- Religious restriction of working

  There are holidays other than public holidays due to religions or customs tradition such as fast Saturday workshop. These activities shall be taken into consideration in the construction schedule.

- Rainy seasons

  There are two rainy seasons. As flood often occurs during the rainy seasons, special attention shall be given to the underwater works.

- Customs clearance

  It takes almost one month for customs clearance at Mombassa port. Thus, close cooperation and support of the GOK will be indispensable in unloading and custom clearance at Mombasa port in order to expedite the mobilization of personnel and equipment on time.

4.6.3 Construction and Supervisory Plan

After signing of the consultant service agreement, the Consultant shall commence the detailed design including preparation of the tender documents. The Japanese staff, comprising of a Project Manager, a bridge engineer, a foundation engineer, a quantity surveyor and a contract specialist, will undertake these services.

During construction stage, the Japanese resident engineer and other Japanese staff will supervise the work. Responsibilities of the key staff are as follows and the organization of the consultant team is shown in Figure 4.11.

1) Project Manager

   He shall be responsible for the management of all services concerning the detailed design, tendering and construction matters.

2) Bridge engineer

He shall be responsible for the detailed design of the bridge superstructure during the design stage, and the supervision of the bridge during the construction stage.

3) Foundation engineer

He shall undertake the design of structures such as foundation, abutments, piers, river bed protection, etc., during the design stage and inspection of foundation soil and supervision of the substructures during the construction stage.

4) Quantity Surveyor

He shall review construction plan for the basic design and estimate the project cost in detail during the design stage.

5) Contract specialist

He shall prepare the tender and the contract documents during the design stage.

6) Resident Engineer

He shall be stationed at the site to manage all services such as the construction schedule, quality control and technical aspects of the work through the construction period.

7) Material Engineer

He shall inspect the materials on quality, strength and supervise the work during the beginning stage of the construction.

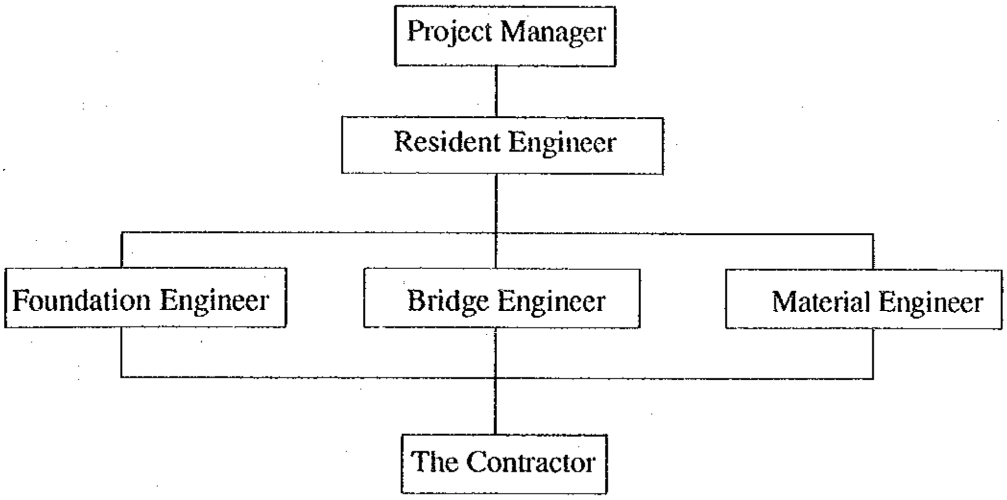


Figure 4.10 Supervision Organization by the Consultant

4.6.4 Procurement Plan

1) Labour market

The project is to be undertaken by a Japanese firm and the construction time is limited. The work then would be carried out in a very tight schedule.

The local contractors have been experiencing small bridge construction but no prestressed concrete works. It would be difficult to recruit operator's or technician with experience of the prestressed concrete work, but skilled and casual labourers will be recruited in Malindi town.

2) Materials

Cement and reinforcing steels are produced in Kenya and were used in the Kilifi bridge construction. Sand and crushed stone for the concrete are available from the same sources as the Kilifi bridge construction used.

Materials for the temporary bridge, and staging for the pile construction will be brought from Japan or other country since it is very difficult and time consuming to get in Kenya in large quantities.

Almost all the equipment except for the road construction machine are brought from Japan due to non available in Kenya. Support of the Kenya government will be indispensable in quick clearance at the Mombasa port to avoid delay of the work.

(1) Cement

Portland cement, sulfate resistance cement, low heat cement, etc., in accordance with BS12: 1978 are being produced at Mombasa.

The production capacity has been enough to supply these cements.

