REPORT ON BASIC DESIGN FOR BETIO FISH PORT COMPLEX PROJECT IN THE REPUBLIC OF KIRIBATI

FEBRUARY, 1981

JAPAN INTERNATIONAL COOPERATION AGENCY

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PREFACE

It is with great pleasure that I present this report entitled BASIC DESIGN FOR BETIO FISH PORT COMPLEX PROJECT to the Government of the Republic of Kiribati.

This report embodies the result of a basic design survey which was carried out in the Republic of Kiribati from November 1 to November 13, 1980 by the Japanese survey team commissioned by the Japan International Cooperation Agency following the request of the Government of the Republic of Kiribati.

The survey team, headed by Mr. Kiyohide Nemoto had a series of close discussions with the officials concerned of the Government of the Republic of Kiribati and conducted an extensive field survey and data analyses.

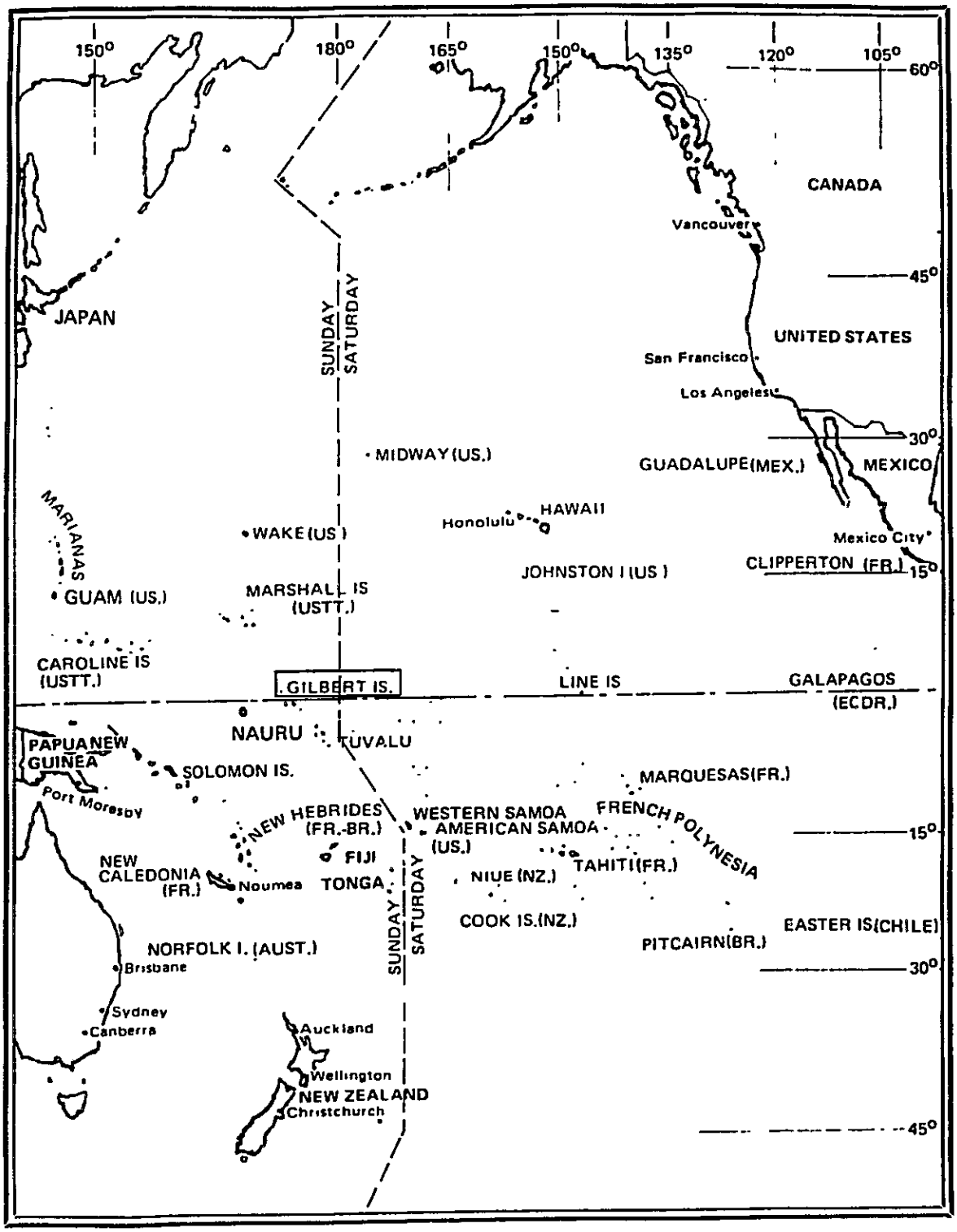
I sincerely hope that this report will be useful as a basic reference for development of the project.

I wish to express my deep appreciation to the officials concerned of the Government of the Republic of Kiribati for their close cooperation extended to the Japanese team.

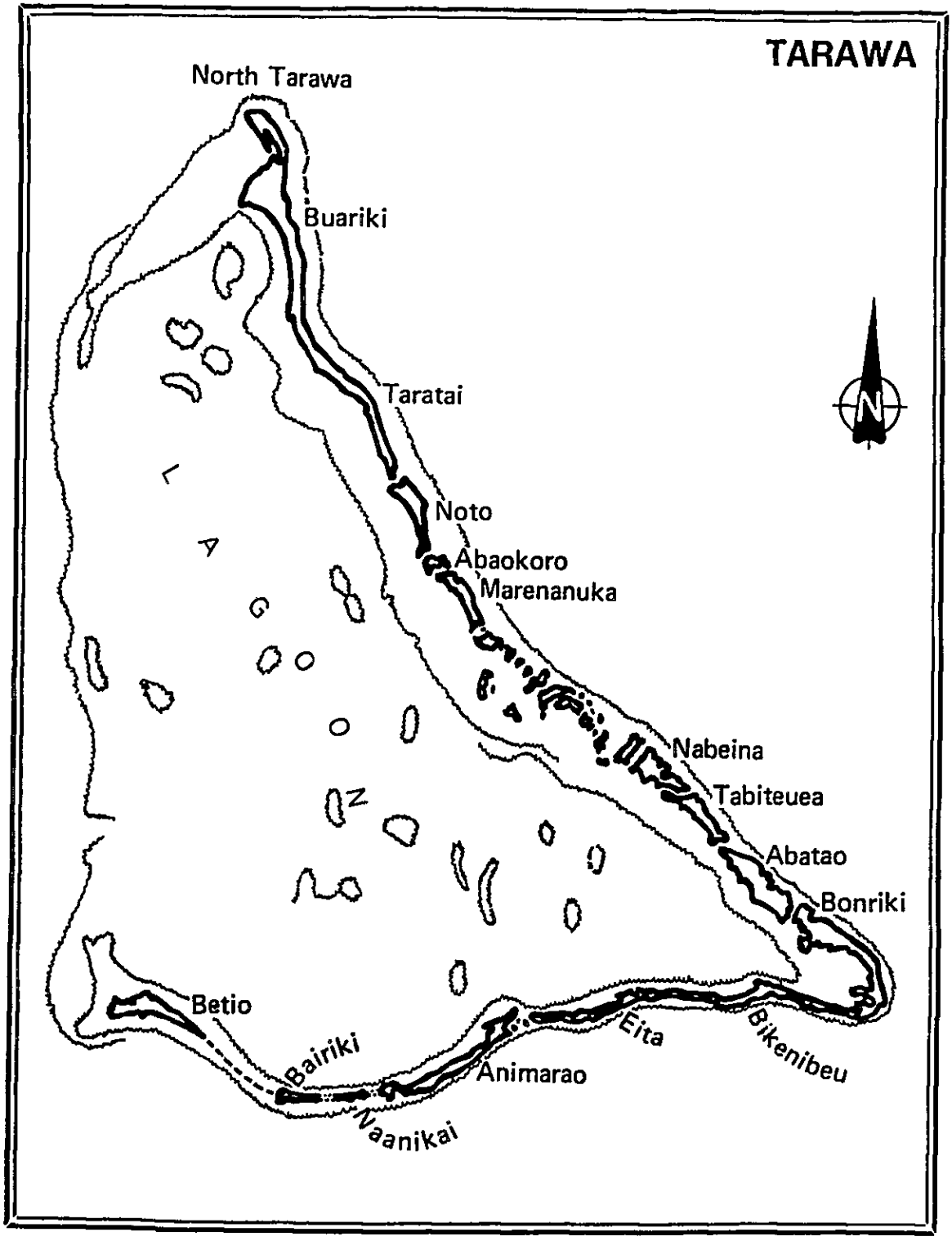
February, 1981

Keisuke Arita

Keisuke Arita
President
Japan International Cooperation Agency



Location of the Republic of Kiribati



Planned Site for Betio Fisheries Jetty

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SUMMARY

The Republic of Kiribati consists of three groups of islands called Gilbert Islands, Phoenix Islands and Line Islands, scattering in the sea area extending for 2,000 km from the south and to the north and for 3,800 km from the east to the west at lat 4° N. and 3° S., and long. 172° to 177° E., with the land area of about 719 km^2 and the population of about 56,500.

The country's industries are phosphate rock on Banaba Island and copra production which take up 99% of its total export, and had been dependant on phosphate rock for more than half of the national income. However, the phosphate rock had been exhausted at the end of 1979. The only resource expected to hereafter support the national economy is the fishery resource in the vicinity of the country, and thus the Kiribati Government places the top priority on the fishing development.

As a link of the National Development Plan, the Government is promoting the Fishery Development Project, and places the highest expectation on the skipjack and tuna fishing. The resource survey conducted by Japan International Cooperation Agency in 1977 and 1878 indicated a bright outlook for the future. 100-ton skipjack pole & line fishing boats were offered under the grant aid from the United Kingdom in 1978 and from Japan in 1979. With the assistance from FAO/UNDP and Japan International Cooperation Agency, the test operations for skipjack pole & line fishing by People of Kiribati were started, thus paving the way for development of skipjack/tuna resources.

Against such a background, the Government of the Republic of Kiribati plans to establish in 1981 "Te Mautari Ltd.", a public corporation for fishery wholly invested by the Government for promoting the export industry of skipjack and tuna, for an integrated operation using the presently owned skipjack fishing boats for fishing operation, storage, domestic sales and export.

However, it is necessary to provide such functional facilities as freezers and ice-making machines, as well as a jetty where the fishing boats and the export carriers can berth in order to promote the project.

The Kiribati Government has prepared the Betio Fish Port Complex Project and requested the Japanese Government to render assistance under a grant aid.

In compliance with such a request, the Japanese Government decided to conduct a basic design survey for formulating the Betio Fish Port Complex Project and consigned Japan International Cooperation Agency to implement the same.

The Agency sent the Basic Design Survey Team headed by Mr. K. Nemoto, the advisor of All Japan Fishing Port Association, to the Republic of Kiribati from November 1, 1980 to November 13th to confirm the basic plan made by the Kiribati Government and to conduct the field survey.

This Report summarizes the results of the survey, and the Survey Team submitted the following proposal as being appropriate for Betio Fish Port Complex Project to be offered under the Fishing Grant aid.

Betio Fish Port Complex Project

1) Facility to be constructed: Jetty

2) Scope of facility: length: 100 m
water depth at the tip: -4.5 m
berth length: 90 m

3) Facility structure: length of access portion: 60 m ...rock filled
berth portion : 30 m ...pontoon
connecting portion : 10 m ...bridge

Whereas the Kiribati Government indicated that they would like to have a piled jetty of more than 140 m length and of more than -7.7 m depth which can accommodate the large sized carriers as in their initial request, the proposal as above was submitted because (1) the plan for receiving the large sized carrier vessels was not yet sufficiently concrete, (2) the priority should be placed on berthing 100-ton type skipjack pole & line fishing vessels, and (3) there is a possibility

of unexploded ordnance existing locally and limitations in selecting the pile structure because of the lack of boring data.

After the field survey was completed, the Kiribati Government requested for the feasibility review for a pile system with a 60 m rock-filled portion since the stones are precious resource to them provided that (a) search for the unexploded ordnance and the sweeping of the sea are conducted, and (b) boring is conducted. Having reviewed their proposal, the Survey Team reached the conclusion that

1) it is possible to construct the facility as a pile system.
2) the construction cost would be higher than that for the rock-fill system.

This conclusion is discussed in the present Report as the review based on the proposal from the Republic of Kiribati.

OUTLINE OF THE SURVEY

Chapter 1: Outline of the Survey

1-1: Purpose of the Survey

The purpose of the survey was to have consultations and discussions with officials concerned of the Government of the Republic of Kiribati on the proposed construction of fisheries jetty for which the Government asked under the grant from Japan, to confirm the justification of the project and to conduct field survey. Based on the survey results obtained, it was aimed to perform basic designs which would facilitate sucessful implementation under the grant aid for construction fisheries jetty in order to develop fisheries in the Republic of Kiribati.

1-2: Background of the Request

After exhaustion of phosphate resource which had been so far the mainstay of economy, the Republic of Kiribati is now left only with the marine resources within her 200 sea mile waters.

The Government has been interests on tuna resources around the country for its latent marketablity. To develop tuna fishery is given the top priority in the National Development Plan of the Government. The Government has been endeavoring since the beginning of 1970's toward this goal by conducting test operations, etc. for tapping the tuna resource, and in the years 1977 and 1978 Japan has sent the survy team lead by Japan International Cooperation Agency to conduct the survey on fishing of skipjack, etc. as well as on the baits for skipjack, and in 1979 the training ship for skipjack fishing, etc. was provided as a grant aid.

Based on these past achievements, expectations for the assistance in the fisheries from Japan is quite high. Lack of live bait and basic facilities were the bottlenecks in the development of the fisheries. As for the baitfishes, the solution is expected since artificial culture of milk fish under the assistance from FAO/UNDP has been started. The lack of basic facilities, particularly of wharf facilities, still presents grave difficulties in development of tuna fisheries.

The Government of the Republic of Kiribati has planed a project for building fisheries jetty in Betio to remove these difficulties. However, the Government has submitted the request to Japan for assistance in carrying out this project in view of the difficulties they would encounter

in trying to carry out the project for themselves, and the basic design survey team was dispatched in response to the request to conduct survey on the fisheries jetty.

1-3: Members of the Survey Team

The survey team is composed of the following persons and headed by Mr. Kiyohide Nemoto, the advisor of All Japan Fishing Port Association.

In charge of	Name	Organization
Head of the Team	Kiyohide Nemoto	All Japan Fishing Port Association
Cooperation planning	Teruo Sugawara	Disaster Prevention and Coastal Protection Div., Fishing Port Dept., Fisheries Agency
Coordination	Hiroshi Saito	Fisheries Technical Cooperation Division, Japan International Cooperation Agency
Civil engineering design (Fishing port construction)	Koichi Igari	Nippon Tetrapod Co., Ltd.
Architect (Production and distribution facilities)	Toshiya Ogasawara	Nippon Tetrapod Co., Ltd.
Structure (Fishing port, facilities)	Masafumi Ito	Nippon Tetrapod Co., Ltd.
Estimation for facilities	Kuniaki Takahashi	Nippon Tetrapod Co., Ltd.

Dr. Taiji Endo and Mr. Naohiko Nakajima accompanied the survey team.

1-4: Itinerary of the Survey Team

The survey was conducted for the period of 13 days from November 1 to November 13, 1980.

The following table lists the major activities and the itinerary for the survey team.

Itinerary for the Survey

November	1, Sat.	Depart Tokyo at 19:00 by TE #24 for Nadi.
	2, Sun.	Arrive at Nadi at 6:40. Depart Nadi for Suva at 9:00 by FJ #010. Arrive at Suva at 9:35.
	3, Mon.	Visit Japanese Embassy in Fiji. Met Mr. Ohtaka, the Ambassador of Japan and Mr. Takayama, Second Secretary, to explain the outline of the survey.
	4, Tue.	Depart Suva by FJ #013 for Nadi.
	5, Wed.	Discussion on the survey detail and conveniences offered.
	6, Thu.	Depart Nadi at 12:15 by ON #420 for Tarawa via Nauru. Arrive at Tarawa at 18:15.
	7, Fri.	Conference at Ministry of Natural Resources Development. Discussion of survey schedule with Mr. Dalley, Chief Fisheries Officer, Dr. Gopalakrishnan, FAO/ UNDP Project Manager, and others personal concerned. Explanation of background for the request for this grant was given. The survey team requested for conveniences to be offered.
	8, Sat.	Sounding survey. Tidal level observation, levelling, soil sampling.
	9, Sun.	Discussion of scope and techniques for the jetty, and of the construction cost based on the results of the field survey. Sugawara and Takahashi investigated in Betio on the availability of materials and machineries. The proposal based on these results was prepared for submission.

	10, Mon.	Conference at the Ministry of Natural Resources Development. Presented the proposal for discussion. Discussion with Mr. Robson of Public Works Division on the construction plan. Investigated the quarry and the crushing plant.
	11, Tue.	Conference at the Ministry of Natural Resource Development attended by Hon. Teiwaki and government personnel concerned of the Republic of Kiribati. Discussion on the Minutes.
	12, Wed.	Depart Tarawa at 11 : 30 by #321 and arrive at Suva at 20 : 30 via Nauru.
	13, Thu.	Visit Japanese Embassy in Fiji. Report on the result of the survey made to Mr. Ohtaka, Ambassador, and Mr. Takayama, Second Secretary.
	14, Fri.	Depart Suva at 14 : 20 by FJ #434 for Auckland. Arrive at Auckland at 18 : 30.
	20, Thu.	(Western Samoa Time) Meet Mr. Gary Quince, Deputy Secretary, Ministry of Finance to have explanation of the letter to Mr. Ohtaka, Ambassador.
December	15, Mon.	Conference with Mr. Ian G. Grainger, Chief Engineer of Ministry of Communication and Works at the conference room of JICA.

1-5: Participants in Discussions

The survey team had discussions and consultations with many personnel concerned of the Government of Kiribati, of the Japanese Embassy, of the private companies, during the survey period as much as possible in order to learn accurately the local situations. The following are persons participated in the conferences, of the Government of Kiribati.

: Ministry of Finance
Deputy Secretary ..... Mr. Gary Quince

: Ministry of Natural Resource Development
Minister ..... Hon. Roniti Teiwaki
Senior Assistance Secretary
..... Mr. J. H. Jones
Assistant Secretary... Mr. Baraniko Baano
Chief Fisheries Officer.Mr. Brandon Dalley

: F. A. O./U. N. D. P.
Project Manager ..... Dr. V. Gapalakrishnan
: Public Works Division ..... Mr. Robson
: South Tarawa Wharf Area Planning Board
Land & Survey Office ..... Mr. Dominic Moss
: Marine Superintendent & Harbor Master
..... Mr. Schutz
: Shipping Corporation
General Manager ..... Mr. Murdoch
: Ministry of Communications and Works
Chief Engineer ..... Mr. Ian G. Grainger

1-6: Outline of the Survey

1-6-1: Confirmation of Basic Matters

The survey team has paid visits to those in charge of the project of the Government after their arrival, discussed the purpose, the itinerary and the details of the survey, and requested their cooperation. The following basic matters were discussed and confirmed.

(1) Background of the request
(2) Relation to the National Development Plan
(3) The concrete details and the scope of the request
(4) Planned site for the facilities and the construction yard
(5) Management Plan after completion of Fisheries Jetty
(6) Execution Agency

1-6-2: Sounding survey

Sounding survey was conducted at the site in the eastern area of Betio Port on November 9 in respect of the following details.

(1) Levelling
length of survey 400 m

(2) Sounding
length of sounding ca. 2,400 m
sounding points 220
sounding area ca. 65,000 m^2

(3) Soil sampling
sediment sampling of surface layer 3
Underwater photography

1-6-3: Collection of Materials

The materials related to the following matters were collected and the information collected to the extent necessary for the basic design from the government organization concerned and the private companies.

(1) Natural conditions

1) Meteorological conditions

a. Wind

Wind direction, wind speed

b. Rainfall

Maximum rainfall

Mean yearly rainfall

Mean monthly rainfall

c. Temperature

Maximum daytime temperature

Mean temperature

Minimum daytime temperature

d. Relative humidity

2) Marine conditions

a. Waves

Wave height

Wave direction

Wave period

b. Tidal current

Current direction

Current velocity

c. Tidal level

H. W. L.

M. W. L.

L. W. L.

Anomalous sea level

3) Geophysical conditions

a. Topographical map

Plan and cross section of the eastern and the western moles

b. Soil conditions — Boring data for the causeway between Betio and Bairiki

4) Others

Processing diagram for wartime debris (1954)

(2) Socio-Economic Conditions Survey

1) National Plan
2) Population statistics
3) Trade statistics

(3) Matters related to Facilities Construction

1) Available materials and machineries
2) Quantities of materials and machineries which can be procured locally
3) Prices
4) Labor costs
5) Labor conditions
6) Workmanship of labors
7) Experiences of similar constructions
8) Private construction companies
9) Laws, regulations and standards, etc. for design planning and construction
10) Transportation of materials

(4) Promotion of Fishing

1) Fisheries Development Plan
2) Establishment Plan of the state fishing corporation "Te Mautari"

(5) Survey of Related Facilities

1) Quarry
2) Stone crushing plant
3) Construction site of causeway between Betio and Bairiki
4) Betio Port

1 - 7: Conference with Government Personnel of the Republic of Kiribati

The Survey Team had discussions with the government personnel of the Republic of Kiribati concerning the planned site, the scope, the structure, the construction methods, etc. for the facilities to be provided under the grant based on the results of the survey. The proposal submitted by the Team as being the most appropriate failed to gain the agreement of the Government, and the construction method preferred by them could not be agreed upon because it would be out of the scope of the Terms of Reference given to the Survey Team. Thus, it was not possible to execute the Minutes during the survey period.

We should like to discuss the appraisal of the Republic of Kiribati on the proposal submitted by the Survey Team, the comments and the technical explanations made by the Survey Team on these, as well as the proceedings of the conferences.

(1) Opinions of the Republic of Kiribati

The Republic of Kiribati gave following opinions on the proposal submitted by the Survey Team.

