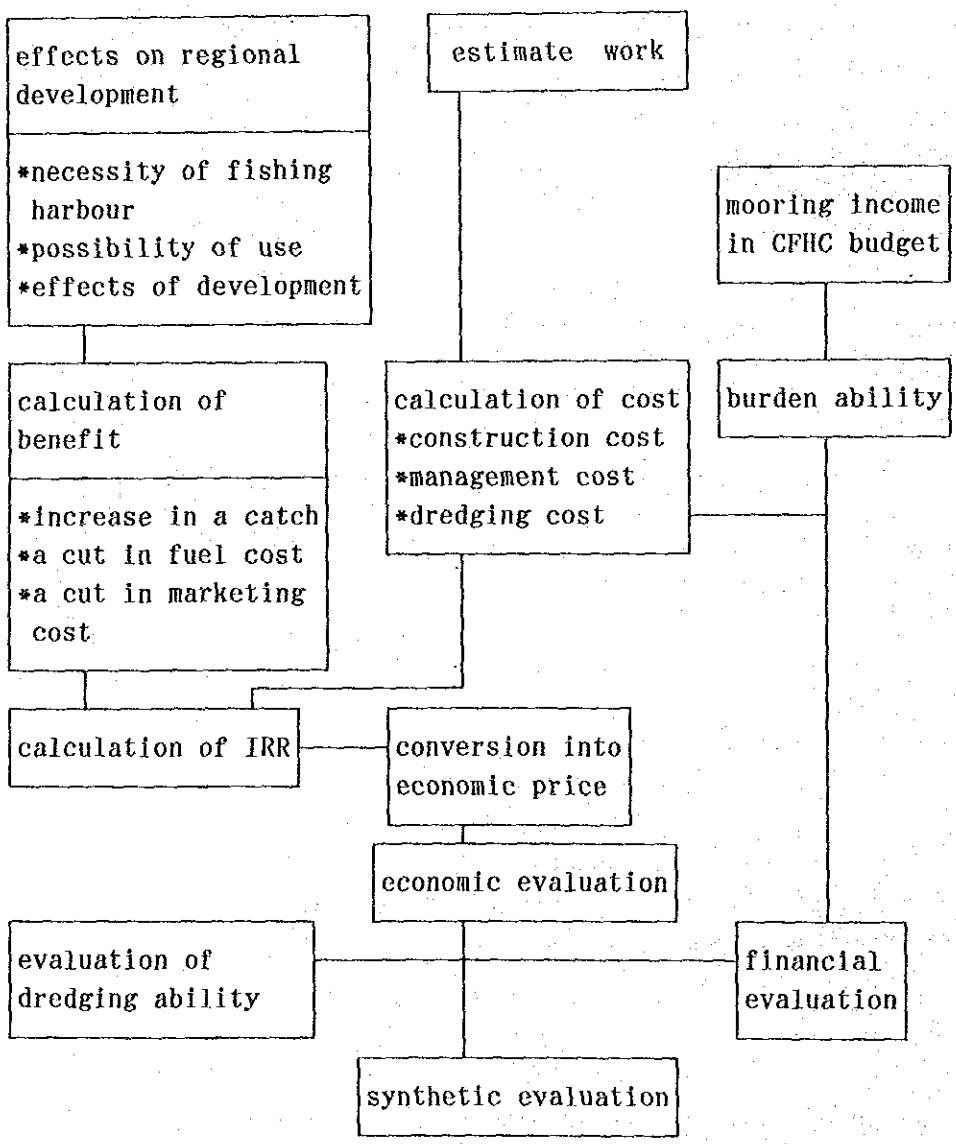



**Fig. 5-1 Evaluation Flow Chart**

## 5.2 Effects on Regional Development

### 5.2.1 Effects on Utilization of Southeastern Fishing Ground

There is an eminent fishing ground called Hambantota Bank in the southeastern coast. As already shown in Fig.3-8, this bank has a wider shallow area in the east, which includes the Great Basses Ridge and the Little Basses Ridge. These shallow sea areas are very good for fishing and their MSY can be totally estimated to be 35,000 ton/year. The present fish catch is estimated to be only 11,400 ton/year in Hambantota District, because of the minor population density and the fishery development lag. This fishing ground is considered to leave about 10,000 ton/year fish catch room in case that the rate of fish catch and fish resource come up to the national level, which is estimated to be 63% in 1989. From the above considerations, the rehabilitation of the Harbour shall contribute to the utilization of the abundant fishing ground.

### 5.2.2 Contribution to Regional Development

Kirinda area, which has a low population density and is located in the center of the Hambantota Bank, shall have the highest possibility of development in comparison with the southwestern region. In case fifty fishing boats are introduced by the Government for five years after rehabilitation of the Harbour, 250 fishermen would increase on the assumption that five fishermen increase per one fishing boat introduced; besides the fishermen families will roughly increase four times the population, that is it will come up to 1,000 inhabitants. Further, supposing that the increase in the population of the related industries would be 10 % of the fishery population, the total increase in the population of Kirinda would be 1,100.

Therefore, the Harbour is positioned as an important part of the KOISP and HIRDEP projects which are developing.

### 5.2.3 Contribution to Supply Animal Protein to the Hinterland

As previously mentioned, according to "The Food Balance Sheet 1988",

people take an average of 7.33 g/day of protein from fish. This amount represents the 14 and 59% of the total protein consumption and that obtained only from animals, respectively. As a special condition of Sri Lanka, there is a big difference in animal protein consumption between urban and rural areas. According to "Labor Force and Socio-economic Survey", in urban area 7.3 kg/month of animal protein is consumed per family, while in rural area is 3.9 kg/month. Fresh fish landed in the Kirinda Harbour will be provided smoothly and inexpensively for the people in the hinterland of Kirinda, e.g. Tissamaharama, Moneragala, Badulla. The population of the hinterland is about 310,000 inhabitants and the amount of fish consumption is estimated to be 2,200 ton/year.

