BASIC DESIGN STUDY REPORT

ON

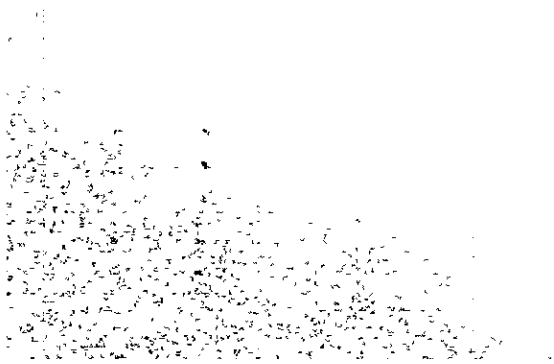
FISHERIES HARBOUR CONSTRUCTION PROJECT

IN

THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA

NOVEMBER 1982

JAPAN INTERNATIONAL COOPERATION AGENCY



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PREFACE

In response to the request of the Government of Democratic Socialist Republic of SRI LANKA, the Government of Japan decided to conduct a basic design study for Fisheries Harbour Construction Project and entrusted the survey to the Japan International Cooperation Agency. The J.I.C.A. sent to Sri Lanka a survey team headed by Mr. Akio SAITO, Deputy Director, Disaster Prevention and Coastal Protection Division, Fishing Port Dept., the Fisheries Agency, from August 3rd to September 1st, 1982.

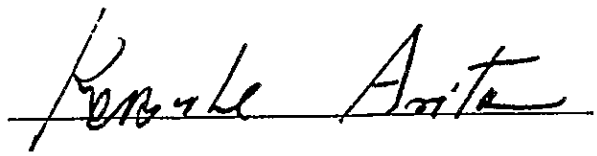
The team had discussions with the officials concerned of the Government of Sri Lanka and conducted a field survey in the Kirinda area.

After the team returned to Japan, further studies were made and the present report has been prepared.

I hope that this report will serve for the development of the Project and contribute to the promotion of friendly relations between our two countries.

I wish to express my deep appreciation to the officials concerned of the Government of Sri Lanka for their close cooperation extended to the team.

November, 1982



Keisuke Arita
President
Japan International Cooperation Agency

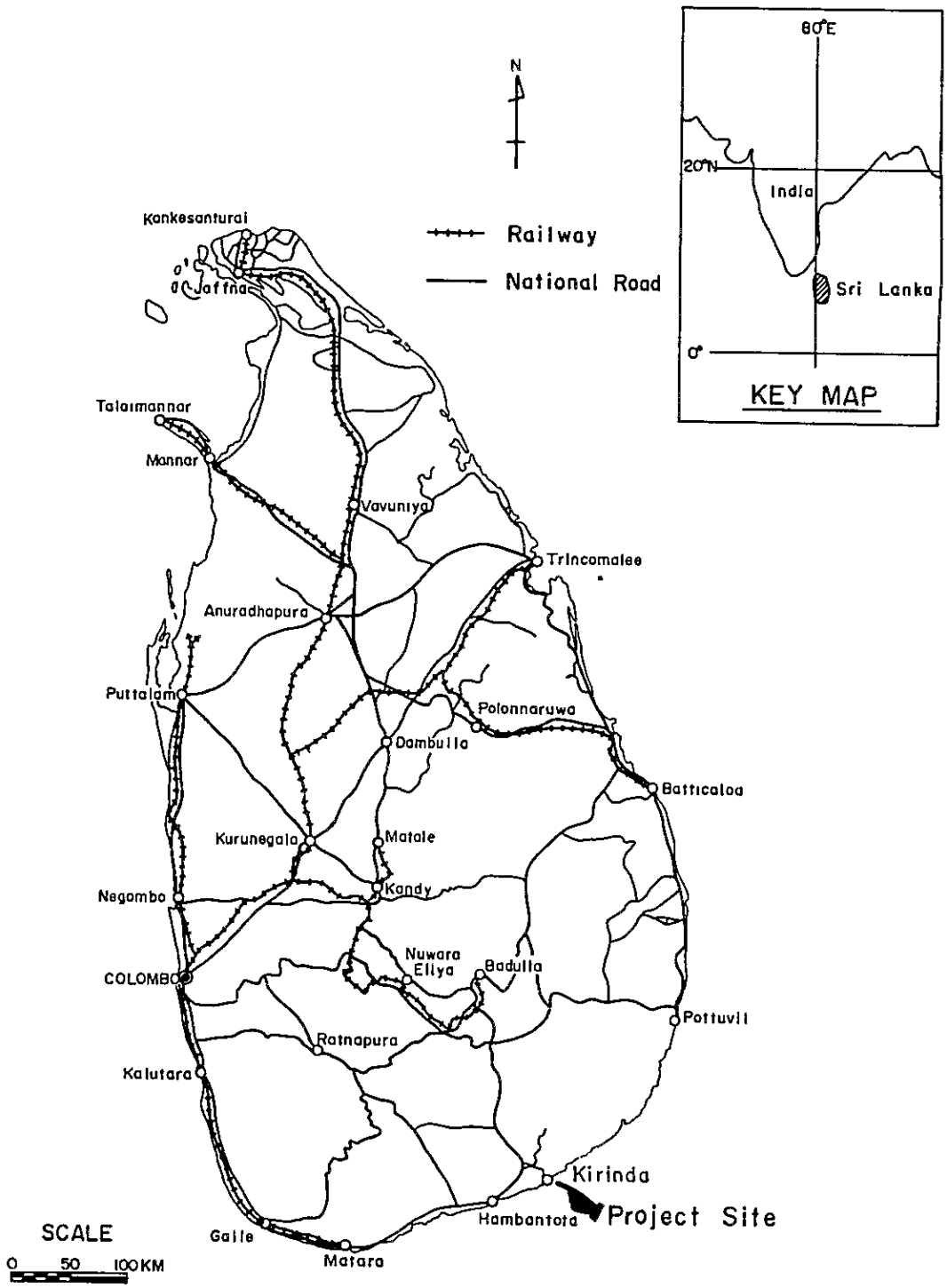


Fig. 1 LOCATION MAP

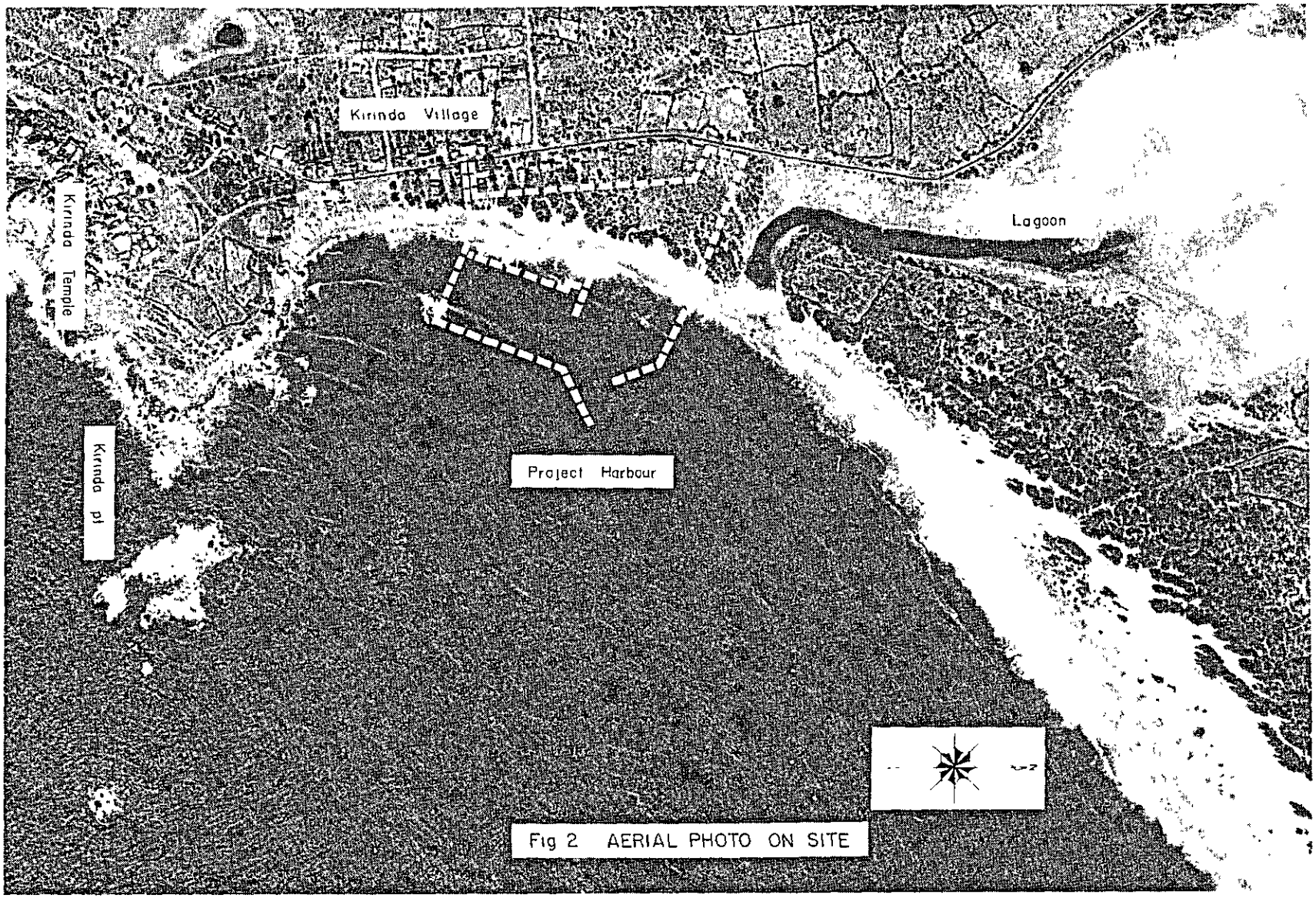
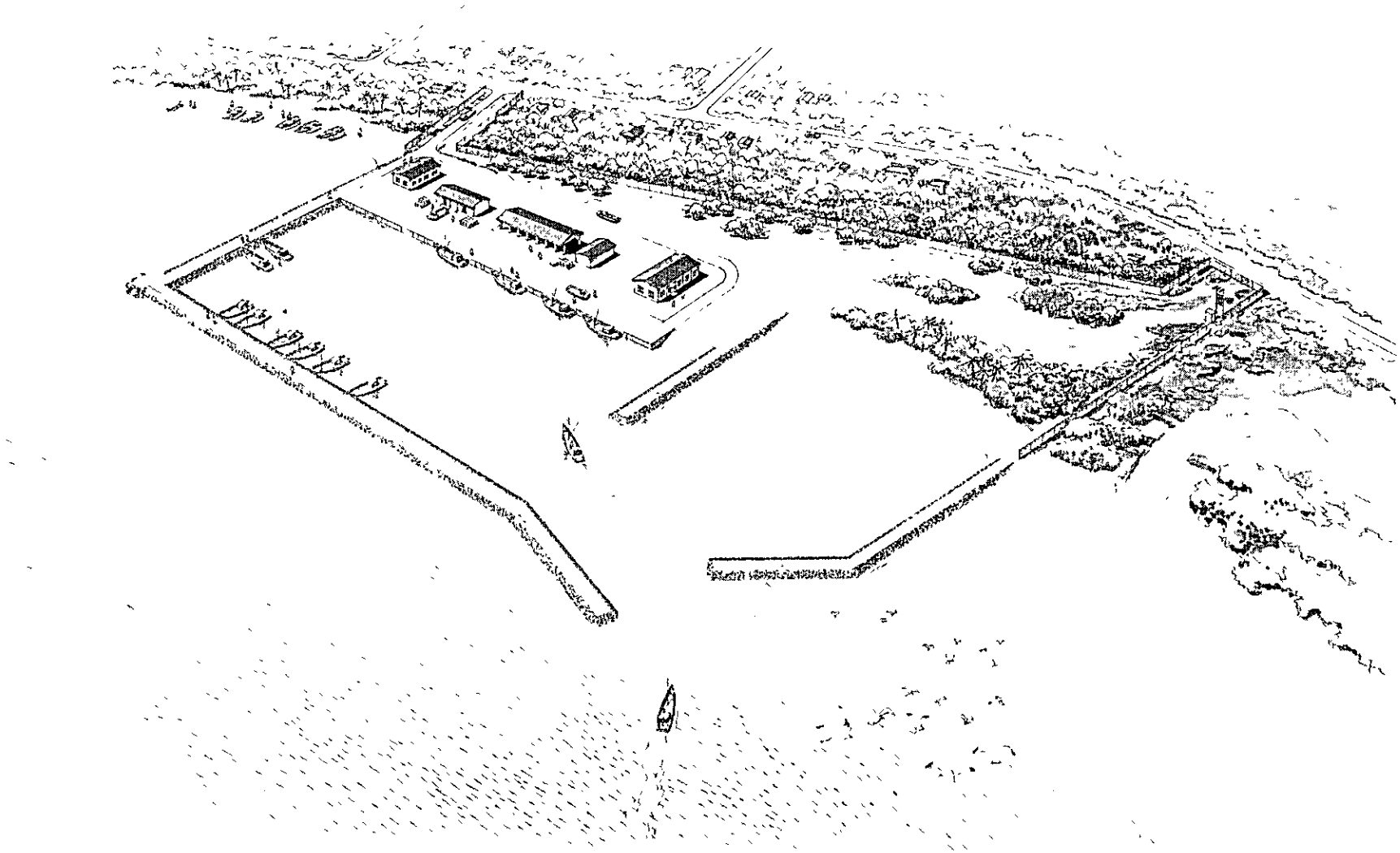


Fig 2 AERIAL PHOTO ON SITE



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SUMMARY

The Democratic Socialist Republic of Sri Lanka has laid great emphasis on the promotion of the fishing industry to secure a stable sources of animal protein. In March 1980, the Ministry of Fisheries published "Master Plan for the Development of Fisheries,1979-83" with the objective to increase fish production up to 300,000 tons by 1983 (184,722 tons,actual production in 1980). To achieve this target, the Plan proposes the introduction of more mechanized boats, replacements of new engines for existing old ones, introduction of bigger boats and provision of harbours and anchorages with ice plants and cold storages.

Under these circumstances, the Government of Sri Lanka requested the Government of Japan for a grant aid assistance in fishery harbour construction project.In response to this request, the Government of Japan dispatched in May, 1982 a preliminary survey team to assess the project. Of the eleven prospective project sites, Kirinda was selected as the results of the preliminary survey. This site has also been given a high priority order by the Authorities. The basic design survey of the project commenced in August, 1982. The results of the study are described in this report.

Several fishery harbours, Beruwala, Galle, Mirissa and Tangalle, are located at the intervals of approximately 50 km (suitable operation distance for small boats) along the south western coast of Sri Lanka. On the other hand, no harbour exists in the southeastern coast. The Kirinda Project Harbour, located in the southeastern coast of Sri Lanka, about 60 km away from Tangalle, will play an important role in fisheries of Sri Lanka. In the vicinity of the Kirinda, there lie two promising fishing grounds, Amaduwa and Patanangala, which are exclusively used by migrant fishermen. The future harbour will control these fishing grounds and also serve as a refuge during the rough SW monsoon season. Therefore, it can be said that, in terms of stable operation and production increase, the harbour development in Kirinda will be quite significant.

The inhabitants living in the Kirinda area earn their living mainly by fishing. Most of the boats used there are canoes and small engined boats. The fish is landed directly onto the beach. The shoreline extends 600 m long, and a small lagoon is located in the north. The inlet of lagoon, trapped by sand bank, is rarely broken through even in the SW monsoon season. South of the beach, there is a promontory, Kirinda Point, with a famous buddist temple on it. This promontory works as a breakwater against the predominant SW waves and also as a groyne to the littoral drift. The harbour has been sited near the existing village, north of Kirinda Point on account of its easy access to the Kirinda village and the relible protection of Kirinda Point.

The annual catch in the project area inclusive of Amaduwa and Patanangala is, at present, assumed to be nearly 1,000 ton of fish. On completion of the Project, it is anticipated that the annual fish production will be raised up to 2,000 ton. To achieve this production increase, one hundred 3.5 ton class boats will be requied. Now, in this project area, 81 numbers of the 3.5 ton class boats are operating. However, in line with the Master Plan, the existing boats will be replaced by bigger engined boats, so that it is realistic to design the harbour with an accommodating capacity for 100 numbers of the 3.5 ton class boats.

The major project facilities for the Kirinda harbour are :

Marine Facilities

Main Breakwater	:	370 m
Sub Breakwater	:	110 m
Groyne	:	160 m
Quaywall	:	150 m x -1.5 m

Onshore Facilities

Cold Storage	:	50 m^2 (10t capacity)
Administration Office	:	80 m^2
Auction shed	:	250 m^2
Repair shop	:	200 m^2
Warehouse	:	100 m^2

The Kirinda Harbour Project will be carried out in two phase development in accordance with the budgetary system of the Grant Aid Assistance. In the 1st phase, a part of the main breakwater and sub-breakwater will be constructed, and in the 2nd phase, the rest of the breakwater, groyne and quaywall together with onshore facilities will be constructed.

An economic evaluation was carried out to assess the feasibility of project. The project benefits are classified into the following items:

i) increase in fish production resulting from more operable days

ii) decrease in fish putrefaction by the existence of cold storage and speedy auctioning

iii) transportation cost saving accompanied by increase in fish production, especially during off-season

iv) stabilization of fish price

v) decrease in occurrence in shipwrecks and casualities

vi) saving of foreign currency expenses resulting from decrease in import of fish products

vii) increase of job opportunities and income level

Of the above seven items, item (i) and item (ii) can be measured in monetary value, so that these benefits have been built into benefit calculation.

The project cost has been considered with the components of the capital cost, and operation and maintenance costs. The economic evaluation has been done through checking the factor of the internal rate of returns. The internal rate of return has been estimated at 7.5%. Considering a variety of benefits to be accompanied with the project, it can be said this figure is quite appreciable.

The financial evaluation of the project has been also carried out to check the financial soundness of the project. In the evaluation, the income and expenditure to be borne during the operation of the Kirinda Harbour have been considered. The items of income are classified as follows:

i) auction fee
ii) cold storage charge
iii) harbour charge

The items of expenditure include operation and maintenance costs together with the depreciation cost of buildings, but excludes the depreciation cost of marine structures such as breakwaters, because those facilities have been considered as permanent structures. The balance between expenditures and income has been checked, and the annual balance has been estimated at Rs 204×10^3 in the black. Therefore, it can be said that financially this project is also quite sound.

As briefly summarized above, the investment in the Grant Aid Assistance of the Government of Japan to the Kirinda Project is feasible from the economical and financial view points, and will fully assist the Government of Sri Lanka in promoting the fishery industry.

CHAPTER 1. INTRODUCTION

1-1 Project History

In response to a request by the Government of the Democratic Socialist Republic of Sri Lanka for a grant aid assistance for Fishery Harbour Construction Project (Project), the Government of Japan has sent, through the Japan International Cooperation Agency (JICA), a preliminary survey team headed by Mr. Masatsugu Fukuya, Deputy Director, Construction Division, Fisheries Agency to carry out a preliminary study on the Project from May 20th to May 27th, 1982.

The Japanese survey team, following preliminary discussions with the agencies of the Sri Lanka Government, commenced its field trip in the company of Government engineers, visiting eleven sites to decide the Project site. The sites visited are Dikowita,Beruwala, Galle, Mirrisa, Puranawella, Tangalle, Amaduwa, Paratupana, Kirinda, Myliddy and Point Pedro.

Of these eleven prospective project sites, Kirinda was selected as the Project site from the view point of a priority order of the Authorities concerned and the results of the preliminary survey by the Japanese survey team and the Authorities concerned. Both parties have agreed to recommend to their respective Governments to examine the results of the survey towards the realization of conducting a basic design study for the Project. Again in August 1982, a Japanese survey team was dispatched, through JICA by the Government of Japan, to conduct a basic study of the Project. The basic design survey team headed by Mr. Akio Saito, Deputy Director, Disaster Prevention and Coastal Protection Division, Fishing Port Dept., the Fisheries Agency, carried out a field survey from August 3rd to September 1st, 1982.

The summary of their findings was briefly explained to representatives of the Ministry of Fisheries, and the Ceylon Fishery Harbours Corporation (CFHC). The Government representatives appeared satisfied with the major design criteria of the Kirinda Fishery Harbour upon which further designing studies will be implemented in Japan.

The Japanese survey team conveyed to the Government of Japan the earnest desire of the Government of Sri Lanka for the materialization of the Project.

1-2 Terms of Reference of Basic Design Study

The objective of the study is to carry out the basic design of the Project (Kirinda Fishery Harbour). The terms of reference of the study team broadly consist of a field work and a basic design study in Japan. The field work includes:

1) Discussion with CFHC and MOF on the implementation of the Project.

2) Collection of information and data necessary for the study

3) Reconnaissance in the project area and other similar fishery harbours

4) Field survey in the project area

   - Topographic survey
   - Water depth sounding
   - Construction material survey
   - Socio-economic survey
   - Survey on rural development and fisheries development program

5) Preparation of basic concept for establishment of Kirinda Fishery Harbour

6) Preparation of preliminary layout of onshore and offshore harbour facilities

The basic design study in Japan includes:

1) Determination of final layout of Kirinda Fishery Harbour

2) Basic design of onshore and offshore facilities

3) Cost estimates

4) Preparation of construction plan

5) Project evaluation

6) Preparation of report

The team members engaged in this study and their activities are listed in Table 1-1.

Table 1-1 Team Members and Their Activities

Name	Activities
Mr. A. Saito	Team Leader
Mr. Y. Shikama	Project Coordinator
Mr. Y. Fujimoto	Fishery Harbour Planning
Mr. N. Murai	Project Evaluation
Mr. K. Okubo	Harbour Designing
Mr. E. Higuchi	Harbour Facilities Designing
Mr. R. Nishimura	Surveyor

CHAPTER 2. SELECTION OF THE HARBOUR PROJECT

2-1 Fisheries Development Master Plan

The fisheries sector in Sri Lanka has a relatively high importance in the economy compared to that in the other countries. In March 1980, the Ministry of Fisheries published their master plan for 1979 - 1983 which established the basic programme of fisheries development in Sri Lanka. The objectives of this development programme are:

1) To step up production of fish and to raise per capita consumption to 44 lbs/head.
(32.7 lbs/head as of in 1980)

2) To raise the income and standard of living of fishermen who are among the least favoured groups in the community.

3) To maximise employment opportunities in the fisheries sector.

At present, major production is from marine fisheries, accounting for 76% of the net supply in 1980. Among possible fish resources lying within Sri Lanka's 200 mile exclusive economic zone, the primary fish resources lie on the continental shelf area which is narrow, rarely exceeding 25 miles. A secondary resource is the fish available in the area beyond 25 miles. The present catch from those coastal zone are only half of the estimated substainable yield, while harvests of the offshore resources represent a small fraction of the potential yield. Therefore most of the development activity in the next five or ten years shall be concentrated on the coastal fishery. This emphasis on coastal development also reflects the government's view that the owners of coastal fishing boats do not have the expertise or finance to make a rapid transition to offshore and deep sea fishing.