1) The Kiribati Government shall conduct the search and removal of the unexploded ordnance at the planned site, if necessary. They will make necessary arrangement for the Survey Team.
2) Whereas the Kiribati Government requires the jetty to the point of -7.7 m depth, the design shows the jetty only up to -4.5 m depth. From the design, it does not appear that the foundation is sufficiently solid to allow extension of the jetty to the desired point at a later date.
3) Extension of the solid structure (rockfill type) for 60 m might cause problems to the current.
4) Obtaining required quantity of stones for filling the solid structure is not practical.
5) Water permeation may cause grave difficulties to the structure at a later date.
6) Scouring might deteriorate the problem 5), and cause the structure to sink.

7) The pontoon will be useful for only 2 to 3 years until the jetty is extended. The Government cannot think of any place where such a pontoon may be useful thereafter.
8) The permanent maintenance of the anchor cable for the floating structure will be too heavy a burden for the Government.

The Survey Team gave the following comments and the technical explanation.

(2) Opinions of the Survey Team

1) Concept of "Te Mautari Ltd." for promotion of marine industry by the people of the Republic of Kiribati is an excellent one.
2) The desire to export the frozen fish caught by the Republic of Kiribati is appreciated very much.
3) However, with no master plans for the jetty completed, it is impossible to construct the part of the jetty under the proposed grant aid.
4) Since there is no guarantee for another grant to follow this one, the Survey Team is forced to disagree with the idea of "completing the jetty with the yearly grants."
5) The facilities to be constructed with the grant must be those with own unique inherent economic effect. Constructing a part of the Master Plan, which part per se is of no practical use, cannot be offered under the grant aid.
6) The proposed plan was prepared having considered the Minister's plan to place a top priority on the fisheries development in the Republic of Kiribati, under the restricted condition of fisheries grant aid, the budget and the construction term.
7) It is necessary to increase the catch first if the export of 1,500 ton were to be realized. Toward this goal, it is imperative to improve the fishing techniques presently depended by the two 100-ton skipjack ships. Based on this, the proposal planned a jetty to be exclusively used by 100 ton skipjack ships.

8) The proposed design may not become the part of the great wharf which the Minister is planning, but it will certainly serve as the foundation for promoting fishery.
9) The plan proposed should be used as the jetty exclusively for fishing boats, and it will not hinder formulation of the master plan for the great wharf.

(3) Technical Explanations

1) Whatever stones available at present will be used, and any shortage shall be covered by use of sands or the import from Japan.
2) There will be no problems of littoral drifts with reclamation by the rock-fill of about 60 m. Conversely, it will be effective for preventing shoaling of waterways.
3) The pontoon will be of a concrete structure, and therefore needs hardly any maintenance.
4) Pilling is not possible with locally available heavy machineries. If the heavy machineries are to be transported from Japan, the initial cost will become huge, and cause difficulties to both the construction cost and the construction term.
5) Boring and piling cannot be adopted for any plans to be implemented the next year because of the problems of unexploded ordnance.
6) The pontoon itself may be transferred elsewhere in order not to hinder any future extension plans.

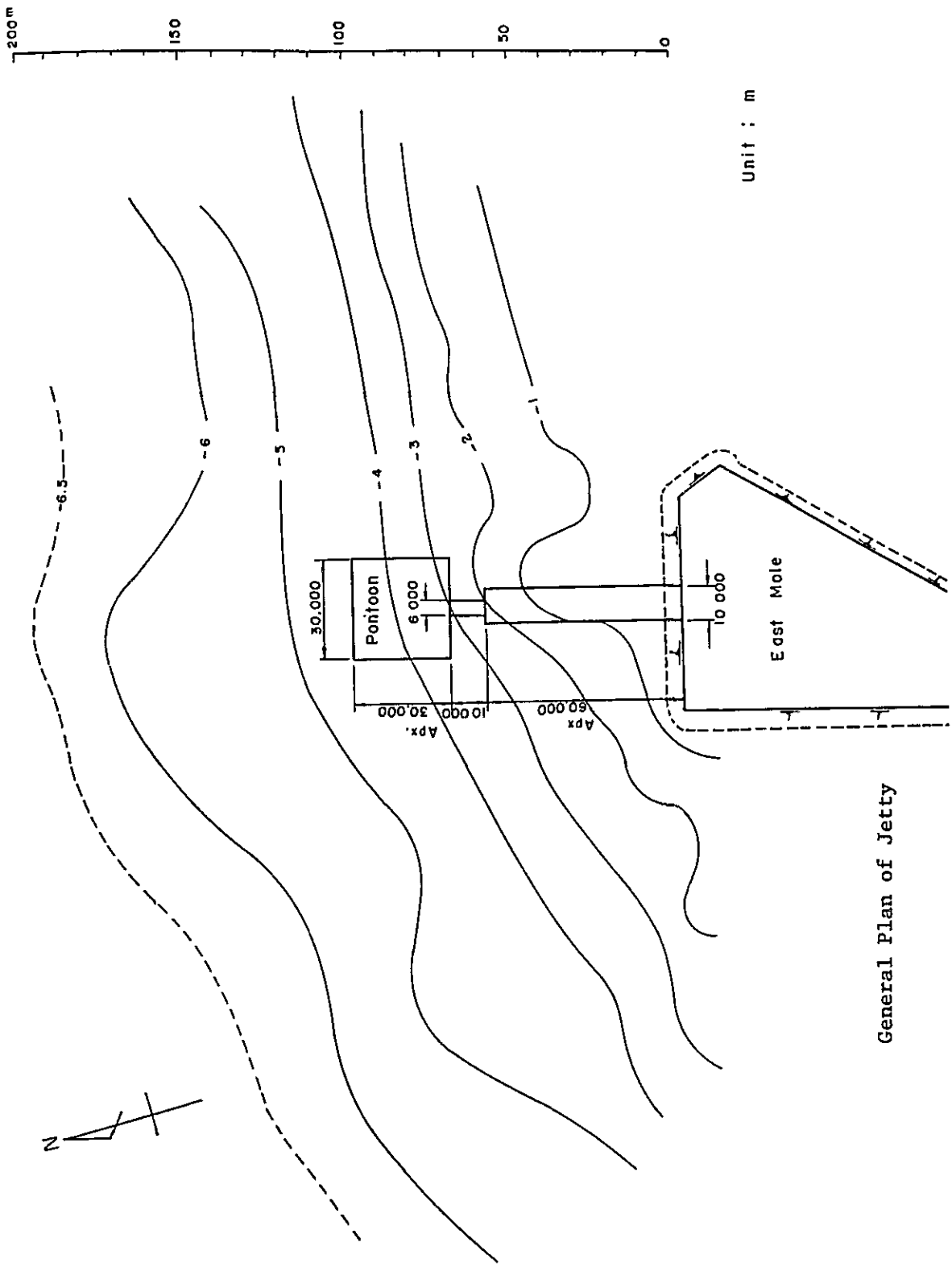
Based on the discussions outlined above, the following comments were made by the Republic of Kiribati:

1) Due to the absence of the chief engineer, no further technical discussions are possible.
2) The Kiribati Government will reach a definite conclusion after the conference to be held upon return of the chief engineer on November 15, and will forward the conclusion in writing to the Embassy of Japan in Fiji.

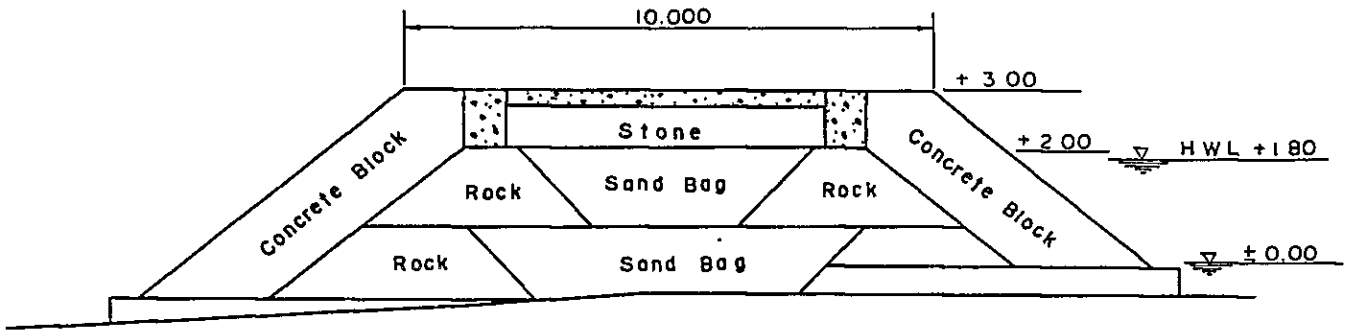
The discussions with the Kiribati Government were thus terminated.

Because the chief enginer was unavailable, the Survey Team submitted the explanation of the basic design in writing which concluded the technical opinions of the Survey Team.

Annex - 1 Proposed Plan by the Team



General Plan of Jetty



unit: m

Typical Cross Section of Access Portion (Rock Fill)

Annex - 2 EXPLANATORY NOTES ON BASIC DESIGN (November 13th, 1980)

1. Field survey outline

1.1 The field survey was carried out in the sea area at the end of the east mole.

1.2 The sounding line totaled to approx. 2400 meters covering the possible site area of approx. 65,000 square meters with the total sounding point of over 220. The bottom soil was sampled at 3 points and underwater photograph were taken widely for latter analysis of bottom conditions.

1.3 Soundings were made by a lead from sounding boat guided by transit on land and by measuring rope, one end of which is fixed to a point on land.

1.4 Temporary tidal gauge was set out and tidal level was observed and recorded every fifteen minutes during whole sounding operation. The levels from BTGZ of the temporary tidal gauge were measured by a level from the bench mark located near the tidal gauge station of Betio Harbour on the west mole.

1.5 Recorded data were processed and the bottom contour line was charted as shown in attached sheet.

2. Overall review of survey results

2.1 Water depth appeared to be shallower than what was informed previously.

2.2 The reef edge extends to the depth of 2 to 2.5 meters and the slope becomes steep at the front.

2.3 Bottom soil is fine sand of coral origin with relatively light gravity.

2.4 The maximum tidal range is approx. 2.5 meter.

2.5 The current in the lagoon is mainly caused by tidal movement and naturally fairly even.

2.6 On the bloblem of sand drift, we will review the information and make a comment, but sand drift is not considered to be very serious.

3. Basic design study

3.1 Based on the above survey results the design of jetty was studied.

3.2 The limiting factors that had to be considered for designing were:

Factor (1) Unexploded bomb may exist
(2) Geotechnical data is unavailable
(3) Lack of heavy equipment
(4) Limit of aggragate supply
(5) Construction time within 8 to 10 months
(6) Cost/benefit ratio must be high
(7) Shallow water area above - 2.0 m

3.3 Five different types of jetty i.e. fill type, floating type, gravity type, pier and bridge type and pile type were examined.

3.4 Followings were the results.

Type	Unclearable factor
Fill	4 5
Floating	6 7
Gravity	3 4 5
Pier and bridge	3 4 5
Pile	1 2 3 5

3.5 None of the types can clear all of the limiting factors and further studies led to the conclusion of hybrid type i.e. shallower part than -2m.; fill type, and deeper part; floating type.

3.6 The design features of hybrid type can be summarised as follows:

3.6.1 The shallower part can only be utilised as access to jetty and the fill type proved to have high cost/benefit ratio.

3.6.2 It is apparant from the survey results that the extents on of several hundred meters will be necessary to meet the final requirement (7 m. depth) of fisheries development. The future jetty development plan must be carefully reviewed after the operation results of the State Fishing

Company (Te Mautari Ltd) has been cleared. The floating type will be most versatile to accept any form of future plan.

3.6.3 Required construction period is relatively short as the two parts can be constructed in parallel.

4. Some additional technical comments

4.1 The study of present form of Betio harbour revealed that the extention of east mole is approx. 200 meters longer than west mole which was apparently designed to block the sand drift from east side. The small extention of present east mole with fill type structure will not give any serious problem to sand drift.

4.2 Prediction of hydrological change generally requires large scale computer simulation combined with hydraulic modeltest. However the current in the lagoon is fairly even and no major hydrological change may be predicted as a whole by placing small solid structure at the end of east mole. Partial influence to be caused by wave current can be minimised if carefully designed.

4.3 Careful study against subsidence, scour and seapage is a prerequisite for designing any type of marine structure. Proposed basic design was given full consideration to these problems, and this may be confirmed if structural difference with existing east mole is examined.

4.4 Designed load at the connecting bridge or the weakest point in the hybrid tyre still permits the transportation of 15 tons container loaded on a truck which considered to be sound enough for the future expansion.

4.5 Crushing strength of aggregate of coral stone is not known but appeared to be suitable to make massive concrete block of 1-ton.

4.6 Floating structure including anchore chain is designed to have durability of more than 20 years. Periodical inspection of anchor chain will be the only maintenance work required to the floating structure.

4.7 Shortage of locally available stone and aggregate is serious problem but this may be solved by bringing from outside Tawawa necessary quantity beyond the local supply limit.

4.8 Reinforcement of both corners of existing mole will be necessary when the extention with solid structure is made and this will be done by placing 1-ton block in front of the mole edge.

Chapter 2 : Basic Design of Betio Fish Port Complex Project

2 - 1: Basic Concept of Project

The economy in the Republic of Kiribati has been of the monoculture type with phosphate rock and copra sharing more than 99% of the total value of export. However, phosphate rock which takes up more than 80% of the export had been exhausted by the end of 1979, and the marine resources is expected to be the only resource for sustaining the national finance. The Government of the Republic of Kiribati places the top priority on the development of fishery.

Skipjack and tuna fishing is considered the most promising in the fishery development. The survey for resource development conducted by the Japan International Cooperation Agency in 1977 and 1978 also report that skipjack fishing had a good prospect.

In 1978, the United Kingdom offered a skipjack fishing boat of 100 t class, "NEI MAGANIBUKA", and the test operations for skipjack pole and line fishing by the people of Kiribati were started with the aid of FAO/UNDP and the cooperation of the Japan Internationa Cooperation Agency. Further in 1979, the Japanese Government offered the skipjack fishing boat of 100 t class and fish market facilities under the grant aid, which lead to the acceleration of development of skipjack and tuna resources.

With the above background, the Republic of Kiribati plans to establish "Te Mautari Ltd." in 1981 to be invested solely by the Government for promoting the export industry of skipjack and tuna. This public corporation is expected to consistently handle skipjack fishing operation with existing boats, maintenance of land facilities, and management of domestic sales and export.

The corporation hopes to obtain a fish catch of about 1,200 t in the second year, majority of which will be exported.

As the FAO survey team recommended, however, it is necessary to construct berthing facilities such as wharfs for skipjack fishing boats and loading wharfs for exporting vessels as well as functional facilities such as freezers and ice machines.

Betio Fish Port Complex Project is to be framed and promoted with due consideration of the future plans mentioned above.

2 - 2: Basic Policy

In preparing Betio Fish Port Complex Project, the following basic policy must be followed in view of the prevailing fishing situation and government project for promoting fisheries in the Republic of Kiribati.

(1) The project aims not only to overcome the lack of existing facilities, but to build facilities capable of meeting the expansion in the near future in order to cope with a rapid progress of the fishery.

(2) The fish port is to be improved to ensure full functioning of a well-equipped fish port as the center of the development of fishery in the Republic of Kiribati.

(3) The facilities are to be made compatible with the regional climates and natural features in an attempt to harmonize with the existing facilities and to facilitate the future maintenance and management.

(4) Plans for construction works must be made with due consideration to the local construction situations. Procurement of local construction materials must be avoided as much as possible, but its construction machineries and labor force must be fully utilized.

(5) The plan is to be based on the discussions with the Kiribati Government on the basic design survey and the results of the field-survey. (The matters not consented by the Kiribati Government shall be listed separately.)

2 - 3: Selection of Planned Site

The planned site for wharf requested by the Kiribati Government is located at the tip of the eastern jetty of Betio Port. Fig. 2-1 shows the topography around Betio Port. Presently, Betio Port has eastern and western jetties called East Mole and West Mole, and the area between the two jetties is used for navigation. The East Mole is longer than the West Mole by about 200 m, perhaps as a counter-measure for littoral drifts, and extends as far as the tip of the reef.

Despite dredging, the maximum depth of present waterway is less than 3 m, allowing no entry of larger sized ships. Skipjack fishing boats of 100 t class and regular ferry vessels of Daiwa Line are obliged to moor offshore.

As shown also in Fig. 2-2, there is only a limited space available in the vicinity of Betio Port, and a freezer is installed at the base of West Mole on the west of Betio harbor.

The area near the tip of East Mole is considered to be ideal for constructing the fish port facilities including the land facilities in view of the situation discussed above.

In other words, the fishing wharf can be made shorter for the extra length of East Mole. The sea area on the east of East Mole are generally of reef and thus shallow; it is suitable for reclamation and will facilitate the land for functional facilities of fish port in the future.