### 5.2.4 Effect on Fishery Industry

Generally effects of the fishery arrangement on the regional development are linked as shown in Fig.5-2.

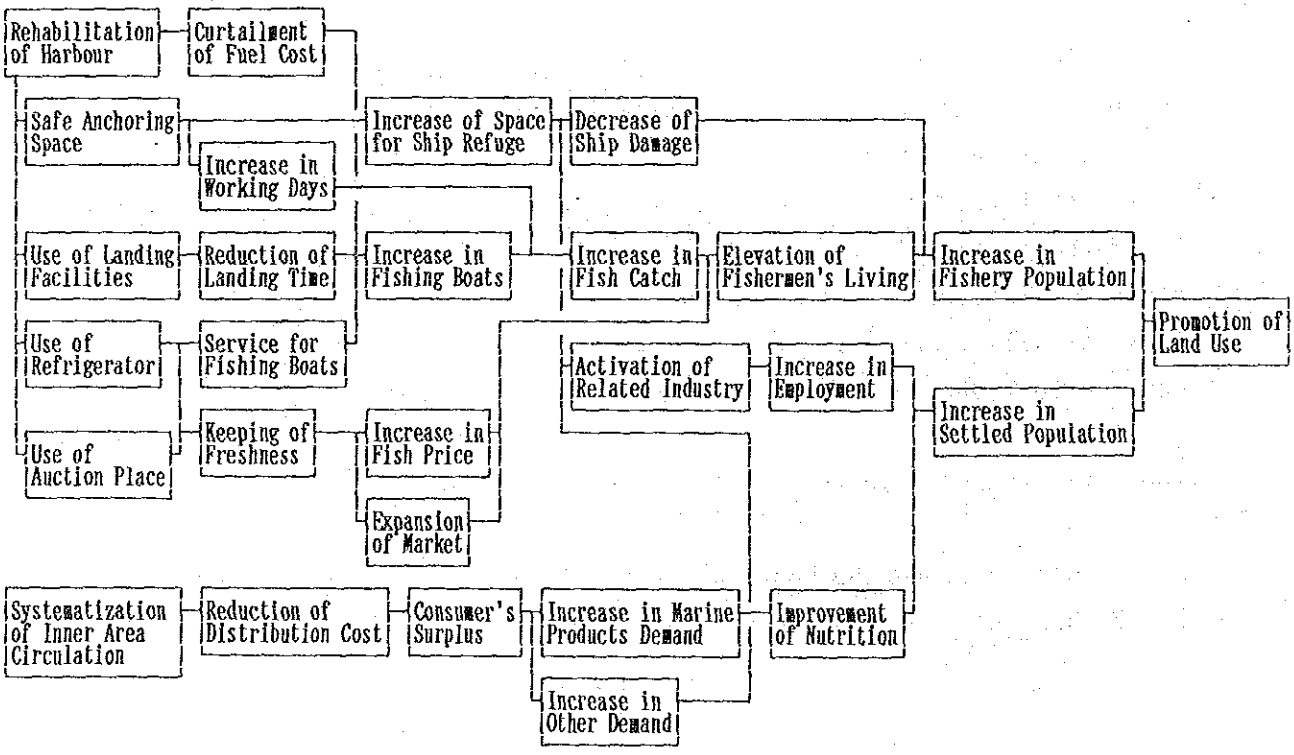



**Fig.5-2 Economic Effects by Rehabilitation of the Harbour**

In case of rehabilitation of the Kirinda Harbour, the following effects are expected.

a. Increase in Fish Catch due to the Rehabilitation

The introduction of 3.5 GT fishing boats can expand the fishing ground and allow all year-round fishing activities in the Kirinda area. Furthermore landing time will become shorter by the arrangement of the existing quay wall, consequently the fishing time shall be extended.

The rehabilitation shall be effective not only for 3.5 GT fishing boats but also for FRP fishing boats and canoe with outboard engine.

b. Reduction of Fuel Consumption of Fishing Boat

At present, the Tangalla Fisheries Harbour is the only harbour which has the well-equipped landing facilities for more than 3.5 GT fishing boats in Hambantota District. The Tangalla Harbour is located at 60 km west of Kirinda and the rich fishing ground, e.g. the Great Basses Ridge and the Little Basses Ridge, is positioned at the east of Kirinda. Therefore in case that more than 3.5 GT fishing boats use the Harbour, fuel consumption of the fishing boats shall be reduced.

c. Storing Fish by Use of Cold Storage

Using the cold storage to keep ice and fish, the fish can be protected from spoilage. In case that 3.5 GT fishing boats are used for multi-days fishing operation in future, the ice storage or the ice plant shall be the most important for keeping fresh fish.

d. Improvement of Safety in Navigation

By the rehabilitation of the Harbour, the anchorage will be expanded and consequently the safety in navigation for fishing boats will be raised.

e. Saving of Distribution Cost

The increase in fish catch at Kirinda will promote the introduction of insulated vans in the hinterland. Therefore efficiency of the fish transportation will be raised. The distribution distance between the landing place to the market place shall be also reduced. These conditions will be expected to contribute to the reduction of the distribution cost.

The effect of the saving by reduction of the distribution distance can be estimated as the benefit value.

f. Increase in Fishermen's Income

Table 5-1 shows the expectation of fishermen's income after rehabilitation of the Harbour. The increase in the income will be considered to occur by modernization and increase the number of the fishing boats. The fishermen's income in Kirinda will come up to three times of the present one, and the income per fisherman will increase one and half times.