(2) Reinforcing bar

Conventional reinforcing bar and high-tensile steel twisted bar conforming to BS4449 are available in Mombasa. These steel were used in the Kilifi bridge construction.

(3) Crushed Stones and Sand for the Concrete

Crushed stones are available from quarry near Jaribuni, which were used in the Kilifi bridge construction. Sand is hauled from the Mjanaheri deposits north of the Sabaki river near Mambrui. This is pure deposit of well graded quartz sand, and also used in the Kilifi bridge construction.

(4) Pavement Material

Asphalt mixture for the pavement is hauled from asphalt plant of a local contractor in Mombasa. Lime for subbase course is also available in Mombasa. Crushed stones for base course are taken from quarry site at Jaribuni or crushed coral stones are available near the construction site.

(5) Structural Steel

Structural steel such as rolled steel, plate, channel are available from several firms at Mombasa. H-section rolled steel and other steel for the temporary bridge will be imported from Japan or other country for use in large quantities.

(6) Other Materials

Procurement plan for other major material are shown in Table 4.3

Material	In Kenya	From Japan	From other countries	
Prestressing wire/strand		O	Δ	Not manufactured in Kenya, imported from Japan for quality reason
Prestressing bar		O	Δ	- do -
Asphalt concrete mixture	O			Available in Kenya
Timber	O			- do -
Concrete admixture		O	Δ	Not manufactured in Kenya
Expansion joints		O		Not manufactured in Kenya, imported from Japan for ease of construction
Handrail	O			Available in Kenya
Structural steel	O			- do -
Material for temporary bridge & cofferdam		O		Available in Kenya but not possible for bulk purchase in need
Bridge bearings		O		Not manufactured in Kenya

Table 4.3 Purchasing Schedule for Other Material

3) Capacity of the Kenyan contractors

Subletting of the primary part of the works (prestressed concrete work) to the local contractors will not be possible as they have little experience in the bridge constructions of this nature. Some local contractors was sub-contracted approach road construction in the Kilifi bridge construction project.

4.6.5 Implementing Schedule

The Project will start only after signing of the Exchange of Notes mutually agreed upon between the GOK and GOJ. A possible implementing schedule is shown in Figure 4.11.

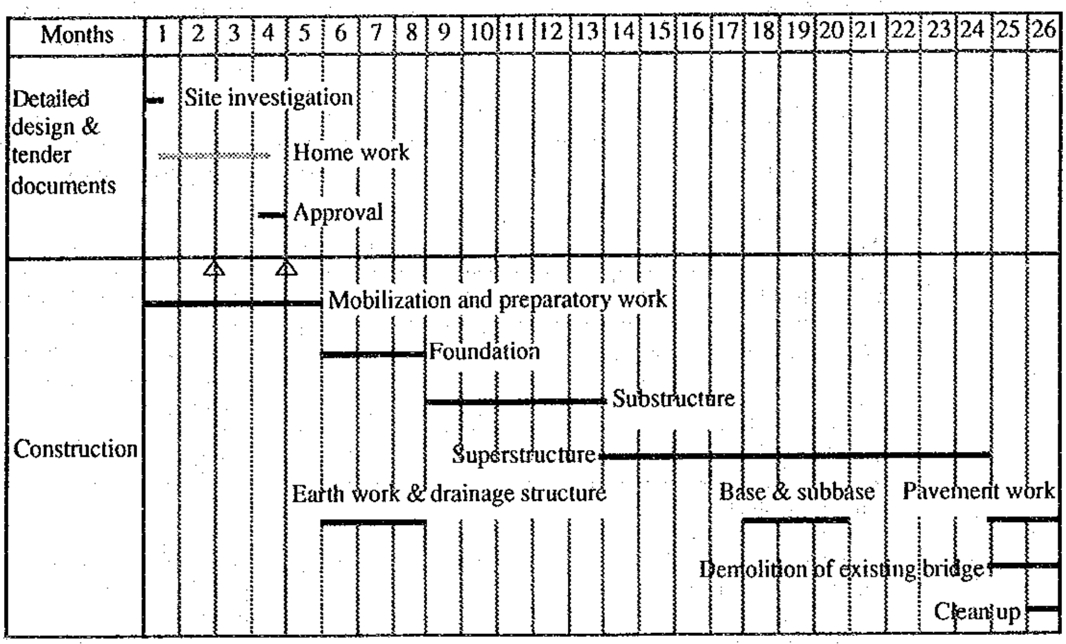


Figure 4.11 Implementing Schedule

1) Detailed Design

The consultant shall carry out the detailed design and prepare the tender and other relevant documents based on the basic design.