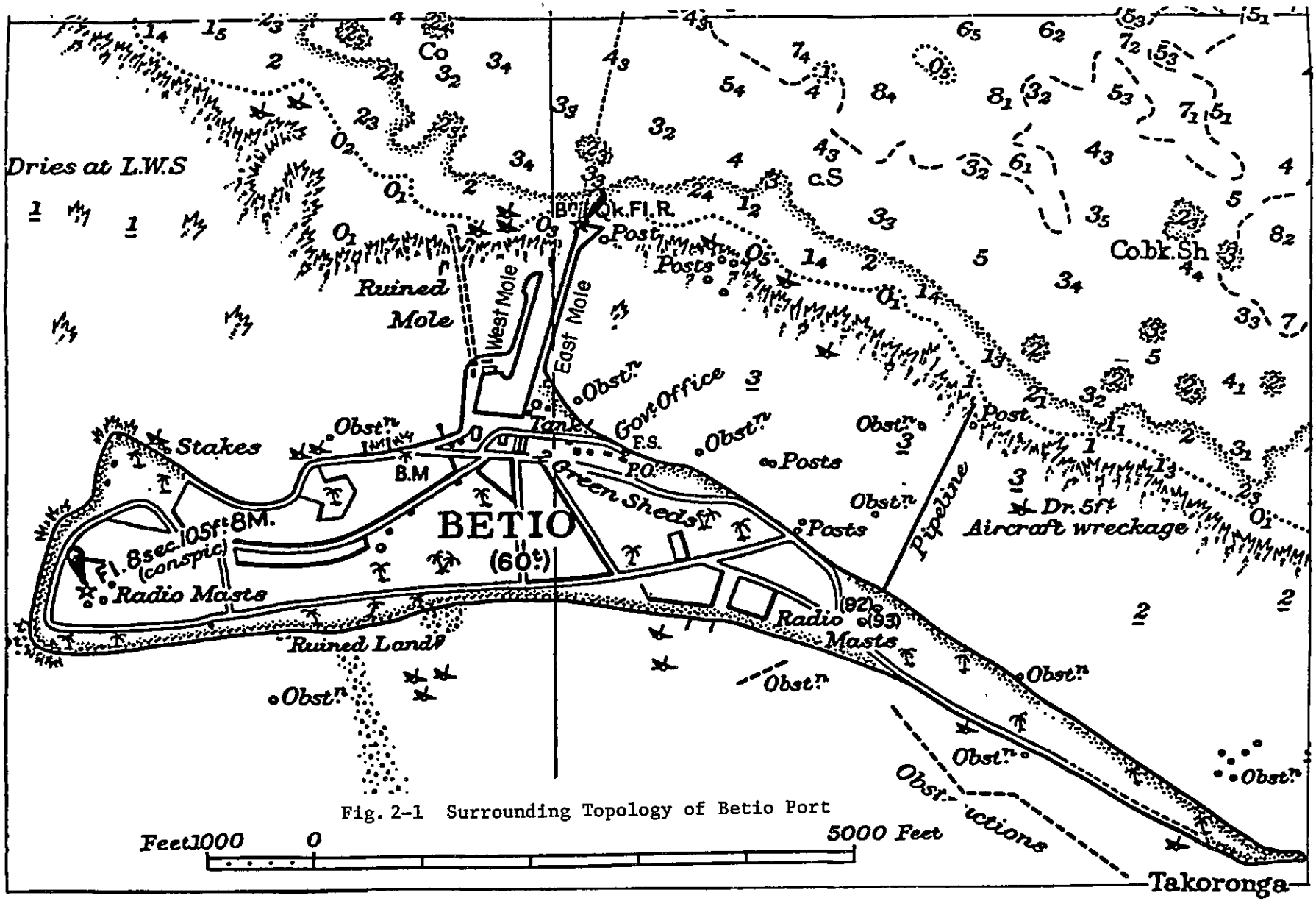


Fig. 2-1 Surrounding Topology of Betio Port

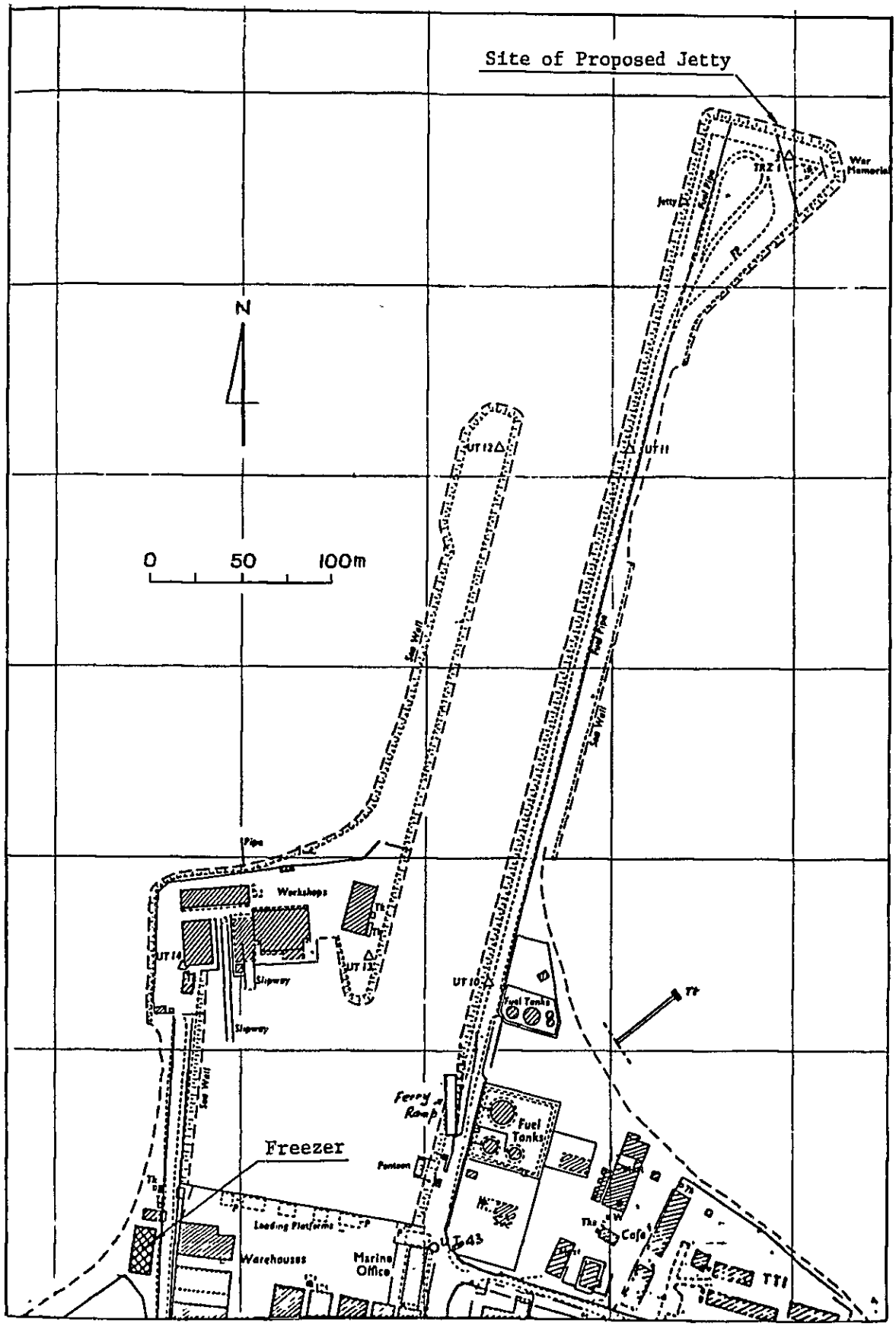


Fig. 2-2 Plan of Betio Port

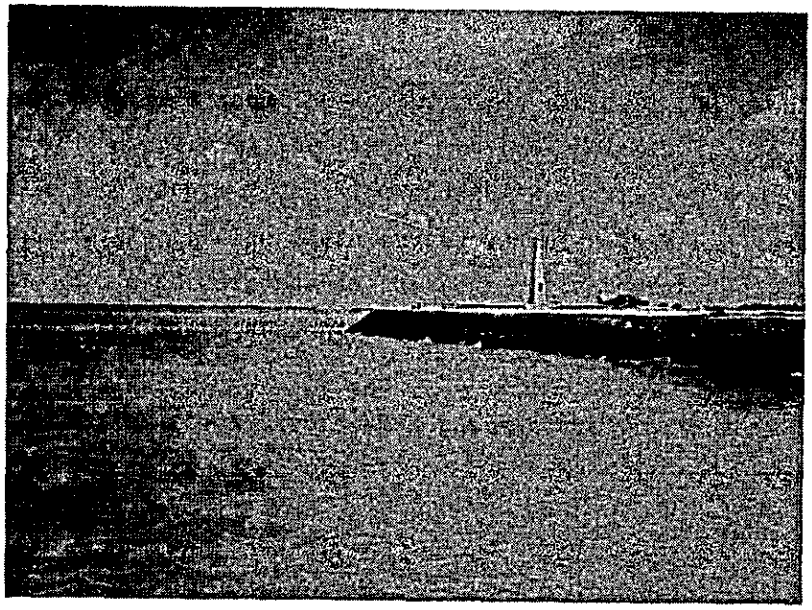


Photo. - 1 Construction Site (East Mole)

Photo. - 2 Tip of the East Mole

2 - 4 : Site Conditions

2-4-1 Topography

Fig. 2-3 is a sounding map prepared based on the results of the field survey. As the tip of the East Mole is located over the reef, the depth is shallow and the area with -0.5 to -1.0 m is prevalent. The field survey revealed that the depth of -2.0 to -2.5 m corresponds to the edge of the coral reef, beyond which point the depth suddenly plunges and reaches -3 m to -4 m.

The bottom slope beyond this point toward the sea is gentle, and the depth is merely -6.5 to -6.7 m at 180 m off the tip of the East Mole.

The center portion beyond the tip of the East Mole is the most shallow and the area on the navigation channel side is as deep as 1.4 m or more. The reef is cut at the eastern tip of the East Mole toward the sea and therefore the water depth is rather deep.

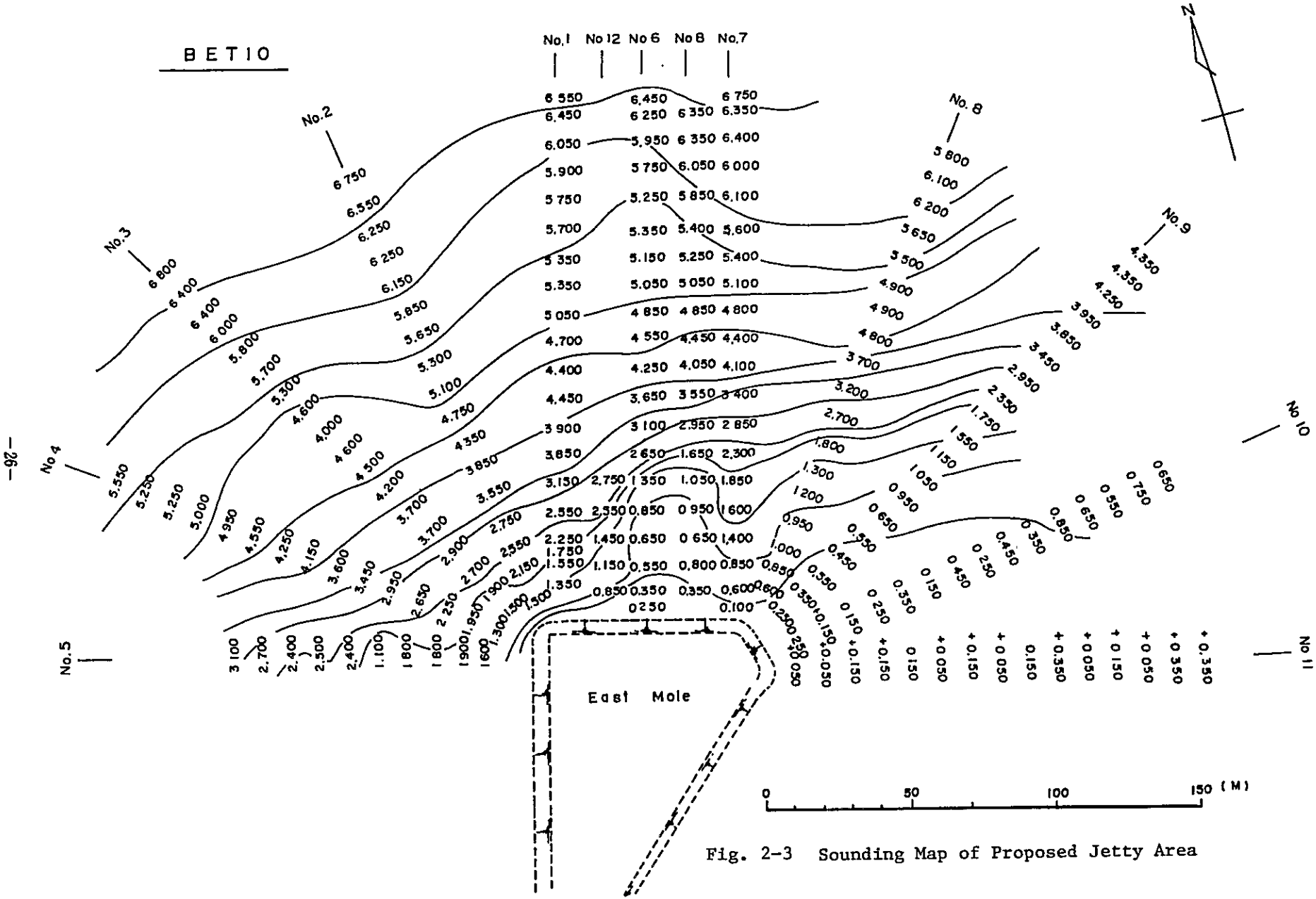


Fig. 2-3 Sounding Map of Proposed Jetty Area

(2) Soil Conditions

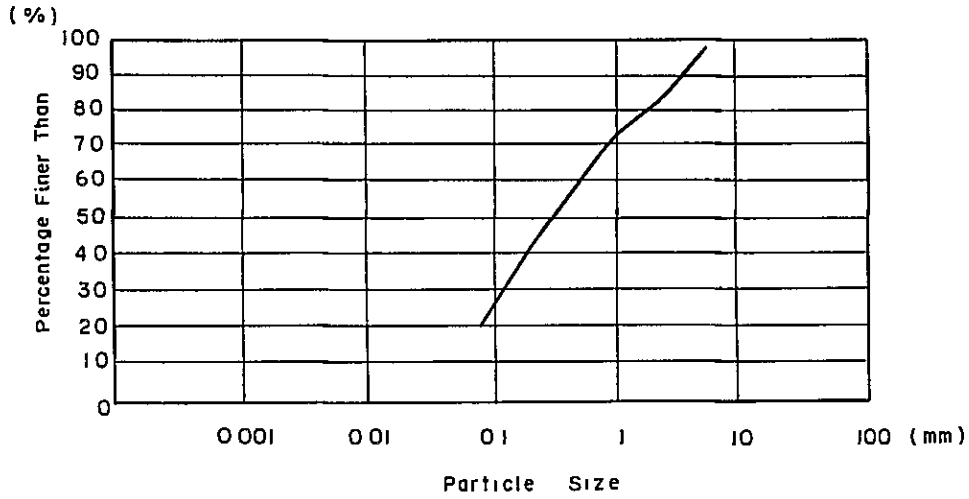
There are no geophysical data available for the planned site. The field survey results showed that the foundation is of coral rocks up to 60 m from the tip of the East Mole. Beyond this point it is sandy foundation of coral reef. As shown by the grain distribution of the sands in the surface layer in Fig. 2-4, grains are comparatively fine. There are no problems for anchoring since big sized tankers, etc. are presently at anchor.

The sand layer thickness off-shore and the coral rock foundation depth are not known because the boring data is not available.

Fig. 2-5 and 2-6 show the results of boring at the depth of ca. -5 m within the lagoon about 2.5 km east of the planned site. According to Figs. 2-5 and 2-6 the ground is calcareous sand mixed with white silts and the mean N value is 20. There exist coral rocks at about -10 m.

Considering that they are within the same lagoon, the area about the tip of the East Mole is expected to have approximately the same cross section of boring data.

However, the boring data is required for the detail design and selection of construction systems such as piling, etc.



Particle Size Distribution Curb

B H No 19

Depth 2.1 ~ 2.6 m

Description White silty sand and coral

Fig. 2-4 Grain Size Accumulation Curve

BOREHOLE SECTION No 9

Sample		Change of Strata			Description of Strata
Depth	Type	Legend	Depth	CD Level	
				0.0	Admiralty Chart Datum
0.0	D		0.0	- 5.2	Bed Level
0.7 ~ 1.0	S (21)		0.6	-5.8	White silty fine to medium Calcareous Sand
0.6 ~ 1.0	D				
2.3 ~ 2.5	S (19)		2.6	-7.8	White silty calcareous Sand
2.1 ~ 2.6	D				
2.6 ~ 3.7	D		3.7	-8.9	White calcareous Sand with fragments of CORAL

April, 1977

D : Disturbed Sample
S : Standard penetration

Fig. 2-5 Borehole Section (1)

Borehole Section
Betio - Bairiki Causeway - Tarawa - Apr, 1977

BOREHOLE SECTION No.11

Sample		Change of Strata			Description of Strata
Depth	Type	Legend	Depth	C.D.Level	
				0.0	Admiralty Chart Datum
			0.0	-5.3	Bed Level
0.6 ~ 0.9	S(19)				
0.6 ~ 0.9	D		1.4	-5.7	White fine to medium calcareous SAND
1.4 ~ 2.0	D				
1.6 ~ 1.7	S(15)				
1.6 ~ 1.7	D				
2.0 ~ 3.0	D		2.0	-7.3	White sandy calcareous SILT
			3.0	-8.3	White fine to medium calcareous SAND
3.2 ~ 3.5	S(57)				
3.0 ~ 3.5	D				White silty calcareous SAND
3.5 ~ 4.7	D		3.7	-9.0	with fragments of CORAL
			4.7	-10.0	White calcareous SAND

April, 1977

D : Disturbed Sample

S : Standard Penetration

Fig. 2-6 Borehole Section (2)

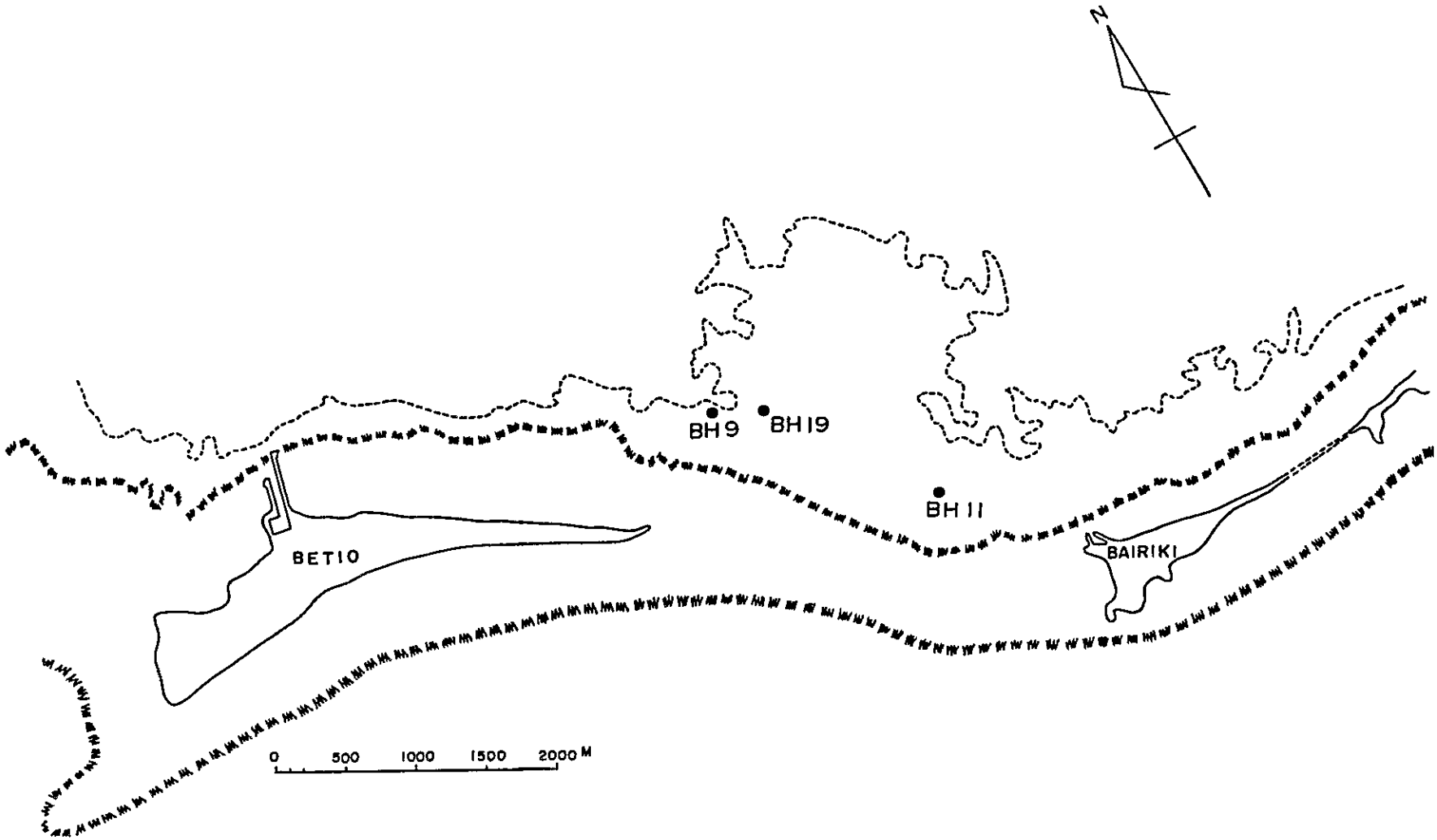


Fig. 2-7 Location of Borehole

(3) Marine Conditions

Tidal levels at Betio are as follows:

H.W.L. + 1.80 m
M.W.L. + 0.94 m
L.W.L. + 0.09 m
H.H.W.L. + 2.59 m

(4) Waves

As Betio Port is located inside a lagoon, the waves from the ocean break on the ring reef and become attenuated. Therefore, they hardly enter the lagoon. Although the western part of Betio Port is somewhat subjected to their influences, the wind waves generating within the lagoon generally predominate in the Betio Port area.

Table 2-2 shows the fetches from Betio within the lagoon. The longest effective fetch is 17.6 km in direction of NE. If the mean water depth in the lagoon is set at 9 m (high tide), the probability of the waves inside the lagoon will be shown in Table 2-1.

Table 2-1: Probability of Waves inside Lagoon

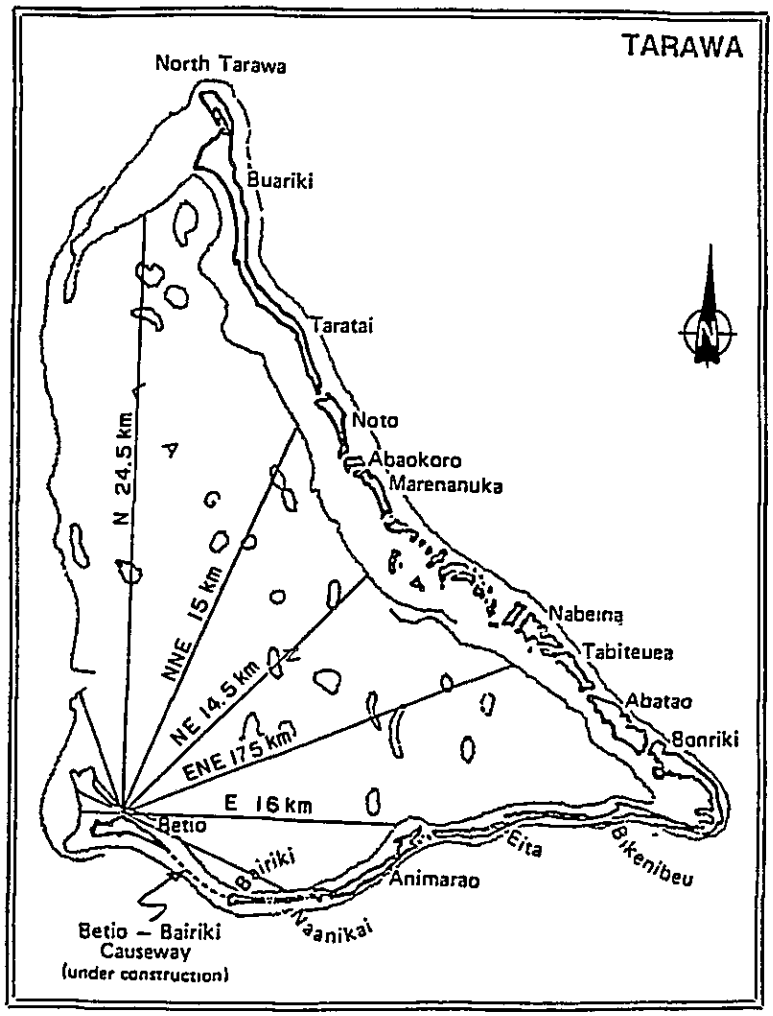
	T (sec.)	H (m.)
Once a year	3.6	1.0
Once a decade	4.1	1.4
Once five decade	4.8	1.65
Once a century		1.8

Table 2-2: Fetches from Eastern Jetty in Betio Port

Direction	N	N 22.5°E	N 45°E	N67.5°E	E
Fetches	24.5 km	18 km	14.5 km	17.5 km	16 km
Direction		N 22.5°W	N 45°W	N 67.5°W	W
Fetches		5 km	2 km	1.5 km	3 km

Effective fetches are calculated as follows.

NNE	16.7 km
NE	17.6 km
ENE	16.1 km



(5) Currents

Tidal currents are predominant inside the lagoon. Because Tarawa Atoll faces islands in NE and S, and the western reef is lower, the seawater mainly enters the lagoon from the west. Accordingly, the current flows east during the high tide and west during the low tide. The current speed is the average of 1.5 - 2 knots (0.8 - 1.0 m/sec). (B.B.C.T. Design Report)

(6) Unexploded Ordnance

Betio Port in Tarawa served as a battle ground during the Second World War.

Therefore, there were many wartime debris at the site planned for the jetty over the reef at the tip of the East Mole. The same situation is expected to exist at the sandy area toward the sea beyond the reef, and there is no record to show that there remains no unexploded ordnance.

(7) Water Supply

The altitude of Tarawa islands is low and there are no rivers. The only source of water supply is storing the rain water. The water from the well contains salt. There is, therefore, no water supply system available. The rain water is collected at each of the buildings, and stored in tanks.

It is therefore necessary to provide storage tanks for construction uses to store rain. For concrete works, it is necessary to drill the well and use the water from the well in spite of its salt content.

(8) Electricity

Betio has a power station and distributes the electricity throughout the island. Accordingly, it is possible to use the electricity once temporary wiring is secured for construction. However, a generator may be required to secure the power for construction.

(9) Fuel

There are oil tanks at Betio Port which are supplied by tankers coming from Fiji at an interval of once three months. The fuel stand is located at the base of the East Mole in Betio Port and its capacity is considered sufficient to meet the supply unless an extremely large quantity of oil is used.

2 - 5 : Plan for Basic Facilities

2 - 5 - 1:Facilities Included in the Plan

Facilities which the Kiribati Government requested for Betio Fish Port Complex Project include a jetty as the basic fish port facility and a freezer/an ice-maker as related functional facilities. The highest priority, however, is placed upon the jetty and the Government requested to make the length of the jetty as long as possible. The present plan, therefore, includes the following facilities:

1. Jetty
2. Related facilities
   - Fenders, Mooring posts,
   - Water pipeline,
   - Fuel pipeline

2 - 5 - 2:Plan of Jetty

(1) Ships to be served

The Survey Team discussed with the Kiribati Government the plan conditions, but failed to reach the final agreement. The plan conditions proposed both by the Team and the Government are discussed separately. This draft will base the present plan to be implemented upon the conditions proposed by the Team.