**Table 5-1 Expectation of Fishermen's Income**

| Item | 1989 | Future |
|---|---|---|
| Fish Catch(ton) | 837 | 2,500 |
| Amount of Fish Catch(Rs.M) | 24.02 | 71.75 |
| Fishermen's Income(Rs.M) | 3.14 | 9.54 |
| Number of Fishermen | 250 | 500 |
| Income per Fisherman(Rs.) | 12,574 | 19,089 |

g. Increase in Opportunity of Employment

Activation of inner-circulation by the fishery industry will stimulate the related industries in a hinterland. Particularly the hinterland of Kirinda is benefited with tourist resources such as Yara natural park, Kataragama etc., so that it could influence not only commerce or the process-products of agriculture but the tourist industry as well. Furthermore,

increase in fishermen's income shall also contribute to activate the related industries. From the above considerations, increase in the employment opportunity in the hinterland is expected.

h. Promotion of Regional Development by Fish Protein Supply

The stable fish protein supply shall guarantee the health of the people who have settled in the hinterland, and contribute greatly to promote the settlement plans.

i. Other Effects

In case that a lot of 3.5 GT type fishing boats use the Harbour, the Tangalla Harbour's burden will be reduced and activation of larger type of fishing boats can be promoted in Tangalla.

Since the Harbour shall have a larger anchorage area after its rehabilitation, in comparison with the actual one, there will be a possibility to receive more than 3.5 GT type fishing boats by extension of the landing facilities such as the quay in the future. Hence, it is expected that the Kirinda Harbour will be available to be used as a base of the offshore fishery as the Tangalla Harbour is.

As mentioned above, this Project will not only influence the regional socio-economic progress, but also will make possible that the Harbour play a leading rule in the fishery industry in the south region.

## 5.3 Economic Analysis

### 5.3.1 Scope of the Economic Analysis

A general property of a project is to discuss about whether the benefit by the project exceeds its investment. In case of this Project, one purpose is to rehabilitate the Harbour which was constructed in 1985 and became immediately malfunction due to siltation. Since some amount of money have been already spent in the previous project, these and the additional investment by this Project were considered as part of the economic analysis. The other part of this analysis neglected the expenses of the previous project. Thus, the economic analysis of the Project was conducted under the following conditions:

(1) Analysis for 33 years from 1991 in which rehabilitation of the Harbour will be commenced, to 2023 which corresponds to 30th after completion of the Project. The previous construction cost is not considered.

(2) Analysis for 41 years from 1983 in which the previous project was started, to 2023.

In this study, the exchange rate 3.468 yen/rupees is used.

### 5.3.2 Economic Benefit

The economic benefit is estimated from the following three aspects:

(1) Effect of Increase in Fish Catch
(2) Effect of Reduction of Fuel Cost
(3) Effect of Reduction of Distribution Cost

(1) Estimation on Effect of Increase in Fish Catch

The following 3 points are generally considered as primary factors of increase in fish catch.

a. Increase in Fishing Boat

b. Extension of Fishing Operation Period

c. Extension of Daily Fishing Operation Time

a. Number of Fishing Boats in Kirinda

The object of this estimation shall include the fishing boats which are planned to be introduced and are not being used at present.

From the results of the field survey, it was clarified that 100 units per year of 3.5 GT type fishing boats are planned to be introduced by the Government of Sri Lanka during five years, starting from 1991, and 10 % of them are expected to be preferentially distributed to the Harbour. Therefore the number of boats is expected to be increased in 50 units during five years. The increase of the fishing boats will be realizable considering the actual results regarding the number of the fishing boat in Tangalla Harbour (refer to Fig. 2-8).

According to personal communication, FRP boats and canoes with outboard engine, which are using natural sandy beach for landing, are also increasing. After the harbour rehabilitation, these boats will use the extensive calm area, which will be generated by the new groyne and sub-breakwater, for landing or anchoring. They will also use the quay. Consequently, the number of these boats will be expected to increase further.

To calculate the harbour benefit, the following 2 cases are investigated:

Case 1: considering the increment of 3.5 GT fishing boats only
Case 2: considering the increase in FRP and mechanized canoes, besides 3.5 GT boats

The number of the fishing boats is estimated as shown in Table 5-2.

Table 5-2 Estimation of Fishing Boat

| Case | Boat Type | Present | 1993 | 1994 | 1995 | 1996 | 1997 | After 1998 |
|---|---|---|---|---|---|---|---|---|
| 1 | 3.5GT-Type | 40* | 50 | 60 | 70 | 80 | 90 | 90 |
| | FRP | 30 | 30 | 30 | 30 | 30 | 30 | 30 |
| | Canoe(OB) | 20 | 20 | 20 | 20 | 20 | 20 | 20 |
| | Canoe(Non-mech) | 61 | 61 | 61 | 61 | 61 | 61 | 61 |
| | total | 151 | 161 | 171 | 181 | 191 | 201 | 201 |
| 2 | 3.5GT-Type | 40* | 50 | 60 | 70 | 80 | 90 | 90 |
| | FRP | 30 | 33 | 36 | 40 | 44 | 48 | 48 |
| | Canoe(OB) | 20 | 22 | 24 | 26 | 29 | 32 | 32 |
| | Canoe(Non-mech) | 61 | 59 | 57 | 55 | 52 | 49 | 49 |
| | total | 151 | 164 | 177 | 191 | 205 | 219 | 219 |

* Number of 3.5 GT boats, which is considered to be using the actual grounds of the Kirinda harbour, estimated from the fish-catch data.

b. Fishing Operation Term

Although 3.5 GT type fishing boats can be used all year-round, they move to other fishing grounds during the SW monsoon season, following the canoes that help them to commute and transport fuel, water, etc. After the harbour rehabilitation its landing facilities shall allow the all year-round fishing operation by 3.5 GT boats.