To cater for the above requirement, the coastal fishing fleet shall be expanded by the introduction of large numbers of craft which have already proved to be successful in the fisheries.

The master plan proposes to increase the number of 18 - 24 ft. boats to 5,250, the 28 to 32 ft. boats to 3,026 and other indigenous mechanized boats to 8,200 with the total catch increasing to 300,000 tons by 1983.

The master plan states that most of the existing fishing craft are less than 30 ft. in length, which the fishermen would like to moor close to their homes at night for reasons of security and convenience.

It is obviously too costly to provide every fishing community with a backdoor harbour. However, it is equally obvious that the present fishery harbours do not provide for the needs of the existing coastal fishing fleet, particularly the small mechanized craft. The master plan states also as follows;

* The harbours are unnecessarily elaborate and too far apart. Indeed, some regions of the coast, especially the south east and north east have no harbours at all. This means that small mechanized boats cannot operate on large sections of the coastal fishing ground during monsoon period.

* The fishermen are not given incentives to use the existing harbours like the provision of in harbour services and transport to their homes.

* The vessel repair and maintenance services provided in the harbours are inadequate.

The needs of the planned offshore fleet expansion are mostly covered by existing harbours for the time being. An investment programme to recondition and up-grade these harbours is proposed. It is planned to make intermediate scale investments at a number of sites, where there are some coastal vessels and more will accumulate over the period 1979 - 1983 after feasibility studies. These sites are Puranawella, Dodanduwa, Peraliya, Dickowita, Ambalangoda, Hambantota, Kottegoda, Kirinda, Kathaluwa and several others. Table 2-1 gives a schedule of the investments together with a brief description of the facilities.

Table 2-1 Proposed Investment in New Harbours, Anchorages, Access Channels and Shore Facilities 1979—1983

	Location	Description of work	Total estimated investment millions	Earliest possible date of completion
1.	Ambalangoda	Removal of rocks, breakwater construction and dredging	15.0	1982
2.	Arnolda canal	Dredging	7.6	1980
3.	Chilaw	Stabilization of lagoon inlet and shore facilities	21.2	1982
4.	Dickowita/ Uthurumodera	Breakwater construction, access channels, lock gates, workshop and navigational aids	5.0	1982
5.	Hambantota	Breakwater construction	10.0	1982
6.	Hikkaduwa	Improvements to sheltered area and navigational aids	2.5	1980
7.	Kalmunai	Construction of breakwater, revetment, jetties and shore facilities and navigational aids	30.5	1981
8.	Kalpitiya	Jetty and navigational aids	1.0	1981
9.	Kathaluwa	Stabilization of river inlet at Habaraduwa	7.5	1983
10.	Kirinda	Breakwater construction	10.0	1982
11.	Mannar	Dredging, bulkhead, jetty, navigational aids and shore facilities	under const.	1981
12.	Negombo	Dredging of lagoon and providing shore facilities	5.4	1980
13.	Peraliya	Breakwater construction	30.5	1980
14.	Puranawella	Breakwater construction	5.0	1981
15.	Thoduwawa	Stabilization of river inlet dredging	15.7	1982
16.	Vlaichchenai	Construction of jetty, revetment, dredging, shore facilities and navigational aids	under const.	1981
17.	Wennappuwa	Development of Gin Oya inlet at Wellamankara	7.8	1980

As shown on Table 2-1, Kirinda Harbour Project is listed as one of the proposed new harbours in Sri Lanka. Also included in nearby area are Hambantota and Puranawella which require breakwater construction.

2-2 U.N. Survey on Fisheries Development

With a view to reviewing the Master Plan and identifying prospective harbour sites for development of fish landing centers, the Government of Sri Lanka has requested the United Nationas Development Programme and the Food and Agriculture Organization of the United Nations to perform a preliminary survey along the coastline of Sri Lanka.

This preliminary survey was concentrated on selecting suitable sites for the provisions of landing facilities to cater for the needs of the small scale fishery; to propose outlines for future development; and to identify the methods to be adopted in achieving these objectives.

Out of the sites reconnoitered the description about the Kirinda area and nearby landing centers such as Kirinda, Amaduwa, Hambantota and Puranawella are quoted as below:

Kirinda: "Beaching of boat is possible due to subdued wave action at this site. A beach landing facility with winch hauls can be provided at this site."

Amaduwa: "This center has a partly sheltered bay with rocky outcrops on the south western shore. The shelter can be further improved by construction of a breakwater, which should not be too costly, extending the existing rocky outcrops by 20 m to 30 m and by filling gaps between the existing rocks. In addition, constructions of two groynes - one, connecting the existing rock south of the hotel to the beach and the other north of the property line of the hotel - can be provided. The groynes would intercept drift into the harbour while preserving the beach in front of the hotel."

Hambantona: "The proposal of fishery harbour development was formerly submitted to the Government by the German Rhein-Rhur agency. This plan proposes extensive breakwater extension but remains untouched since then. At present, the Hambantota Rural Integrated Development

Project is carried out under the Norwegian Government Aid. This Project includes the development of the onshore facilities with minor landing places."

Puranawella: "The proposed Government's layout for the proposed harbour basin and breakwater system seems appropriate to site conditions. However, the cost could be reduced to some extent by removing the bends in the breakwater."

As briefed above, aside from the provision of beach landing facilities, there is a small description concerning the Kirinda Site.

2-3 Selection of the Harbour Project

The Master Plan has been prepared by the Ministry of Fisheries with a view to increasing production up to 300,000 tons by 1983. To achieve this target, the Master Plan proposes the introduction of more mechanized boats together with the provision of harbours and anchorages with ancillary onshore facilities.

Considering the sailing ability of small mechanized crafts and access to their fishing grounds, the Master Plan also recommends that the fishery harbours on medium scale be located at proper intervals along the coastline of the country.

In fact, along the west to southwest coast of Sri Lanka, several fishery harbours are located at the intervals of about 30 - 60 km distance. Those are Beruwala, Galle, Mirissa and Tangalle. East of Tangalle, there is no harbour as shown in Fig.2-1 , so a new harbour construction in that area will be of primary importance.

Since there is no harbour in the southeast coast of Sri Lanka, the Master Plan put great emphasis on harbour development in that area. In the Master Plan, Hambantota, Puranawella and Kirinda have been listed as proposed sites for harbour development.

On the other hand, the U.N. survey report has identified such harbour sites as Hambantota, Kirinda, Puranawella and Amaduwa in the southern coast of Sri Lanka for the development of fish landing centers. Among them, the greater emphasis is laid on the development of Amaduwa

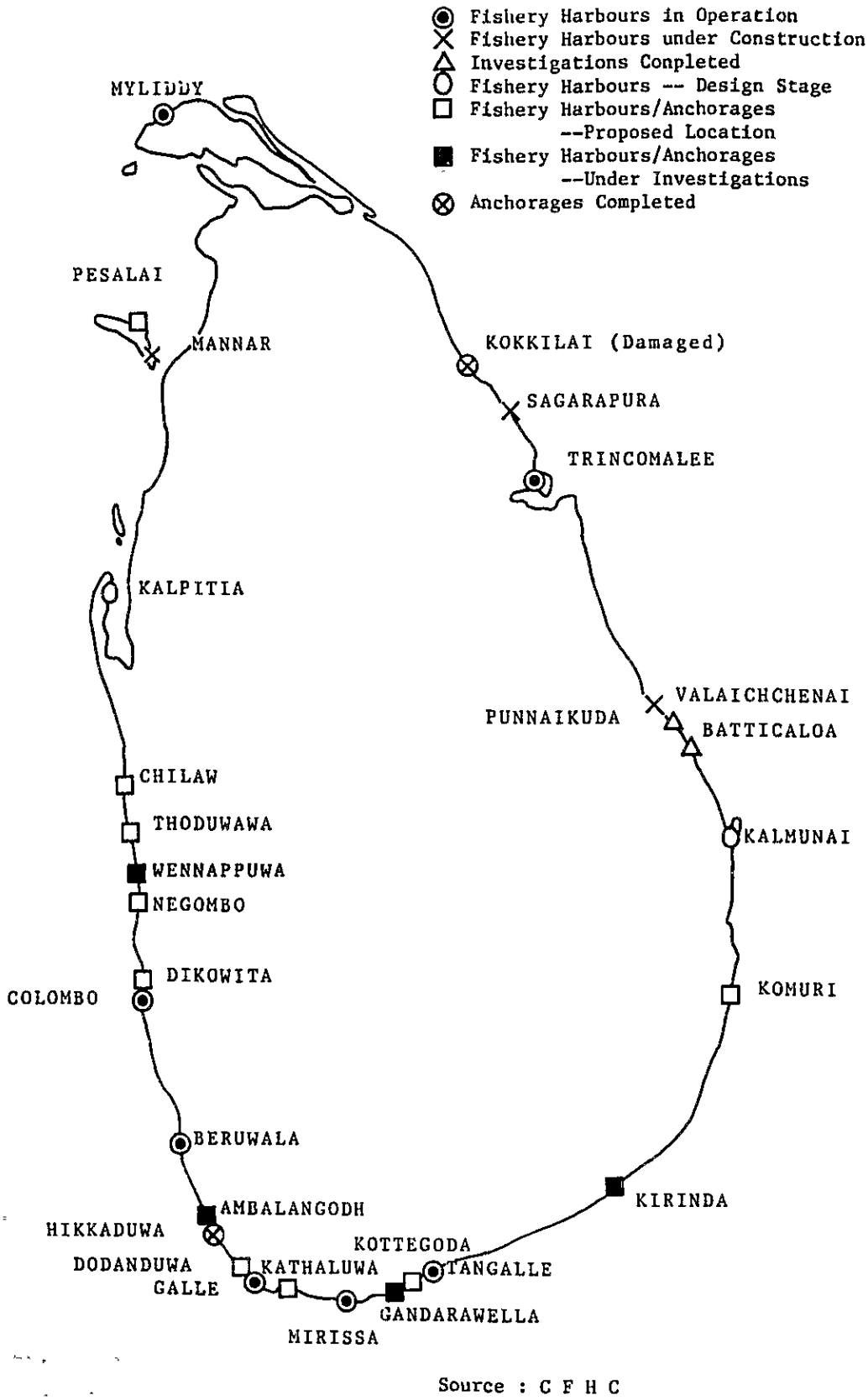


Fig. 2-1 Location of Fishing Harbours in Sri Lanka

site, because of easy construction and good potential of fishing ground. The area off the Amaduwa site is one of the most promising fishing ground in the southeastern part of the country.

Hereinafter, four prospective sites have been outlined and compared with each other so as to identify the harbour project. Those harbours are Puranawella, Hambantota, Amaduwa and Kirinda.

Puranawella

This site is located between the existing harbours, Tangalle and Mirissa which function at present as the center of coastal fisheries in the southern coast. The distance between them is roughly 40 km, so it can be said that there is no need to expedite this development, considering the existing conditions of surrounding fishing harbours in Sri Lanka. Therefore, in the selection of the harbour project, this site has been deleted for the time being.

Hambantota

This site is located about 45 km east of Tangalle, so that like Kirinda it has a good advantage in terms of location. However, this site has already been fully surveyed and financed by foreign aid. Therefore, out of the alternatives, this site has been deleted.

Amaduwa

This site is located in the eastern edge among the four prospective harbour sites, about 110 km away from Tangalle. Though this site is considerably away from the existing harbour, it will have an easy access to a very promising fishing grounds in the southern part of Sri Lanka named Amaduwa and Patanangala. In this sense, it is agreeable to put up a new harbour in Amaduwa.

However, this site is bordered by a protected area, the Yala National Park, so development in Amaduwa may raise some problem in view of environmental assessment. Additionally, since this site is scarcely inhabited, it can be said that the development in Amaduwa has poor potential for harbour development for the time being. Therefore, this site has been deleted from the alternatives.

Kirinda

This site is located about 60 km east of Tangalle, so that this location is quite agreeable from a strategic view point. In the vicinity of the Kirinda area, there lie two promising fishing grounds named Amaduwa and Patanangala which are exclusively used by migrant fishermen. The Kirinda Harbour, if established, will cover those fishing grounds which are located within the operational distance of small boats (3.5 ton class). Since there is no refuge near Amaduwa and fishermen living there cannot sail out for fishing during rough seasons. In this sense, the location of Kirinda Harbour will provide a reliable refuge during the monsoon season, and will assist in increasing the operability of small boats, resulting in increasing fish production in the Kirinda area.

Compared to Amaduwa and Puranawella, this site is comparatively populated, and the existence of the Kirinda temple has been attracting many tourists. In connection with tourism, this site has good prospects for regional development on religion-associated-industry.

There is a regional master plan of the regional development in Kirinda with a view to raising the local living standard through making full use of local industries like tourism and fisheries. The target population in the regional master plan is 6,000 - 7,000 in 2000.

The matter of regional development shall be referred not only to the Kirinda area but also to all the other developing rural areas inclusive of other alternatives. Here, much emphasis has been laid on the Kirinda site from a view point of the priority order of the Authorities concerned.

As described above, among the prospective four sites, the Kirinda site has been selected as the Harbour Project, and hereinafter the harbour development of Kirinda will be studied.

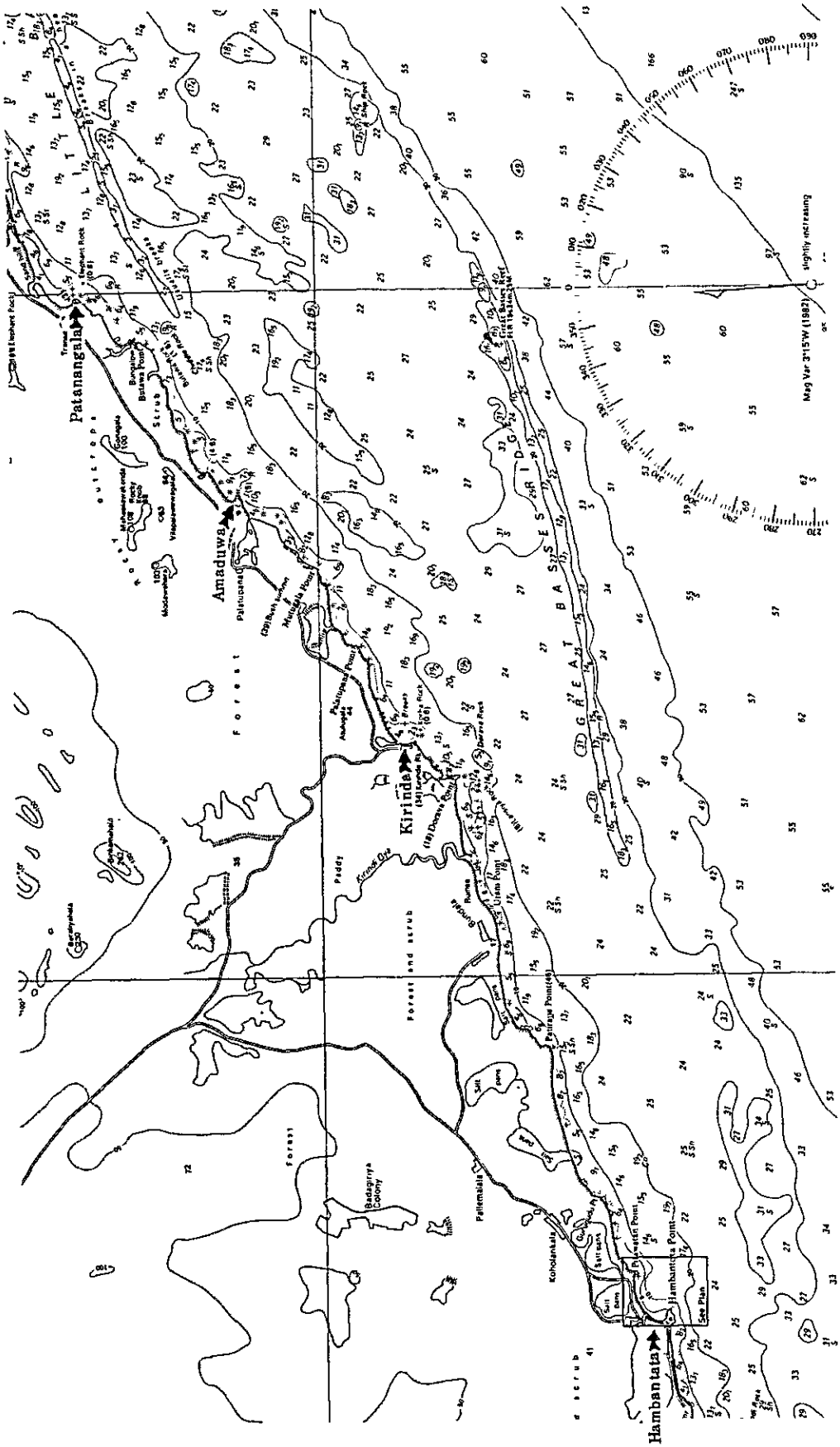


Fig. 2-2 Fishing Ground around Project Area

CHAPTER 3. THE PROJECT AREA

3-1 Location

The Harbour Project is to be located in the Kirinda Area in the southeastern coast of Sri Lanka. Administratively, it belongs to the Hambantota District. The capital of Hambantota is about 30 km away from Kirinda.

The national road "Route A-2" which originates from Colombo city, runs along the west to south coast of Sri Lanka turning to north direction near Kirinda to detour the "Yala National Park", so there is no connection east to Kirinda. The distance from Colombo city to Kirinda is about 250 km with a part running over the regional road between Tissamaharama and Kirinda.

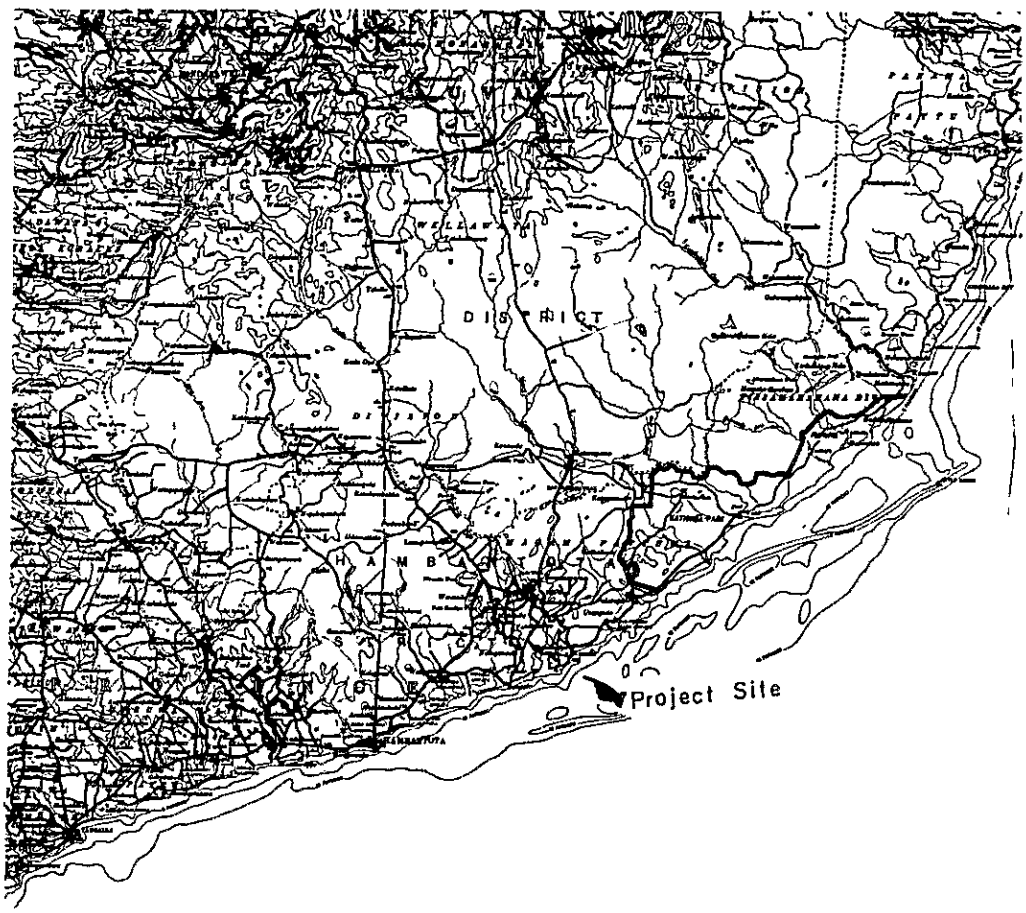


Fig. 3-1 Project Area

3-2 Climate

The climate in Sri Lanka is clearly characterized by two typical monsoons, the SW monsoon from April to October and the NE monsoon from November to March. During the SW monsoon, humid monsoon winds, blocked by the mountain range lying in the central south of Sri Lanka, produce heavy rains in the south-western part of country, while on the contrary the NE monsoon brings a rainy season in the north-eastern part of the country. Generally speaking, the volume of rainfall brought about by the NE monsoon is lower than by the SW monsoon.

The project area is located in the southeastern part of Sri Lanka, so that the rainfall is comparatively lower than in other parts of the country. As shown on Table 3-1, the average precipitation in Hambantota which is located about 30 km west of Kirinda Harbour gives the least figure of 1,075.4 mm/year among the typical weather stations representing the respective parts of Sri Lanka.

On monthly base, in April and May (SW monsoon) and in October, November and December (NE monsoon), the precipitation is comparatively heavier. The maximum daily rainfall in 1981 was 61.7 mm on October 27th.

Table 3-1 Precipitation Records in Sri Lanka

Unit: mm

Station	Average 1931 - 60	1978	1979	1980
Colombo	2,395.5	1,954.4	2,450.6	1,995.9
Jaffna	1,329.4	1,162.0	1,391.7	914.0
Trincomalee	1,726.7	1,464.6	1,473.0	765.3
Hambantota	1,075.4	976.5	796.6	1,125.5
Ratnapura	3,887.7	3,742.5	3,490.4	3,270.8
Anuradhapura	1,447.3	1,194.7	1,371.3	1,123.6
Kandy	2,021.8	1,924.5	1,995.4	1,552.6
Diyatalawa	1,730.8	1,275.1	1,658.3	1,283.7
Nuwara Eliya	2,162.7	2,604.6	2,195.8	1,417.4

Source: Dept. of Meteorology

Table 3-2 Hambanthota—Rainfall
(Monthly total)

in mm

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
1979	50.1	40.4	4.5	36.1	46.2	50.2	25.5	26.0	89.4	60.7	217.3	150.2	796.6
1980	17.0	Trace	29.6	291.3	108.0	49.5	13.1	33.0	44.2	180.3	283.9	75.6	1,125.5
1981	48.3	43.5	12.8	169.8	54.3	11.6	26.0	82.5	39.5	96.4	66.2	100.8	751.7

Table 3-3 Hambanthota—Rainfall
(Daily total)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
JAN.	42.8	0	5.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FEB.	0	0	0	0	33.3	1.9	0	9	0	0	0	0.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8.0	0	0	0	0
MAR.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0	12.8	–	–	–	–	–	–	–
APR.	–	–	–	45.2	–	21.6	–	5.2/42.3	–	–	40.1	5.2	–	–	–	–	–	–	–	–	–	–	3.5	–	1.4	–	–	–	–	8.8	–
MAY.	–	9.8	–	–	18.1	–	–	–	–	0.1	–	7.8	–	–	–	–	–	–	–	–	–	–	3.5	–	–	–	–	0.5/14.5	–	–
JUNE.	–	–	–	–	–	2.2	0.8	–	0.4	–	0.4	0.4	1.7	0.3	0.6	0.4	3.4	–	–	–	–	–	–	–	–	–	–	–	–	–	–
JULY.	–	–	–	–	9.0	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0.2	1.3/14.5	–	1.0	–	
AUG.	1.1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0.9	7.7	–	–
SEP.	–	–	–	0.3	1.0	–	1.1	1.2	7.6	1.9	–	1.8	8.9	0.1	–	3.4	6.8	0.5	–	3.3	–	–	–	–	1.6	–	–	–	–	–	–
OCT.	–	–	–	–	0.2	–	–	–	–	–	–	–	0.2	0	–	–	1.3	0	0.3	–	–	–	1.8	7.0/22.9	0	61.7	0.2	0.8	0	–	
NOV.	1.5	0.5	1.3	–	–	–	–	–	–	2.4	–	3.1	–	–	–	–	–	–	–	46.6	1.8	–	–	–	0.7	–	–	–	8.3	–	–
DEC.	0.1	–	–	21.5	5.6	–	–	–	–	–	–	–	–	0.3	0.4/61.4	6.7	–	–	–	–	–	0.6	–	4.2		–	–	–	–	–	–

The records of temperature at the respective weather stations are also shown in Table 3-4. It seems that the temperatures in the inland area are comparatively lower than those in the coastal area.