The type of ships to be served is 100 ton class skipjack pole fishing boats. The types of existing skipjack fishing boats are listed below:

	THE NEI ARINTETONGO	THE NEI MANGANIBUKA
Length	35.00 m	35.00 m
Breadth	5.70 m	5.70 m
Depth	2.65 m	2.60 m
Draft	2.40 m	2.34 m
Gross Tonnage	121.86 ton	96.94 ton

The maximum boat requested by the Government of Kiribati is described below:

Maximum length	65.0 m
Maximum draft	7.0 m
Minimum length	15.0 m
Minimum draft	1.8 m

There were problems with the above boat in that the draft was extremely large compared to the length. The Kiribati Government explained that it did not plan to use the new facilities for the existing skipjack fishing boats but for 2,000 to 3,000 ton class freezer/carrier ships or even 10,000 ton class freezer/carrier ships. Though the Team appreciated the Government's far-sighted scheme for the future, they judged that a certain volume of fish catch had to be secured in order to invite such freezer/carrier ships to call at the port. Since such a required volume of catch was not guaranteed for the time being, and since the export would be possible by using container ships (as currently conducted), they explained to the Government that the type of the ships to be served in the present plan were skipjack fishing boats rather than the carriers.

(2) Water Depth

Draft of 100 ton class skipjack fishing boat	2.40 m
Allowance	0.5 m

The minimum water depth along the jetty is set at -3.0 m which may be made to -4.5 m by extending the jetty. The Government of Kiribati expressed its opinions as follows on the above plan.

The Government needs to make the jetty up until the point of -7.7 m so as to serve freezer/carrier ships, while the plan set the jetty only up to -4.5 m.

The Team responded in the following manner.

1) The planned water depth is sufficient to serve 100 ton skipjack fishing boats.
2) The result of the sounding survey indicates that the water

depth of -7.7 m can not be obtained unless it is 200 m off shore from the tip of the East Mole.

3) The water depth of -7.7 m is not necessary for even 2,000 to 3,000 ton class freezer/carrier ships; therefore, there are no well founded reasons to require the depth of -7.7 m.

(3) Extension of the Jetty

As shown in Fig. 2 - 3, the section of less than -2.0 m extends for about 60 m and this section is of reef. For this reason, dredging will be difficult and therefore skipjack fishing boats can not be berthed. The 60 m section is considered as an access to the jetty and the portion of the jetty extended beyond this section will serve skipjack fishing boats. Skipjack fishing boats are supposed to be berthed laterally.

Number of fishing boats	2
Length of lateral berth	boat length + allowance
	35.46 + 5.34 ≒ 41 m

Therefore, the planned jetty will have the access of 60 m, the connecting portion of 10 m and the berth portion of 30 m, making the total length of 100 m.

Width of the jetty tip is to be 30 m so that the two skipjack fishing boats can be berthed on both sides of the jetty.

Length of one berth	30 m
Total length of berth	90 m

Length of 1 berth is shorter than that of the boat, and is insufficient to secure the predetermined berth length. But this is considered sufficient to be used exclusively for boats and not as a continuous berth. At high tide, 3,000 ton class freezer/carrier ships can be berthed.

The Government of Kiribati further expressed its opinions that the 100 m jetty would not be a solid foundation for the future extension to the desired water depth. If it is impossible to

construct the jetty to -7.7 m depth at this time, the Government of Kiribati would like the policy of a partial assistance at the time of the future construction.

The Team replied that

1) Since there has not been completed the master plan for the jetty, it is extremely difficult for the Team to construct a portion of jetty with the present grant aid.
2) Since there is no definite guarantee for the future grant, the Team can not agree with the scheme "to complete the jetty with the next assistance/grant aid."
3) Facility constructed with the grant aid generally must have its own inherent economic effects.
   Even though a portion of the master plan is executed, if the portion is of no practical value, such a partial construction could not be offered under the grant aid.
4) The jetty must be extended by more than 200 m in order to secure -7.7 m depth as requested by the Government of Kiribati.
   This is impossible under the present grant aid.
   Further, it is necessary to draw a master plan for such an extensive jetty construction.
5) The submitted plan may not be a part of the Great Wharf planned by the Minister, but it will serve as a foundation for the development of fishery industry.

(4) Crown height of the jetty

It is obtained by adding 1.0 m to the mean monthly highest water level.

Crown height = H.W.L. (+1.8) + 1.0 ≒ +3.0 m

This is identical to the reclaimed ground level of the East Mole.

2 - 5 - 3: Layout plan of jetty

The jetty initially requested by the Government of Kiribati is similar to the Plan I of Fig. 2-8 according to the draft sketch attached to the plan.

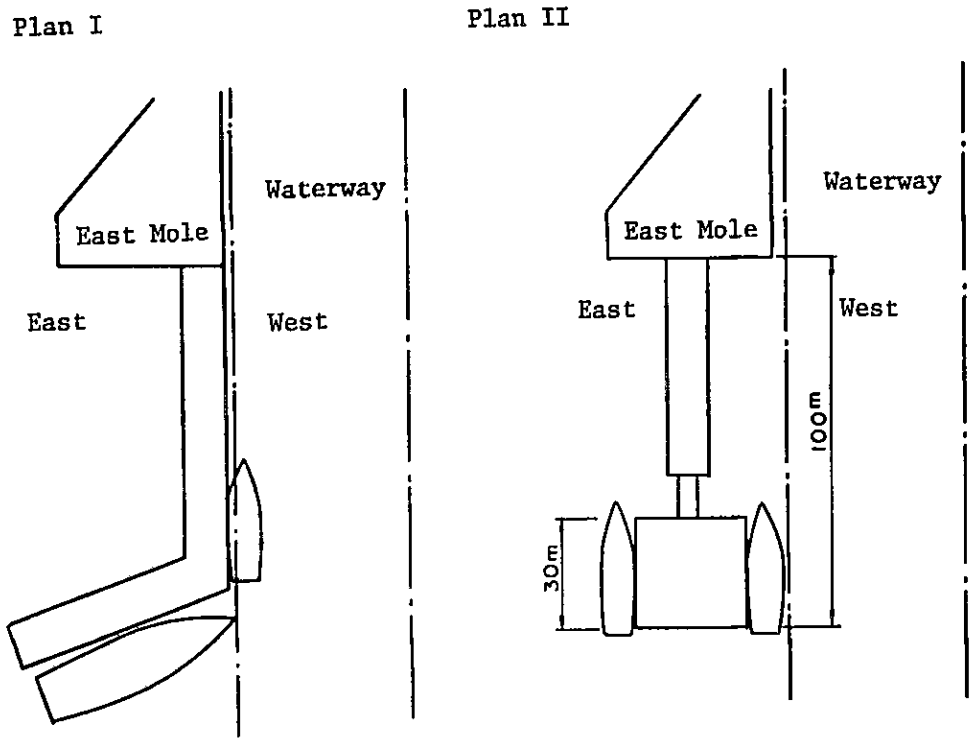
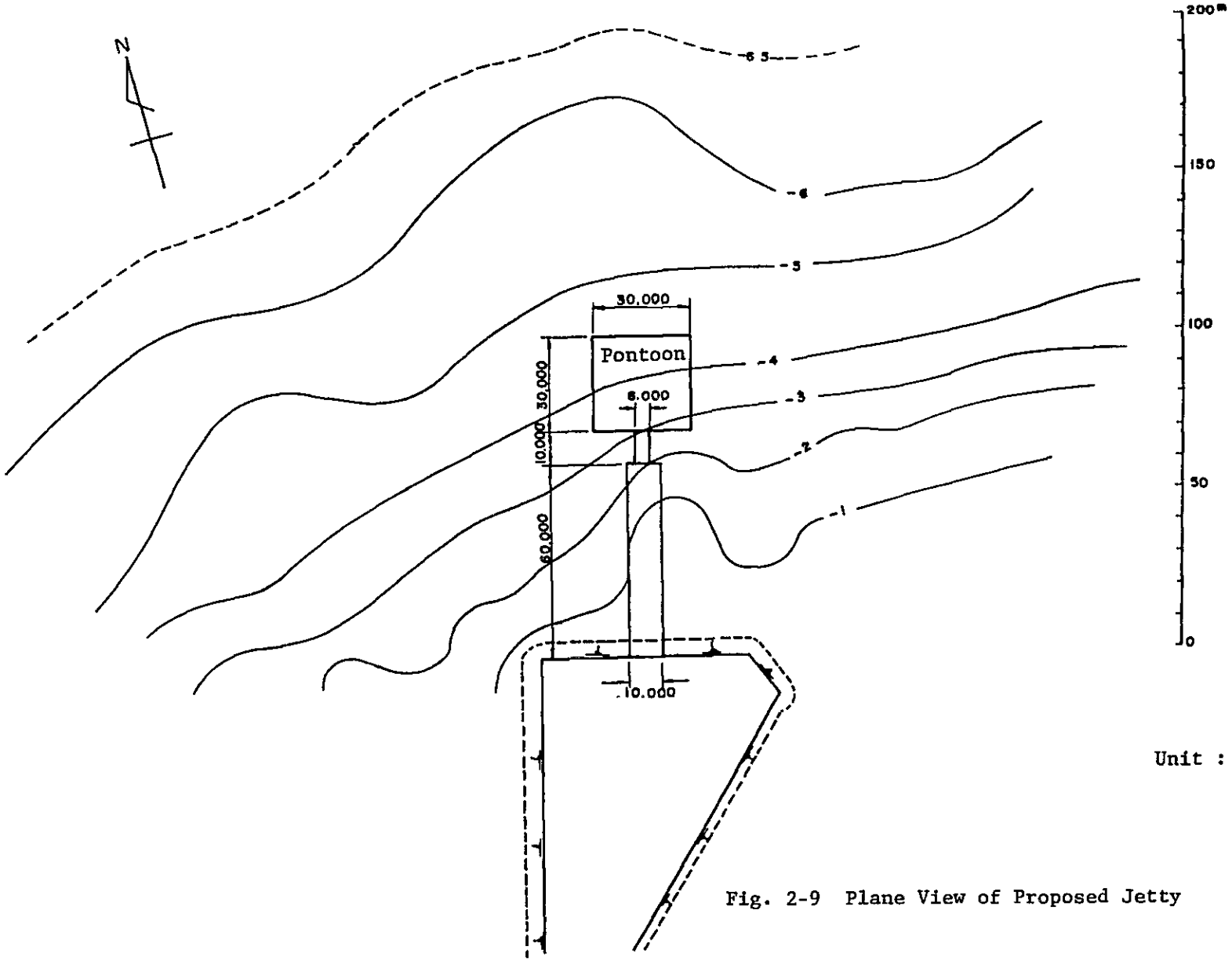


Fig. 2-8 Comparison of Jetty Plans

As shown, the Government of Kiribati planned to extend the jetty from the western end of the East Mole and curve the end where maximum class ships may be berthed. This plan is not preferable because ships must be moored within the navigation channel of Betio Port, although the water along the extension line from the western end of the mole is the deepest, and therefore, the wharf can readily be built (on the other hand, the water depth toward the sea is shallow).

Therefore, the Team planned to move the jetty toward the center of the East Mole and to prevent the ships moored on the west side from obstructing the navigation channel of Betio Port. (The Plan II in Fig. 2-8)



Unit : m

Fig. 2-9 Plane View of Proposed Jetty

2-5-4 : Construction Method of Jetty

In determining a construction method for the jetty, it is necessary to comprehensively compare and evaluate 1) locally procurable materials, 2) construction machineries, 3) topographical and geophisical conditions, 4) construction term and 5) budget, and then to select a feasible method for the construction.

The Kiribati Government indicated that the jack-up barge type system was most appropriate. However, the Team did not include this system in their review because of many unresolved technical difficulties involved.

Prerequisites for the selection are as follows:

1) Risk of unexploded ordnance
   Explosions may occur if piles are accidentally driven into unexploded ordnance. Physical detection and mine-sweeping operation are, therefore, needed but it is considered difficult to complete them within the planned construction term.
2) No boring data is available.
   The length of pile in pile driving is determined depending on soil conditions, and therefore it is extremely difficult to even give an estimate on construction cost. Due to the condition mentioned in 1), immediate boring survey is difficult.
3) Shortage of stones and coarse aggregates
   Tarawa Islands consist of coral reefs. There are no stone materials available except for old hardened coral reefs. Each of the islands is separated by waterways and northern islands are unaccessible by trucks. In the northern part such as Nuatabu and Nabeina, rubble stones from coral reefs are available but they must be transported over the sea.
   Coarse aggragates obtained by crushing coral stones are supplied at the rate of 4 m^3 /day at the maximum. The maximum supply of stone materials is 15 m^3/day and the problem would be how constantly the supply will be made.

4) Topographical conditions
There are reefs at the tip of the East Mole, and the section up to 60 m offshore is the coral rock area with the water depth as shallow as -0.5 to -2.0 m.

5) Shortage of heavy machineries
(the maximum size available is 15-ton crane)

6) Actual construction term is as short as 10 months or less.

7) Budget is limited.

8) Maintenance and administration costs are quite limited.

Upon such prerequisites, the following systems were reviewed and compared:

a) Pontoon type system

b) Gravity wall type system

c) Pier and bridge type system

d) Pile type system

e) Rock-fill + pontoon type

The plan and cross sections of respective types are shown in Figs. 2-10 to 2-14.

In order to point out the comparison in materials, plans are made assuming that the length is 100 m and the width at the tip portion of 30 m is 30 m. The quantity of materials broken down by types is indicated in Table 2-3.

Results of comparison are listed in the following table.

Type	Prerequisities which are crucial
a	4, 8
b	3, 6
c	3, 5, 6
d	1, 2, 5, 6, 7
e	

As is clear from the table, none of the above types is free from defects and therefore can not be selected alone.
More specifically,

1) In the pontoon system, the floating body touches the sea basin because the depth in the mounting portion is shallow.

2) In gravity wall type and pier and bridge systems, the stone materials will be short.

3) In the piling system, possible existance of unexploded ordnance and unavailability of boring data pose a problem.

Therefore, Type e, hybrid type of rockfill type and pontoon is selected.

The rock-fill type is selected as the construction system for the shallow section of 60 m where the water depth is less than -2.0 m and the pontoon type is selected for the offshore section of 30 m.

The grounds for such selections are:

1) The pontoon can be manufactured in Japan while the rock-fill is executed on the site; therefore, parallel operations are possible.

2) The stone materials and coarse aggragates are procured locally as much as possible and the shortage will be supplemented from Japan.

3) The shallow portion can be used as an access.

4) The pontoon is movable and therefore would not disturb the future Great Wharf Plan. The pontoon per se can be always used as a wharf for fishing boats.

The Kiribati Government said that if jack-up barge type was infeasible, the pile type system was preferred on the following grounds:

1) The unexploded ordnance does not cause serious problems. The explosives left from the War have already been disposed. If necessary, the Kiribati Government will investigate the matter.

2) A large amount of stones are required, but the supply is instable.

3) The sucked mounds will pose serious problems in the future.

4) The solid structure of 60 m will accelerate the shoaling of waterways.

5) The pontoon has a durability as short as 2 - 3 years.

6) The pontoon, especially chains and bridges require maintenance. The Government can not spend much money on them.

The Team offered technical supplemental explanations and presented a plan indicated in Fig.2-15 as the most preferable plan.

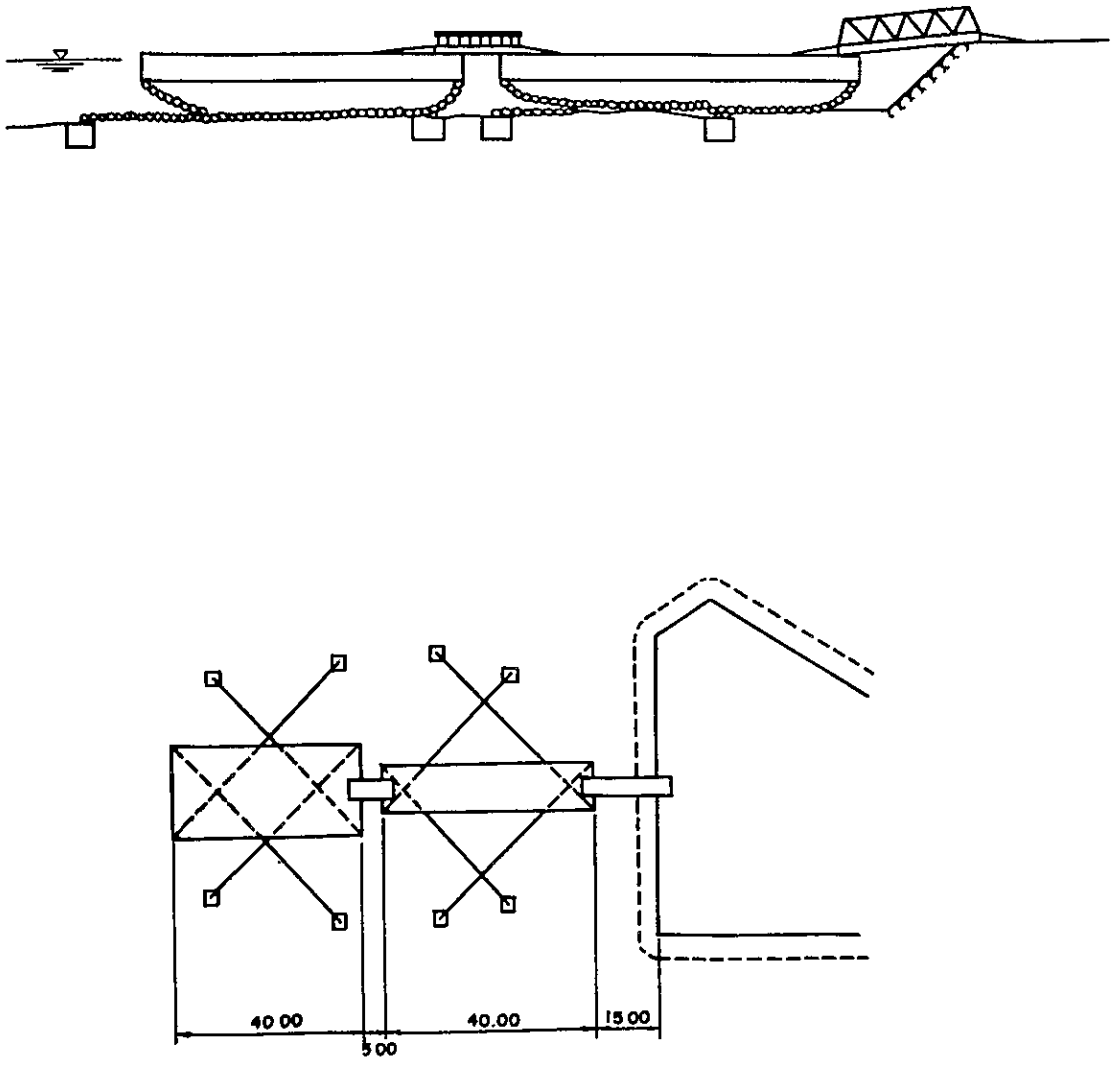
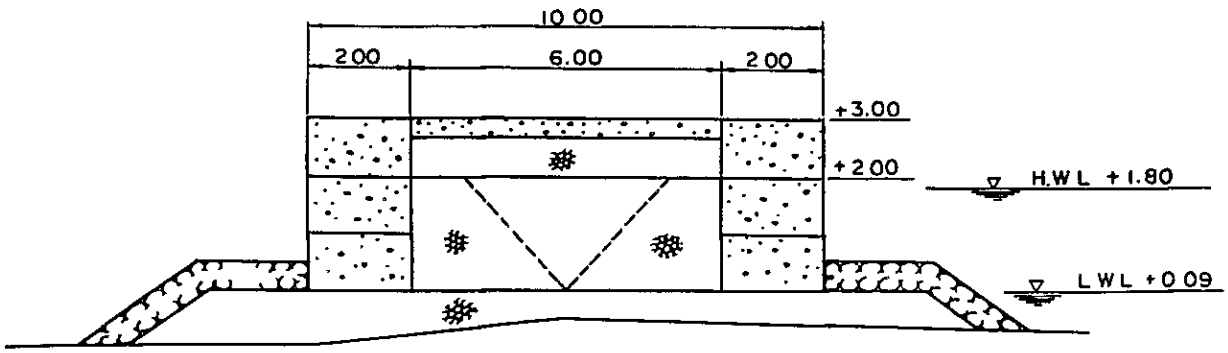