The number of operating days by 3.5 GT fishing boats is set to be 200 days; this is estimated from the actual result of the fish catch and the number of fishing boats, as shown below, and it also corresponds to the planning operating days by MOF.

| Year | Annual Production (ton/year) | Number of Boats | Catch per boat (kg/day) | Number of Operating Day per year |
|---|---|---|---|---|
| 1983 | 57,375 | 2,861 | 100 | 200.5 |
| 1987 | 50,960 | 2,657 | 100 | 191.8 |

Furthermore, expansion of the calm sea area by rehabilitation will enable FRP boats to work throughout the year. Since maintenance of FRP boats is considered to be easier than that of 3.5 GT boats, it is estimated that the annual working days of FRP boats can be more than that of 3.5 GT boats. On the other hand, regarding canoes, since the operation during the beach erosion season is dangerous, a considerable increment of working days, comparing with those of the 3.5 GT or FRP boats, can not be expected.

Based on the above assumptions, the working days by each type of boat are estimated as shown in Table 5-3.

**Table 5-3 Estimation of Working Days**

| | Present | After Rehabilitation |
|---|---|---|
| 3.5 GT | 140 | 200 |
| FRP | 140 | 220 |
| Canoe(OB) | 140 | 150 |
| Canoe(Non-mech) | 140 | 150 |

c. Increase in Daily Fish Catch per Fishing Boat

The landing time of 3.5 GT and part of the FRP boats will be reduced by the facilities of the Harbour. Therefore, the fishing operation time of these boats shall become longer and the catch by canoes will also increase under the influence of the fishing activities.

From the above assumption, the fish catch per day is assumed to be as shown in Table 5-4.

**Table 5-4 Expectation of Fish Catch per Day**

| | Present | After Rehabilitation |
|---|---|---|
| 3.5GT | 70kg | 100kg |
| FRP | 40kg | 50kg |
| Canoe(OB) | 40kg | 45kg |
| Canoe(Non-mech) | 20kg | 25kg |

d. Increase in Annual Catch

From the above considerations, the following annual catch by each type of boat is expected.

**Table 5-5 Estimation of Annual Catch (ton)**

| | Case 1 | Case 2 |
|---|---|---|
| 3.5GT-Type | 1,800 | 1,800 |
| FRP | 330 | 528 |
| Canoe(OB) | 135 | 216 |
| Canoe(Non-mech) | 229 | 184 |
| Total | 2,494 | 2,728 |

e. Benefit Estimation

Though the fish producer prices vary according to the kind of fish, in this study the producer price is assumed to be Rs. 28.7/kg, which is considered as the average of main kinds of fish.

The benefit is obtained by subtracting the sum of the fuel, maintenance and depreciation costs from the total amount of the fish production. A percentage of the benefit is set to be 73% of the total amount of the fish production, which is similar to that obtained in the previous basic design study.

Increment of Fish Catch = (Future)-(Present)

= 2,494 - 837 = 1,657 ton/year

Benefit per year = 1,657 x Rs.28,700/ton x 0.73

= Rs.34,716,000 (120,394,000 yen)

(2) Benefit on Fuel Reduction of Fishing Boats

The fuel reduction is estimated under the assumption that the 3.5 GT fishing boats, which at present are using the Tangalla Fisheries Harbour, will use the Kirinda Harbour.

The benefit is obtained by multiplying the difference of the distances, from Tangalla and Kirinda to a fishing point, by the unit fuel consumption price by double the annual fishing frequency (means up and down).

The calculation of the relations between the locations of the fishing ground and Tangalla and Kirinda Harbours is simplified as shown in Fig. 5-3.

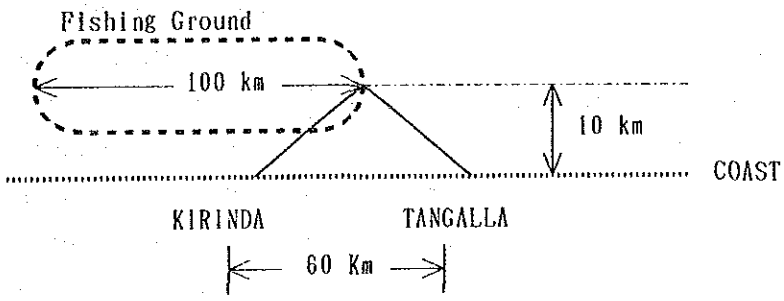



**Fig. 5-3 Relation of Locations**

For some fishing points, in the fishing ground, the differences of the distances between them and both harbours are calculated. The saving distance is obtained as 98 km/boat per trip by taking an average of the differences.

The number of 3.5 GT boats, which are supposed to operate in the fishing ground, and belong to the Tangalla harbour originally, are 38

boats. This number is calculated by subtracting two boats which belong to Kirinda Cooperative Association from 40 boats which are considered to be landing fish at Kirinda at present. The benefit is estimated as follows:

| | |
|---|---|
| Fuel Consumption | : 0.8 l/km |
| Unit Price of Diesel Oil | : Rs.20/l |
| Saving Distance per year | : 98 km x 38 boats x 200 days = 744,800 km |
| Benefit per year | : 744,800 x 0.8 x 20 = Rs.11,917,000. (41,327,000 yen) |

(3) Benefit on Reduction of Distributing Cost

In the second field survey, it became clear that the fish distribution to the inland is pretty active and the insulated vans are considerably used for the long distance transportation. The distance from Kirinda to the hinterland is shorter than that from Tangalla. Therefore, the benefit of cost reduction for distribution to the hinterland can be estimated by multiplying the difference of the distance by a unit price of fuel consumption.