Table 3-4 Temperature Records in Sri Lanka

Station	1931 - 60		1979		1980	
	Max.	Min.	Max.	Min.	Max.	Min.
Colombo	30.0	23.9	31.1	23.2	31.2	24.3
Jaffna	30.1	25.2	28.8	23.9	31.0	25.8
Trincomalee	31.0	24.9	28.6	24.7	32.3	26.0
Hambantota	30.2	24.0	29.6	23.4	30.6	24.1
Ratnapura	31.5	22.8	31.7	22.6	32.2	23.3
Anuradhapura	31.7	22.9	29.4	23.2	32.5	23.8
Kandy	28.8	20.0	29.0	20.1	29.4	20.3
Diyatalawa	24.6	15.8	22.6	16.0	25.5	15.5
Nuwara Eliya	20.1	10.8	19.0	12.0	19.8	11.5

Source: Dept. of Meteorology

The wind characteristics in the project area can be also derived from the records in Hambantota. Concerning wind speeds, the records in Hambantota show the higher figures than those recorded in the western coast of Sri Lanka represented by the data in Colombo. The wind records with a speed of more than 10 m/sec are extracted and tabulated on Table 3-5.

Table 3-5 Extracts from Field Book Records -Wind Speed at Hambanthota

Year	Month	day	2.30	5.30	8.30	11.30	14.30	17.30	20.30	23.30
1978	Apr.	15	5.0 W	13.8 W	13.0 W	19.0 W	24.0 SW	33.0 SW	30.0 WSW	12.0 WSW
		16	20.0 W	6.0 W	12.0 SW	24.0 SW	40.0 SW	39.0 WSW	30.0 SW	26.0 SW
		17	20.2 SW	13.2 SW	17.0 WSW	24.0 SW	36.0 SW	36.0 WSW	30.0 SW	27.2 WSW
		18	18.0 WSW	8.0 WSW	16.2 WSW	36.0 SW	40.0 WSW	25.0 WSW	18.0 WSW	19.4 WSW
		19	14.0 WSW	20.4 WSW	12.4 WSW	32.0 SSW	47.8 SW	30.0 sw	6.0 SW	21.0 SW
		20	16.0 SW	5.0 SW	15.0 SW	15.0 SW	38.0 SW	34.0 SW	18.0 SW	15.0 SW
1978	May.	21	13.2 W	24.0 W	25.4 WSW	32.2 WSW	32.2 WSW	30.0 SW	33.0 SW	26.8 WSW
		22	15.0 WSW	29.0 WSW	30.0 SW	40.2 SW	38.0 SW	41.6 SW	28.4 WSW	27.2 WSW
		23	29.4 WSW	35.6 WSW	27.4 WSW	33.8 WSW	30.6 SW	36.6 WSW	27.0 SW	47.0 SW
		24	40.0 SW	27.4 SW	28.8 WSW	34.8 SW	39.0 WSW	36.4 SW	18.0 SW	13.2 SW
1978	Sept.	1	9.0 SW	13.2 WSW	15.6 W	24.0 SW	26.0 SW	30.4 SW	15.0 SW	15.0 WSW
		2	7.2 W	9.0 W	19.2 WSW	29.8 WSW	29.8 SW	34.0 SW	30.0 SW	9.0 SW
		3	10.0 SW	13.2 SW	17.4 SW	34.8 SW	48.0 SW	34.2 SW	27.8 SW	19.4 SW
		4	13.2 SW	10.8 WSW	24.0 SW	45.0 SW	50.0 SW	37.4 SW	25.8 SW	15.8 SW
		5	17.4 SW	18.4 SW	22.4 WSW	23.0 SW	22.2 SW	22.4 SW	24.0 SW	16.2 SW
		6	17.0 SW	12.6 SW	29.6 SW	20.6 SW	48.0 SW	44.0 SW	24.0 SW	18.4 SW
		7	9.0 SW	10.4 SW	14.4 SW	22.8 SW	39.0 SW	42.0 SW	18.0 WSW	10.2 WSW
		24	12.0 WSW	16.0 WSW	21.0 WSW	30.8 WSW	30.0 SW	39.2 SW	18.0 SW	15.0 SW
		25	16.0 WSW	18.0 SW	15.6 SW	36.0 SW	39.0 WSW	45.0 WSW	18.0 WSW	12.0 SW
1978	Oct.	13	10.4 WSW	11.0 WSW	22.8 SW	29.4 SW	53.8 W	45.4 SW	19.8 SW	19.2 SW
		14	10.2 SW	14.0 SW	20.6 SW	40.2 WSW	40.4 SW	47.6 SW	16.0 SW	23.2 SW
1978	Nov.	23	6.0 NNW	9.0 N	7.2 NNW	4.2 W	12.2 WSW	45.6 WSW	40.8 WSW	36.2 WSW
		24	40.8 WSW	60.0 WSW	54.0 WSW	19.8 WSW	10.2 WSW	3.6 W	3.8 W	6.0 NW
1979	Jan.	1	10.8 NNE	12.0 NNE	12.6 ENE	21.0 ENE	21.0 ENE	20.2 ENE	23.4 NE	9.0 NE
		2	13.2 NE	10.4 NE	15.0 NNE	30.2 NE	36.4 NE	30.0 NE	27.0 NE	15.8 NNE
		3	15.4 NNE	15.2 NNE	16.8 NNE	24.0 NE	30.2 NE	33.0 NE	27.0 NNE	18.0 NNE
		4	16.2 NNE	19.8 NNE	14.8 NNE	24.0 NNE	18.0 NNE	30.0 NE	36.0 NE	12.0 NNE
		16	14.0 E	22.8 NNE	14.0 NNE	28.2 NE	23.6 E	34.6 ENE	25.8 E	18.4 NNE
		17	14.0 NE	16.8 NNE	15.0 NNE	14.4 NE	26.4 NE	34.0 NE	20.2 NE	15.0 NNE
		18	11.8 NE	11.2 NE	13.2 NNE	18.0 NE	15.2 ENE	36.2 NE	20.0 NE	13.2 NE
		19	13.8 NE	17.0 NNE	15.0 NNE	22.2 ENE	16.0 ENE	32.6 ENE	19.2 NE	12.2 NE
		20	17.0 NNE	18.2 NNE	17.4 NNE	16.8 NE	28.0 ENE	26.8 ENE	24.0 ENE	23.4 NE
		21	15.6 NE	13.4 NNE	24.0 NNE	27.0 NE	30.0 ENE	41.1 ENE	28.8 NE	24.6 NNE
		22	18.0 NE	16.8 NE	29.8 NNE	25.4 ENE	18.0 ENE	42.0 ENE	16.2 NE	18.0 NNE
		23	17.2 NE	21.0 NNE	24.0 NNE	24.0 NNE	33.0 ENE	33.0 ENE	21.0 ENE	9.0 NNE
		24	13.2 NNE	12.6 NNE	12.6 NNE	26.4 ENE	34.8 ENE	30.0 ENE	18.6 NE	13.0 NE

Lastly, the project area is slightly influenced by cyclone activities. According to the records of the Colombo Weather Station, there was only one cyclone that hit the eastern coast of Sri Lanka adjacent to the project area. That cyclone landed at the town Batticaloa, on November 23, 1978, causing a lot of damage there, but no significant damage was reported in the Kirinda area.

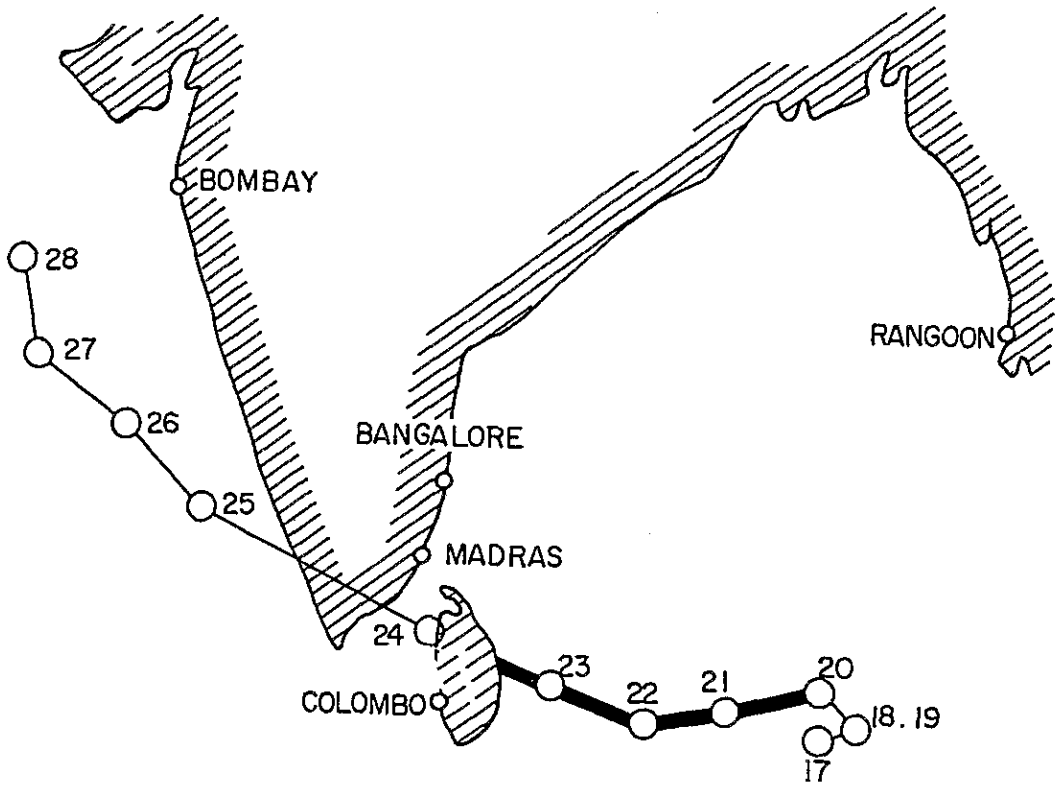


Fig. 3-2 Track of Cyclone (Nov. 23, 1978)

3-3 Topography

The project site is located north of Kirinda Point. The Dorawe river is flowing out to the sea about 2 km southwest of Kirinda Point. About 500 m north of the Kirinda Point, a small lagoon named "Kirinda Lewaya" is located. About 3.5 km west of Dorawe river, another larger river "Kirinda Oya" meanders to the sea. East of Kirinda Oya, a spacious area for paddy irrigation is extending up to west of the Kirinda-Tissamaharama road. Near Tissamaharama, there is a huge tank named "Yoda Wewa".

The elevation of Yoda Wewa is approximately 30 m higher than that of Kirinda area, so that the flat terrain is lying behind Kirinda project site in a gentle slope of 1/240 - 1/300.

The lagoon "Kirinda Lewaya", 200 m long and 600 - 700 m wide, is almost dried out all through the season. Pent-up water in the wet season rarely breaks through the sand bank deposited in the inlet of the lagoon.

According to information collected from the inhabitants living there, it seems that only for two or three days once a year, the pent-up water breaks through to the ocean, incurring no fatal affect for siltation problem in the area.

3-4 Population

The total population in Sri Lanka was 14.7 million in 1980, and population density is 228 persons per km^2. The Hambantota district where the project site is located has a population of 340,254 in 1971 and 408,000 in 1980. The population density in the Hambantota District is 131 persons/km^2 in 1971 and 157 persons/km^2.

The Hambantota District is divided into eight Divisions, one of which is the Tissamaharama Division under which 14 Grama Sevaka Division is positioned. Kirinda belongs to this Grama Sevaka Division. The Tissamaharama Division has a population of about 6,400. Kirinda Grama Sevaka Division has a population of about 1,500.

Table 3-6 Population in District

	Area (Sq.Kilo-metres)	Population		Density per Sq. Kilometre		%
		1971(1)	1980(2)	1971(1)	1980(2)	In-crease
Colombo	652.44	1,498,393	1,724,000	2,297	2,642	15.1
Gampaha	1,398.73	1,173,872	1,346,000	839	962	14.7
Kalutara	1,606.54	729,514	836,000	454	520	14.6
Kandy	2,157.50	1,096,737	1,234,000	508	572	12.5
Matale	1,995.26	314,841	368,000	158	184	16.9
Nuwara-Eliya	1,437.22	541,466	562,000	377	391	3.8
Galle	1,673.78	735,173	841,000	439	502	14.4
Matara	1,246.43	586,443	688,000	470	552	17.3
Hambantota	2,593.23	340,254	408,000	131	157	19.9
Jaffna	2,072.20	696,664	834,000	336	402	19.7
Mannar	2,002.10	74,125	91,000	37	45	22.8
Vavuniya	2,645.20	60,212	80,000	23	30	32.9
Mullaitivu	1,966.03	43,625	49,000	22	25	12.3
Batticaloa	2,464.59	256,721	318,000	104	129	23.9
Amparai	4,539.34	272,605	333,000	60	73	22.2
Trincomalee	2,618.16	188,245	239,000	72	91	27.0
Kurunegala	4,772.70	1,025,633	1,206,000	215	253	17.6
Puttalam	2,976.87	378,430	462,000	127	155	22.1
Anuradhapura	7,129.14	388,770	489,000	55	69	25.8
Polonnaruwa	3,403.70	163,653	201,000	48	59	22.8
Badulla	2,818.07	615,405	677,000	218	240	10.0
Monaragala	5,580.95	193,020	244,000	35	44	26.4
Ratnapura	3,238.78	673,283	770,000	208	238	14.4
Kegalle	1,662.77	642,813	738,000	387	443	14.8
Sri Lanka	64,651.78	12,689,897	14,738,000	196	228	16.1

Source: Registrar-General's Department

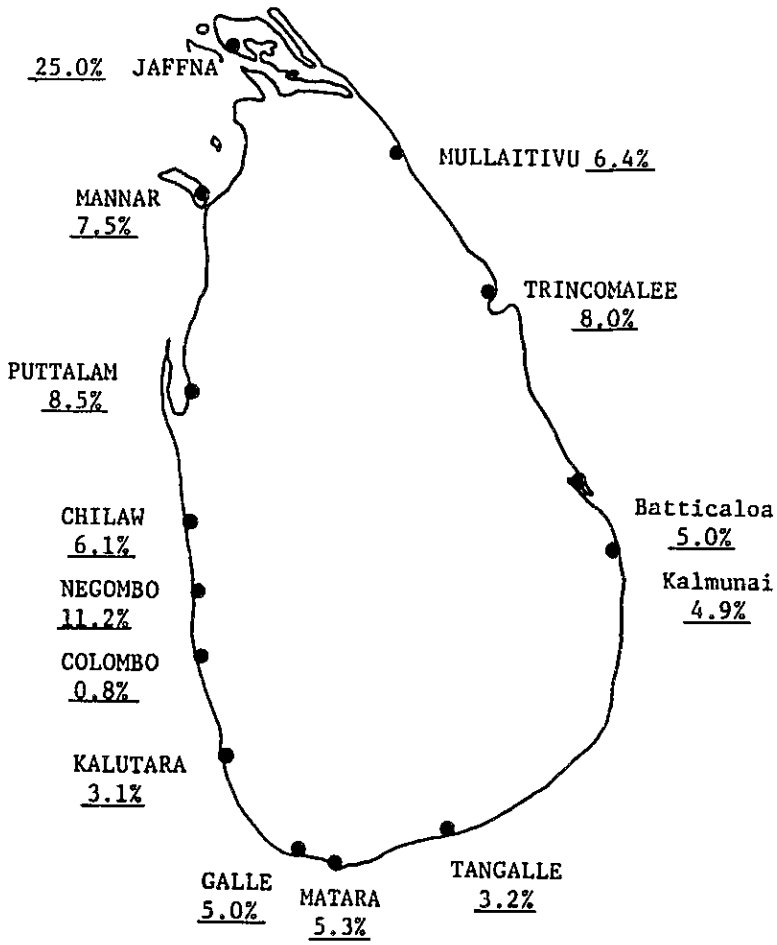
(1) Census Year - The population and area for Kandy and Nuwara Eliya Districts have been revised according to the present boundaries.

(2) Provisional mid year estimates.

Administratively, the Kirinda area is controlled by Grama Sevaka of Kirinda which is positioned under the Assistant Government Agent (AGA) of Tissamaharama.

3-5 Fisheries

The major industry of Kirinda is fishery. The fishing ground of Kirinda is under the jurisdiction of the District of Fisheries Extension Office (DFEO), Tangalle. Of all the catch in the 14 sea grounds of Sri Lanka, the catch in DFEO, Tanglle accounts for 3.2%. As shown in Fig. 3-3, Jaffna is the best fishing ground, accounting for 25% in share, followed by Negombo with 11.2%, Puttalam with 8.5%, Trincomalee with 8%, Mannar with 7.5% and Chilaw with 6.1%.



SOURCE : M O F

Fig. 3-3 Fish Production in Sri Lanka in 1981

The fishing grounds concerned with the Project Area under the DFEO, Tangalle are Kirinda, Patanangala and Amaduwa. The latter two fishing grounds are exclusively used by migrant fishermen. According to the statistics issued by DFEO, Tangalle, the fishing activities in those there fishing grounds are summarized as below.

Table 3-7 No. of Fishermen and Canoes in 1981 in Project Area

	Total	Kirinda	Patanangala	Amaduwa
No. of fishermen (migrant)	810	110	500	200
No. of fishermen (settled)	170	170	-	-
No. of canoe (migrant)	101	15	46	40
No. of canoe (settled)	55	55	-	-
No. of 3-1/2 boat	81	43	20	18

Most of the fishermen are engaged in seasonal fishing, especially in Patanangala and Amaduwa. The settled fishermen are concentrated in the Kirinda area. The major fleet of fishing boats are canoes in non-mechanized craft and 3-1/2 ton crafts in mechanized craft. At the Kirinda area, fish production in 1981 was reported to be 385 tons. The productivity of fishing crafts at Kirinda area can be assumed as shown in Table 3-8. The catch per boat is derived from the actual production in Kirinda in 1981 and other related informations.

Table 3-8 Productivity of Fishing Craft in Project Area

Boat size	Off Season		On Season		Operation Time
	Catch/ boat	Monthly operation day	Catch/ boat	Monthly operation day	
3-1/2 ton boat (Permanent)	500 Kg	20-22	7,040 Kg	20-22	6:00 PM - 8:00 AM
3-1/2 ton boat (Migrant)			7,040 Kg	20-22	6:00 PM - 8:00 AM
17-1/2 ft. boat (Migrant)	110 Kg	20-22	880 Kg	20-22	2:00 AM - 8:30 AM 4:00 AM -10:00 AM
Canoe (Permanent)	110 Kg	20-22	880 Kg	20-22	3:00 AM - 7:00 AM
Canoe (Permanent)			880 Kg	20-22	3:00 AM - 7:00 AM

Source : DFEO, Tangalle

The major fishing gears used in Kirinda are a drift gill nets, bottom gill nets and hand lines, and no beach seine and trawler can be seen. The typical netting of gill net is shown in Fig. 3-4. This type can be used by canoes in a train of 10 sets.

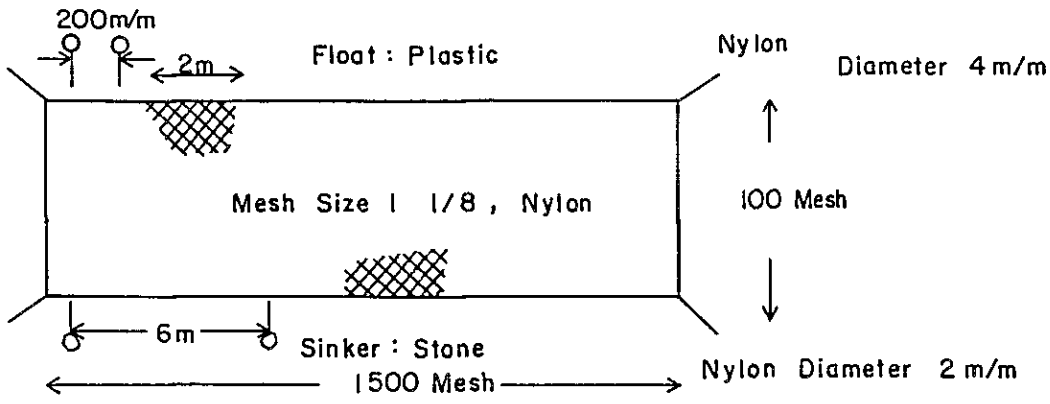


Fig. 3-4 Example of Gill Net

The species captured are skipjack, yellowfin tuna, spanish mackerel, shark,horse mackerel, stingray, red mullet, snapper and sardine, and very scarce shrimp.

The fishing ground of Kirinda, which is characterized by narrow continental shalf with indented seabed, is severely influenced by southwest and northwest monsoon drifts.

In the vicinity of Kirinda, there lies a national park called "Yala", which extends about 26 miles wide in the northeast of Kirinda. The coastal sea ground off this park is of good potential for future exploitation.

Only 10% of the production in Kirinda is locally consumed, and the remaining 90% is transported to surrounding inland villages. The major destination of Kirinda fish are Wellawaya, Katragama, Tissamaharama, Yoda Kandiya, Hambantota, Kudawella, Tangalle and Ratnapura.

Ice making plants are in operation or under construction in Tangalle District. Their major dimensions are given in Table 3-9.

Table 3-9 Ice Plants in Tangalle District

	Ice making plant (t/day)	Ice storing capacity (t)	Regend
Tangalle	10 (B)*	20	CFHC
Hambantota	5 (B)*	20	CFHC, under construction
Kalametiya	-	6	under construction
Kudawella	-	6	under construction

Source: DFEO Tangalle

*B means block ice.