Fig. 2-10 Pontoon Type



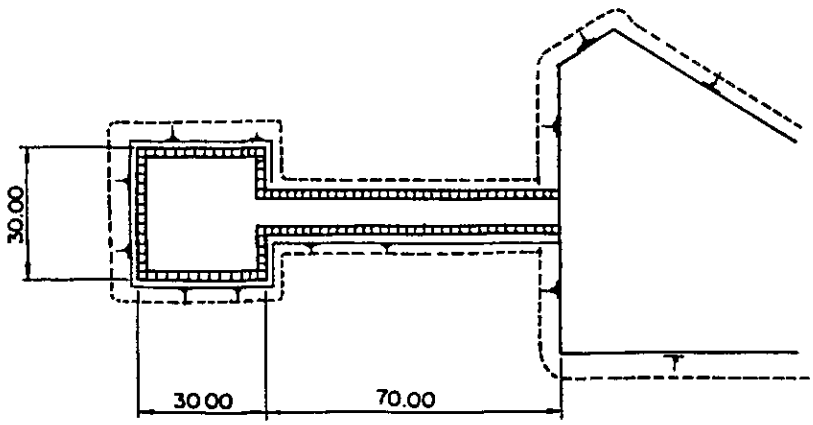


Fig. 2-11 Gravity Wall Type

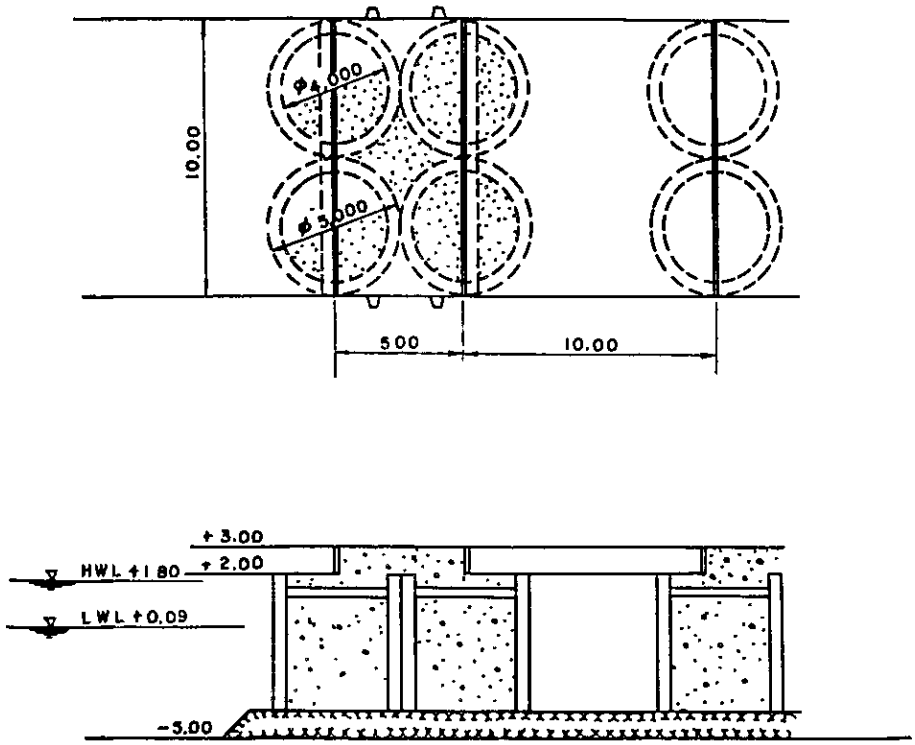
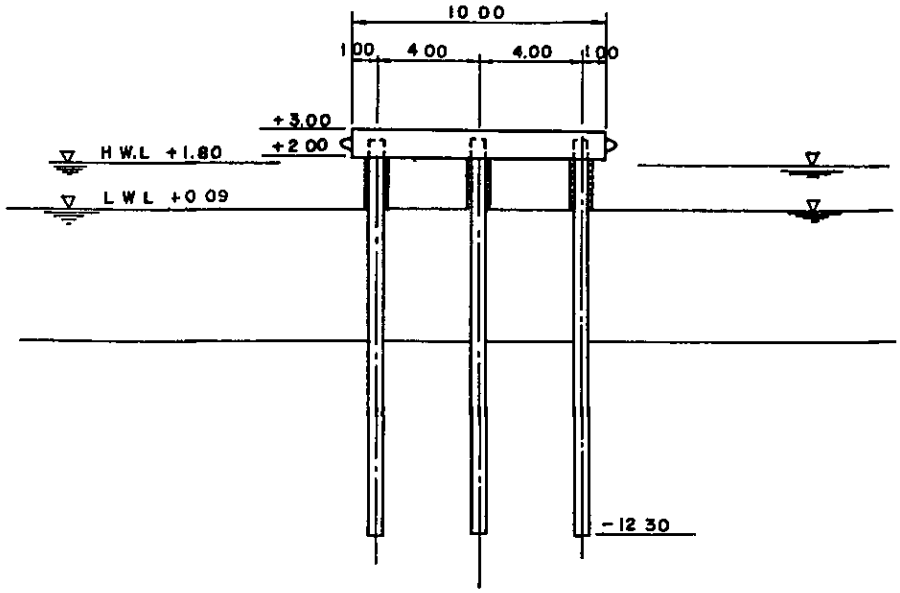


Fig. 2-12 Pier and Bridge Type



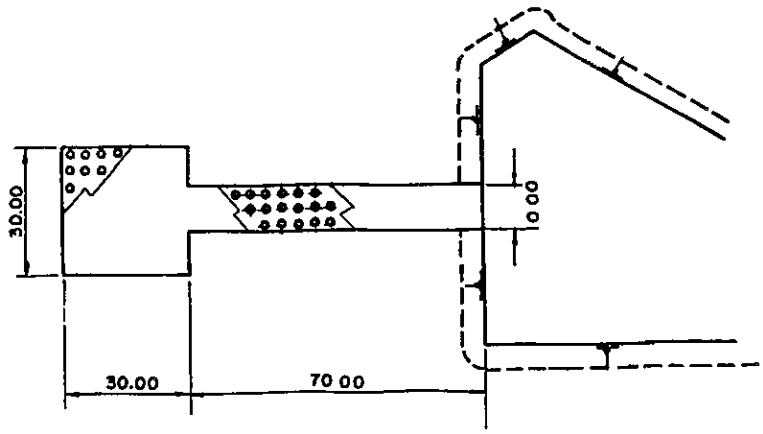


Fig. 2-13 Pile Type

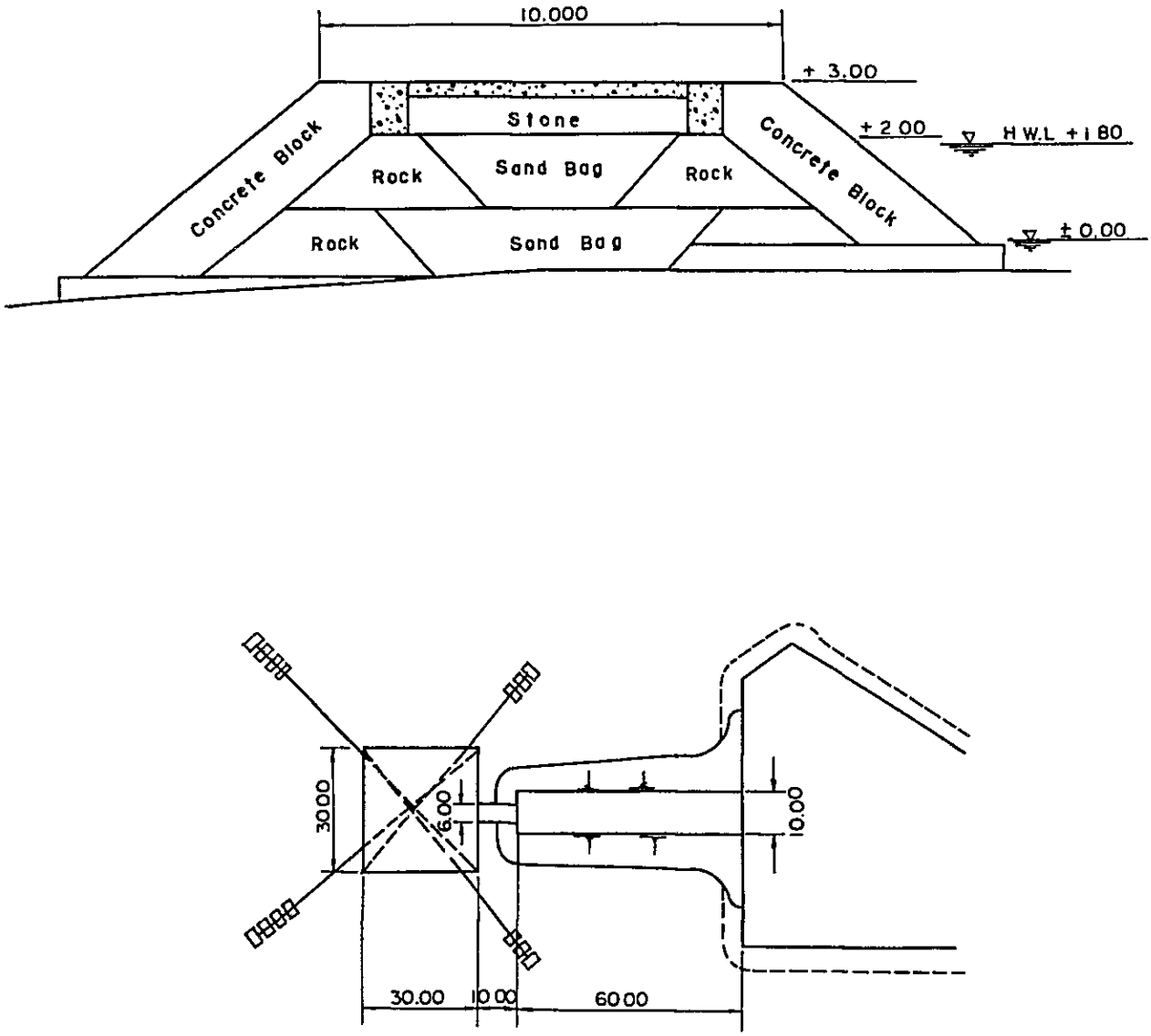


Fig. 2-14 Pontoon and Rock-fill Type

Table 2-3 Quantity of Materials Broken Down by Construction Methods

	Concrete (m^3)					Stone (m^3)									
	cellular concrete	rect. block	block	in-situ concrete	total	armor stone	rubble stone	gravel filling	backfill rubble	rubble mound	total	sand (m^3)	steel pile	pontoon	bridge
Pontoon type	-	-	-	-	-	-	-	-	-	-	-	-	-	40m x 10m 40m x 20m	5m 10m
Gravity wall	-	2,587	-	1,043	3,630	902	519	-	4,473	43, 17	10,210	1,946	-	-	-
Pier and bridge type	1,110	-	1,403	464	2,977	1,414	-	627	-	43, 17	6,358	1,044	-	-	-
Pile type	-	-	-	612	612	-	-	-	-	-	-	-	84	-	-
Rockfill + Pontoon type	-	-	655	265	920	-	1,772	-	-	-	1,772	822	-	30m x 30m	10m

2 - 6: Design of Basic Facilities

(1) Design conditions

Following conditions are considered for the jetty:

1) Tidal level

H.W.L. + 1.80 m

L.W.L. + 0.09 m

2) Wave

Wave height H = 1.6 m

Period T = 4.0 sec

3) Current

2 kt

4) Ships to be served

100 GT type fishing boats (skipjack fishing boats)

Tractive force: 10 t (1 block)

5) Surcharge

$q = 1.00\ t/m^2$

6) Foundation

Sandy

7) Seismic force

Horizontal seismic coefficient kh = 0

Vertical seismic coefficient kv = 0

(2) Jetty Design

1) Rock-fill cross section (60 m Portion)

Fig. 2-15 shows the standard cross section of the rock-fill portion. Surface layers on both sides are armor layers covered with concrete blocks.

The armor layer has the void ratio of 50% (if Tetrapods are used). Since 1 ton type blocks are used, it is sufficiently stable against the design wave height. It can attenuate the energy of waves as well as prevent reflected waves or waves transmitting along the jetty.

The planned jetty will form a corner with the tip of the East Mole and cause the waves to become converged. For this reason

armour blocks such as tetrapods to attenuate the wave enrgy are used.

Under the layers of the armour blocks will be the rubble-stone layer where greater sized rubble stones are used for the upper layer. Sands are used in the filling portion, but sand bags are used in the surface layer in order to prevent suction.

The crown width will be 10 m to secure the 6.0 m width in the center for vehicles.

2) Pontoon

Fig. 2-16 shows the cross sectional view of the pontoon. The pontoon is 3.0 m high and the draft is 1.5 m. The pontoon is made of P.C. concrete with the wall thickness of 20 cm and the intervals between keel center are 2.0 m. Fig. 2 - 17 shows the mooring arrangement of the pontoon.

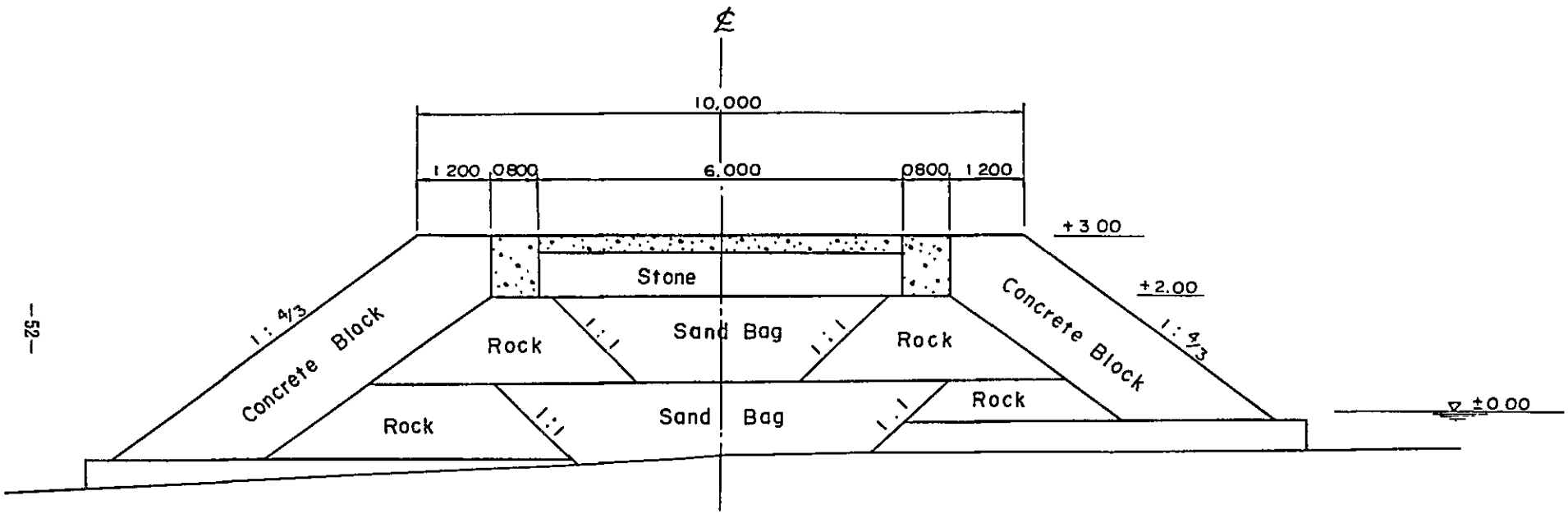


Fig. 2-15 Standard Cross-section of Rockfill Portion

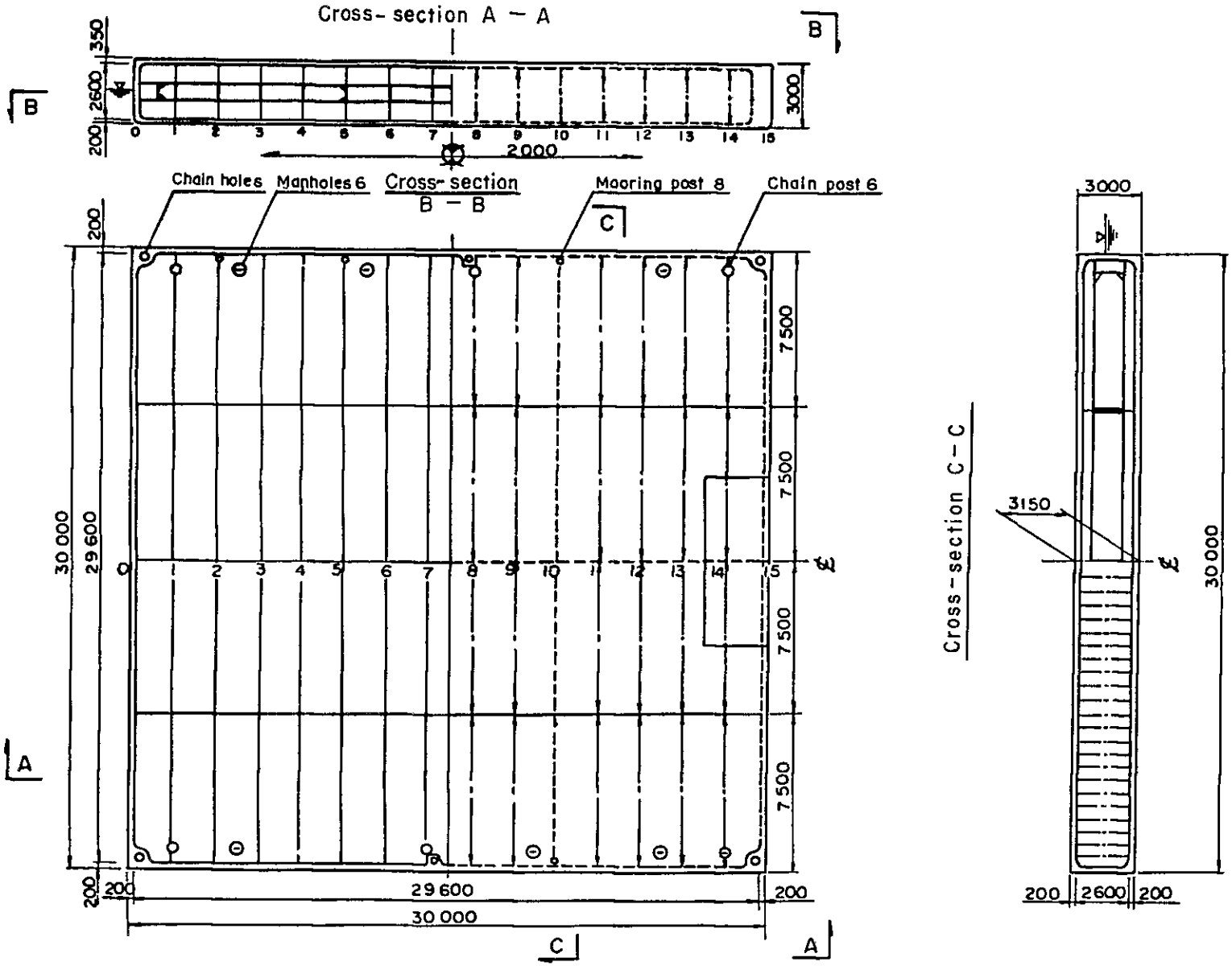


Fig. 2-16 General Structure of Pontoon

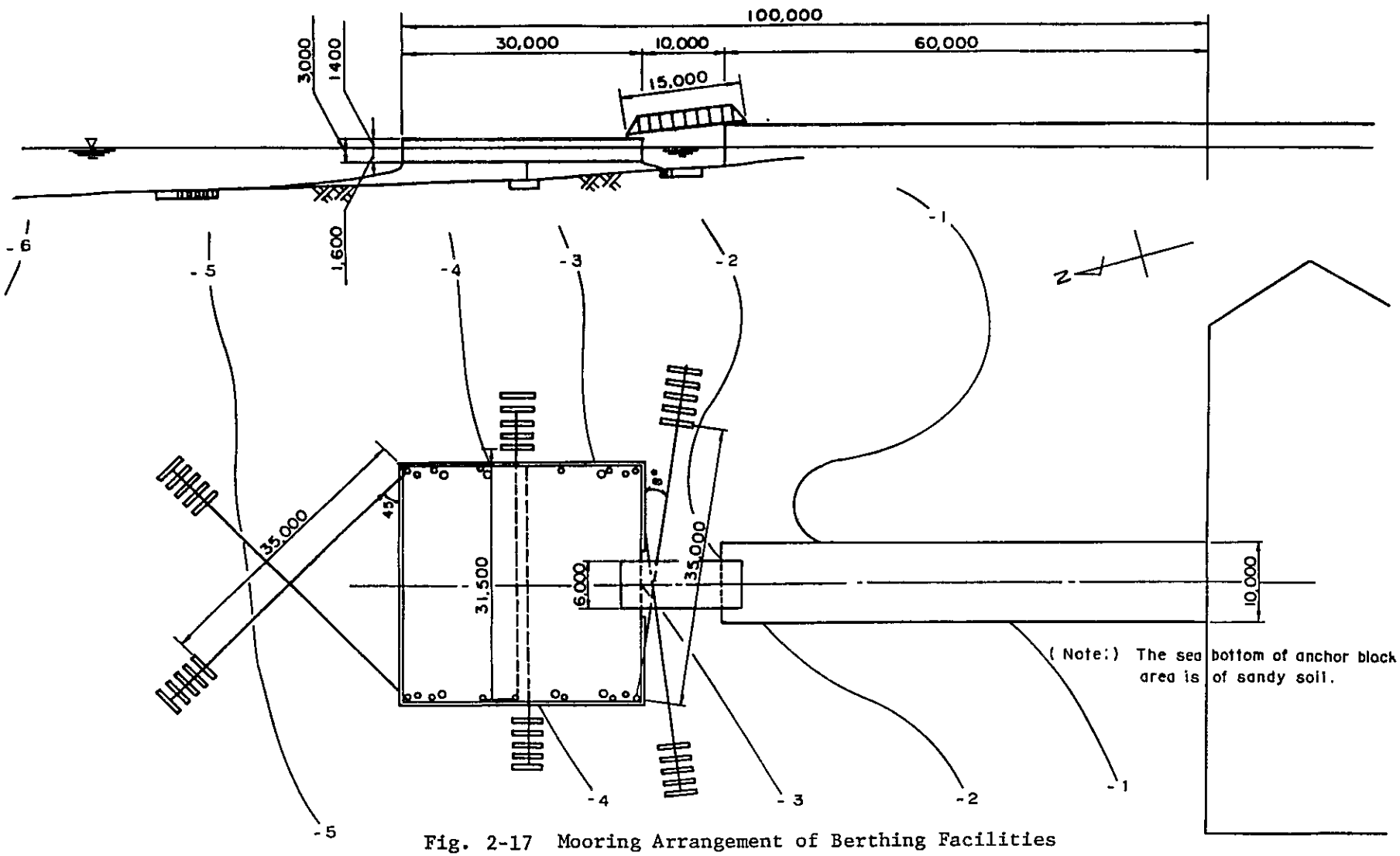


Fig. 2-17 Mooring Arrangement of Berthing Facilities

Chapter 3: Construction Plan

3-1: Scope of Construction Work

(1) Construction by the grant aid from the Government of Japan

1) Wharf (length 100 m)

2) Related facilities

Fenders

Mooring posts

Water pipeline

Fuel pipeline

(2) Responsibilities of the Republic of Kiribati

1) Secure the water area for implementation of the present Plan

2) Secure the land required for construction of the present plan

3) Construct service power line for the construction and management of the present plan

4) Speedy unloading, customs clearance and transportation to the construction site of goods imported under the grant aid.