The volume of fish transportation to the hinterland is evaluated from the relation of the population in the hinterland and the fish consumption volume per capita. In this survey, the potential fish demand in Moneragala and Badulla Districts is assumed as 1/4 of the population, because there are lots of plantations in these districts and the fish supply from the eastern coast is also expected. The population in the hinterland is set as follows:

Population Estimated in 1989

| | |
|---|---|
| Tissamaharama AGA | 54,000 |
| Moneragala District | 339,000*1/4 |
| Badulla District | 698,000*1/4 |
| Total | 312,000 |

The fish consumption volume per capita is estimated at 7.66 kg/year in "Food Balance Sheet 1988" and the fish consumption volumes in

rural and urban are in the ratio 3.1 : 3.4. Accordingly the total fish consumption volume in the hinterland is calculated as below:

312,000 x 7.66 kg/year x 3.1/3.4 = 2,179 ton/year

This volume is about 80% of a catch in Kirinda harbour, and assuming that the number of working days of the fish transportation is 220 days, the fish volume which is carried by vans will be 10 ton per day. In case of the volume of ice and fish in the ratio 1:3, it is necessary to carry the fish 7 times a day by a 2 ton insulated van.

The distance to be cut down is considered to be 48 km. Therefore, if 7 vans go and return, the saving distance is 672 km/day totally. As the fuel consumption of a van is assumed at 6 km/l, the saving diesel oil is 112 l/day. From the above considerations, the benefit is calculated below.

112 l x 220 days x Rs.20/l = Rs.492,800/year
(1,709,000 yen)

5.3.3 Economic Cost

The project cost, which are mentioned in chapter 4, consists of the following three items.

(1) Construction Cost
(2) MO (maintenance and operation) Cost
(3) Dredging and Monitoring Cost

The monitoring cost means the cost of the bathymetric surveys by which the sea bottom deformations are known.

The MO, dredging and monitoring costs, which are estimated based on the actual results of CFHC are summarized in Table 5-6. The unit dredging cost is set to be Rs.100/$m^3$.

**Table 5-6 MO, Dredging and Monitoring** (Unit:Rs.)

| | |
|---|---|
| Maintenance and operation cost | |
| maintenance cost of facilities | 1,000,000 |
| fuel cost (electric charges) | 100,000 |
| personnel expenses | 380,000 |
| sub-total | 1,480,000 |
| Dredging and monitoring cost | |
| dredging cost | 1,000,000 |
| monitoring cost | 450,000 |
| sub-total | 1,450,000 |
| grand total | 2,930,000 |

The financial price is converted into the economic price corresponding to the international price by the following methods.

* The construction cost is divided into labour cost and tradable and non-tradable goods.

* The labour force is classified into skilled and non-skilled.

* The international price of skilled labourers is obtained by multiplying market wage by consumption conversion factor, and that of unskilled is gotten by multiplying market wage by consumption conversion factor and shadow wage rate.

* CIF price is applied to import goods and FOB price to export goods.

The cost-benefit by the economic price is shown in Table 5-7.

**Table 5-7 Cost-Benefit by Economic Price** (Unit:Rs.M)

| Item | Economic Price Case-1 | Economic Price Case-2 |
|---|---|---|
| Benefit | | |
| Increase of Fish Production | 31.5 | 36.0 |
| Fuel Cost Reduction | 11.9 | 11.9 |
| Distribution Cost Reduction | 0.5 | 0.5 |
| Cost | | |
| Construction Cost (Sri Lanka) | 20.0 | 20.0 |
| MO cost | 1.3 | 1.3 |
| Dredging & Monitoring Cost | 1.3 | 1.3 |

Case-1:considering the increase in 3.5 GT boats only
Case-2:considering the increase in FRP boats and also canoes(OB), besides 3.5 GT boats

5.3.4 Calculation of Economic Internal Rate of Return (EIRR)

Table 5-8 shows the result of the calculation of EIRR. The calculations are done in two cases regarding fish production and two cases regarding calculation term.

The contents of the two cases of fish production are indicated in the subsection 5.3.2.

One case of calculation term is from 1983 to 2017, including the previous construction period, and another is from 1991 to 2025, which covers this Project. In the former case the increment of fish catch in the period from 1983 to 1991 is supposed to be the benefit.

In case of considering the previous construction cost, the benefit of increasing a catch is considered, because the tendency represents the effects of expectation to re-opening harbours.

Besides, the cold storage, which will belong to the shore facilities after the rehabilitation, is assumed to have an economical service life of 15 years.

**Table 5-8 Result of EIRR**

| | Planned Amount of Fish Production(ton) | EIRR (%) 1983-2023 | EIRR (%) 1991-2023 |
|---|---|---|---|
| Case-1 | 2,494 | 2.01 | 3.65 |
| Case-2 | 2,728 | 2.46 | 4.40 |

## 5.4 Financial Evaluation

### 5.4.1 Basic Concept of Financial Evaluation

Funds for the rehabilitation cost of Kirinda Harbour shall be covered by a grant from Japan, while the MO, dredging and monitoring costs shall be covered by Sri Lanka government or beneficiaries. In this section, the feasibility of this project is investigated from a financial view. Particularly special attention is given to the possibility of operation and maintenance of the Harbour against siltation. CFHC, which is the substructure of the MOF, is assumed to be an organization to operate and maintain the Harbour. The role of CFHC is also argued to be restricted to the construction work and maintenance of fishing harbours. It is intended that the profitable fields such as management of an ice plant be managed by fishery cooperatives or private sectors in future.

In the evaluation of financial feasibility, the following items are considered as income and expenditure.