CHAPTER 4. PROJECT

4-1 Scale of Harbour Development

4-1-1 Future production in project area

In 1978 to 1980, the Norwegian survey team conducted a research of fishing resource in Sri Lanka in association with the Fisheries Research Station, Colombo and the potential of fishing resources was estimated by use of biomas.

Based on the biomas method, it is expected that the annual catch in the project area will be in the order of 8,000 - 9,000 tons, equal to approximately 8 - 9 t/sq.km.

It is the team's opinion that this figure is enormously high, considering the condition of fishing ground in Sri Lanka. Aside from the ultimate resources in the project area, it is reasonable to take the figure of one third or one forth of the above rate for planning the practical scale of the fishing harbour, so the figure of 2 - 3 t/km^2has been adopted.

On the other hand, the practical fishing ground to be covered by the operation of the Kirinda Fishery Harbour, inclusive of Amaduwa and Patanangala is about 800 km^2 area.

Applying the above unit production rate, an annual catch of 1,600 - 2,400 ton can be obtained. Therefore, annual production of 2,000 ton has been taken for planning the scale of the Kirinda Fishery Harbour.

4-1-2 Scale of harbour development

As mentioned before, there is no fishery harbour east of Tangalle in the southern coast of Sri Lanka, so that the Kirinda Fishery Harbour, if established, will govern the fishing ground of Amaduwa and Patanangala inclusive of Kirinda. In those fishing grounds, a variety of fishing crafts are operating such as canoes, 3-1/2 ton crafts, 17-1/2 ft. FRP boats, other mechanized crafts and non-mechanized crafts. During on-season, 20 numbers of 3-1/2 ton boats operate in Patanangala , 18 boats

in Amaduwa and 43 boats in Kirinda area, totaling 81 boats of 3-1/2 ton class.

As tabulated in Table 4-1, in 1981 a total catch of 386,720 ton was landed in Kirinda area. Inclusive of Patanangala and Amaduwa, a total catch in the Project Area was approximately 1,000 tons. On completion of the Kirinda project, this production rate will be stepped up on account of efficient landing and longer fishing period. Considering the upgrading of the production rate inclusive of the fleet operation in Amaduwa and Patanangala the annual catch in the project area has been figured out as shown in Table 4-1.

Table 4-1 Fish Production in Project Area

		Without Project				With Project			
		No. of boat	Production (off-season)	Production (on-season)	Total Production	No. of boat	Production (off-season)	Production (on-season)	Total Production
Kirinda	3-12/ ton boat (Permanent)	3	1,500 Kg	29,400 Kg	30,900 Kg	3	24,000 Kg	33,000 Kg	57,000 Kg
	3-1/2 ton boat (Migrant)	40	20,000	392,000	412,000	40	320,000	448,000	768,000
Pattanangula & Amaduwa	3-1/2 ton boat (Migrant)	38	19,000	372,400	391,400	38	304,000	426,000	730,000
New Supply	3-1/2 ton boat	-	-	-	-	19	152,000	213,000	365,000
Kirinda & others	17-1/2' boat (Migrant)	15	1,650	97,500	99,150	15	15,000	21,000	36,000
Canoe	(Permanent)	55	6,050	67,760	73,810	55	55,000	77,000	132,000
Canoe	(Migrant)	15	-	18,480	18,480	15	-	21,000	21,000
Total			48,200 Kg	977,540 Kg	1,025,740 Kg		870,000 Kg	1,239,000 Kg	2,109,000 Kg

* The Production in Pattanangula & Amaduwa has been assumed based on the information obtained from CFHC

The production with project has been also given by the authorities concerned in CFHC.

To produce an annual catch of 2,000 ton, a total of one hundred 3-1/2 ton boats will be required in the project area inclusive of the additional new nineteen 3-1/2 ton boats, which may be introduced to replace the existing fifteen 17-1/2 ft. boats.

Most of the above 3-1/2 ton boats are engaged in seasonal fishing, and some of them may have utilized the Galle harbour or Hambantota as mother ports.

However, on completion of the Kirinda Fishery Harbour, all the boats operating in the above three fishing grounds will make full use of the Kirinda Harbour for landing fish as well as for getting supply of fuel, water and other necessary goods for better convenience in all respects.

Especially in case of emergency like cyclone or seasonal blast occurring periodically, all boats in the above three fishing grounds will be accommodated in the Kirinda Harbour for safety mooring and landing. Under these backgrounds, it is recommended that the Kirinda Harbour be developed both for landing the annual catch of 2,000 ton and for providing a good refuge.

4-2 Design Requirement for KIRINDA Harbour

4-2-1 Space requirement

In accordance with the scale of harbour development determined in 4-1-2, the Kirinda Fishery Harbour shall accommodate one hundred fishing boats of 3-1/2 ton class. Since the proposed area for harbour development at Krinda is open to the sea, Kirinda Harbour shall be protected by breakwater in order to secure the required calmness inside harbour. The area required for accommodating one hundred boats can be developed through a control area derived from the existing six fishing harbours in Sri Lanka. Statistically it has been observed by the CFHC that an average fishing harbour can berth about 40 boats/hectare. Also in Japan, the area requirement of small fishing boat is 250 m^2/craft. Therefore, 25,000 m^2 of calm harbour area will be provided for Kirinda Harbour..

4.2.2 Navigation aspects

The specification of an average craft (3-1/2 ton) is given as below:

Length	:	9 - 10 m
Beam	:	2.54 m
Draught	:	0.86 m

Depth of approach channel

The depth of the approach channel shall be sufficient enough to clear the full-load-draft plus some allowance on the safe side. According to the Design Standard of Fishing Harbour in Japan, (DSFH) the depth requirement for approach channel can be determined as follows:

Depth of approach channel = max draft + allowance (i)or(ii)

(i) Seabed condition

Hard subsoil (rock) ..... 1.0 m <
Soft subsoil (silt) ..... 1.0 m >

(ii) Vessel action (trim)

Assuming the critical wave height for 3-1/2 ton boat to sail out is 3.0 m, allowance covering trim action can be calculated at 2.0 m. (= 3 x $\frac{2}{3}$)

Therefore, the depth of approach channel has been figured out as follows,

0.86 m + 2.0 m (1.0 m) ≒ 3.0 m

Width of the approach channel

According to the DSFH, the width of approach channel is prescribed as 6 B or 8 B where B is the width of the fishing boat to travel the channel. Taking 8 B on safe side plus some allowance, the width of the channel has been assessed as follows:

Channel width = 8 B + allowance

= 8 x 2.54 + 10

= 30.3

≒ 35 m

Depth of basin area

According to the DSFH, the depth of basin area can be figured out as follows:

Basin depth = max. draft + allowance

= 0.85 + 0.5

= 1.35 m ≒ 1.50 m

Though the required water depth of the basin area has been calculated at 1.50 m, the planning water depth is determined at 2.50 m, considering the fact that the existing water depth inside harbour is mostly under - 2.50 m, and the possibility of calling of 10 t class boat whose draft is 1.68 m.

(1.68 + 0.5 = 2.18 ≒ 2.50 m)

4-2-3 Berthing facilities

The fishing craft is berthed at 90° to the fender line, bow to the waterfront. In this pattern a total berth line required is 300 m, based on the assumption: (2.54 + 0.50) x 100 = 300 m where 2.54 m is beam, 0.50 m is allowance and 100 is number of boats. It is expected that the frequency of all the 100 boats calling at the harbour simultaneously is very rare, so that full length berth is not necessary nor economical. Allocating the boats berthed double, the design requirement of berth length is determined half of the calculated length (300/2 = 150 m).

4-2-4 Shore facilities

The shore facilities of Kirinda Harbour will be provided on the standard level of the existing fishing harbours in Sri Lanka.

i) Cold storage
ii) Administration office
iii) Auction shed
iv) Work shop

v) Warehouse

vi) Other miscellaneous facilities

Besides above facilities, such functional facilities as apron, road, parking lot and green buffer zone will be laid out in close coordination with the shore facilities. The capacity of each shore facility has been determined in the following procedure.

i) Cold storage

The capacity of cold storage has been determined taking into account the maximum daily landing volume during on-season.

a) Maximum daily landing volume

3-1/2 ton boat ..... $\frac{1,600 \text{ Kg} \times 100 \text{ boats}}{20 \text{ trips}} = 8,000$ Kg

Outboard engine .... $\frac{200 \text{ Kg} \times 15 \text{ boats}}{20 \text{ trips}} = 150$ Kg

Canoe ..... $\frac{200 \text{ Kg} \times 70 \text{ boats}}{20 \text{ trips}} = 700$ Kg

8,850 Kg ≒ 9,000 Kg

b) Volume locally consumed (10%)

9,000 x 0.1 = 900 say 1,000 Kg

c) Volume temporarily stocked before transporting

(1 day or so)

8,000 x 1/2 = 4,000 Kg = 4 t

e) Ice requirement for transporting fish

8,000 x 1/2 = 4,000 Kg = 4 t

f) Holding capacity of cold storage

(d) + (e) = 8 t

Considering some allowance

: 8 x 1.3 = 10 t

g) Holding temperature

-5°C - -10°C

h) Land requirement for cold storage installation hasbeen determined based on DSFH

$6.75\ m^2/t \times 10\ t = 70\ m^2$

(actual building area is $50\ m^2$)

ii) Administration office

The land area and office area for administration office has been determined reflecting the existing conditions of administration offices which are being used by CFHC.

Office area	:	$80\ m^2$
Land area	:	$300\ m^2$

iii) Auction shed

The land area and building area for action shed has been determined reflecting the existing conditions of auction shed which is now in operation in Sri Lanka.

Building area	:	$250\ m^2$
Land area	:	$500\ m^2$

iv) Workshop

The land area and building area for workshop has been determined as follows:

Building area	:	$200\ m^2$
Land area	:	$400\ m^2$

v) Warehouse

The land area and building area for warehouse has been determined as follows.

Building area	:	$100\ m^2$
Land area	:	$300\ m^2$

vi) Water supply

The capacity of water tank has been determined reflecting local conditions.

Capacity	:	100 t
Land area	:	$100\ m^2$

vii) Apron

The width of apron is determined considering the method of cargo handling through the berth. The width of apron for Kirinda Harbour has been set at 10 m inclusive of space for sorting and packing the cargoes.

viii) Road

The roads running behind the apron and sheds will be designed with two lane road, 3 m each in width.

ix) Parking lot

Inside the Kirinda Harbour, sufficient space will be provided for parking use. Here in this plan, a total of 400 m^2 has been secured for accommodating 10 nos. of sedan-type passenger cars and 3 nos. of lorry. All shore facilities considered hereinbefore are summarized as in Table 4-2.

Table 4-2 Area Requirement of Onshore Facilities

Facilities	Land area	Building area
Cold storage	150 m^2	50 m^2
Administration office	300	80
Auction shed	500	250
Workshop	400	200
Warehouse	300	100
Water tank	100	-
Parking lot	300	-
Apron and Roads	2,500	-
Green and others (50% of above land requirement)	2,250	-
	6,800 ≒ 7,000 m^2	680 m^2

4-3 Design Information

4-3-1 General

To proceed with the designing of Kirinda Harbour, design information has been collected and considered. Here in this chapter is mentioned the design information required for establishing the harbour layout and for finalizing the structure type of major harbour facilities like breakwaters, revetments and quaywalls.

The items discussed hereinafter are tides, currents, winds, waves water depth and subsoil conditions.

4-3-2 Tides

The standard port in Sri Lanka is Colombo port, and the secondary port is Hambantota. The time difference of Hambantota to Colombo is + 20 minutes, and the ratio of range of Hambantota to Colombo is 0.65. Based on the tidal elevation of Colombo, that of Hambantota can be developed as follows.

	Colombo	Hambantota
MHWS	+0.72 m	+0.47 m
MHWN	+0.48	+0.31
MSL	+0.38	+0.25
MLWN	+0.30	+0.20
MLWS	+0.06	+0.04
MLLWS	+0.02	+0.01

Kirinda Harbour site is located approximately 30 km east of Hambantota, and the configuration of coast line between them is simple enough not to produce significant tidal change between them.

Therefore in the stage of basic designing, the tidal elevation of Hambantota has been adopted as the tides for designing the Kirinda Habour.

Table 4-3 Tidal Elevation of Kirinda

H.W.L	+0.50 m
M.W.L.	+0.25 m
L.W.L.	±0.00 m (Datum Line)

4-3-3 Currents

The offshore currents of Sri Lanka are strongly influenced by the monsoon. During the NE monsoon season, the offshore currents flow in the direction of SW, and during the SW monsoon season in the direction of NE. For the time being, no actual currents measurement has been carried out in and around the Kirinda Harbour site, so that data on current speeds cannot be in hand.

According to the visual observation, the currents near the Kirinda point is considerably fast in case of north or northeastward running. Under these circumstance, the small fishing crafts do not cast anchors in the well sheltered zone behind the Kirinda point even in the SW monsoon season.

4-3-4 Winds

In chapter 3-2 "Climate", the information of winds at the project site has been described. Here in this chapter another consideration is given in view of designing and construction of harbour.

According to the wind records at the Hambantota weather station, the days with a wind speed more than 10 m/sec occur frequently all through the year especially in the SW monsoon season. However the duration in this speed is mostly less than 3 - 4 hours rarely exceeding 12 hours. As to the daily pattern of the wind speed, in the morning the wind is comparatively calm, getting stronger toward 2 p.m. or 4 p.m. and at night diminishing again. The wind direction with a wind speed of more than 10 m/sec are concentrated on the direction of SW and WSW. These wind characteristics shall be fully taken into account in preparing the construction schedule and in setting the channel orientation.

There is no record that cyclone has struck the project area with inflicting significant damage. Therefore, in the design of Kirinda Harbour, the activities of cyclone will not be considered.

4-3-5 Waves

Since the coast line of the Kirinda Harbour site is stretching from NE to SW, Kirinda Harbour will be affected by the offshore waves from SW to NE directions. The predominant wave direction is from SW, especilly from April to October, and in the remaining months from March to October the waves from E to NE directions prevail.

In September, which is the transition month from the SW monsoon season to the NE monsoon season, the waves from NE and waves from SW occur simultaneously, resulting in higher waves when intersecting. (somewhat called pyramidal waves).

The offshore waves data useful for developing the design waves at Kirinda Harbour are given below.

i) "Ocean Wave Statistics", National Physical Laboratory 1967

ii) "Marine Climatic Atlas of the World, Volume III," Indian Oceas-US Navy 1976.

In the "Ocean Wave Statistics", Area 30 covers the project area, and in the "Marine Climatic Atlas of the World", Area 8 and Area 13 have considerable bearing on the project area.

The Area 8 which is severely influenced by the cyclones occurring in the Indian Ocean is susceptible to misleading the wave climate of the project area that has been rarely striken by cyclones. The Area 13, located in the vicinity of the equator, has low frequency of higher waves due to the slight occurrence of stronger winds, giving comparetively conservative conditions to the project area. Therefore, in defiance of respective regional characteristics, the "Area 30" has been taken for studying the offshore wave climate for the project.

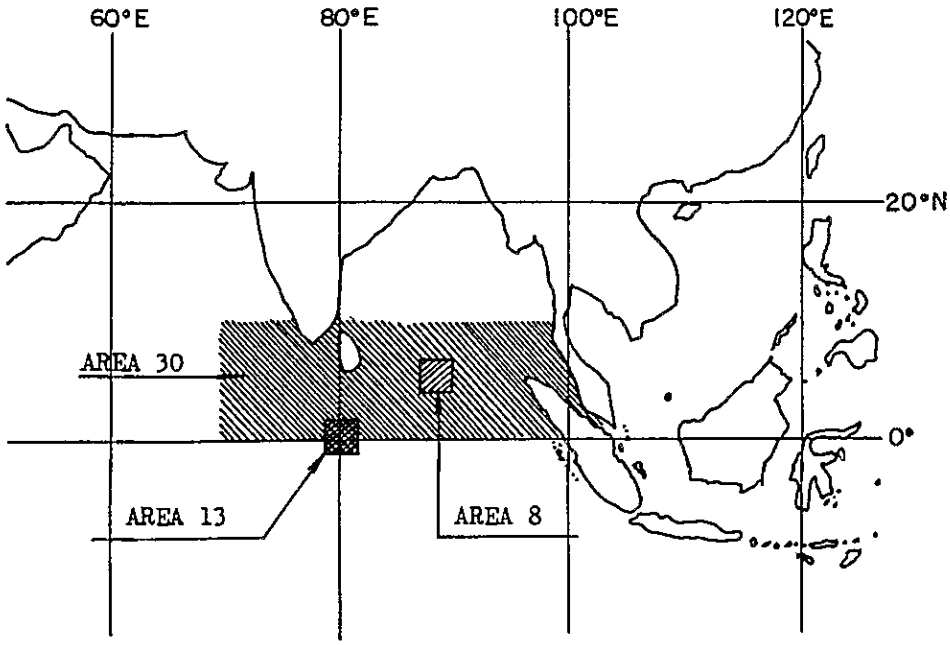


Fig 4-1 Wave Observation Area

The frequency of wave height occurrence by directions is illustrated in Fig. 4-2. From December to February the waves from N - NNE are predominant, and from May to September the waves from WSW - SSW are predominant. The waves with a height larger than 2.5 m occur mainly in SW season.

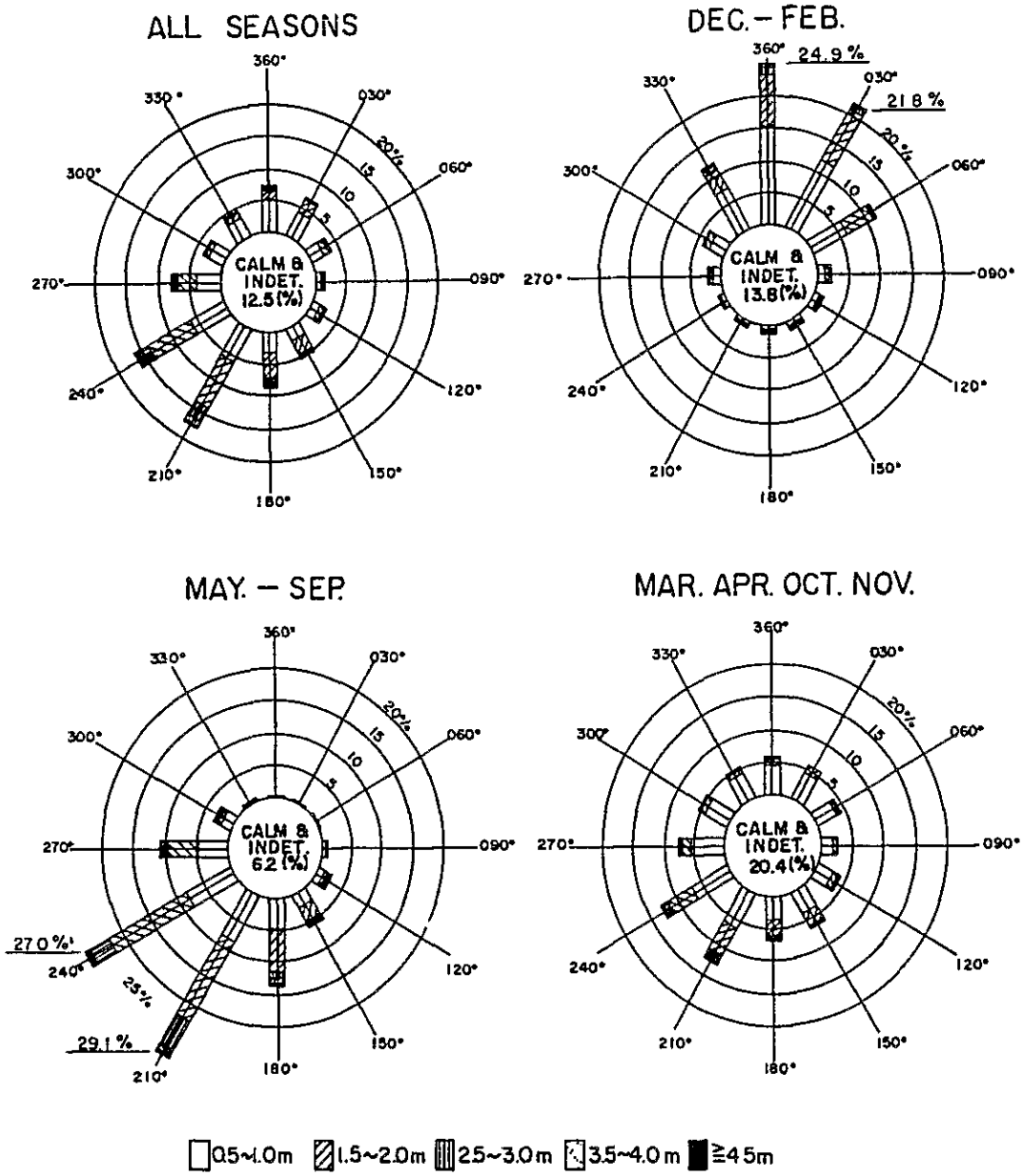


Fig 4-2 Frequency of Wave Height Occurrence by Directions

The waves in the Kirinda area can be developed from the offshore waves. When approaching to the project site, the offshore waves are subject to the wave-diminishing-factors which are closely connected with the seabed friction.

Assuming that the predominant wave period is 10 seconds, the refraction coefficients and shoaling coefficients in the corresponding wave directions can be calculated as shown on Table 4-4.

Table 4-4 Refraction and Shoaling Coefficient

	Kr	Ks	Kr · Ks
ENE	0.385	1.112	0.428
E	0.452	1.112	0.503
ESE	0.781	1.112	0.868
SE	0.774	1.112	0.861
SSE	0.782	1.112	0.870
S	0.700	1.112	0.778
SSW	0.592	1.112	0.658
SW	0.358	1.112	0.398

Kr : Refraction coefficident

Ks : Shoaling coefficient

Applying the corresponding coefficients to the offshore waves, the shallow-water-waves in the project site can be assessed by directions in the Table 4-5. For example, a predominant SW offshore wave of 2.0 m are diminished to about 0.80 m (2.0 x 0.398 = 0.796).

Table 4-5 Frequency Distribution of Shallow Water Waves

ALL SEASONS

Height	Direction 050° 070°	080° 100°	110° 130°	140° 160°	170° 190°	200° 220°	230° 250°	Total
0.5	2.5	1.1	3.5	6.0	12.5	21.0	11.3	57.9
1.0	0.2	0.1	1.7	3.5	6.3	10.7	2.4	24.9
1.5	*	*	1.0	2.0	2.5	4.5	0.3	10.3
2.0			0.3	0.6	1.0	1.3	*	3.2

DECEMBER - FEBRUARY

Height	Direction 050° 070°	080° 100°	110° 130°	140° 160°	170° 190°	200° 220°	230° 250°	Total
0.5	8.7	1.8	2.5	2.0	1.7	1.1	0.7	18.5
1.0	0.7	0.2	1.3	1.0	0.9	0.5	*	4.6
1.5	*	*	0.5	0.4	0.4	0.2		1.5
2.0			0.1	*	0.1	*		0.2

MAY - SEPTEMBER

Height	Direction 050° 070°	080° 100°	110° 130°	140° 160°	170° 190°	200° 220°	230° 250°	Total
0.5	0.1	0.5	3.3	7.5	19.1	32.0	22.0	84.5
1.0		*	2.2	4.7	10.0	19.5	4.8	41.2
1.5		*	1.2	2.9	4.5	8.5	0.5	17.6
2.0			0.7	1.5	1.7	2.7	*	6.6

(*... indicates 0.05%, but 0%)

Besides the shallow-water-waves developed from the offshore generated waves, locally generated waves shall be also considered for determination of design waves. The locally generated waves can be hindcast with a SMB method, using wind data of the Hambantota weather station.