5) Application procedures for approval and permission necessary for the construction

6) Exemption of the Kiribati internal taxes for the Japanese related to the construction work and for all of the machineries and/or devices which are brought in for the grant

3-2: Execution Plan.

3-2-1: Local Situations for Construction

The field-survey indicates that the following situations should be taken into consideration for constructing the jetty in Kiribati.

(1) Construction machinery on the sea

In Kiribati almost no construction on the sea has been conducted in the past. Ferries, however, are used for transportation between reefs while barges for the import/export at Betio Port. Tug-boats and 100 ton class pontoons are available for the construction on the sea during the time when ocean going ships are not in port. There will be no difficulties at all for transportation and unloading of the materials on the sea; however, it should be noted that various unexpected matters might take place in the construction on the sea.

Ships are leased by Shipping Corporation in Betio.

(2) Construction Mashinery on Land.

Machines to be used on land may be leased from Public Works Division.

As for the cranes, the maximum capacity available is 15 ton and two cranes of this type may be hired for the present work. There are a large number of trucks used in the private section and trucks required for stone material transportation etc. can be hired from the private companies.

P.W.D. possesses some bulldozers, concrete-mixers, etc..

(3) Materials

Coral sands are generally used and they can be procured in Betio. Stones, however, must be transported from northern islands; small sized barges must be provided for transportation by the sea route.

Crushed stones must be transported from the crushing stone plant near the air port, preferably by the sea route together with the stone materials.

Either sea water or the water from wells to be drilled will be used for mixing concrete.

(4) Labor

Since wages for unskilled labor is as inexpensive as 0.5 A$/hr., labor forces can be recruited in Betio. Skilled labor such as truck drivers is available and cranes, etc. are leased with drivers. However, skilled labor for other special works are unavailable.

(5) Laws and Ordinances related to Construction

The Kiribati Government does not have any regulations for design standards and construction specifications for civil engineering presently.

Therefore, no problems will be encountered if the design standards and construction specifications in Japan are observed.

3-2-2: Execution Plan

(1) Construction Method

Types of construction work to be used for the jetty construction are listed below:

Rock-fill portion

1) Rubble stone work (filling)

2) Armour stone work
3) Trimming of rubble mound
4) Armour block work (block manufacture/installation)
5) Land filling (including sandbags)
6) Cast-in-place concrete

Pontoon portion

1) Pontoon manufacture work
2) Pontoon transportation work
3) Anchor manufacturing work
4) Anchor installation (excavation work)
5) Pontoon installation

After conducting the survey on the local construction conditions, it was decided to employ the end-on system for the rock-fill portion. The pontoon portion will be carried out on the sea except for pontoon and anchor block manufacture.

(2) Construction Yard

A large yard is required for the stock of stones and for manufacturing concrete blocks. However, no land is available except for the space at the tip of the East Mole.

The space usable in the end of the East Mole is S ≒ 4,200 m^2, a portion of which is used as access on the eastern side of the East Mole.

The space of (S ≒ 500 m^2) can be used as the stock yard for the rubble stones since the water depth surrounding the Mole is shallow and the area will be dried out when the tide is low.

The yard at the tip is used mainly for block manufacture and as the access to the stock yard.

1) Space required for block manufacture yard (240 m^2)

Since coarse aggragates are supplied at the rate of 4 m^3/day, the concrete volume is mixed at the rate of 6 - 7 m^3/day.

Tetrapod of 1 ton size is 0.4 m^3/piece, the number of blocks manufactured per day will be 15 to 18.

Required yard space A = 2.5 m^2/piece

$$S = A \times 16 \text{ pieces} \times 3 \text{ fold} \times 2 \text{ (retained 2 days)} = 240\ m^2$$

2) Space for block stock yard (800 m^2)

Space per piece of 1 ton block, 1.66 m^2

S = 16 pieces/day x 1.66 x 30 days ≒ 800 m^2

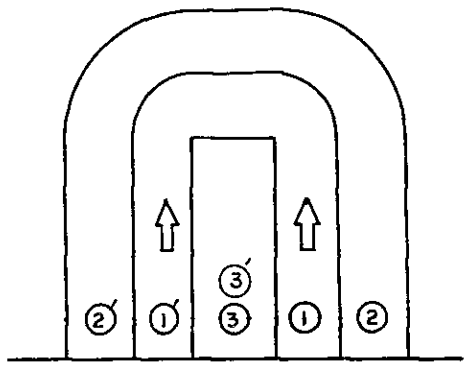
Therefore, it is possible to store one month supply. The number of blocks equivalent for one month stock can be installed in one operation.

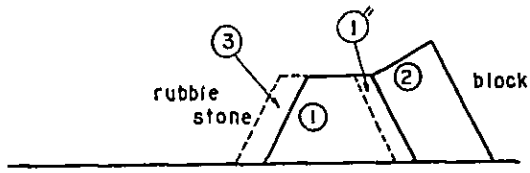
(3) Work Procedure

Rock-fill portion

The rock-fill portion for the access is constructed by the end-on system. Procedures are as follows:

① End-on laying of rubble stones
↓
①′ Armor stones
↓
①″ Rubble stone trimming
↓
② 1 ton block installation
↓
③ Sand bag
↓
③′ Sand fill
↓
④ Cast-in-place concrete work
↓
⑤ Pavement construction work

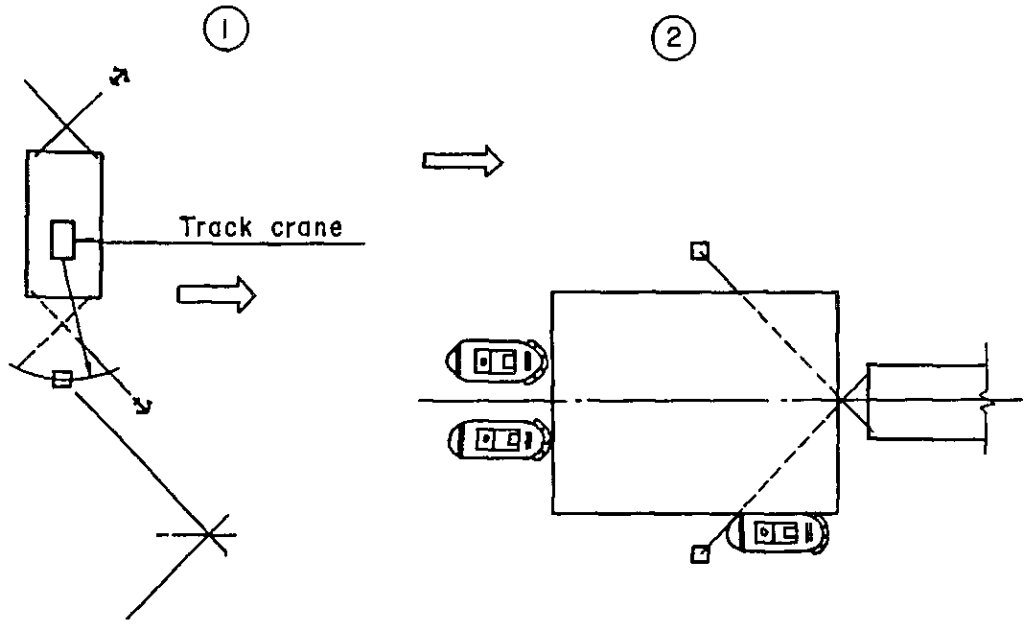




Pontoon installation

Pontoon is tugged inside the lagoon by the ocean tug boats. It is then separated from the tug boats at 4 to 5 km offshore from the East Mole.

1) A truck crane is placed on the pontoon to set the anchor.
2) The pontoon is tugged by the tug boats to the tip end of the East Mole and installed there.


①
②
Track crane

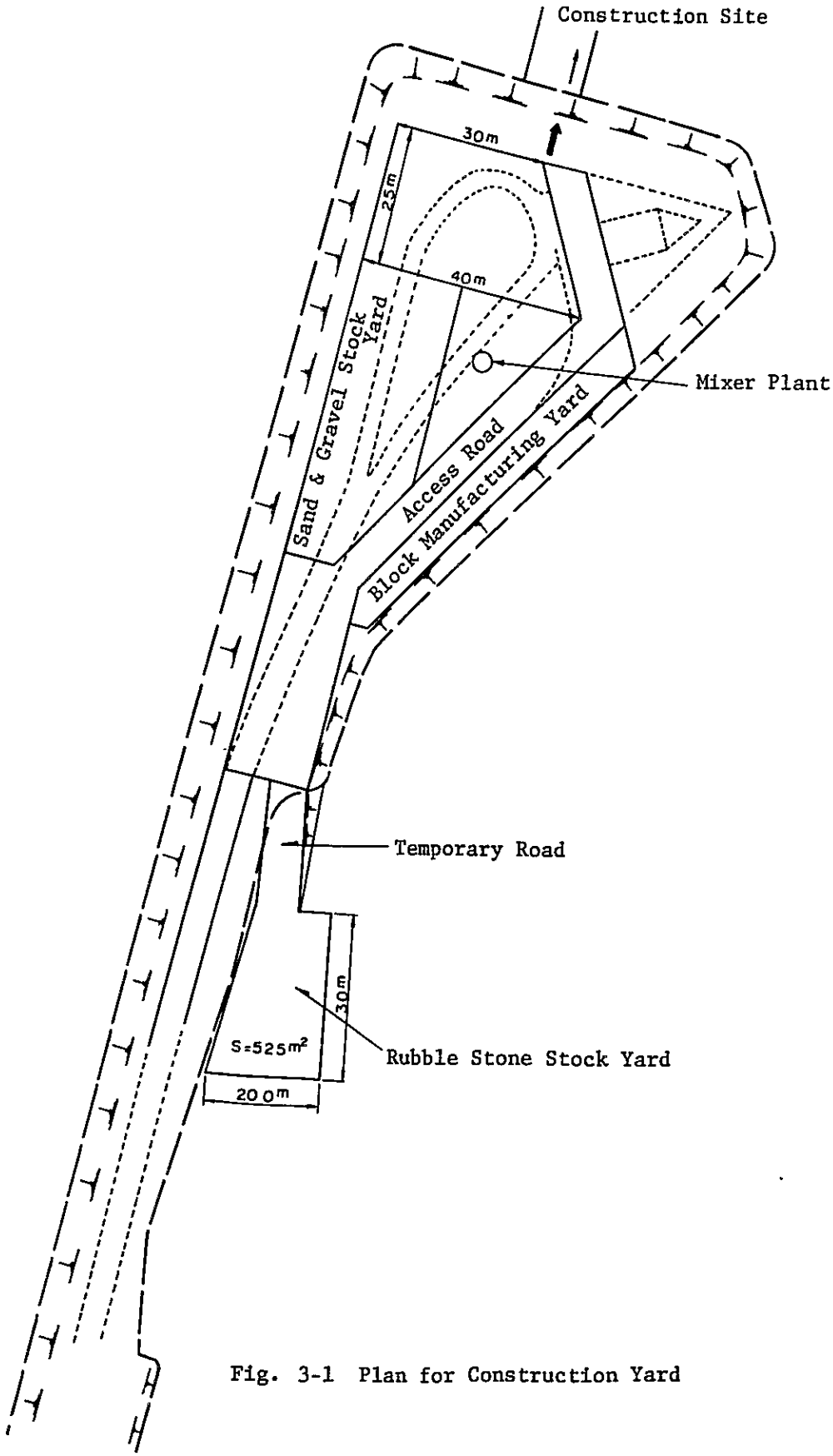
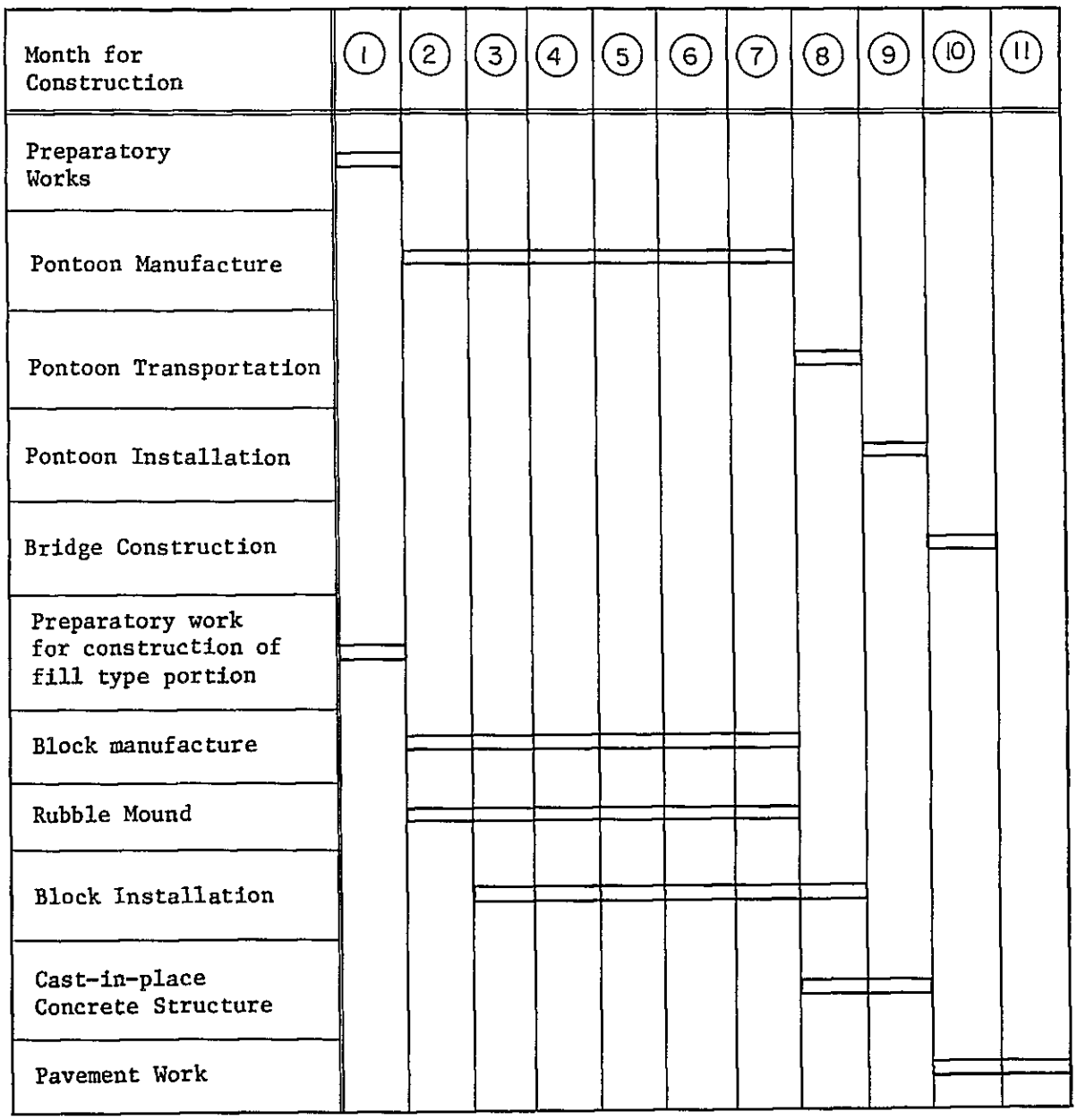


Fig. 3-1 Plan for Construction Yard

3-3 Construction Schedule

Construction schedule is as follows:



Chapter 4: Estimation and Evaluation of Effects of the Grant

4-1: Economic Analysis

In order to assess the investment effects, the Cost Benefit Analysis computing the cost benefit ratio and the internal rate of return was used, which is the generally employed technique in economic analysis of the development projects.

4-1-1: Calculation of Benefits

Items in the following table are generally cited as the investment effects for the fishing port construction. Following items are particularly conceivable as the benefits for the present Project.

a. Shortened time for the fish catch discharge and the boats to enter the port
b. Increased fish catch brought about by the improved operational efficiency of the fishing boats
c. Improved freshness preservation of the fish catch
d. Increased fish export

In this Project, the following additional items which are usually not counted as the benefits for the fishing port construction are envisaged because the completion of the Project will realize the only facility in Kiribati capable of serving the ships of a greater drafts.

e. Decrease of the lighterage for the export/import cargo and transportation between islands
f. Fortified export capacity brought about by the improved shore facilities, and stable supply of merchandise

Of the above mentioned benefits expected out of the improvemnent to the Betio Fisheries Jetty, the following items were selected as the quantitatively determinable benefits.

a. Increased fish catch brough about by the improved operational efficiency of the fishing boats
b. Increased fish export
c. Decreased lighterage for the export/import cargo and transportation between islands

Items for Assessment of Investment Effects in Coastal Fishing Port

Direct effects	Indirect effects
Production Increase of fish catch & discharge Increased days of fishing operation Diversified fishing operations (emergence of new techniques)	Improved regional economy Increased income for handlers, processors, dealers, etc. Increase in the local tax income Increase in employment opportunity Settling of inhabitants caused by the regular annual operations Development of related industries (Shipbuilding, repair, oil dealers, material dealers, processing plants etc.)
Distribution, Improved freshness preservation Higher or more stable prices of fish (price formation is improved by the increased volume of merchandise collected) Improved freshness preservation	Increased scope of supply Increased protein intake by the local population
Discharge Preparation for fishing expeditions Simplified discharge operations for fish caught Reduced manpower required for unloading/loading to and from fishing boats Shortened preparation time for fishing expeditions (oil supply, water supply, loading of food, water, materials, etc.)	Healthier fishing management Increased incentive for production Lower costs for collecting marine products Increased income brought about by shipment from own cooperation
Safety of fishing boats Shortened berthing time Saving of materials used such as rope, etc. Decreased damage to boats Extended durable years for boats	Improved production brought about by labor saved Extended fishing ground Utilization of hetherto untapped resources
	Increased income for fishermen Wages earned through employments in other industries during surplus time Increased side income from parallel jobs

Direct effects	Indirect effects
Improved safety to the life to fishermen	Improved and modernfishing boat equipments
No further need to take refuge in other ports Saving in costs for bringing the ships (personnel, foodstuff, fuel) Improved fishing labor system.	Improved living environment Education in hygiene, transportation, communication, security, and disaster prevention Saving in medical costs brought by less number of accidents and injuries Improved health due to the increased hours of recuperation
Construction of land for fishing port Establishing public facilities on the land built along the sea (union cooperative office, fish sorting depot, processing plant, oil & water supply crew's dormitory, roads, parking lots, meeting place for fishermen training center, etc.)	Betterment of environment Improved environment by more efficient use of land, and by the increased land, concentration of population, centralization of economy accelerated transportation of goods imported/exported, and obtaining better quality merchandise
	Improved dietary life, imrovement in education, Decrease in migrating laborers

(1) Increased volume of fish catch and export brought about by the improved operational efficiency of fishing boats

The benefits from the increased fish catch brought about by the improved operational efficiency was obtained from the following formula

$$B_1 = \sum_{t=1}^{25} H\ P\ V_0\ (N_1 - N_0)$$

wherein

V_0 = number of fishing boats at the time of starting of the fish port construction, subject boats..... 2

H = daily average fish catch

P = average fish price

N_1 = annual average fishing days after completion of fish port

N_0 = annual average fishing days before construction of fish port

t = number of years after completion of fish port

The number of operating days of the Nei Manganibuka for the period from February through November, 1979 was 111 days. The FAO/UNDP record for 1980 was lost in the arson in a labor dispute and thus unavailable to the Survey Team. The report for "Basic Design Survey for Fisheries Development Program in the Republic of Kiribati" conducted last year sets the days planned for ocean operation for the training ship for skipjack fishing to be offered under the grant as 208 days. The report assumed the daily average fish catch of 2 tons, 90% of which to be exported and 10% to be offered for sale locally, the export sales price at FOB $500/ton, and the domestic sales price at $0.63/kg. From the above assumptions, the benefits accompanying the increase in the fish catch and the export are assumed to be as per shown in Table 4-1.

Table 4-1: Maximum Benefit Obtained from Increase in Fish Catch & Export Brought About by Improved Operational Efficiency of Fishing Boats

Unit: A$

	Fish catch/export increase	Fish catch/local sale increase
1981	174,600	24,444
1982	174,600	24,444
1983	174,600	24,444
1984	174,600	24,444
1985	174,600	24,444

(2) Decrease in lighterage for trade and for transportation between islands

Table 4-2 shows the actual records of cargo handled in 1979 at Betio Port.

Table 4-2: Record of Cargo Handled at Betio (unit: ton)

Imported cargo (fuel)	26,840.0 (6,747.1)
Export cargo	475.0
Export copra	5,741.4
Copra shipped from islands	5,310.1
Cargo shipped from islands	1,451.0
Cargo shipped to islands	6,884.4

Although the data on the volume of cargo for import/export handled by ships is unavailable, it is assumed that the majority was handled by the Pacific Princess and the Fiji Maru of Daiwa Line which regularly call at Betio. Both ships cannot berth along the jetty at the planned depth. It was therefore assumed that 20% of the import/export cargo excluding fuels would be handled by the boats which can berth along the planned jetty. Thus, the lighterage for 4,200 tons at the rate of A$2.60/ton will be reduced by A$10,920 per year.

4-1-2 Calculation of Costs

(1) Jetty Construction Cost

Jetty construction cost includes the construction cost, reserve fund, designing and supervising costs.

(2) Maintenance/Administration Costs

Sum of A$4,000 is estimated annually as the necessary cost for maintenance and administration of jetty facilities such as coating of jetty.

(3) Facility Depreciation Cost

Of the jetty facilities, the approach and floating body, excluding road pavement, shall not be replaced during the period of review (25 years). The durable years of road pavement were set to be 20 years.