2) Tendering

A contractor will be selected from the Japanese contractors through open tender, who are prequalified for competitive tendering for the project. Criteria for prequalification will be discussed with JICA for approval. Prequalification will be carried out by the consultant on behalf of the implementing agency of the GOK.

The tender will be opened and the tender sum will be read in the presence of the tenders with representatives of the client and consultant. The consultant will start contract negotiation with the lowest tenderers in general and prepare the tender evaluation report to submit the GOK for approval.

The contract agreement becomes valid only after verification by the GOJ. The GOK has to conclude banking arrangement (B/A) with an authorized Japanese foreign exchange bank to open an account to receive aid fund from the GOJ and to make payments to the contractor.

3) Construction

The work consists of preparatory work, primary work and appurtenant work. Preparatory work includes preparation of the camp and plant yard to facilitate offices and storage houses, installation of temporary plants such as concrete batching-plant, etc.

Appurtenant work includes approach road, slope protection, river bed protection work, etc.

4.6.6 Scope of the Work

In case of the Project being materialized under the Japan's Grant Aid system, scope of the work by the GOK and by the GOJ was outlined in Section 3.3.6 and 3.3.7 respectively.

The expenditure to be bone by the GOK in connection with the implementation of the Project will be about 9.52 million shillings as shown below.

To secure right-of-way including compensation	1.2 million shillings
To secure camp and plant yard	0.08 million shillings
To remove stay for electric pole	0.3 million shillings
To dismantle part of embankment	3.15 million shillings
Total	4.73 million shillings

CHAPTER 5 PROJECT EVALUATION AND CONCLUSION

CHAPTER 5 PROJECT EVALUATION AND CONCLUSION

5.1 Project Evaluation

As a result of the technical assessment, and socioeconomic and traffic investigation carried out in the Study, the gist of the impact and the effects, which are broadly divided into direct and indirect and could be generated by the Project implementation, are as follows;

1) Direct Impact and Effects

Present Conditions and Problems	Countermeasures taken in the Study	Direct Impact and Effect
1 The existing Sabaki bridge has been severely deteriorated due to chloride attack, and accordingly an allowable vehicle load is presently being restricted upto 15 ton. In the worst case if some of the inside wires were broken, it was reported that the load become about 7 ton. Under these conditions, some of over weighted vehicles are imposed to load and unload their cargo but a few of them are likely passing on the bridge during night time. Rupture of the wires which is a fatal defect of the Sabaki bridge is still in progress. Hence it can be concluded that the Sabaki bridge is in very dangerous condition.	The existing bridge is replaced by a new modern bridge with applying HA & HB (30 Unit) loading in accordance with MOPWH Standard.	- Maintenance cost saving derived from balance of maintenance cost for between the existing steel bridge and a new concrete bridge. - Decreasing probability of the bridge collapse generates socioeconomic stability in the study area. - Eliminating of the loading and unloading due to dissolution of the load limitation creates some saving.

Present Conditions and Problems	Countermeasures taken in the Study	Direct Impact and Effect
2 Since all the traffic bottlenecks in the southern part of B8 road have been resolved by 1992, the Sabaki bridge having a single lane is the sole bottleneck remaining on B8 road, and is being utilized under one way traffic. It is apparent that the traffic volume in the B8 road increases resulting from the on going the Tana river basin development and eventually Sabaki bridge will become a critical bottleneck.	Based on the traffic forecast results, it is applied a double lane bridge of 6.5m carriageway width.	- Under the one way traffic, waiting time, at least 2 min. sometime about 10 min. during peak hour, is imposed to cross the bridge. Due to resolving this problem, both time and operation cost saving are generated. - It is also expected to decrease traffic accident, to increase driving comfort, and to reduce driver's physical fatigue.
3. The number of pedestrians crossing Sabaki Bridge are about 220 during the peak hour. However, this is dangerous due to the absence of sidewalks for them.	Provision of a sidewalk of 1.5 m width at each side is considered in the Plan.	- It is expected to reduce accidents resulting in injury or death.
4. The existing bridge opening is inadequate for the design flood discharge. It is therefore possible to be washed away the existing bridge.	The bridge opening of new Sabaki bridge is designed to accommodate the design flood discharge. Moreover, 2 m free board is considered for driftwood and future sediments.	- Decreasing probability of the bridge being washed away generates socioeconomic stability in the study area.

2) Indirect Effects and Impact

The indirect effect and impact derived from the project implementation are likely acceleration of the agricultural development, improvement of the stability of production and transportation schedule, correction of regional disparities, expansion of market spheres, dispersion of the urban population and rationalization of the distribution process in the study area especially in the Tana river basin area. Furthermore, it is expected to improve the stabilization of people's livelihood and national consciousness in the area where the public security is being aggravated, and to strengthen accessibility to the medical and educational facilities in the project area.