Tracing back the wind records in 1978 and 1979, a series of windy days which have a wind speed of more than 10 m/sec have been extracted. Applying every three hours' wind records to the S.M.B. method, a maximum significant wave of 3.2 m has been hindcast on Nov. 24, 1978.

The offshore generated waves has been already developed into the shallow-water-waves in Table 4-7, and through the Gumbel method, the waves with a return period of 10 years, 20 years, 30 years and 50 years has been obtained as shown on Table 4-6. Here for designing the break-water the 1 in 30 years significant wave has been adopted taking into account the life time of the structure.

Table 4-6 Waves in Each Return Period

	ENE	E	ESE	SE	SSE	S	SSW	SW
10 years	3.6	3.6	4.5	4.5	4.5	6.1	6.1	6.1
20 years	4.1	4.1	4.8	4.8	4.8	6.5	7.1	7.1
30 years	4.5	4.5	5.0	5.0	5.0	6.7	7.6	7.6
50 years	4.8	4.8	5.2	5.2	5.2	7.0	8.3	8.3

The offshore waves occuring once in 30 years has been assessed at 7.6 m in the direction of SSW and SW. The shallow-water-waves in the project area have been also assessed using the coefficients already established.

Table 4-7 Shallow Water Waves

Offshore Wave Direction	ENE	E	ESE	SE	SSE	S	SSW	SW
Wave Direction in front of Breakwater	ESE	ESE	ESE	SE	SE	SE	SE	SE
Wave Height	2.1	2.4	3.4*	3.5*	3.5*	3.7*	3.7*	3.2*

* Breaker height

A wave height of locally generated waves (3.2 m) is lower than that of offshore generated waves (4.3 m), so that the offshore generated waves has been adopted for designing the marine structures of Kirinda Harbour. Here, as the offshore design wave, the following dimensions has been established.

Ho 1/3	:	7.60 m
To 1/3	:	10 sec.
Direction	:	SE

4-3-6 Water depth

In the stage of basic designing, water depth sounding has been conducted by use of echo-sounder. The isobatic contour lines of water depth is included in the enclosure attached to this report. The seabed contours in the project harbour site is not so gentle. The isobatic contour line of -5 m runs about 150 m - 200 m away from the shoreline, and -10 m line runs about 800 - 900 m away.

The average slopes in the water depth of less than -5 m and between -5 m and -10 m are respectively 1/35 and 1/65. In the area north of Kirinda Point, many shoals and outcrops of seabed are scattered, and no definite contour lines can be drawn.

The largest outcrops found in the project site has a diameter of 20 - 25 m at the seabed.

4-3-7 Subsoil condition

In the stage of basic designing, no test boring has been carried out on site and no boring record has been collected during the site investigation. Judging from the seabed condition partly uncovered by bottom sampling, subsoil condition can be tentatively assumed as follows: top soil is loose sandy soil, under which silty sand lies and seabed is composed of the rock likely to be similar to outcrops in characteristics. However, the depth of the medium layer is not clear.

4-3-8 Siltation

In Sri Lanka, beach erosion and accretion occur significantly along the entire stretch of the coast lines. The railway and the roads running near the shorelines are severely influenced by this beach erosion, so that beach protection is one of the important problem in Sri Lanka.

Like other parts of the country, the Kirinda area is also subject to this siltation problem. According to fishermen living in the Kirinda area, the sand beach in the project site is as wide as 60 m during October to March (NE monsoon season), while this beach is eroded away during May to August (SW monsoon season), resulting in 40 m in width. This fact reveals clearly the existence of littoral drift in the Kirinda area.

The beach erosion is caused by SW waves, and the beach accretion by NE waves. This pattern of erosion/accretion seems to be repeated every year, and total littoral drift seems to be balanced. However, it can be said that this conclusion may be considerably premature, so that at least two or three years' investigation is required to analyze the overall movements of littoral drift in the project site.

In the stage of basic design, bottom sampling has been carried out to grasp the seabed condition for siltation study. According to the grain size analysis, the medium grain size is in the range of 0.07 mm - 0.20 mm. Applying this figure to the "experience formula" assessing the critical water depth under which the bedload is susceptible to move by the waves, the critical water depth has been figured out to be 5 - 6 m in the event that the prevailing wave height is 2.0 m. This result will give some constraint on determining the location of harbour entrance.

4-4 Harbour Layout

4-4-1 Site selection

The shoreline of Kirinda is characterized by such things as the existence of Kirinda Point, scattered outcrops of bedrocks, a lagoon called "Kirinda Lewaya, and sand beach accompanied by accretion and erosion. On top of the Kirinda Point there is a famous Temple called Kirinda Temple, and the area within 400 yards from the temple is completely controlled by the temple as a sacred zone where any activity unreligious to the temple is prohibited. In other words, even the harbour construction cannot be easily implemented without any consensus with the authorities concerned. Therefore, it would be desirable that the proposed harbour site be sought out in the area 400 yards away from the temple.

As described in the design information, the prevailing waves in Kirinda come from SW, so that the shoreline north east of Kirinda Point is more sheltered on account of the existence of Kirinda Point during the SW monsoon season. Therefore, it is preferable that the proposed harbour site is located north east of Kirinda Point, and additionally as near to the Kirinda Point as possible for securing sufficient protection against SW-waves.

Approximately 600 m north east of Kirinda Point, there is an inlet of the lagoon "Kirinda Lewaya". As previously mentioned, in this lagoon no large breakthrough of pent-up water has been experienced. However, there remains some possibility of breakthrough of the lagoon in the future. To ged rid of this risk it is preferable that the proposed

harbour is located in such area as not to block the flooding water from the lagoon.

Lastly, the shoreline of the Kirinda area is considerably affected by littoral drift, it is preferable that the proposed harbour site be located in such a way not to cause erosion especially in the inhabited area.

In order to meet the above requirements, the proposed site of Kirinda Harbour has been located, in the area between about 450 yards northeast of Kirinda Point and south of the inlet of the lagoon. This site selection is also favorable for the following reason, because the proposed site is so near the existing villages of Kirinda fishermen that the access to/from the harbour and their security can be fully assured.

4-4-2 Layout consideration

The constraint technically governing the layout study of Kirinda Harbour are those factors given below.

i) Waves
ii) Water depth
iii) Siltation
iv) Seabed
v) Winds
vi) Currents

Waves

As tabulated in 4-3-5, the predominant directions of offshore waves are concentrated between S - SSW. This S - SSW waves are refracted to almost SE direction in approaching to the harbour site. Therefore, it is recommended that the main breakwater shall be located to block the waves from the SE direction.

It is required that the orientation of the approach channel is approximated to the SE direction as much as possible in order to facilitate maneovering in stormy weather. The waves with a height of more than 2.0 m occur 3.2% all through the year and a height of more than 1.5 m in 10.3%. Therefore, it is anticipated that there will be no fatal damage resulting from the little difference in orientation of the approach channel.

Water depth

In the vicinity of the inlet of the lagoon, a water depth contour runs nearer to the shoreline as compared to the other parts of the shoreline in the Kirinda area. To make use of the natural water depth it is recommended that the entrance of the harbour is located near this area. As described in 4-3-8, the littoral drift is comparatively active in a water depth of less than-5 - 6 m. The head of the breakwater is better to be extended at least to the area with a water depth of -5 m. The surf zone lies usually in the water depth of 2 m - 3 m, so that the main breakwater shall not be located in this water depth.

Siltation

Siltation is remarkably eminent in this area, and the littoral drift seems to move back and forth along the shoreline of the Kirinda beach. The main breakwater plays a role of groyne against the littoral drift from the S direction. To cope with the littoral drift in advance direction, some groyne shall be constructed. The water depth at the head of this groyne is desirably as deep as 5 m.

Seabed

The seabed is covered by loose sandy soil, and in places outcrops are scattered. It is prefavorable that the breakwater line is aligned on the outcrops as much as possible so as to save the volume of breakwater as well as to avert the requirement of rock blasting in case that the outcrops are sited in the berthing area as a result of the harbour layout.

Winds

The orientation of approach channel/berth is frequently controlled by the predominant direction of wind in case of bigger vessels. However, the manouvering of fishing crafts of 3.5 ton class may not be subject to the wind directions under the wind speed of less than 10 m/sec. Therefore, in the layout study of Kirinda Harbour, no special care has be taken to the wind conditions.

Currents

The currents in the proposed harbour site are not significantly active, so that no special caution has been put on in the layout study. (However, if noteworthy findings come about in the D/D stage, this will be fully incorporated in the final designing.)

4-4-3 Harbour layout

Based on the major factors discussed in 4-4-2 the harbour layout of Kirinda has been determined as shown in Fig. 4-3 . Hereinafter are roughly described the setting-out of the breakwater lines that is the most important part of the harbour layout.

1) A main breakwater projects out, about 200 m away from the foot of Kirinda Point, to 100 m offshore perpendicular to the coast line in the direction of ESE with right angle return at the outcropsed rock. (This part of main breakwater hereinafter called south-breakwater.)

2) A main breakwater extends continuously from the outcropped bedrock in the direction of NNE through the distance of about 200 m and again bends toward NE direction, terminating in the water depth of more than -5 m, about 50 m apart from the head of the groyne. (This part of main breakwater hereinafter called east-breakwater.)

3) A sub-breakwater, located 200 m north of the south-breakwater, also projects out perpendicular to the shoreline through the distance of 100 m.

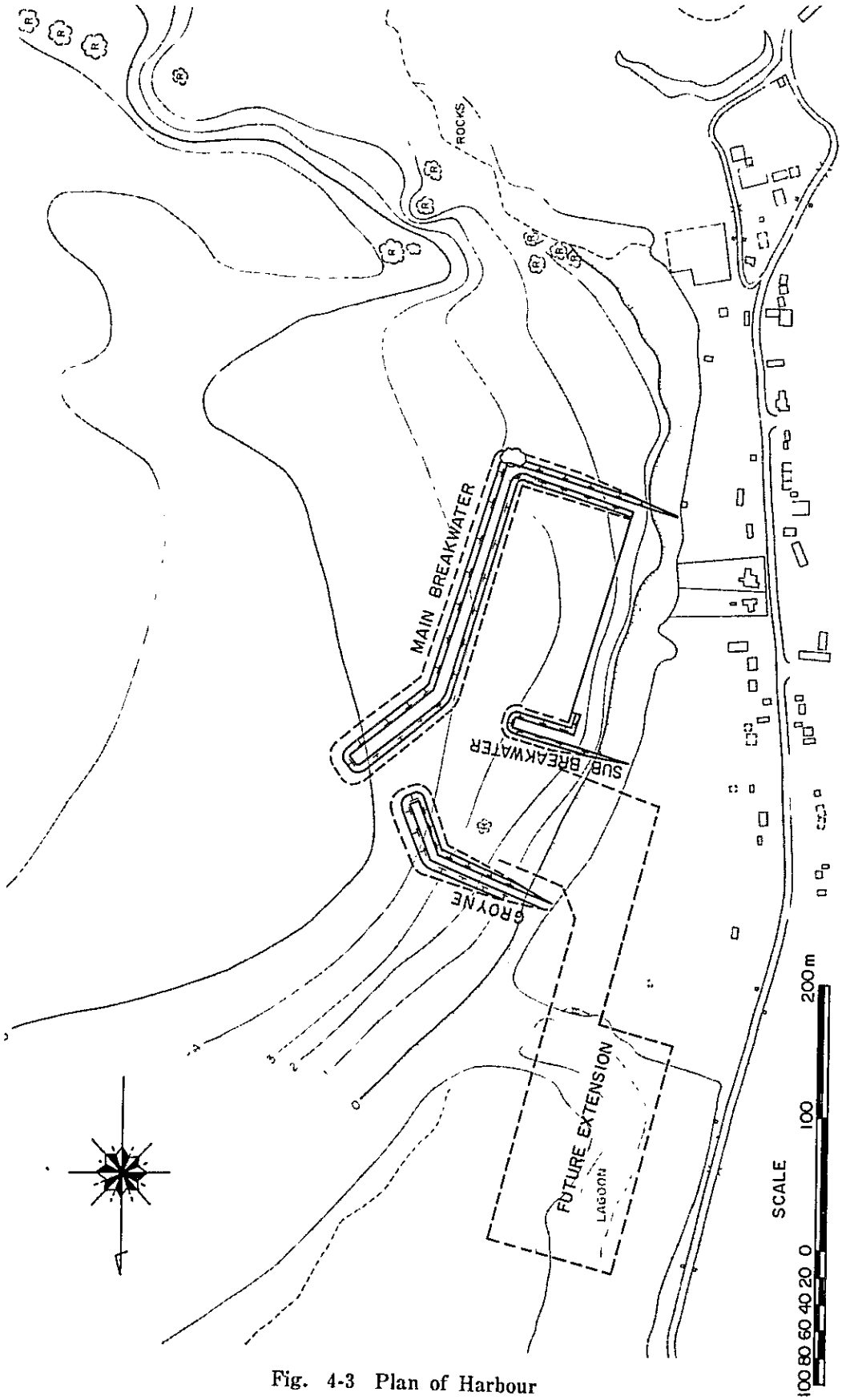


Fig. 4-3 Plan of Harbour

4) A groyne, located 140 m north of the sub-breakwater, extends nearly parallel to the other two breakwaters up to the water depth of -3.5 m, and bends toward SSE direction, terminating 50 m apart from the head of the east-breakwater.

The areas protected by the main breakwater and the groyne is approximately 25,000 m^2. This figure meets the design requirement of space allocation. The construction of breakwater will be carried out in two phase development due to the constraint of the budgetary system of the Grant Aid Assistance. As detailed in clause 4-6, the south-breakwater, sub-breakwater and a part of east-breakwater will be constructed in the first phase, and the remaining part inclusive of groyne will be constructed in the second phase.

In each phase, the calmness inside the harbour has been checked by use of diffraction diagram. (see Fig. 4-4). Even in case of the 1st phase, the wave height in the harbour is reduced to 1/6 of the wave height outside the harbour, which gives sufficient calmnêss for manouvering, berthing and anchoring of small boats of 3.5 ton class.

Generally it can be said that the design criteria of wave height inside of harbour is 0.50 m, which is equal to 3.0 m in the waves outside the harbour in the first phase. Therefore, the breakwater configuration is sufficient enough to commence operation on the completion of the first phase development.

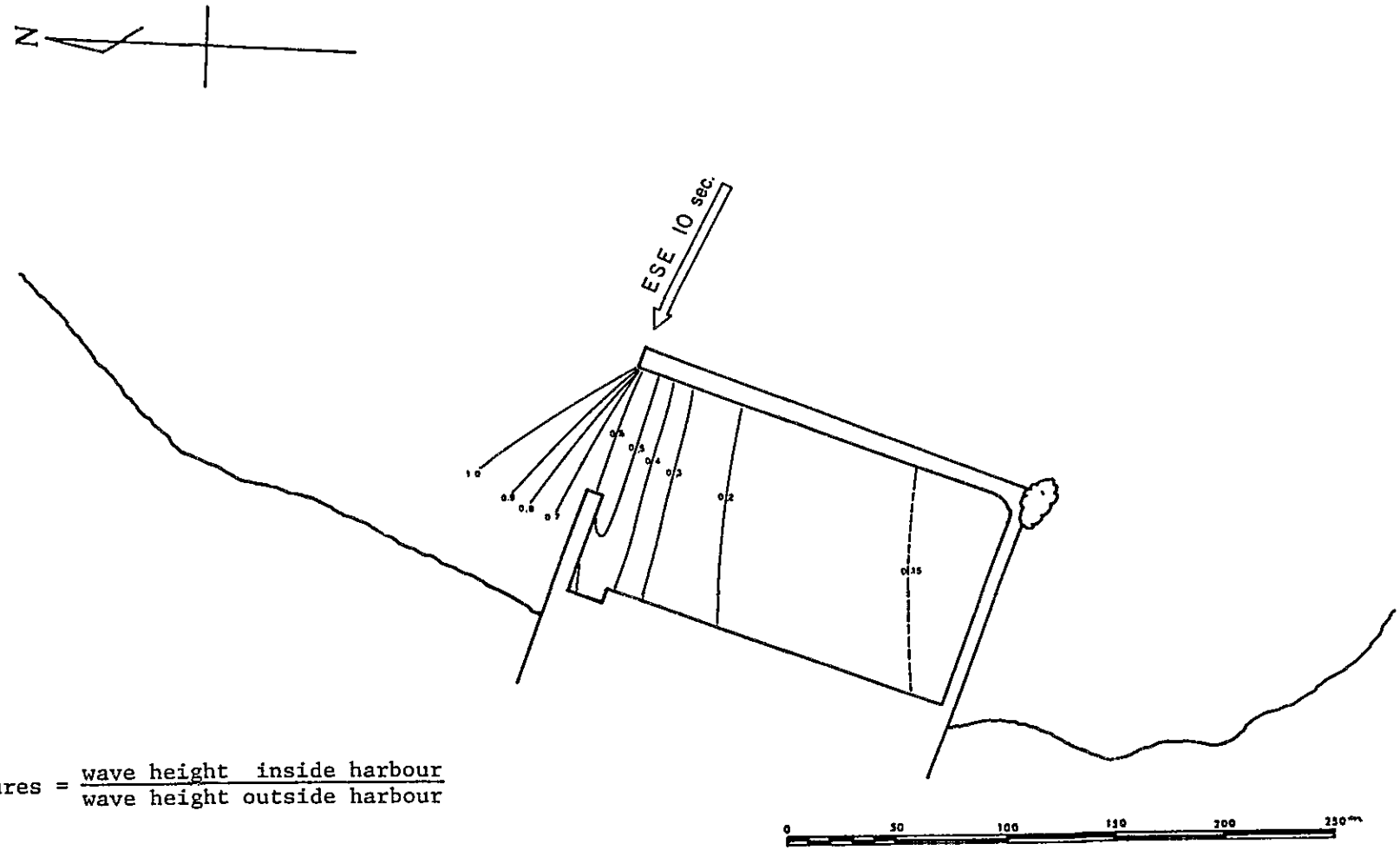
In the second phase, the wave height inside the harbour is reduced to 1/10 of the wave outside the harbour. In other words, the breakwater configuration in the second phase ensures the required calmness against up to 5 m high waves. Therefore, it can be said that the breakwater alignment of Kirinda Harbour will be quite satisfactory in calmness requirement. The groyne will not only work as a sandtrap but also as a guide wall for flood water in case of flooding of Kirinda Lewaya. The sub-breakwater will also work as a sand trap, but mainly assist in reducing the wave height inside the harbour.

The entrance of the harbour is located at the north-eastern part of the harbour so as to make full use of the natural water depth of the -5 m contour line where the movement of littoral drift is comparatively weak, resulting in less siltation in the harbour.

The approach channel is oriented in the direction of ENE, so that the manoeuvering of small boats in stormy weather is not so difficult. The 40 m wide harbour entrance satisfies the design requirement of 35 m.

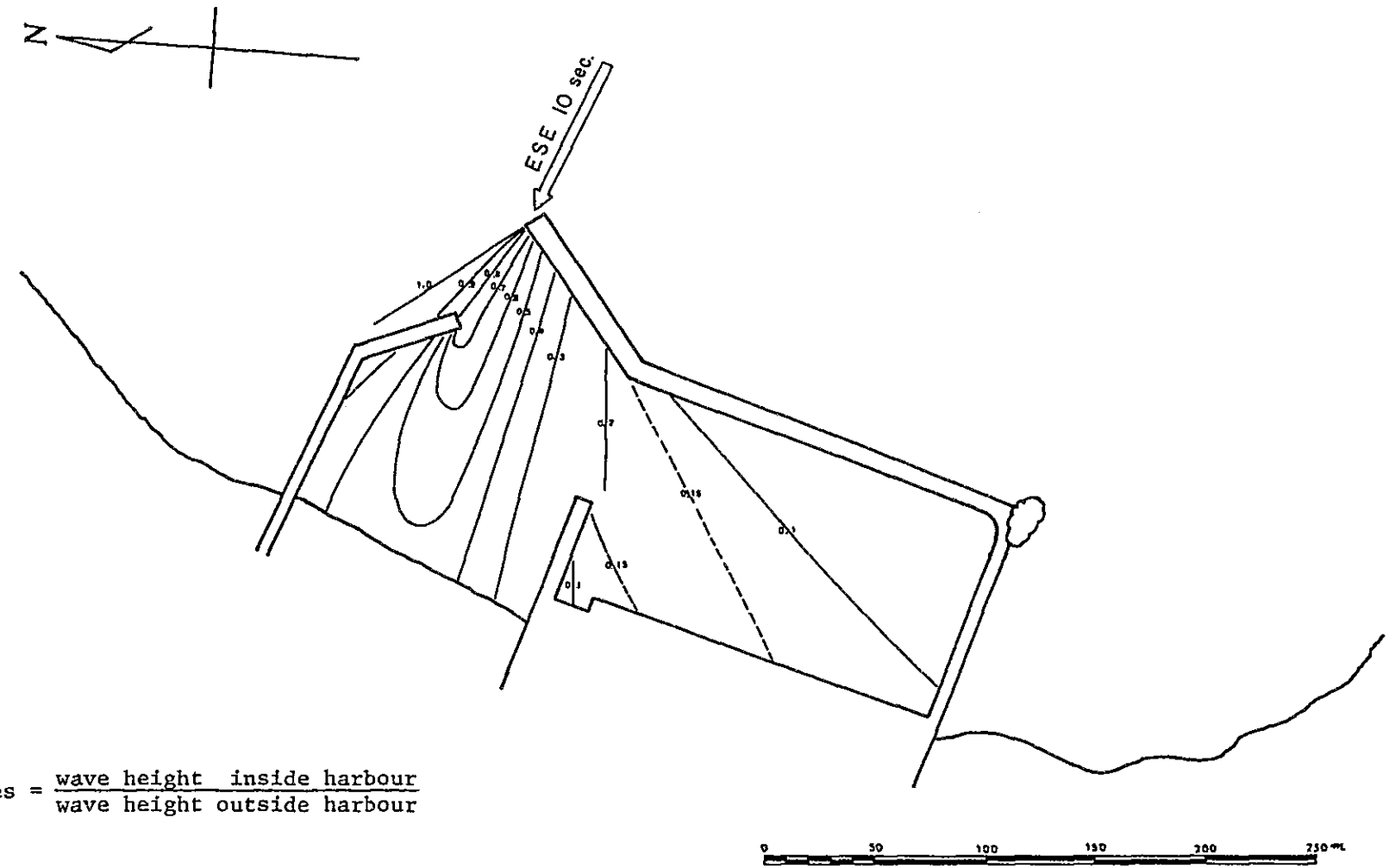
The existing water depth inside the harbour is deep enough to clear the water depth requirement of the berthing area (-1.5 m) and the approach channel (-3.0 m) with some exceptions. The area immediately in front of the berth line shall be dredged to -1.5 m. The outcrops existing between the groyne and sub-breakwater shall also be removed for safe manoeuvering.