4-1-3: Economic Analysis

Costs and benefits calculated based on the market prices are converted to the border prices. The standard conversion factor was obtained from the following formula;

$$SCF = \frac{I_m + E_x}{(I_m + T_i) + (E_x - T_x)}$$

wherein

SCF = standard conversion factor

I_m = total import value (CIF price)

E_x = total export value (FOB price)

T_i = total import duties

T_x = total export duties

From the 1979 Trade Statistics data,

$$SCF_{79} = 0.92$$

As for the evaluation of the labor force, the domestic market prices were considered to represent the opportunity cost for the skilled labor, and the shadow wage ratio was

$SWR_s = SCR = 0.92$

The marginal production for the agricultural labor was considered to represent the opportunity cost for the unskilled labor, and shadow wage ratio for the unskilled labor was obtained from the following formula

$$SWR_u = \frac{D}{S} \times W \times \frac{SCF}{W} = \frac{D}{S} \times SCF$$

wherein
- SWR_u = shadow wage ratio for unskilled labor
- D = number of agricultural labor
- S = total labor supply
- W = mean wages

Based on the figures from the National Development Plan 1979 - 1982, the following is obtained;

$$SWR_u = 0.533 \times SCF_{79} = 0.49$$

Table 4-3 shows the results of the Cost Benefit Analysis based on the border prices calculated from the above conversion rate. The Cost Benefit Ratio at the discount rate of 8% is 23.3%, the Net Present Value A$4,516,000, and IRR 11.14%. This indicates that the cost and benefit reach the break-even point at the discount ratio of 11.14%, and the Project is benefitial national economy-wise.

Table 4-3 Economic Analysis (Border Price Australian dollar = ¥260) (in A$: 1,000)

	Construction Investment	Maintenance Cost	Facility Renewal Cost	Total Cost	Increase in Trade	Increase in Domestic Sale	Decreased Lighterage	Total Benefit	Net Benefit	Cost at 8% Discount	Benefit at 8% Discount	Net Benefit at 8% Discount	Net Benefit at 11% Discount	Net Benefit at 12% Discount
1981	1,884.5	3.7	—	1,888.2	174.6	22.5	10.0	207.1	△1,681.1	1,888.2	207.1	△1,681.1	△1,681.1	△1,681.1
2	—	3.7	—	3.7	174.6	22.5	10.0	207.1	203.4	3.4	191.8	188.4	183.2	181.6
3	—	3.7	—	3.7	174.6	22.5	10.0	207.1	203.4	3.2	177.6	174.4	165.1	162.2
4	—	3.7	—	3.7	174.6	22.5	10.0	207.1	203.4	2.9	164.4	161.5	148.7	144.8
5	—	3.7	—	3.7	174.6	22.5	10.0	207.1	203.4	2.7	152.3	149.6	134.0	129.2
6	—	3.7	—	3.7	174.6	22.5	10.0	207.1	203.4	2.5	141.0	138.5	120.7	115.4
7	—	3.7	—	3.7	174.6	22.5	10.0	207.1	203.4	2.3	130.5	128.2	108.8	103.0
8	—	3.7	—	3.7	174.6	22.5	10.0	207.1	203.4	2.2	120.8	118.6	98.0	92.0
9	—	3.7	—	3.7	174.6	22.5	10.0	207.1	203.4	2.0	111.9	109.9	88.3	82.1
1990	—	3.7	—	3.7	174.6	22.5	10.0	207.1	203.4	1.9	103.6	101.7	79.5	73.4
1	—	3.7	—	3.7	174.6	22.5	10.0	207.1	203.4	1.7	95.9	94.2	71.6	65.5
2	—	3.7	—	3.7	174.6	22.5	10.0	207.1	203.4	1.6	88.8	87.2	64.5	58.5
3	—	3.7	—	3.7	174.6	22.5	10.0	207.1	203.4	1.5	82.2	80.7	58.1	52.2
4	—	3.7	—	3.7	174.6	22.5	10.0	207.1	203.4	1.4	76.1	74.7	52.4	46.6
5	—	3.7	—	3.7	174.6	22.5	10.0	207.1	203.4	1.3	70.5	69.2	47.2	41.6
6	—	3.7	—	3.7	174.6	22.5	10.0	207.1	203.4	1.2	65.3	64.1	42.5	37.2
7	—	3.7	—	3.7	174.6	22.5	10.0	207.1	203.4	1.1	60.4	59.3	38.3	33.2
8	—	3.7	—	3.7	174.6	22.5	10.0	207.1	203.4	1.0	56.0	55.0	34.5	29.6
9	—	3.7	—	3.7	174.6	22.5	10.0	207.1	203.4	0.9	51.8	50.9	31.1	26.4
2000	—	3.7	37.6	41.3	174.6	22.5	10.0	207.1	165.8	9.6	48.0	38.4	28.0	30.8
1	—	3.7	—	3.7	174.6	22.5	10.0	207.1	203.4	0.8	44.4	43.6	22.8	21.1
2	—	3.7	—	3.7	174.6	22.5	10.0	207.1	203.4	0.7	41.1	40.4	22.7	18.8
3	—	3.7	—	3.7	174.6	22.5	10.0	207.1	203.4	0.7	38.1	37.4	20.5	16.8
4	—	3.7	—	3.7	174.6	22.5	10.0	207.1	203.4	0.6	35.3	34.7	18.4	15.0
5	—	3.7	—	3.7	174.6	22.5	10.0	207.1	203.4	0.6	32.7	32.1	16.6	13.4
合計	1,884.5	92.5	37.6	2,014.6	4,365.0	562.5	250.0	5,177.5	3,162.4	1,936.0	2,387.6	451.6	14.4	90.7

B/C Ratio When 8% $B_0/C_0 = 2,387.6/1,936.0 = 1.233$ IRR $= 11 + \frac{14.4}{14.4+90.7} = 11.14\%$

4-2: Assessment

The project is reviewed usually from two different points of views in analysising the project. One is to review what economical values the implementation of the project would bring to the overall economy of the nation. The other is to review if the operation of the facility to be built under the project would be profitable or not. The former is the economic analysis and the latter is the financial analysis.

In the preceding section, we analysed the national economy and found that construction of a fisheries jetty in Betio would bring an extensive economical effect and the project is sufficiently worthy of investment. It would be proper, therefore, to conduct the financial analysis of the fishing jetty here in order to review the profitability of the operation, and evaluation the project along with the results of the analysis, however, the financial analysis will not be carried out in this report.

The primary reason for not doing so is because the fishing jetty will be under the management of the state fishing corporation "Te Mautari Ltd.". "Te Mautari" owns and controls the fishing boats which will be primarily served by the jetty and there will be no passing of the fees for the use of jetty. Thus, it would be necessary to review first the management plan for "Te Mautari" in order to perform the financial analysis.

The second reason is that the fee for using the jetty for purposes other than for fishing must be determined with overall considerations. The object of the present grant is the in the field of the fishery. However, it can be understood that this fish port would function in the fields other than fishery as the port of entry of daily necessities just as in the case of such fish ports in isolated islands in Japan. However, the fee for use of jetty in such a circumstance would be determined with overall consideration, and the matters concerning the management become to take a secondary significance.

The third reason concerns the management plan for "Te Mautari". The Survey Team's responsibility lies in the basic design for the

plan for the fisheries jetty, and the Team is not in a position to conduct evaluation of the Fisheries Development Program of the Republic of Kiribati per se, nor the Team has been informed of any detailed management plan for "Te Mautari". However, if we were to refer only to the portion of the project related to the present fishing jetty project, the Fisheries Development Program based on the prerequisite of a freezer/carrier or mother ship requiring the depth of -7.7 m is not a realistic one considering the present status of Kiribati fishery, and it is hoped that the Fisheries Development Program reviewed once again.

Chapter 5: Review on the Basic Facilities Based on the Proposals Submitted by the Kiribati Government

5-1: Past Development

While the Survey Team was visiting Tarawa, the chief engineer of the Kiribati Government was absent from his office and the Team could not obtain decisive answers for the proposal made by the Team. Both sides consequently failed to reach an agreement on the minutes.

In designing the basic facilities, the Survey Team considered 1) the risk of unexploded ordnance, 2) unavailability of boring data, and 3) difficulty of boring to be readily conducted in the near future under the condition mentioned in 1). The Team proposed that the jetty should be of the hybrid type of rock-fill and pontoon.

The Kiribati Government, however, did not alter its initial plan to build it with the pile system without giving expressive response on the points raised in the proposal by the Survey Team.

After the Survey Team returned to Japan, an unofficial communication was received from the Kiribati Government indicating that the chief engineer hoped to come to Japan for consultation with the Survey Team. The Survey Team accepted such a proposal.

On December 12, Mr. I. G. Grainger, the chief engineer, arrived in Japan and on December 15 had a conference with the Survey Team at a JICA Conference Room. (The visit of Mr. Grainger was reported to the Ministry of Foreign Affairs through the Embassy of Japan in Fiji.)

5-2: Proposal from the Kiribati Government

The proposal shown below came from the Kiribati government.

MEMORANDUM FROM CHIEF ENGINEER KIRIBATI GOVERNMENT

15 December 1980

1. Possible risk of unexploded ordnance at site of proposed jetty. A visual underwater survey of the area will be carried out by 31 December 1980. Provided suitable underwater metal detector is obtained the area will be searched by metal detector at the same time. It is not known if such equipment is readily available or what range such equipment has. This will be investigated. Any unexpected ordnance so located will be disposed of by 31 January 1981.

2. Geophysical Survey

   This will be carried out by the survey team expected on Kiribati during January 1981. This team is being provided by the Asian Development Bank for another purpose but arrangements to employ the team of the Fisheries Jetty survey have already been discussed with the A.D.B.'s consultants. Failing the arrival of the A.D.B. survey team it may be possible to obtain borehole rock samples and a geologists report from the Australian water investigation team already working on Tarawa atoll.

   As a last resort an American firm Geomarex is working in the Line Phenix Islands of the Kiribati group and they would be employed to carry out the survey. Their equipment is very portable and their expertise is in mineral exploration but it is believed they could carry out the work required.

I. G. Grainger
Chief Engineer
Kiribati Government

In summation, they proposed:

1) The detection of unexploded ordnances was to be finished by January 31, 1981.
2) The geophysical survey was to be conducted in January, 1981 and the report on the basis of the data analysis was to be submitted by the end of March.

The Kiribati Government side requested the Survey Team to reconsider the jetty construction plan for the piling system on the basis of their proposal.

The following points were raised:

1) Since the Kiribati Government side had understood that the pontoon had a sufficient durability, it agreed with the proposal of the Team.
2) The supply capacity of rubble stones and coarse aggragates depended on the methods of transportation. If tug boats and barges were used as planned by the Team, a sufficient supply would be possible. Stones, however, are precious resource in the Republic of Kiribati since they are in a great demand for repair of runways at the air port, construction of causeway and for the new air port.
3) At present, it is unavoidable that the design is for the 100 ton class Skipjack fishing boats.

Afterward, as the Government of Kiribati officially communicated to the Ministry of Foreign Affairs through the Embassy of Japan in Fiji, to the effect that the proposed matters should be executed, the Survey Team decided to reconsider the feasibility of the piling system construction in place of the rock-fill portion by using locally available machineries, on the premise that the proposed matters will be executed.

5-3: Review of Piling System

Construction methods at the stage of the basic design were compared and the following points were raised as problematic aspects of the piling system.

1. There is a risk of unexploded ordance.
2. There are no available geophysical data.
5. Heavy machineries are in shortage. (The maximum size available is 15 ton crane.)
6. The construction term is short. (in substance 10 months)
7. The budget is limited.

The Kiribati Government proposed on December 15 that it would finish the survey of 1, 2 by the end of March, 1981, and some difficulties are considered to have been resolved.

As to other matters, the consideration was initially on the following conditions:

1) Since the local natural conditions are severe, piles should be made of concrete to avoid corrosion.
2) The head of piles should be treated with reinforced concrete.
3) In order to secure the minimum grant aid effect, the length should be 100 m.
4) Since piling cannot be performed by locally available machineries (1.3 ton hammer), pile driving barges must be tugged from Japan.
5) Coarse aggragates for cast-in-place concrete are insufficient in strength because they are coral. Therefore, coarse aggragates must be transported from Japan.

As a result, the following problems remain:

a) Since pile head treatment is time consuming, the prescribed construction term might not be met if the whole length of 100 m was constructed by the end-on system from the land.
b) Since concrete piles are heavy in weight (6 - 7 ton/pile), large-sized driving machines are required, increasing the initial costs.

After the conference with the chief engineer on December 15 where the matter of piling system was discussed, it was agreed that the following method would be adopted.

1) Provided that suitable anti-corrosion treatment is used, steel piles may be used.
2) The length shall be 60 m, and the offshore section of 30 m may be of pontoon type.
3) Two units of 15 ton cranes are available.
4) The pile head can be treated with steel material.
5) Diesel hammers and augers must be brought in from Japan.

Accordingly, it was decided that the 30 m tip portion was to be made of pontoon and the length of 60 m from access portion was to be re-investigated to see whether piling was possible or not by using the locally available machineries.

However, since boring data is indispensable for reviewing the piling system, it should be noted that this conclusion is based merely on assumed conditions.

(1) Design of Piles

The 60 m portion is of coral rocks and N value is unknown. The design is made on the assumption that N value is more than 50. Figure 5 - 1 shows the standard cross section and the plan view of the piled wharf. The diameter of steel piles is 400m/m and the legnth is 12.00 m.

Although pile driving may be stopped at the point where a sufficient support is secured, it is assumed that -10.0 m of depth is needed for driving piles in this design.

Piles heads are processed by welding ribs made of plates on them, and secured to piles with box girders. I beam is then placed upon them to be welded thereto and gratings are welded further on them. The super structure of the piled jetty comprises gratings.

Concrete is not used for the super structure but used as fillings of piles.

Details of the pile heads are shown in Fig. 5 - 2.

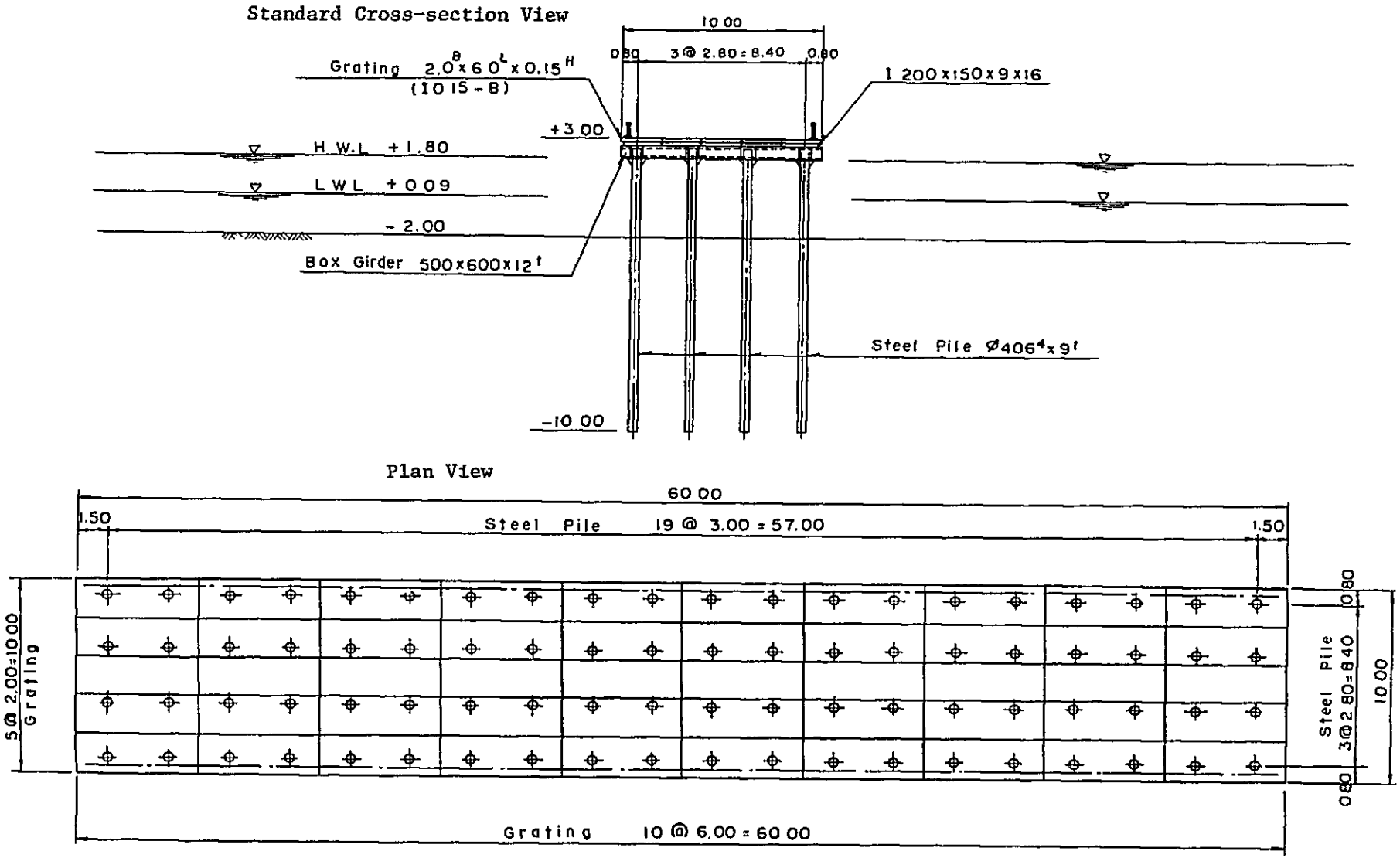


Fig. 5-1 Structure of Piled Jetty

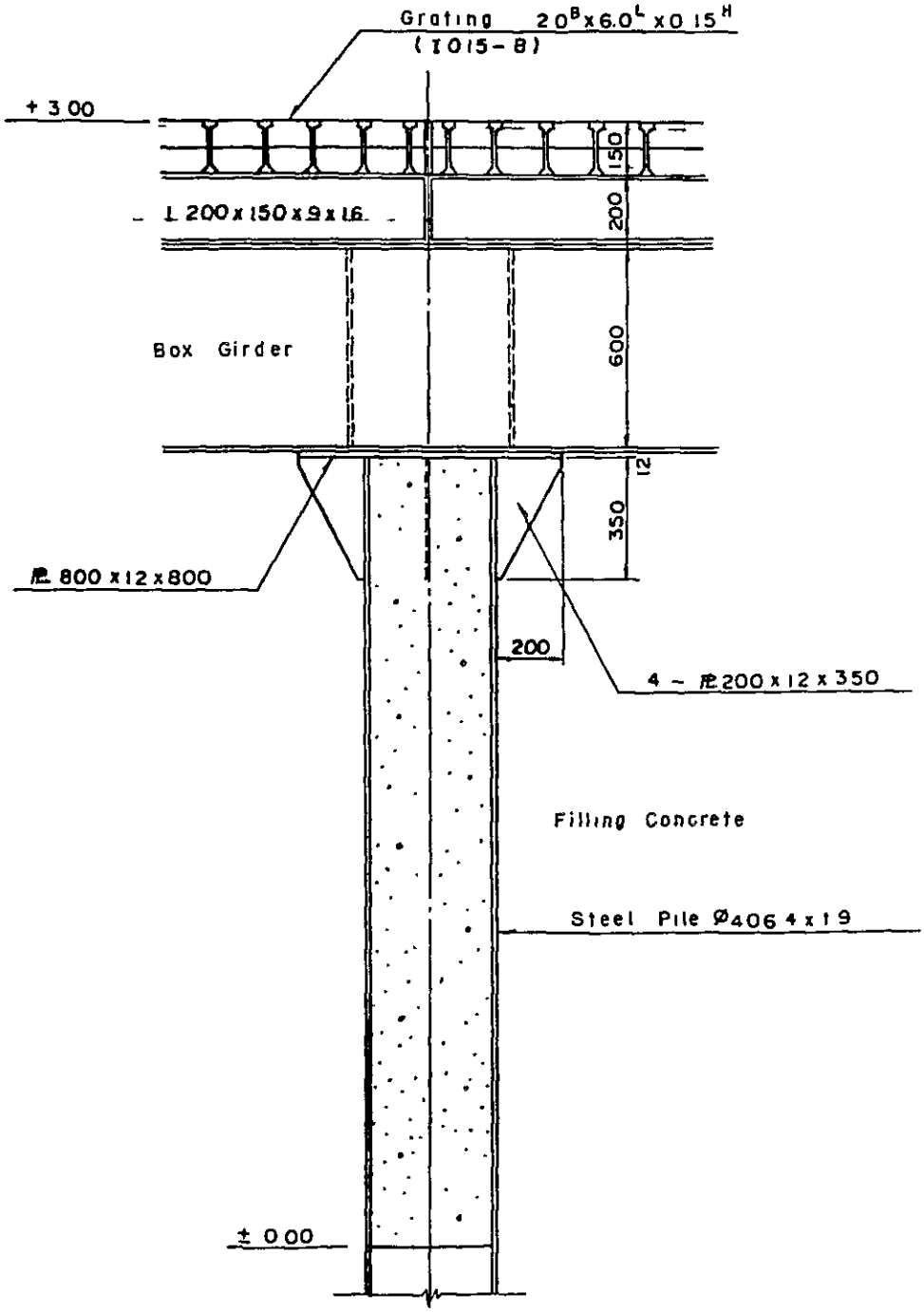


Fig. 5-2 Details of Pile Head

5-4: Execution Plan of Piled Jetty

Piled jetty is constructed in the following manner:

(1) Prepare driving piles (crane, assembling of a pile driver)

↓

(2) Pitch steel piles and start driving

↓

(3) Drive in steel piles (after the completion of span, process pile heads and mount box girders)

↓

(4) Move crane

↓

(5) Pitch and drive steel piles

↓

(6) Process pile heads and mount box girders

↓

(7) Place I beam girders and gratings

↓

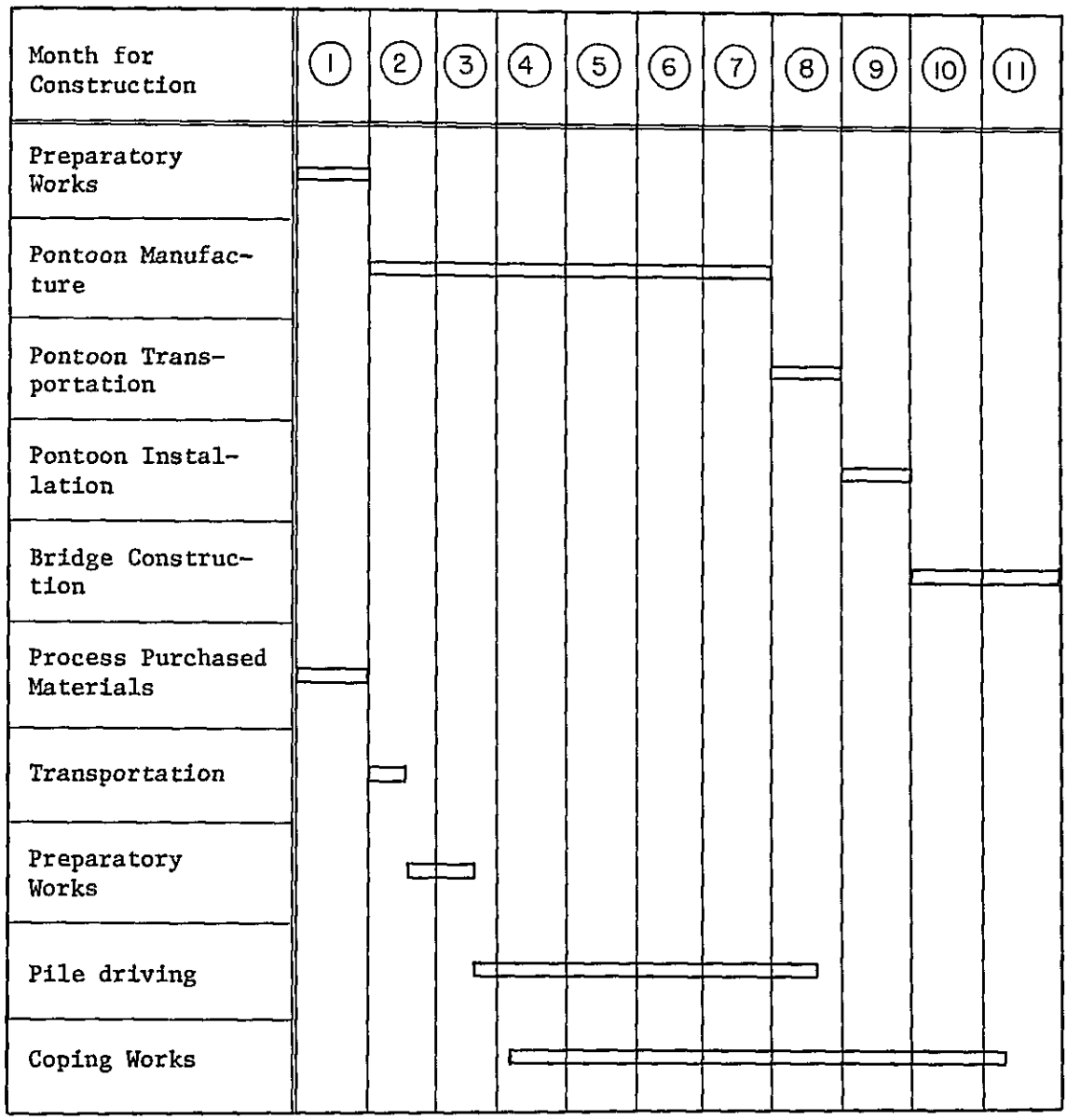
(8) Paint (anti-rust coating, main painting)

↓ Repeat the above steps (4) - (8)

Completion

5-5: Construction Schedule

Construction schedule is as follows:



Note: 1) Pile driving per 1 span

Pile driving 4 piles per 1 span ÷ 2 piles/day 2 days

Pile head processing 1 day

Mounting box girders 2 days

5 days x 20 span ≈ 100 days

2) The super structure is finished with gratings.