5.2 Conclusion

As the existing Sabaki bridge is in a very severe and dangerous condition. It should be replaced urgently by a new one. This scheme is listed in the Third Highway Sector Program and coincides with the basic principles in the current National Plan. Moreover, it is presumed that the project would be implemented without any special problems in Japan's Grant Aid system and after completion the bridge will be maintained properly by the GOK. Taking the above enumerated impact and effects into account, the project implementation, through the cooperation of the Japan's Grant Aid Program, would be very meaningful and thus its early implementation is most desirable.

APPENDICES

APPENDICES

Appendix-I Member List of Study Team

1. Field Survey Mission (from July 25th to August 28 th ,1993)

Name	Designation	Title
Masatoshi SASAKI	Team Leader	Manager of Maintenance Div. Ohmishima Operation Office, Third Construction Bureau, Honshu-Shikoku Bridge Authority
Koichi TAKEI	Project Coordinator	Consultant Contract Div.,
Kazumasa TADA	Project Manager	Nippon Koei Co., Ltd.
Nobuyuki SUZUKI	Bridge Designer	Construction Project Consultants, Inc.
Tetsu NAKAGAWA	Natural Conditions Surveyor	Nippon Koei Co., Ltd.
Toshinori TODA	Construction Planner / Cost Estimator	Construction Project Consultants, Inc.

2. Draft Report Mission (from November 8th to November 19th ,1993)

Name	Designation	Title
Masatoshi SASAKI	Team Leader	Manager of Maintenance Div. Ohmishima Operation Office, Third Construction Bureau, Honshu-Shikoku Bridge Authority
Masao SHIKANO	Project Coordinator	Procurement Dep., JICA Grant Aid Project Management Dep., JICA Second Project Management Div.
Kazumasa TADA	Project Manager	Nippon Koei Co., Ltd.
Nobuyuki SUZUKI	Bridge Designer	Construction Project Consultants, Inc.

Appendix-II Survey Itinerary

First Servey

No.	Date	Member	Activities	Stay
1	7/25 (Sun)	Sasaki, Takei, Tada, Suzuki	Leave Narita for Kenya (JL-405)	Paris
2	7/26 (Mon)	Sasaki, Takei, Tada, Suzuki	Move from Paris to Nairobi (AF-484)	On board
3	7/27 (Tue)	Sasaki, Takei, Tada, Suzuki	Arrived at Nairobi Visit to JICA Office Courtesy call to MOPWH Internal meeting of JICA mission	Nairobi
4	7/28 (Wed)	Sasaki, Takei, Tada, Suzuki	Preliminary meeting with MOPWH	Nairobi
5	7/29 (Thu)	Sasaki, Takei	Moving to Mombasa: Visit to Coastal Provincial Office of MOPWH	Mombasa
		Tada, Suzuki	Moving to Mombasa for geological and topographic survey. Investigation of new Nyali Bridge	
6	7/30 (Fri)	Sasaki, Takei, Tada, Suzuki	Investigation of Mtwapa and Kilifi Bridges	Mombasa
7	7/31 (Sat)	Sasaki, Takei	Site Investigation on Sabaki Bridge Back to Nairobi	Nairobi
		Tada, Suzuki	Meeting with on Geological and Topographic surveyor Back to Nairobi, signing of contract for survey	
8	8/01 (Sun)	Sasaki, Takei, Tada, Suzuki Nakagawa	Internal meeting of study team Mr. Nakagawa arrives at Nairobi	Nairobi
9	8/02 (Mon)	Sasaki, Takei, Tada, Suzuki Nakagawa	Meeting with JICA on draft of M/M Discussion with MOPWH on draft of M/M	Nairobi
10	8/03 (Tue)	Sasaki, Takei, Tada	Interview OECF, Nairobi office	Nairobi
		All Member	Discussion with MOPWH on M/M	
11	8/04 (Wed)	All Member	Discussion about draft of M/M with MOPWH Internal meeting of study team	Nairobi
12	8/05 (Thu)	All Member	Signing of Minute of meeting Meeting with MOPWH on 2nd site investigation	Nairobi
13	8/06 (Fri)	Sasaki, Takei, Tada	Report to JICA and Embassy of Japan	Nairobi
		Suzuki, Nakagawa	Data collection and meeting with geological and topographic surveyor	
14	8/07 (Sat)	Sasaki, Takei	Leave Kenya	London
		Tada, Suzuki, Nakagawa, Toda	Toda arrives at Narita Internal meeting	Nairobi
15	8/08 (Sun)	Tada, Suzuki, Nakagawa, Toda	Arrangement of collected data	Nairobi
16	8/09 (Mon)	Tada, Toda	Call on JICA, Meeting with Bridge section of MOPWH	Nairobi
		Suzuki, Nakagawa	Move to Mombasa, Data collection at MOPWH Coastal Provincial office	Malindi
17	8/10 (Tue)	Tada, Suzuki	Drafting design requirements	Malindi
		Nakagawa, Toda	Preparation for traffic survey, and quarry site investigation	
18	8/11 (Wed)	Tada, Suzuki	Traffic survey	Malindi
		Nakagawa, Toda	Investigation of existing bridge and quarry site	
19	8/12 (Thu)	Tada, Suzuki	Supervising geological and topographic surveyors	Nairobi
		Nakagawa, Toda	Meeting with Geological and Topographic surveyor Move to Mombasa	Mombasa
20	8/13 (Fri)	Tada, Suzuki	Discussion with MOPWH, bridge section on design Call to Ministry of Finance	Nairobi
		Nakagawa, Toda	Investigation of Nyari, Mtwapa Bridges	Mombasa