The quaywall is located deep inside the harbour to secure sufficient calmness and good access to the shoreside. The length of the berth line is 150 m. The reclaimed area enclosed by the berth line and revetment is 7,000 m^2. This figure also meets the area requirement for onland facilities.



* figures = $\frac{\text{wave height inside harbour}}{\text{wave height outside harbour}}$

Fig. 4-4 Calmness Inside the Harbour (Phase 1)



* figures = $\frac{\text{wave height inside harbour}}{\text{wave height outside harbour}}$

Fig. 4-5 Calmness Inside the Harbour (Phase II)

4-5 Harbour Structure

4-5-1 General

The major harbour facilities consist of marine structures and onshore structures. The marine structures are breakwaters, a revetment, a groyne and a quaywall. The onshore facilities are a cold storage, an administration office, an auction shed and a warehouse.

The designing procedure of marine structures will follow the "Technical Standards for Port and Harbour Facilities in Japan" (hereinafter called TSPHF) and "Shore Protection Manual" (hereinafter called SPM). The designing procedure of onshore structures will be carried out in accordance with local code.

The design criteria of the natural conditions are summarized from design information and established in the designing of each structure.

4-5-2 Designing of breakwater

Design Waves

As the design offshore wave, the following wave characteristics has been adopted in the design information.

H 1/3	:	7.60 m
T 1/3	:	10 sec.

Using the "Calculation Diagram of Maximum Wave Height in Wave Breaking Zone" in TSPHF, the above offshore wave has been developed into the shallow-water-waves in the respective water depths where the breakwaters will be located.

Water depth	H 1/3
-5 m	3.9 m
-4 m	3.5 m
-3 m	2.8 m
-2 m	2.2 m

Selection of Structural Type

The small to medium-scaled-breakwaters may be generally classified into the following types.

a. Rubble Mound Breakwater
b. Breakwater Armoured with Wave Dissipating Concrete Block
c. Caisson Type Composite Breakwater
d. Cellular Concrete Block

A rubble mound breakwater can be constructed by supplying and placing the rubble stones and armor stones, while the other three structural types require the concrete block for forming the structure.

The supply of locally produced cement is limited and its cost is comparatively high if supplemented by imported cement, so that structures requiring a huge amount of concrete are not recommendable for Kirinda Harbour. On the other hand, the quarry site capable of supplying suitable rocks are easily found within an economical reach from the harbour site.

On account of the easiness of the construction method, most of the structures of breakwater in Sri Lanka have been implemented in this rubble mound type. Therefore, in the Kirinda Harbour, the rubble mound breakwater has been selected.

Crest Height of Breakwater

The crest height of the breakwater shall not be less than about 0.6 times the design significant wave height above the mean spring high water level. Therefore, the crest height can be calculated as follows:

$$\begin{aligned} \text{Crest Height} &= \text{H.W.L} + 0.6 \times H_{1/3} \\ &= 0.50 + 0.6 \times 3.8 \\ &= 2.78 \\ &\fallingdotseq 3.0 \text{ m} \end{aligned}$$

Crest Width of Breakwater

The crest width of breakwater has been determined at a minimum of 5.0 m, considering the construction method applied.

Breakwater Slopes

In accordance with SPM the slope of breakwaters has been determined as follows:

	See side	Lee side
Trunk portion	1 : 2	1 : 1.5
Head portion	1 : 2.5	1 : 1.5

Weight of Armor Stone and Rubble Stone

The weight of stones has been calculated by use of the formula prepared by "Iribarren-Hudson."

The required weight of the stones in respective water depths are given below:

Water Depth	Weight of Armor Stone
-5.0 m	7 ton
-4.0 m	5 ton
-3.0 m	3 ton
-2.0 m	2 ton

Typical Cross Sections of Breakwaters

The typical cross sections of breakwaters are illustrated in Fig. 4-6.

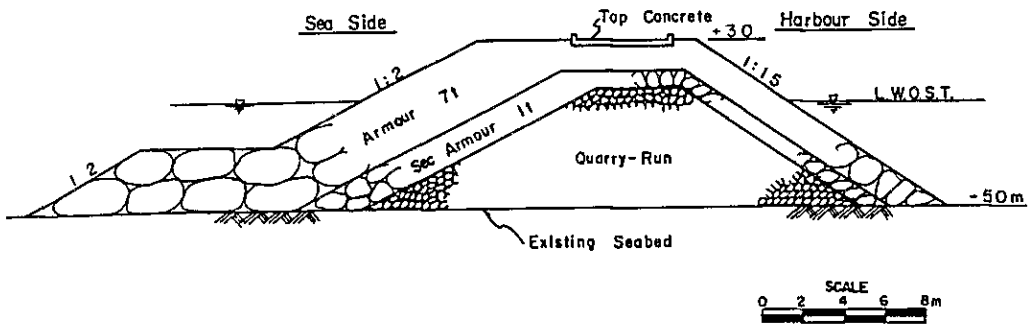


Fig. 4-6 Typical Cross Section of Breakwater

4-5-3 Designing of quaywall

Design Criteria

The design criteria applied for the designing of the quaywall is given as follows:

Surcharge	:	0.5 t/m^2
Elevation	:	+1.50 m
Water Depth	:	-1.50 m
Vessel	:	3.5 GT

Selection of Structural Type

There are a variety of structural types for the quaywall such as gravity type, sheet pile type, pier type and pontoon type. The sheet pile type and pier type have been deleted considering the difficulty of piling work in the project site. The pontoon type is not necessary in the area where tidal range is less than 1.0 m. Therefore, the gravity type has been further studied and finally the cast-in-place concrete type has been selected based on the following reasons:

1) Water depth is shallow.
2) Outcrops of seabed is scattered.
3) Calmness is sufficient for placing concrete.
4) Construction machines employed for other works can be used.

Typical Cross Section of Quary Wall

The typical cross sections of quaywall are illustrated in Fig. 4-7.

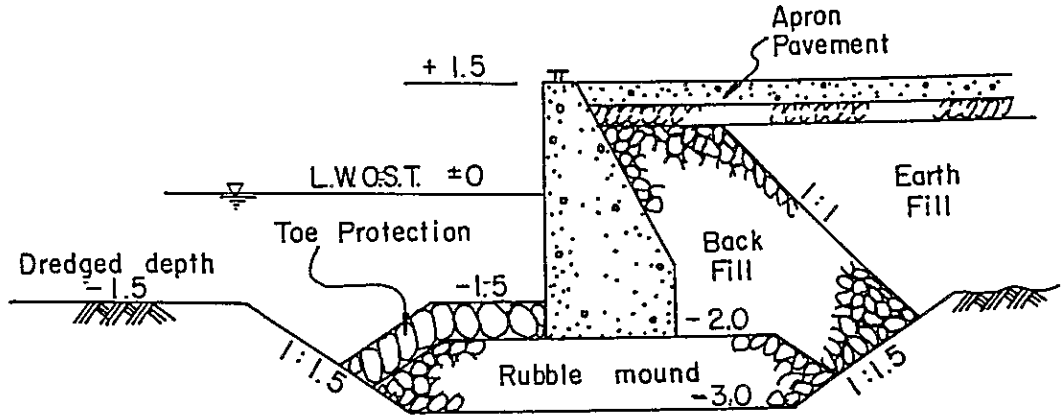


Fig. 4-7 Typical Cross Section of Quaywall

4-6 Harbour Construction

4-6-1 Construction schedule

The major construction works of the Project are summarized as follows:

Table 4-8 Major Construction Works

Construction Works	Q'ty
Main breakwater (south portion& east portion)	370 m
Sub-breakwater	110 m
Groyne	160 m
Quaywall	150 m
Dredging & Reclamation	7,000 m^3
Buildings	
Ice storage	50 m^2
Administration office	80 m^2
Auction shed	250 m^2
Workshop	200 m^2
Warehouse	100 m^2
Water supply	100 t, 100 m^2
Apron	150 m^2
Road	-
Parking Lot	-

In the Kirinda Project, the harbour construction will be implemented in the two phase development in accordance with the budgetary system of Grant Aid Assistance. The 1st phase program consists of a part of the main breakwater and sub-breakwater, while the 2nd phase program will cover the remaining harbour requirement such as the complement of the main breakwater, a groyne, a quaywall, dredging & reclamation and onshore facilities. However, it is understood that the construction work itself will progress without any interruption on site, as shown in Fig.4-8 and 4-9.

The harbour construction will be initiated by the opening of quarry site, followed by transportation of quarried rock to the harbour site. During this period, all other preparatory work inclusive of mobilization of construction crafts shall be also conducted. It is anticipated that these preparatory works will take about half a year after the contract of the Project.

The main breakwater, sub-breakwater and groyne will be constructed in the comparatively calm season other than in the SW monsoon season, and onshore facilities inclusive of quaywall and dredging will be implemented on the completion of the main breakwater and sub-breakwater.

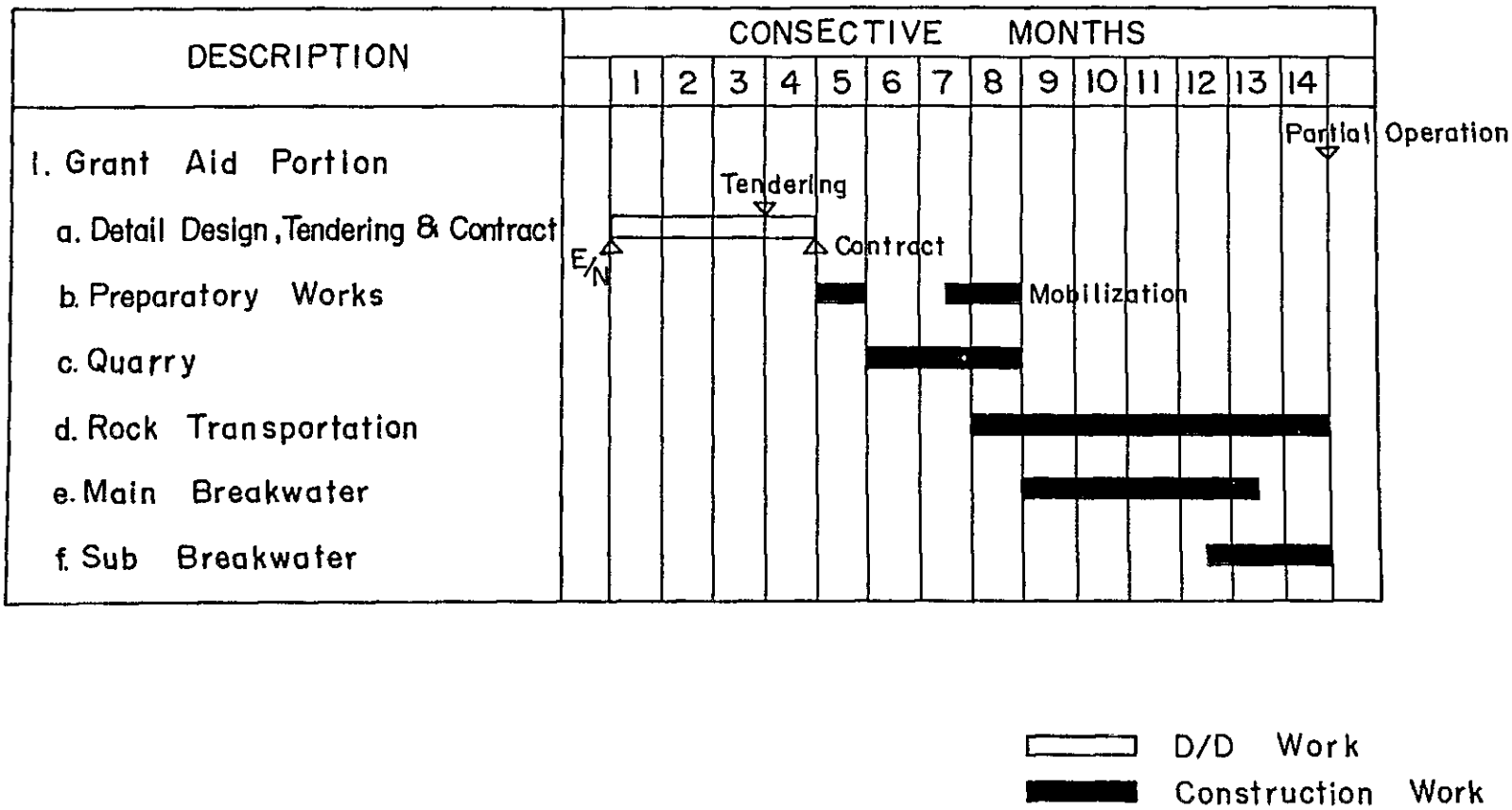


Fig. 4-8 Construction Time Schedule (Phase I)

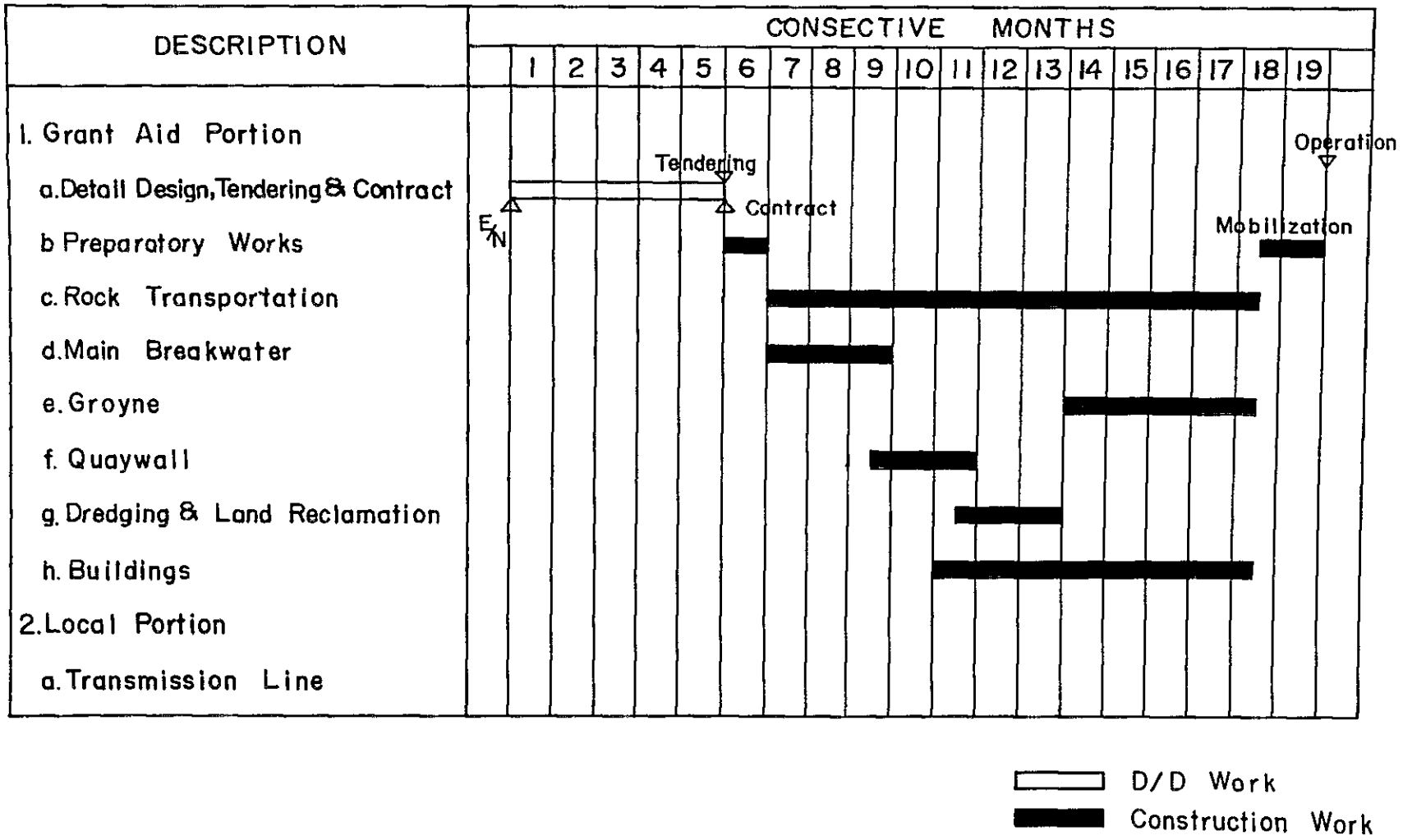


Fig. 4-9 Calmness Inside the Harbour (Phase II)

4-6-2 Construction method

Breakwaters and Groyne

The breakwaters are made of core materials (quarry-run), secondary armor stones and armor stones. Firstly the quarry-run will be transported by barges, dumped into the position, and piled up to the seal level. Then from the shoreside, the remaining portion of the quarry-run will be conveyed by dump trucks using the temporary road which is composed of quarry-run already dumped by truck above sea level and will be finally placed to form the required formation.

The armor stones and secondary armor stones will be transported and placed either by a set of truck and crawler-crane or by a set of barge and crawler-crane mounted on barge.

The construction method employed for the groyne will be the same as that for the breakwater.

Quaywall

The quaywall is of concrete structure. Prior to placing the concrete, the soft and weak foundation will be removed and rock materials will be graded. The concrete will be cast in place. Then, acceptable material will be backfilled behind the structure.

Dredging & Reclamation

Inside the harbour, there are some outcroped bedrocks. These rocks will be removed to the required level by rock-blasting operation or by machines. The part of the berthing area will also be dredged to the required level by grab-dredger, and suitable portion of the rocks will be used for land reclamation.

The sand bank near the inlet of the lagoon will also be used as the fill material for land reclamation.

Buildings

As the scale of each building is relatively small and the buildings are of ordinary ones, no foundation piles nor heavy construction machines will be required, and all structural and finishing materials will be of local products. Therefore, a local contractor can carry out the construction without difficulties. Expatriate staff will mainly engage in the supervision of the works.

In terms of easy access and functional operation, all the buildings will be put up just behind the apron in close coodination with each other. The quaywall structure shall be initiated as soon as possible to permit land reclamation for building work, that will require half of the construction period in the 2nd phase.

4-6-3 Construction materials

Most of the construction materials are available in Sri Lanka except for the plant of cold storage and other minor building materials. Materials such as cement, reinforcement bar and metals are limited in domestic supply, so that part of them may be imported in some case.

The coarse aggregates necessary for the concrete is easily obtained from the existing quarry site operating near the Project site, but the rock materials required for the construction of breakwater and groyne may be obtained from a new quarry exclusively established for this project.

The prospective quarry sites are located near Kirinda Point, near the Yala park and in the area along the Kataragama road.

CHAPTER 5. PROJECT EVALUATION

5-1 Economic Evaluation

5-1-1 General

The economic evaluation on the project has been carried out to examine the economic feasibility of the investment by grant aid assistance to the project harbour construction. The evaluation results from the comparison between project cost and project benefit. Here in this project the evaluation has been done through checking the factor of the internal rate of returns.

The project benefit has been assessed in the difference of benefits resulting from with-project and without project.

That is : with project ..... in case that Kirinda Harbour is established.

without project... in case that Kirinda Harbour is not established.

The benefit accruing from the project is classified into the following items.

(1) Increase in fish production resulting from more operable days

(2) Decrease in fish putrefaction by the existence of cold storage and speedy auctioning

(3) Transportation cost saving accompanied by increase in fish production, especially during off-season

(4) Stabilization of fish price

(5) Decrease in occurrence of shipwrecks and casualties.

(6) Saving of foreign currency expense resulting from decrease in import

(7) Increase in work opportunity of regional people

Of the above seven items, item (1) and item (2) can be measured in monetary value. Other item (3) - (7), though countable to some extent, are difficult to be monetized. Here in this report, item (1) and item (2) has been considered for benefit/cost analysis, and other items have been omitted.

5-1-2 Project benefits

(1) Benefit of production icnrease

At present, due to the absence of safe anchorage area and proper landing facilities in the project area, the fishing boats in the rough season cannot operate as long as in the calm season. During the rough season, those boats operate as migrant in the fishing ground other than the Kirinda area.

On completion of the Kirinda project, the operability will be stabilized all through the year, and the practicable days and hours in operation will be lengthened, leading to a production increase in the project area. This production increase can be presented as one of the project benefits. This production benefit can be estimated as follows:

$$\text{Production benefit} = \frac{(\text{selling price of fish} - \text{running cost})}{\text{actual gain}} \times (\text{production increase})$$

In figuring out the actual gain by fishermen, the portion of the running cost that is to be compensated later by the fishermen such as fuel cost, maintenance cost and depreciation cost shall be deducted. According to the survey conducted by F.A.O. the operation cost of 3.5 ton cloass boat is classified as shown in Table 5-1. The portion that shall be compensated accounts for 27% of the selling price.

Table 5-1 Breakdown of Operation Cost

	Item	Share	
i)	Fuel	7%	27%
ii)	Maintenance	3%	
iii)	Depreciation	17%	
iv)	Insurance	6%	
v)	Loan repayment	11%	
vi)	Others (inclusive of profit)	56%	
	Total	100%	

The selling price has been assumed to be Rs. 12 per kg taking into account the market price of the typical species in the project area such as skipjack, shark and horse mackerel. Based on the above assumption and the estimated production increase that has been already established in clause 4-1-1, the production benefit can be assessed as follows:

Production increase = Production in case of "with project"
- Production in case of "without project"

= 2,109 t/year - 1,026 t/year

= 1,083 t/year

Production benefit = Production increase x selling price
x Deduction factor

= 1,083 x t/year x 12,000 Rs/t x (1 - 0.27)

= $\underline{9,487 \times 10^3 \text{ Rs/year}}$

(2) Benefit of putrefaction loss saving

At present, the landing fish are auctioned in the beach, so there is no shade during auctioning. Some of the fish remain untouched for a long time under the straight sun shine, and it is rare to use ice in preserving and transporting fish. Being such conditions, it is assumed that 20% of the existing production has been rotted due to poor preservation.

Since cold storage is to be installed at the site in the project, this loss will saved. Using the existing production of 1,026 t/year and same price information applied in chapter 5-2-1, the benefit of putrefaction loss saving can be assessed as follows:

loss of putrefaction = existing production x loss percentage
= 1,026 t/year x 0.2
= 205 t/year

benefit of loss saving = loss of putrefaction x selling price x deduction factor
= 205 t/year x 12,000 Rs/t x 0.73
= $1,795 \times 10^3$ Rs/year

(3) Monetized project benefits

Two kinds of monetized benefits has been calculated; 1) benefit of production increase. 2) benefit of putrefaction loss saving. The former has been estimated at $9,487 \times 10^3$ Rs/year, and the latter at $1,795 \times 10^3$ Rs/year, totaling 11,282 10^3 Rs/year.