5-6: Outline of Review on Piling System

The review on the piling system is summarized as follows:

1) It is possible to construct 60-meter portion of access to the pontoon with the piling system. Since the ground is of coral rocks, it is necessary to bring diesel hammers and augers from Japan for the purpose.

2) It will not be able to drive the pile by 15 ton crane which is available in and at least 30 ton crane will be need.

3) It is possible to meet the planned construction dead line if steel piles are used. Steel piles are preferred considering ease in driving piles and simple processing of pile heads.

4) Almost all materials are to be transported from Japan.

5) The transportation costs will be high since machineries and materials must be imported from Japan.

6) The skilled labores such as welding operators and pile drivers will be need to be provided from Japan.

7) The pile head will be need the suitable anti-corrosion treatment.

8) Therefore, the construction cost will be higher compared to the construction by the rock-fill type.

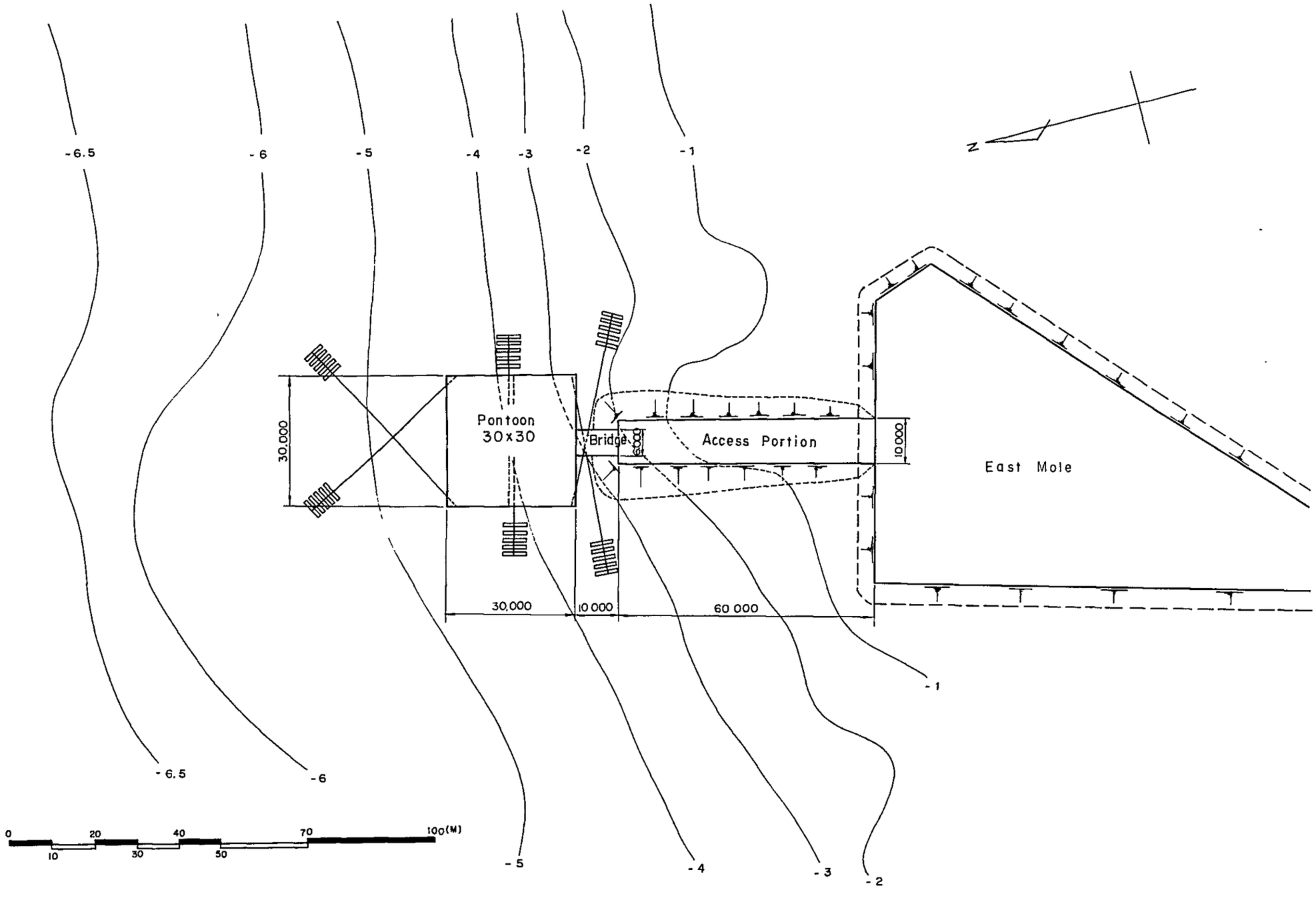
Chapter 6 Proposal for the Future Plan

1: The fishery development plan presupposing a -7.7 m freezer/carrier or mother ship cannot be called a realistic plan for Kiribati fishing industry when viewed in the light of the prevailing conditions. Review of the fishing development plan per se is desirable.

2: It would be necessary to prepare an optimum plan for the future fishing port facilities based on the results of re-investigation of the fishery development plan. It would be further necessary to prepare a master plan for Betio Port as the sole gateway to the sea for Kiribati by integrating the present functions of the Betio Port and the fish port jetty.

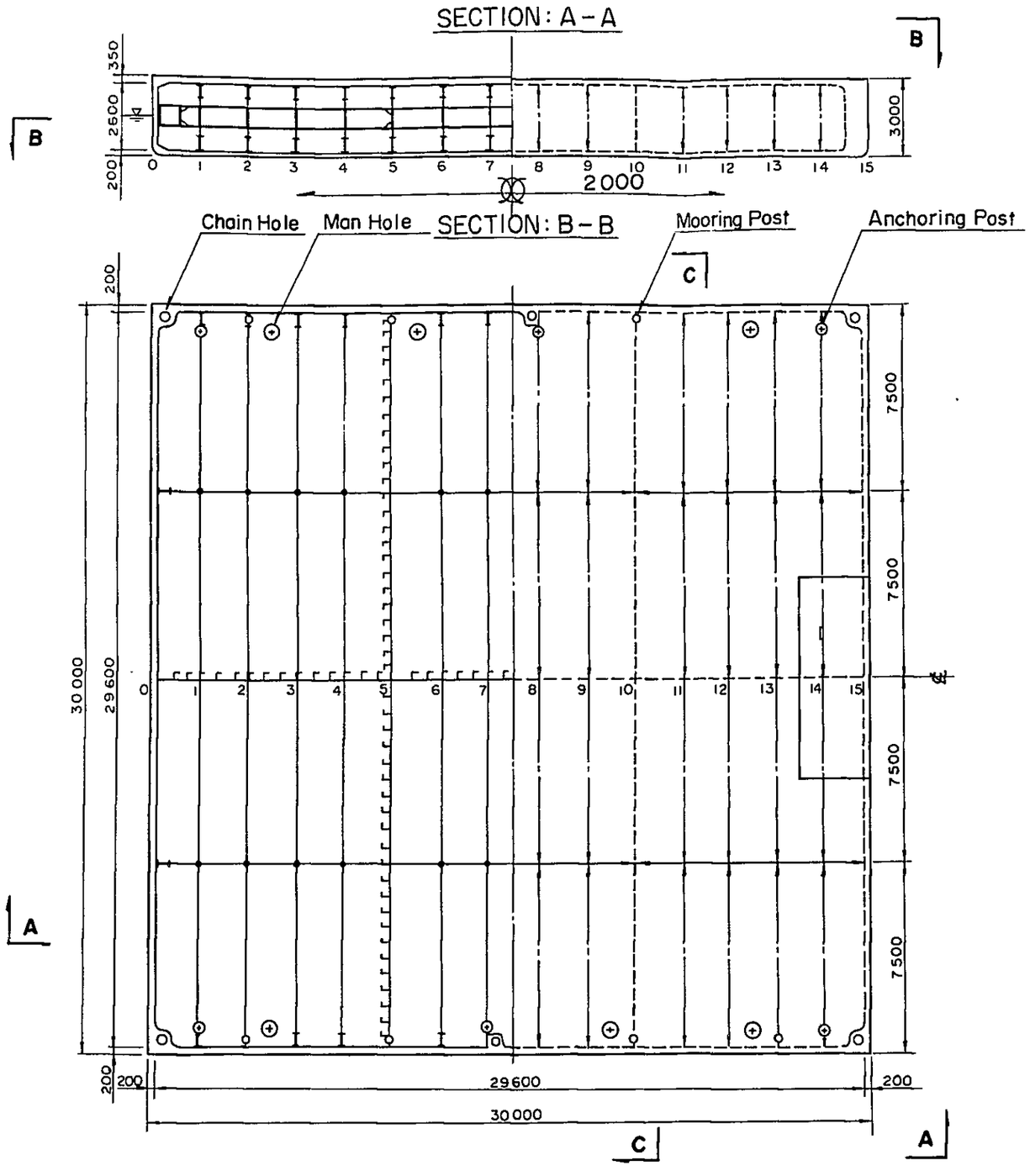
3: It is difficult to improve the present facilities in the single year which would include the extension of the jetty and the land facilities. It would be necessary to prepare a long range plan for improving facilities, providing development steps, thereby securing effective development efforts.

BASIC DESIGN DRAWING

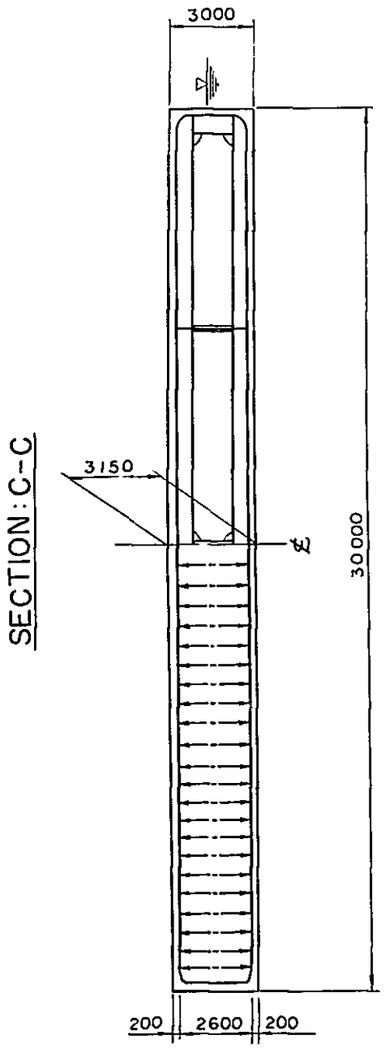


BETIO FISH PORT PLAN

01 GENERAL PLAN OF JETTY

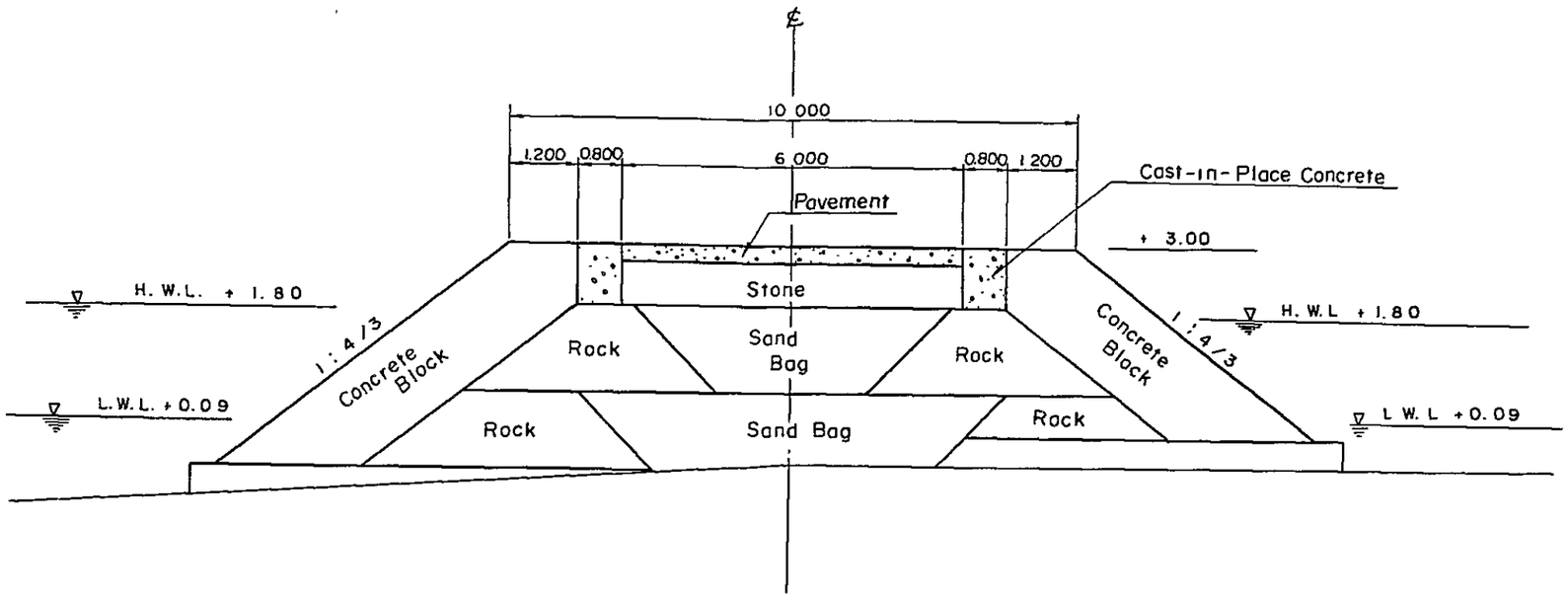


BETIO FISH PORT PLAN



Scale : 1/200

02 TYPICAL CROSS SECTION OF PONTOON



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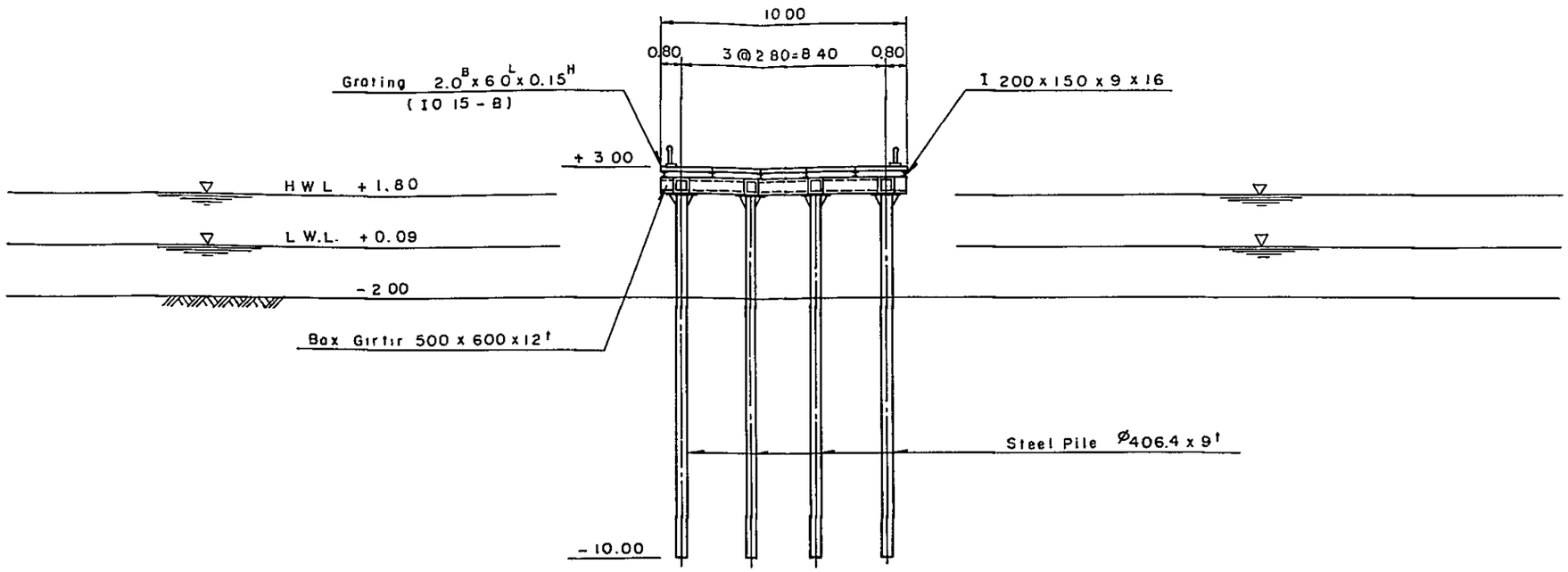
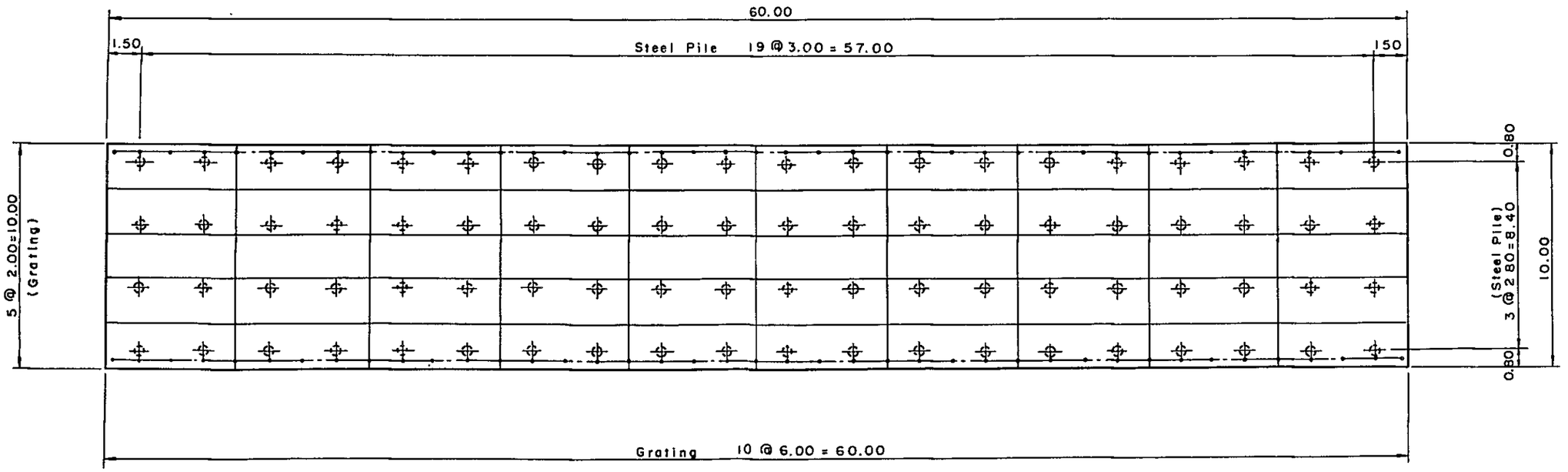
BETIO FISH PORT PLAN

03 TYPICAL CROSS SECTION OF ACCESS PORTION
(ROCK FILL TYPE)

CROSS SECTION



PLAN



BETIO FISH PORT PLAN

04 STRUCTURE OF ACCESS PORTION (PILE TYPE)