Income

1) revenue from commissions of selling fish in auctions
2) revenue from using harbour and landing facilities
3) revenue from using refrigerators

Expenditure

1) personal expenses of staffs and electric charge for the facilities
2) maintenance expenses of facilities and spare-parts
3) depreciation cost related to refrigeration

In this evaluation, the comparison between the revenue mentioned above and the management expenses including dredging and monitoring should be considered. The depreciation cost of civil work of the harbour is not included in the managerial expense, while that of the shore facilities is included. Further the interest cost due to the construction work is not included because the rehabilitation investment is funded as a grant from Japan.

These revenues and expenses will be regular after rehabilitation if the

inflation is not considered, so that the feasibility can be judged by the balance of one year.

5.4.2 Revenue

(1) Selling Commissions

Fishery cooperatives regularly get a commission of 5% of the selling price for opening auctions in Sri Lanka, therefore this ratio is applied to the calculation in this study.

Selling Commission = Future Catch* x Selling Price x 5%
= 2,494ton/year x Rs.28,700/ton x 0.05
= Rs.3,600,000/year (12,400,000 yen/year)

* Five years after the completion of the Harbour

(2) Landing Charges

It is assumed that Rs.5/day per boat is charged to 3.5 GT and FRP boats which will use the landing facilities. Supposing that the annual working days of a 3.5 GT boats is 200 days and that of FRP boats is 20% of 200 days, the annual landing charges is calculated as follows:

Number of Boats : 3.5 GT type 90
FRP 30
Landing Charges : (90 x 200 + 30 x 200 x 0.2) x Rs.5/day
= Rs.100,000/year (333,000 yen/year)

(3) Fee for using Refrigerator

The refrigerator is primarily used for ice storage. The ice from Hambantota or Matara shall be provided for the distributors and the fishing boats. The average ratio of amount of ice and fish, for fish transportation or storage in Sri Lanka is 0.35 to 1. In this study, it is assumed that 90% of fish catch is transported or stored with ice and the fee is 5% of the ice selling price in Matara, which is Rs.50 per 50 kg.

Fee for ice storage a year is calculated as below

2,494 ton/year x 0.90 x 0.35 x Rs.50/50 kg x 0.05
= Rs.40,000/year (140,000 yen/year)

(4) Total Revenue

Total revenue is summarized in Table 5-9.

**Table 5-9 Total Revenue** (Rs./year)

| | |
|---|---|
| Selling Commission | 3,600,000 |
| Landing Charges | 100,000 |
| Fee for using Refrigerator | 40,000 |
| Total | 3,740,000 |

5.4.3 Expenditure

The operation and maintenance expenses are as referred in Table 5-6, subsection 5.3.3. Depreciation costs related to the shore facilities such as the refrigerator and the buildings are calculated according to their economical service life as shown in Table 5-10.

**Table 5-10 Depreciation Costs** (Rs./year)

| Items | Construction Cost | Durability Years | Depreciation cost |
|---|---|---|---|
| Refrigerator | 350,000 | 10 | 30,000 |
| Buildings | 13,300,000 | 30 | 400,000 |
| Total | | | 430,000 |

The annual expenses are shown in Table 5-11.

**Table 5-11 Annual Expenses** (Rs./year)

| | | |
|---|---|---|
| Maintenance Expenses | Breakwaters, etc. | 800,000 |
| | Refrigerator | 100,000 |
| | Offices, etc. | 100,000 |
| Utility Expense | Electric Charges | 100,000 |
| Personnel Expense | | 380,000 |
| Dredging Expense | | 1,000,000 |
| Monitoring Expense | | 450,000 |
| Sub-total | | 2,930,000 |
| Depreciation Cost | | 430,000 |
| Total | | 3,360,000 |

5.4.4 Balance of Revenue and Expenditure

The annual revenue and expenditure after the Project are assumed to be regular in this study so that the balance can be evaluated per year. Table 5-12 shows the balance per year. From the results it is concluded that the Project is feasible financially.

**Table 5-12 Balance of Revenue and Expenditure**

| | |
|---|---|
| Total of revenue (R) | Rs.3,740,000 |
| Total of expenditure (E) | Rs.3,360,000 |
| (R) - (E) | Rs. 380,000 |
| (R) / (E) | 1.12 |

## 5.5 Effects on Environment

By the implementation of the Project in which the structures such as the Groyne and Breakwaters are going to be constructed, some effects on the surrounding environment shall be raised up as mentioned in the Technical Study Report. The environmental changes due to the Project were discussed with the government of Sri Lanka and concerned authorities.

### 5.5.1 Administration of Environmental Protection

In case that the effects on environment of the coastal zone are considered to occur due to the construction of some structures, the permissions must be obtained from CCD(Coast Conservation Department), which is placed under the Ministry of Shipping and Ports, and N.A.R.A.(National Aquatic Resources Agency), which is under MOFAR. Therefore the study team had discussions concerning the implementation of this project with these authorities.