Table 5-2 Project Benefit

Benefit of production increase	$9,487 \times 10^3$ Rs/year
Benefit of putrefaction loss saving	$1,795 \times 10^3$ Rs/year
Total benefit	$11,282 \times 10^3$ Rs/year

5-1-3 Economic evaluation

The economic evaluation has been carried out by use of the I.R.R. method. In calculation of I.R.R. the construction period has been assumed to be one year for the 1st phase and another one year for the 2nd phase. The project life has been set at 30 years considering the life time of major harbour facilities. The annual benefits and costs have been capitalized to the year of 1981 and summed up to obtain the total present value of benefit and cost at the year of 1981.

In estimating the project cost, the construction cost, operation and maintenance cost have been considered. The construction cost is exclusive of the price contingency portion. The operation cost consists of wage for administriave personnel and power to be consumed in the cold storage and buildings. The maintenance cost has been assumed to be 1% of the direct construction cost exclusive of price contingency.

As the result of the benefit/cost calculation the figure of I.R.R. has been calculated out to be 7.5%. Considering a variety of benefits to be accompanied by the project, this figure, though being slightly low compared with other projects in Sri Lanka, can be sufficient enough to justify the promotion of the Project.

5-2 Financial Evaluation

5-2-1 General

The financial evaluation of this project has been carried out with a view to checking on the financial soundness of the project harbour. In the evaluation, the income and expenditure to be born during the administration of Kirinda Harbour has been fully considered and compared, and herein the depreciation cost of the major facilities other than buildings and cold storage has not been incorporated, assuming that the breakwater will not require replacement in future.

It is assumed that the annual expenditure and income will be constant all through the project life, so that the evaluation has been carried out by comparing the annual balance in the value of 1982.

The incomes to the administrative organization (CFHC) are listed below.

a) auction fee
b) cold storage charge
c) harbour charge

The expenditure by the administrative organization are listed below.

a) expenditure for wage and fare of electricity
b) expenditure for repair and maintenance of facilities
c) depreciation cost of buildings and cold storage.

5-2-2 Income

(1) Acution fee

Generally the 5% of the market price is paid to the administrative organization as the auction fee. Applying this figure the annual auction fee can be estimated as follows:

Auction fee = fish production with project x market price x 0.05

= 2,109 t/year x 12,000 Rs/y x 0.05

= $1{,}265 \times 10^3$ Rs/year

(2) Cold storage charge

The cold storage is to preserve both fish and ice. In the Kirinda Harbour, it is anticipated that 10% of the fish will be consumed locally on the same day as landed, and the remaining part will be dispatched same day and next day half by half.

The portion to be allocated on next day is stored for one day in the cold storage and then transported by truck in ice-filled-container. At present the daily cold storage charge is 0.25 Rs/kg. Applying this figure, the annual cold storage charge can be estimated as follows:

Cost storage charge for fish

= fish production "with project" x 0.90 x 0.50 x 250 Rs/t

= 2,109 x 0.90 x 0.50 x 250

= $\underline{237 \times 10^3 \text{ Rs/year}}$

Meanwhile, the ice used for Kirinda Harbour will be supplied from the ice-making plant owned by CFHC in Hambantota.

The ice requirement for storing fish is 1 ton ice for 1 ton fish. All the landing fish except for the portion locally consumed (10%) will require ice. Assuming that charge for storing ice is 40 Rs/ton, the annual charge can be estimated as follows:

cold storage charge for ice

= fish production "with project" x 0.90 x 40 Rs/ton

= 2,109 x 0.9 x 40

= $\underline{76 \times 10^3 \text{ Rs/year}}$

(3) Harbour charge

At present, the harbour charge in the existing fishing harbours is 1 Rs per ship per calling in case of 3.5 ton class boat. Assuming that the annual number of landing is 250 times/year, the annual harbour charge can be estimated as follows:

harbour charge

= No. of boats x No. of calling x 1 Rs/time

= 100 x 250 x 1

= $\underline{25 \times 10^3 \text{ Rs/year}}$

All the incomes considered are summarized as shown in Table 5-3. Total annual income is 1,603 x 10^3 Rs/year.

Table 5-3 Annual Income

auction fee	1,265 x 10^3 Rs/year
cold storage charge	
fish	237 x 10^3 Rs/year
ice	76 x 10^3 Rs/year
harbour charge	25 x 10^3 Rs/year
Total	1,603 x 10^3 Rs/year

5-2-3 Expenditure

The expenditures for wage, fare of electricity and repair/ maintenance has been estimated as same as the costs calculated in the economic evaluation. The depreciation costs for cold storage and buildings have been estimated considering the life time and construction costs. Annual expenditure total amounts to Rs 1,399 x 10^3.

Table 5-4 Annual Expenditure

Operation	258 x 10^3 Rs
Maintenance	1,017 x 10^3
Depreciation	124 x 10^3
Total	1,399 x 10^3 Rs

5-2-4 Balance

The balance between expenditures and incomes can be summarized below. The annual balance has been estimated at 204 x 10^3 Rs/year in the black.

Table 5-5 Balance Sheet

(a) Income	$1,603 \times 10^3$ Rs/year
(b) Expenditure	$1,399 \times 10^3$ Rs/year
(a) - (b)	204×10^3 Rs/year
(a)/(b)	1.15

As easily understood, it can be said that financially the Kirinda project has been proved to be sound.

CHAPTER 6. CONCLUSION AND FECOMMENDATION

In order to step up the fish production in the undeveloped region, especially in the southeastern part of Sri Lanka, the Kirinda site has been selected for the Harbour Project in the Grant Aid Assistance Programme of the Government of Japan.

Though blessed with the prospective fishing grounds like Amaduwa, Patanangala and Kirinda, the present fish production in the project area is not sufficient due to the absence of fishing harbours that allows 3.5 ton class boats, to operate even in rough seasons. On completion of the Harbour Project capable of accommodating 100 numbers of 3.5 ton class boats, it is anticipated that the annual production of fish in the project area will increase from the 1,000 ton-level to the 2,000 ton-level. Additionally, the quaywall and ancillary onshore facilities such as cold storage will speed up the turn-around of landed fish and prevent putrefaction loss of fish.

These benefits accruing from the Project have been calculated and compared with the project costs. In consequence, the I.R.R. of 7.5% has been calculated out in the economical evaluation.

The benefits of the project, other than production increase and putrefaction loss saving, that has not been included in the above benefit calculation are the following tangible and intangible benefits.

a) transportation cost saving accompanied by increase in fish production, especially during off-season

b) stabilization of fish price

c) decrease in occurrence of shipwrecks and casualities

d) saving of foreign currency resulting from decrease in import

e) increase in work opportunity of regional people

Considering the above benefits, it can be said that the economic feasibility will be fully assured.

The financial analysis has been also conducted to check the project soundness. Here, the financial analysis has been carried out from the stance of the administrative body of the Project Harbour (CFHC). As a result of study, the ratio of income to expenditure has been figured out to be 1.15, so that financially this project has been proved to be sound.

Lastly, in view of the effects and benefits accruing from the Project it is recommended that the project be implemented as soon as possible under the Grand Aid of the Government of Japan.

ABBREVIATIONS

JICA	:	Japan International Cooperation Agency
FAO	:	Food and Agriculture Organization of the United Nations
MOF	:	Ministry of Fisheries
CFHC	:	Ceylon Fishery Harbours Corporation
CFC	:	Ceylon Fisheries Corporation
GDP	:	Gross Domestic Product
GNP	:	Gross National Product
DFEO	:	District Fisheries Extention Office
SMB	:	Sverdrup, Munk & Bretschneider
GT	:	Gross Tonnage
IRR	:	Internal Rate of Return
LWOST	:	Lowest Water of Spring Tide

1 mile = 1,6093 Km

1 n · mile = 1,852 Km

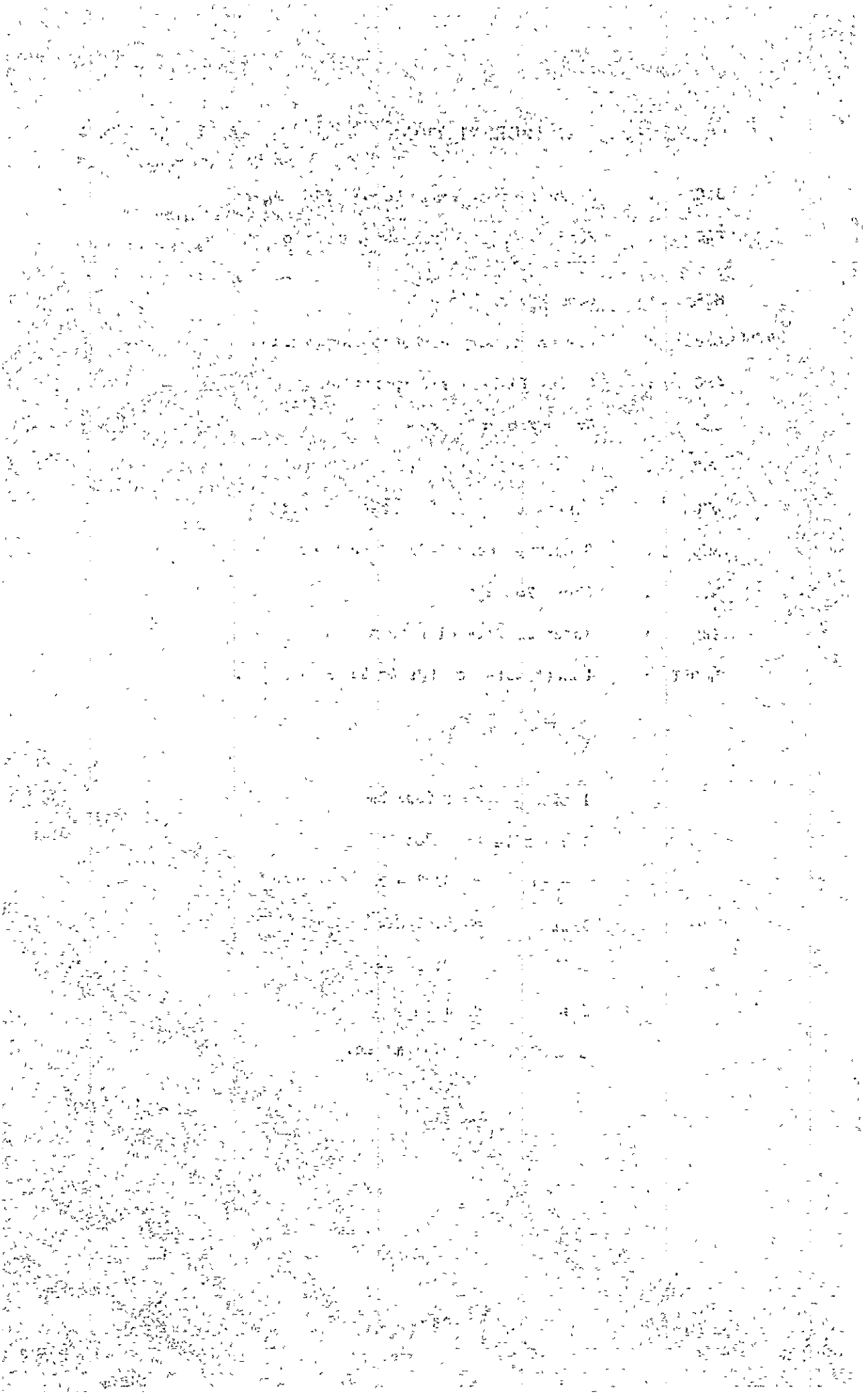
1 yard = 0.9144 m

1 ft = 0.3048 m

1 lb = 0.45 Kg

1 ha = 10,000 m^2

1 knot, kt = 0.41 m/sec.



ANNEX

ANNEX 1 MINUTES OF DISCUSSIONS FOR PRELIMINARY STUDY

MINUTES OF DISCUSSIONS FOR
PRELIMINARY STUDY ON FISHERIES HARBOUR
CONSTRUCTION PROJECT IN THE DEMOCRATIC
SOCIALIST REPUBLIC OF SRI LANKA

In response to a request by the Government of the Democratic Socialist Republic of Sri Lanka for grant aid assistance for Fisheries Harbour Construction Project (the Project) the Government of Japan has sent, through the Japan International Corporation Agency (JICA) which is the official agency implementing the technical cooperation of the Government of Japan, a survey team headed by Mr. Masatsugu Fukuya, Deputy Director, Construction Division, Fisheries Agency to carry out a preliminary study on the Project from May 20th to May 27th, 1982.

The team has carried out a field survey , held a series of discussions and exchanged views with the officials concerned of the Government of the Democratic Socialist Republic of Sri Lanka (the Authorities concerned) on the further study of the Project.

The team and the Authoritues concerned have agreed to recommend to their respective Governments to examine the result of the survey attached herewith towards the realisation to conduct a basic design study for the Project.

May 27, 1982

福屋正嗣
MASATSUGU FUKUYA
Team Leader
Japanese Survey Team
J I C A

Aloy W. Fernando
Actg Secretary
MINISTRY OF FISHERIES

ATTACHMENT

1. The objective of the Project is to construct a Fisheries Harbour for promoting fisheries in Sri Lanka.

2. The Japanese survey team visited the following places to decide the Project Site:

   1) Dikowita
   2) Beruwala
   3) Galle
   4) Mirrisa
   5) Puranawalla
   6) Tangalla
   7) Amaduwa
   8) Paratupana
   9) Kirinda
   10) Myliddy
   11) Point Pedro

3. The proposed site of the Project is in Kirinda. The site was chosen from the view point of a priority order of the Authorities concerned and the results of the preliminary survey by the Japanese survey team and the Authorities concerned.

4. The Japanese survey team will convey the strong desire of the Authorities concerned to the Government of Japan that the latter will send a survey team for the construction project of Kalmunai fisheries harbour in a priority order No.2 by the Authorities concerned.

5. The Japanese survey team will convey the desire of the Authorities concerned to the Government of Japan that the latter will provide a training programme in Japan for a civil engineer.

Contd...../2

6. The Authorities concerned will take necessary measures on condition that the basic design study is provided to the Project :

1) To provide data and information for the study
2) To carry out a soil survey and a sea depth survey in the project area ; and
3) Others .

******

ANNEX 2 MINUTES OF DISCUSSION FOR BASIC DESIGN STUDY

MINUTES OF DISCUSSIONS FOR BASIC DESIGN STUDY ON FISHERIES HARBOUR CONSTRUCTION PROJECT IN THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA

In response to a request by the Government of the Democratic Socialist Republic of Sri Lanka for grant aid assistance for Fisheries Harbour Construction Project(the project) the Government of Japan has sent, through the Japan International Cooperation Agency(JICA), a survey team headed by Mr.Akio Saito (Fisheries Agency of Japan) to carry out a basic design study on the project from August, 3rd to September 1st, 1982. The team has carried out a field survey, held a series of discussions and exchanged views with the officials concerned of the Government of the Democratic Socialist Republic of Sri Lanka(the authorities concerned) about the project.

As the result of the study and discussions, both parties have agreed to recommend to their respective Governments and the authorities concerned to examine the result of the survey attached herewith toward the realisation of the project.

19th August, 1982

斉藤昭雄

AKIO SAITO
TEAM LEADER
JAPANESE SURVEY TEAM
JICA

ANURA WEERARATNE
SECRETARY
MINISTRY OF FISHERIES

MINUTES

ATTACHMENT

I. The objective of the project is to construct a Fisheries Harbour for promoting fisheries in Sri Lanka.

2. The proposed site of the Project will be in KIRINDA (hereinafter referred to as "the project site")

3. The Japanese survey team will convey to the Government of Japan the desire of the Government of the Democratic Socialist Republic of Sri Lanka that the former takes necessary measures to co-operate in implementing the project and provides harbour facilities items listed in Annexure I within the scope of Japanese economic co-operation in grant aid.

4. The Government of the Democratic Socialist Republic of Sri Lanka will take necessary measures in the event that the grant assistance by the Government of Japan is extended to the Project. -

a) to provide data and information necessary for the design and the construction of the project.

b) to secure lands necessary for the construction of the project.

c) to clear and level the Project Site before the start of the construction.

d) to provide the other items listed in Annexure II.

e) to ensure prompt unloading and custom clearance in the Democratic Socialist Republic of Sri Lanka of imported materials and equipment for the construction and to facilitate their internal transport.

f) to exempt the Japanese nationals concerned from customs duties, internal taxes and other fiscal levies imposed in the Democratic Socialist Republic of Sri Lanka for the supply of goods and services for construction.

g) to provide and accord necessary permission, licences and other authorisation deemed advisable for carrying out the project.

5) The Japanese survey team will convey the desire of the authorities concerned to the Government of Japan that the latter will provide a training programme in Japan for a Civil Engineer.

ANNEXURE I

Items requested by the Government of Democratic Socialist Republic of Sri Lanka which will be borne by the Government of Japan -

I) HARBOUR

a) Breakwater (main I) revetment
b) Quay wall
c) Groyne

2) HARBOUR FACILITIES TO BE SUPPLIED FOR

a) Cold Storage
b) Office Room I
c) Auction Shed
d) Work Shop
e) Storage
f) Others

ANNEXURE II

Items the cost of which will be borne by the Government of the Democratic Socialist Republic of Sri Lanka.

I) Electrical power main line to the Project Site.

2) Provision of space necessary for such constructions as temporary offices, working area, stock yards and others.

DRAWINGS

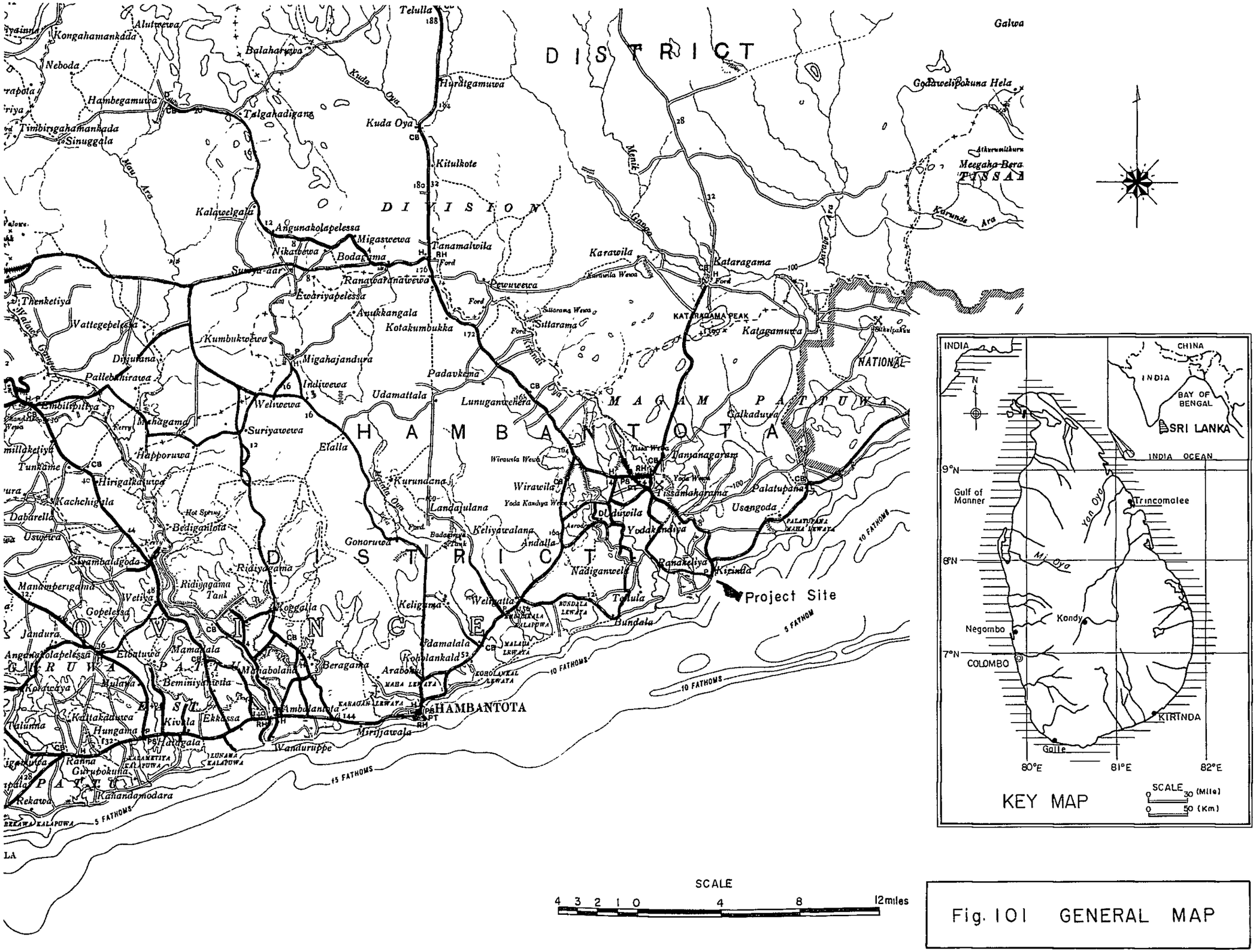


Fig. 101 GENERAL MAP

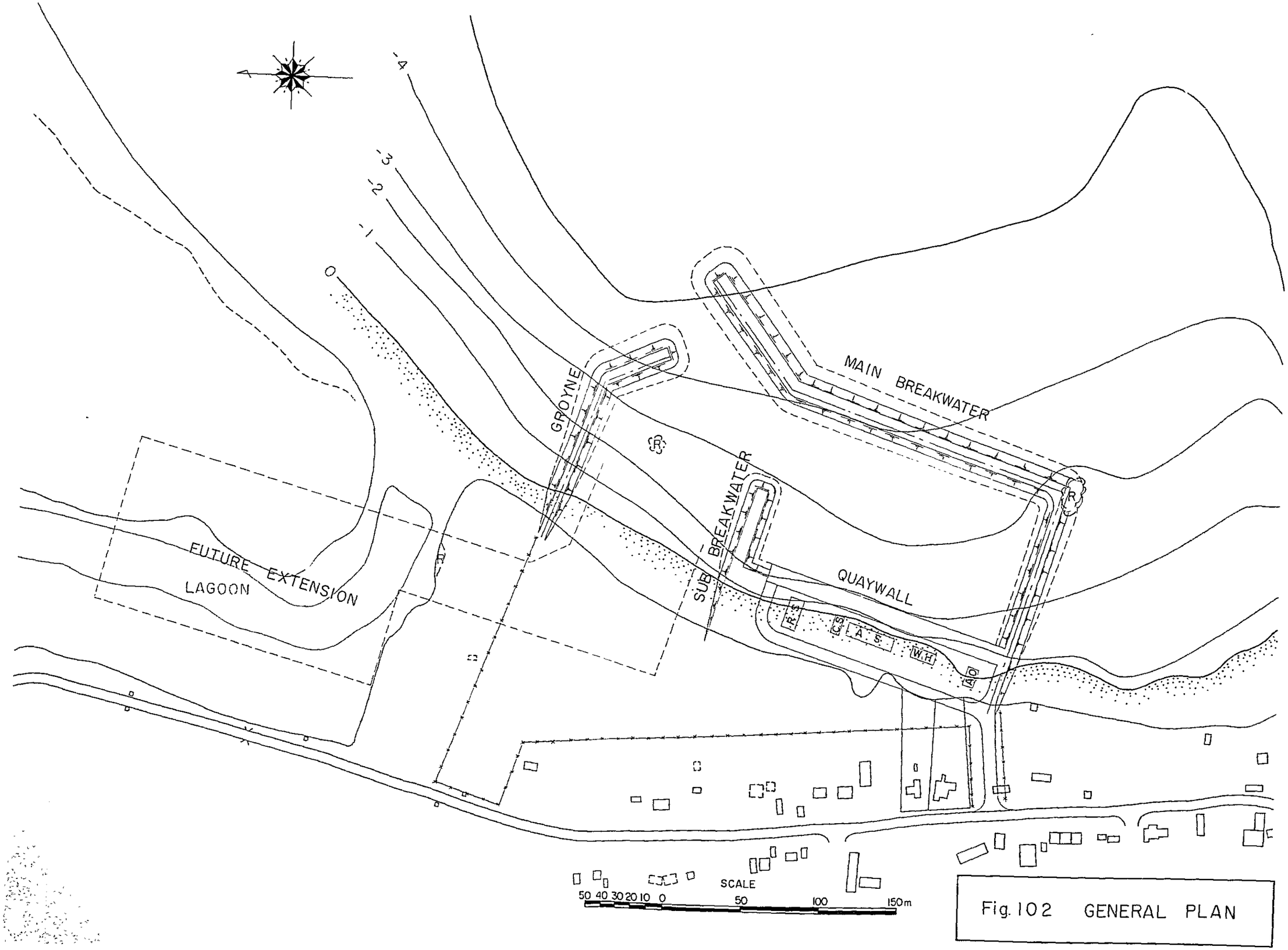
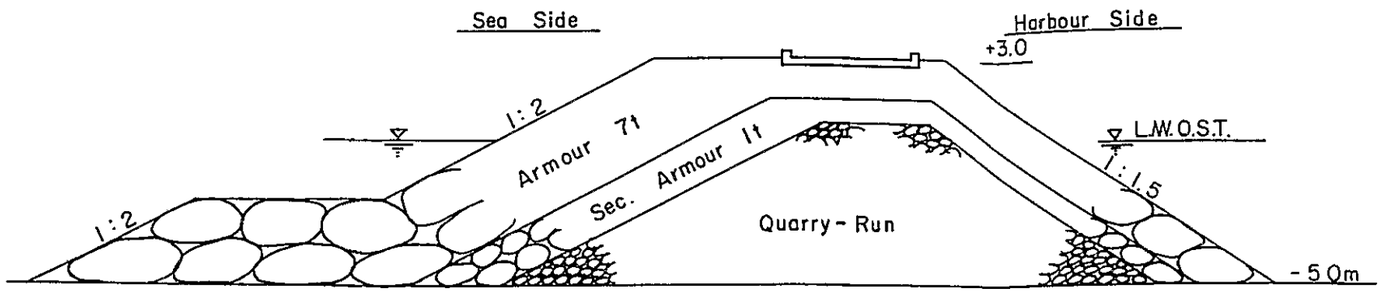