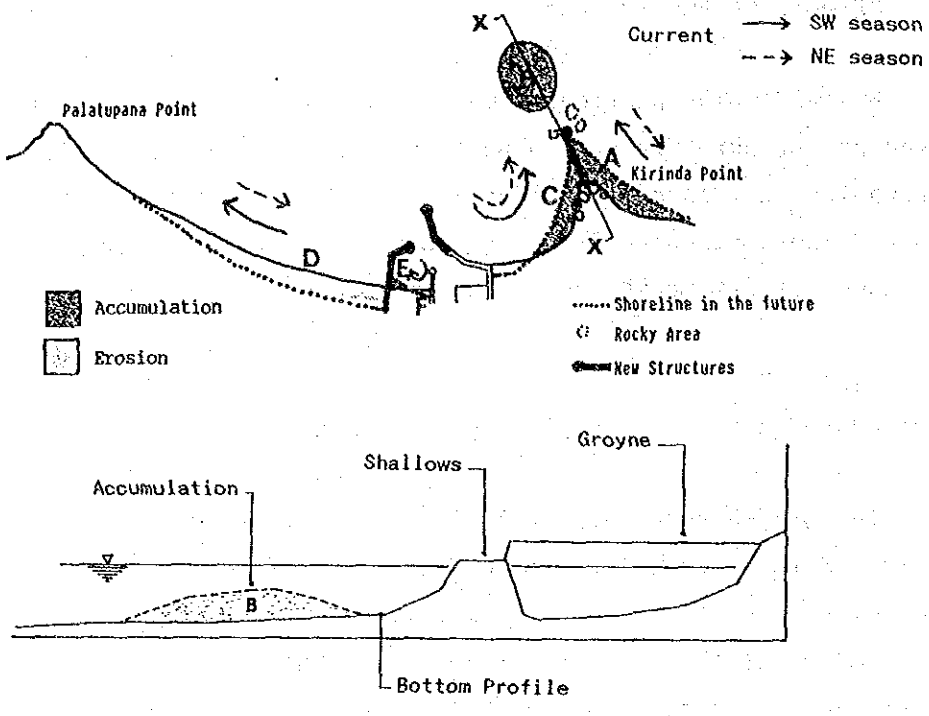
### 5.5.2 Expected Effects by the Project

(2) Topographical Changes

Fig. 5-4 shows the topographical changes after rehabilitation of the Harbour. The locations of typical changes are pointed by alphabet letters and the changes in these areas are expected as followings.

A. Accumulation in the south of the Groyne

This area will be filled up by sand in SW monsoon season and eroded slightly in NE monsoon season.
This area is neighboring the Kirinda Temple which is one of the prominent temples and a scenic place. Therefore from the scenic point of view the Groyne is going to be made by natural rocks. Moreover the sandy beach will create a new landscape that will fit the scenic place.




Cross Section X-X

**Fig. 5-4 Topographical Changes**

B. Sedimentation in front of Kirinda Point

The sand carried by littoral drift from south in SW monsoon season will deposit in front of the Point. Furthermore the deposited sand is considered to be dispersed to wide area and transported to the eastcoast of the Harbour in future.

C. Accumulation in the north part of the Groyne

The accumulation will appear due to the anticlockwise current circulation as illustrated in Fig. 5-4 that will occur even by swells from south in front of the Main-breakwater.

D. Erosion in the Northeast Coast of the Harbour

The shoreline will be considered to move offshore in NE monsoon season and onshore in SW monsoon season. The net direction of

the movement of shoreline is onshore, because it is clear that the net sediment movement is from south to north. From the results of the Technical Study, it is supposed that the erosion will be extended for about 6 km along the coast with 50 m width at most for ten years after the implementation of the Project. By this study, following conditions were grasped concerning this area.

* This area is administrated by the Hambantota GA.
* This area is a dune and the coastal zone controlled by CCD from environmental aspects.
* No one is settled in this area.
* The minimum distance from the shoreline to the road in this area is about 500m.

From these results, this area seems to be not concerning with human life and the effect on the social and natural conditions caused by the shoreline changes could be considered allowable.

E & F. Sea Bed Change between New Sub-breakwater and Existing One

The sea bed change will occur by the clockwise current due to the incident waves in front of the shoreline .

To verify these deformations, the aerial and topographical surveys should be performed before, under and after the project.

(2) Effects on Sea Water

Although muddiness will occur due to dumping of rocks for the constructions of the breakwaters, this will be considered to spread and be diffused by the waves coming constantly and the strong longshore current due to the waves, and further chemical pollution is not expected. Therefore the effects on quality of sea water and sea animals will be negligible.

(3) Effects on Scenery

The Area around the Kirinda Point is a famous scenic place of the hill of great round rocks in Sri Lanka. In consideration of the scenery, the Groyne will be made by natural rocks and will make the new beach by the sand accumulation at the south of it, will not spoil the scenery, but create a new landscape. Therefore the change of the present landscape will be acceptable.

(4) Matters Related to Social Environment

As discussed in relation to the possible effects on the scenery, undesirable effects on the historical and cultural assets of Kirinda Temple will not be anticipated by this project. Permission from the Temple regarding the construction works also obtained.

Resuming the rehabilitation works is expected to improve the infrastructure for the society and transportation in the community as increases are expected in the fish catch, the number of fishing boats and fishermen, the related industries and settling of people, to thereby contribute indirectly to the community.

(5) Effects on Fishery

Construction of the Groyne at Kirinda Point is expected to bring sand deposit in the rocky area off the Point (See Fig. 5-4). Monsoon waves which constantly come and break in this area give the very hard fishery condition. Fishery is not being carried out in this area because it is immediately below Kirinda Temple which preach against killing life. The sea is turbid by the littoral drift in the nearshore. No seaweed or marine lives are washed on the beach. These are considered to indicate that the possibilities of finding useful marine life, seaweeds or algae in the area are quite limited. Thus effects of the proposed rehabilitation works on the fishery activities are considered to be negligible. On the other hand, natural stones are to be used for the Groyne construction, and interstices of the stones are expected to offer new abodes for marine life.

Although, it is hardly that the rehabilitation of the Harbour bring overcatching in the Hambantota Bank, which is the excellent fishing

ground, reinforcing cooperation for investigation, etc. with N.A.R.A. will be recommended.

(6) Effects on Environment during Construction and after Rehabilitation

There is a lagoon on the northeast of the Harbour, with its mouth facing the northern side of the existing breakwater. The mouth is completely closed for the most portion of the year, but as the water level rises in the lagoon during the rainy season, the mouth opens for a short period of time once or twice a year. A road for the construction of the Sub-breakwater and for dumping dredged sand should be built across the mouth. A special care should be taken to prevent undesirable effects on the natural conditions of the mouth when building the road.

In order to secure safety from explosion for quarrying near the quarry site from which stones, the principal construction materials for the breakwaters, are to be taken, the use of road should be controlled and seven to ten families living near the quarry site should be evacuated to safety area. The transportation route from the quarry site to the Harbour is the route designated by R.D.B.(Road Development Authority) in order to minimize damages to the road and effects from vibration and congestion.

The sand volume currently deposited in the harbour is estimated to be about 100,000 $m^3$ and that are planned to be dumped at the dune, which is unoccupied, in the north of the Harbour. MOFAR and CFHC, which are the executing and operation agency in Sri Lanka, will obtain the permit for dumping the dredged sand from CCD and Hambantota GA. The area proposed for dumping sand is the coastal zone owned by the State and there are no private houses or rare species in that hinterland. No effects on agriculture by the sediment transported by water flow or wind are anticipated.

As Sri Lanka has the laws, orders, procedures and a monitor organization established already for environmental preservation, necessary steps and procedures will be taken in accordance with these laws and regulations. The Government of

Sri Lanka has agreed that the proposed rehabilitation plan cannot be implemented without totally affecting the environment, and MOFAR and CFHC, the implementing organization, will perform themselves consultation and preparation for the domestic procedure related to environmental issues and compensation to the inhabitant concerned.

## 5.6 Conclusion and Recommendation

The project aims to review the rehabilitation plan for restoring the functions of the Kirinda Fisheries Harbour closed by sand deposit due to sand drift, and propose an optimum plan. Basically this study was carried out on the basis of the recommendation of the technical study, "the Study on Sand Drift in the Southeastern Coast of Sri Lanka", which was established in 1989 to clarify the mechanism of sand drift near the Harbour, to decrease the sand deposit, to restore the functions of a fishery harbour, to conduct the development survey for preparation of technical countermeasures for maintaining the harbour functions. Namely the construction of the structures, such as the breakwaters and groyne, was recommended to reduce the quantities of sand deposit at the entrance and basin of the Harbour due to sand drift of less than 10,000 $m^3$ a year.

In addition, socioeconomic effects by the rehabilitation, maintenance of the harbour functions after the construction works and effects on the environment by that were also studied.

### (1) Technical Examination

By this project sand deposit in the Harbour will be intended to radically be reduced. As a result, the total annual maintenance dredging volume required for all harbour in Sri Lanka, including Kirinda, will be estimated to be less than the dredging capacity of CFHC responsible for the harbour maintenance in Sri Lanka. In case that the dredging operation is stopped, sand will deposit at the Harbour mouth and to close the mouth again and it is quite likely that harbour functions will deteriorate radically. Therefore, only the construction of the structures is not enough to maintain the harbour functions properly, and that regular monitoring of topographical changes and implementation of maintenance dredging must be the most important operations after the rehabilitation. The topographical monitoring as recommended in this report and the annual maintenance dredging of 10,000 $m^3$ at least are presupposed to keep the Harbour functions successfully.

### (2) Socioeconomic Study

The socioeconomic effects of the rehabilitation of the Harbour were

studied from the viewpoints of the regional development, regional fishery harbours and fishermen, and marine products distribution. This study revealed that the re-opening of the harbour after rehabilitation will secure the supply base for protein sources under the development plan for southern area in Sri Lanka currently being promoted by the Central Government. It is expected that fishing operation periods will increase and fuel cost of fishing boats can be reduced by restoration of functions for landing the catches, anchoring and ice-making, and reduction of distances to excellent fishing grounds. Fishing boats registered at other ports are expected to use the harbour, and the number of boats under the Central Government's Supply Plan for 3.5 GT type fishing boats is expected to increase. Consequently, fishermen are expected to increase their income because of the increased catch quantities and catching rate. Furthermore migrating fishermen are also expected to come and settle in this area. From the standpoint of the marine product distribution, cheap and fresh fish supply becomes possible for the inland area which is adjacent to the harbour because of the reduced distribution costs.

(3) Effects on Environment

Direct and indirect effects on the inhabitants and environment are unavoidable due to the implementation of the rehabilitation works. There will be needed the compensation for allocation of the inhabitants living near the quarry site and the repair of damages to the roads caused by transportation of stones from the quarry site to the harbour site. It is also necessary to take the prescribed steps for preliminary environment assessment under the domestic environmental regulation regarding the dumping area for dredging sand of about 100,000 $m^3$, which currently accumulated in the Harbour. It is anticipated that the beach in the northern side of the Harbour is expected to eroded for about 6 km along the coast with 50 m width maximum for about ten years after the rehabilitation. There will be formed a sandy beach, the sand will deposit on the southern side of the Harbour.

MOFAR and CFHC, the executing organizations, take various legal procedures and coordination such as consultation with the government offices concerned, application and obtain the approvals and attend to compensation during the construction works to the inhabitants in the vicinity regarding the effects of the works on topographical changes and living environment in the area.

After the rehabilitation is completed, development of fishery resources as the number and size of the fishing boats increase, and modernization of the fishing tools will be expected to be promoted. Investigations to assess the marine resources will be necessary to prevent overcatches in the coastal area.

The socioeconomic significance of this project was discussed and the position of the Kirinda Harbour is considered to be not at all low as there are no properly well-equipped fishery harbours in the east of Kirinda in the southern region of Sri Lanka. When the changes to the existing socioeconomic environment after implementation of the work and the preservation of the status quo of the area without implementation are compared, it is judged that this rehabilitation plan will be quite effective.

It is believed that monitoring and survey of the topographical changes in the surrounding area for maintaining the fishery harbour functions, implementation of regular maintenance dredging based on such survey and appropriation of budgets for the purpose are most important. The successful use of the harbour effectively for key to regional development and to marine industry development depends entirely on the maintenance operation.