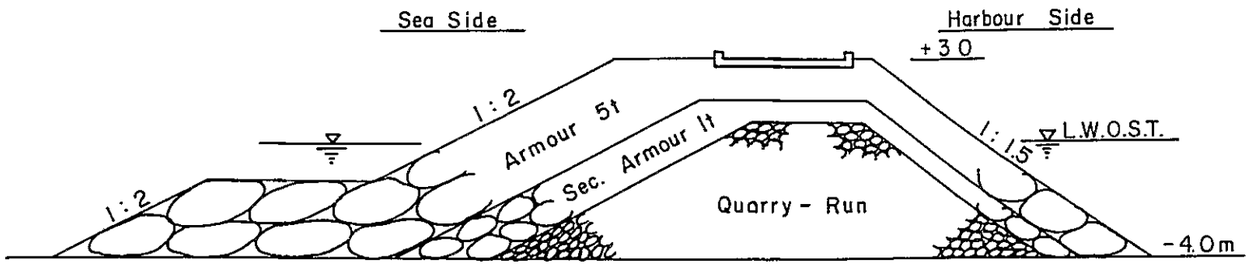
Fig. 102 GENERAL PLAN

MAIN BREAKWATER

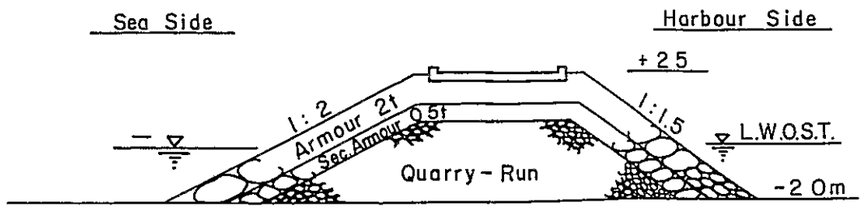
SECTION A-A



SECTION B-B



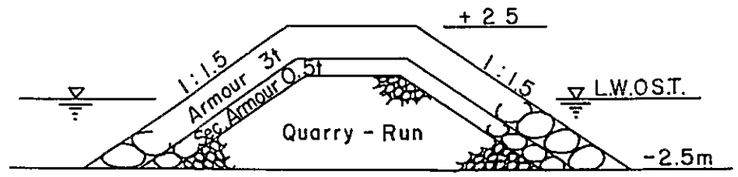
SECTION C-C

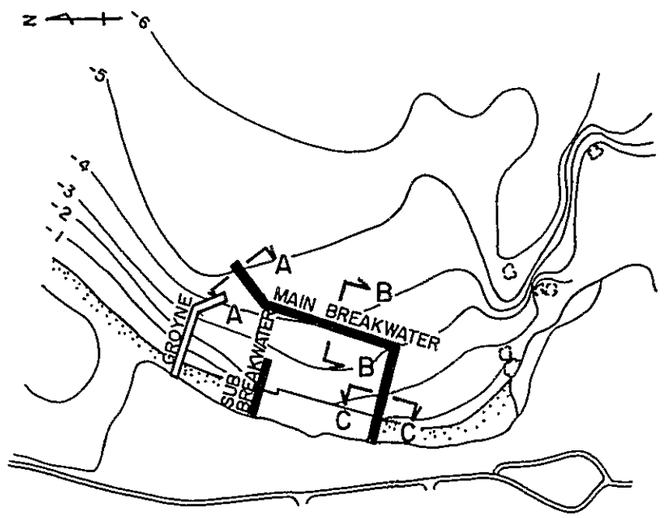


SCALE
5 4 3 2 1 0 5 10M

SUB BREAKWATER

SECTION D-D



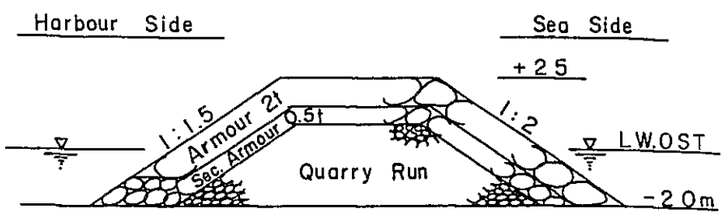


KEY PLAN

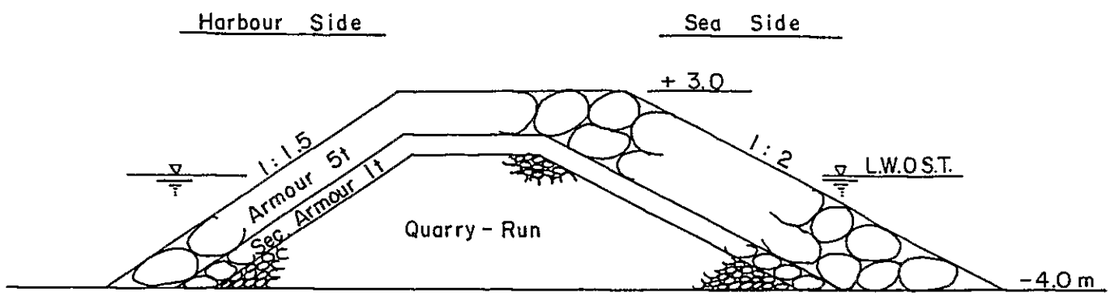
Fig. 201 MAIN BREAKWATER & SUB BREAKWATER

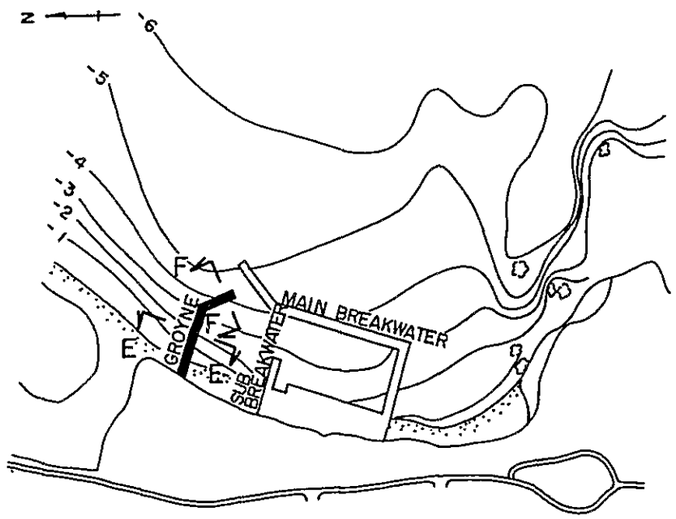
GROYNE

SECTION E-E



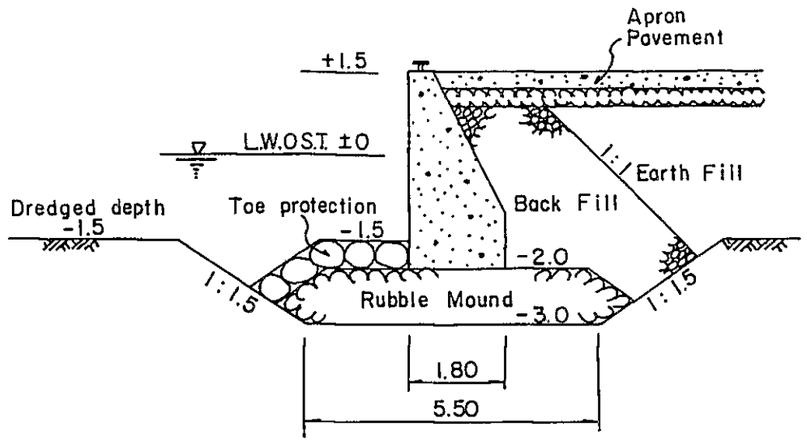
SECTION F-F





KEY PLAN

QUAYWALL

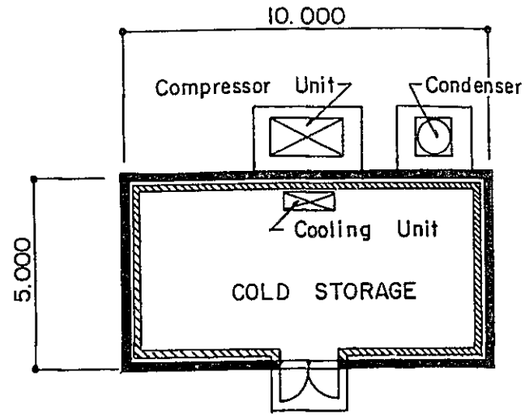


SCALE

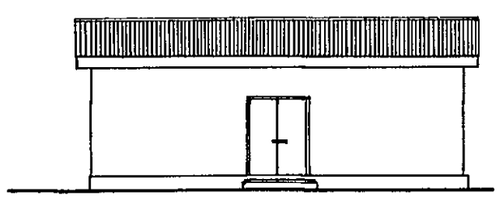
5 4 3 2 1 0 5 10M

Fig. 202 GROYNE & QUAYWALL

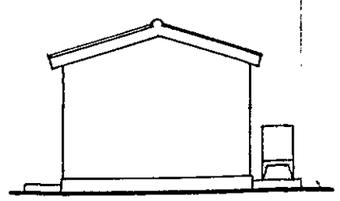
COLD STORAGE



PLAN

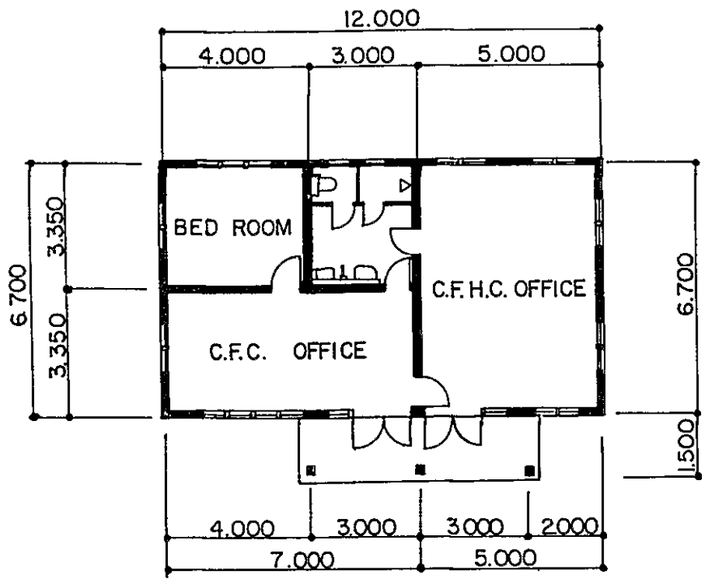


FRONT ELEVATION

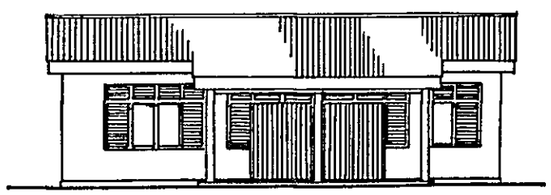


SIDE ELEVATION

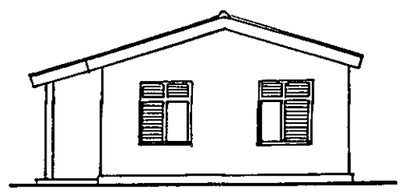
ADMINISTRATION OFFICE



PLAN



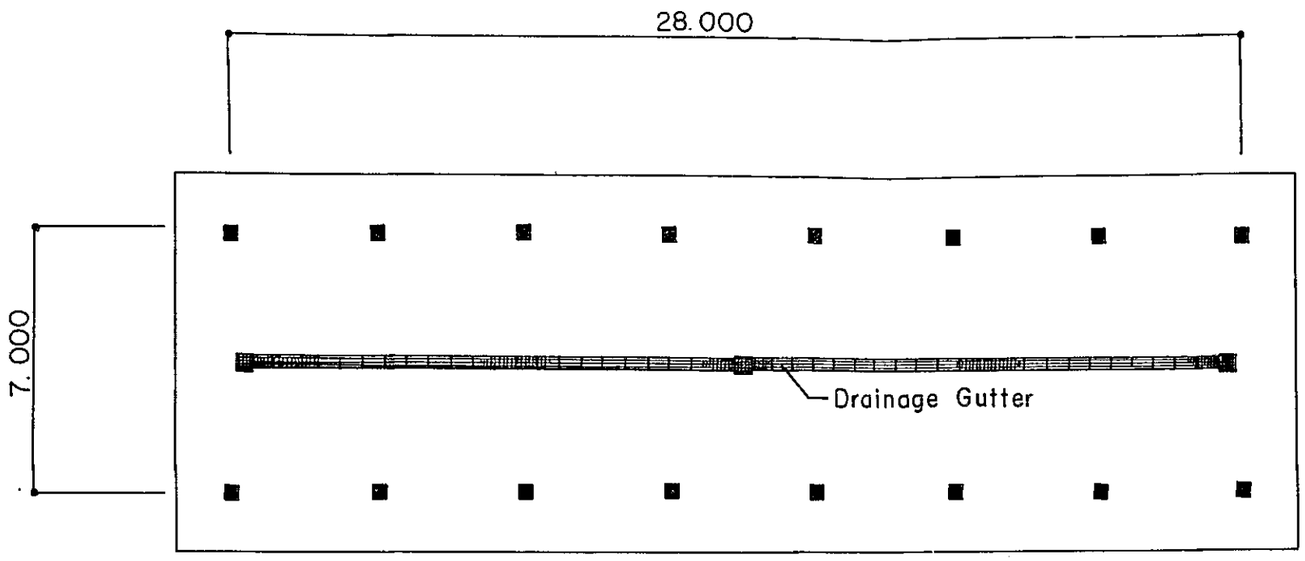
FRONT ELEVATION



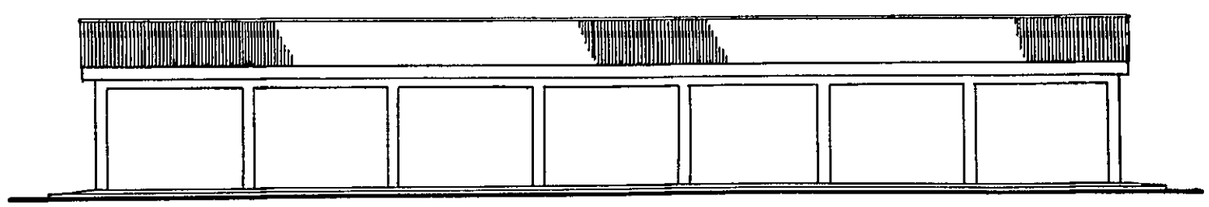
SIDE ELEVATION

SCALE
0 10M

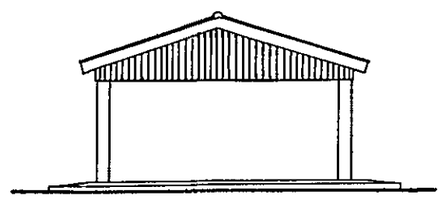
Fig. 301 COLD STORAGE & ADMINISTRATION OFFICE



PLAN



FRONT ELEVATION

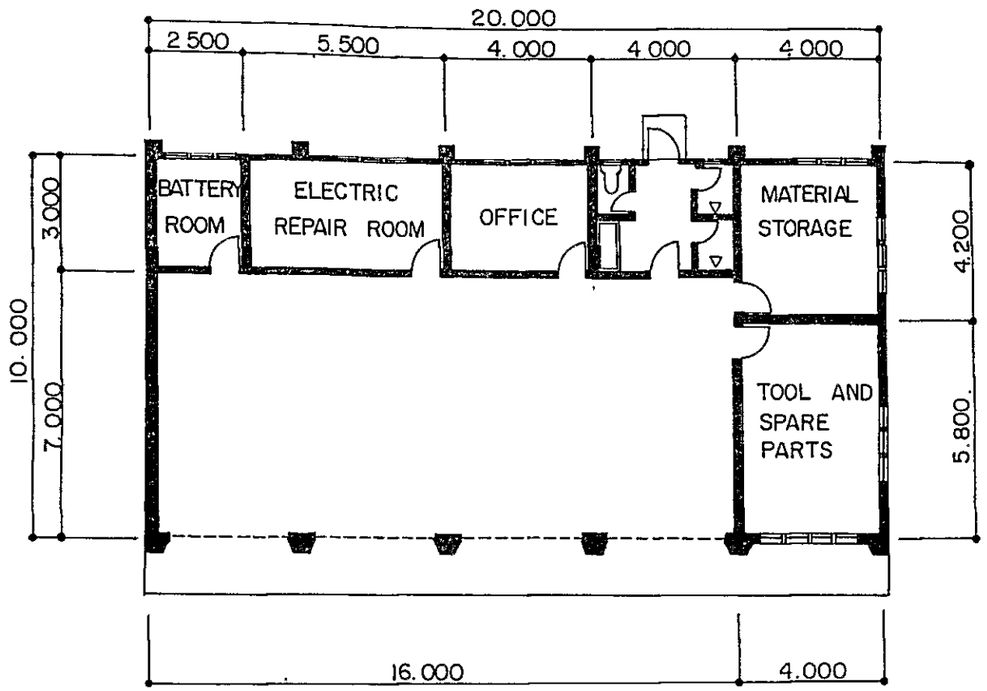


SIDE ELEVATION

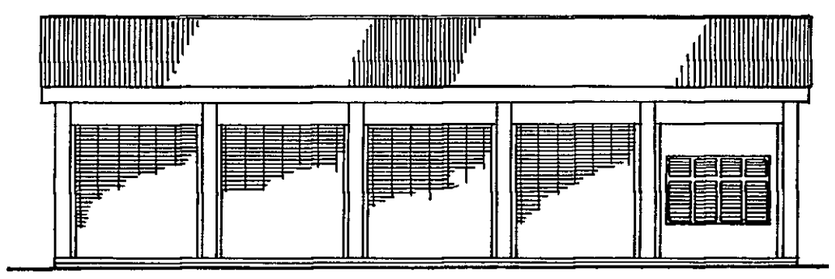
SCALE
0 10M

Fig. 302 AUCTION SHED

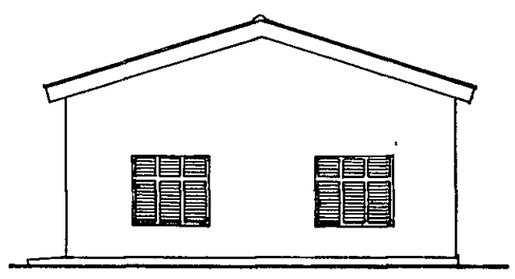
REPAIR SHOP



PLAN

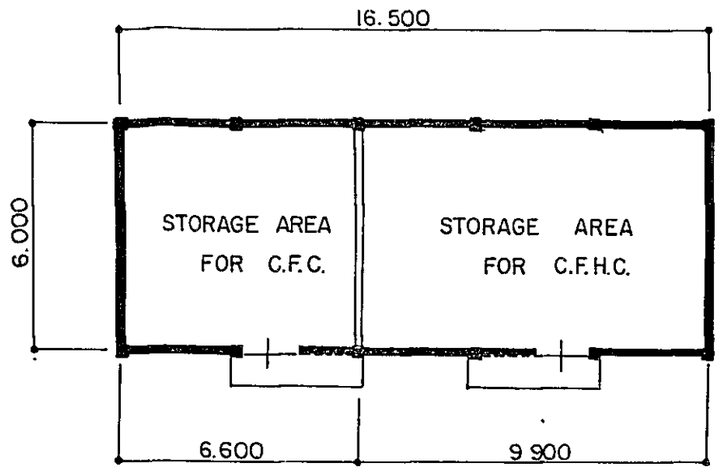


FRONT ELEVATION

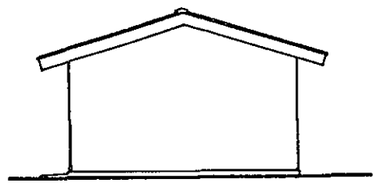


SIDE ELEVATION

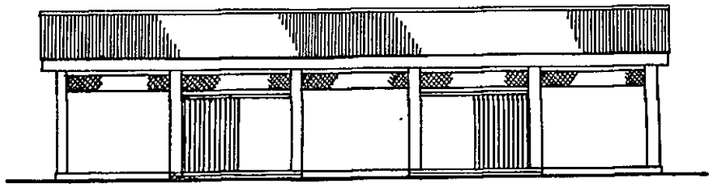
WAREHOUSE



PLAN



SIDE ELEVATION



FRONT ELEVATION

SCALE
0 10m

Fig. 303 REPAIR SHOP & WAREHOUSE

JICA