First Servey

No.	Date	Member	Activities	Stay
21	8/14 (Sat)	Tada, Suzuki	Data collection	Nairobi
		Nakagawa, Toda	Interview local contractors, Back to Nairobi	
22	8/15 (Sun)	All member	Internal meeting of study team	Nairobi
23	8/16 (Mon)	Tada	Discussion with Ministry of Finance and JICA Report to embassy of Japan	Nairobi
		Suzuki, Nakagawa, Toda	Discussion with MOPWH on basic design requirements Meeting with geological and topographic surveyor	
24	8/17 (Tue)	Tada, Toda	Leave Kenya	London
		Suzuki, Nakagawa	Data collection and meeting with bridge section of MOPWH	Nairobi
25	8/18 (Wed)	Suzuki	Preparing memorandum on basic requirement	Nairobi
		Nakagawa	Move to Malindi, Inspection of site work of boring and topo. survey	Malindi
26	8/19 (Thu)	Suzuki	Move to Malindi for supplementary investigation of Sabaki bridge	Malindi
		Nakagawa	Investigation of Baricho intake	
27	8/20 (Fri)	Suzuki	Supplementary investigation of Sabaki Bridge	Malindi
		Nakagawa	Call on Mombasa office of Ministry of Water for data collection	Mombasa
28	8/21 (Sat)	Suzuki	Material investigation around project site	Nairobi
		Nakagawa	Back to Nairobi	
29	8/22 (Sun)	Suzuki, Nakagawa	Arrangement of collected data	Nairobi
30	8/23 (Mon)	Suzuki, Nakagawa	Data Collection Meeting with geological and topographic surveyor	Nairobi
31	8/24 (Tue)	Suzuki, Nakagawa	Hydraulic data collection at Ministry of water	Nairobi
32	8/25 (Wed)	Suzuki, Nakagawa	Signing of memorandum on basic requirement Report to MOPWH and JICA office	Nairobi
33	8/26 (Thu)	Suzuki, Nakagawa	Leave Kenya	Zurich
34	8/27 (Fri)	Suzuki, Nakagawa	Move from Zurich to Narita	on board
35	8/28 (Sat)	Suzuki, Nakagawa	Arrived at Narita	Tokyo

Second Survey

No.	Date	Member	Activities	Stay
1	11/08 (Mon)	Sasaki, Shikano, Tada, Suzuki	Leave Narita for Kenya (SN 208)	Brussel
2	11/09 (Tue)	Sasaki, Shikano, Tada, Suzuki	Move from Brussel to Nairobi (SN 956)	on board
3	11/10 (Wed)	Sasaki, Shikano, Tada, Suzuki	Arrived at Nairobi Visit to JICA office Courtesy call to MOPWH	Nairobi
4	11/11 (Thu)	Sasaki, Shikano, Tada, Suzuki	Explanation of Draft Final Report to MOPWH	Nairobi
5	11/12 (Fri)	Sasaki, Shikano, Tada,	Call on project manager for Tana Basin Road Project, Discussion with MOPWH on M/M	Nairobi
		Suzuki	Collection of additional data	
6	11/13 (Sat)	Sasaki, Shikano, Tada, Suzuki	Moving to Malindi Investigation of existing Sabaki Bridge	Malindi
7	11/14 (Sun)	Sasaki, Shikano, Tada, Suzuki	Investigation of Kilifi and Mtwapa Bridge Back to Nairobi	Nairobi
8	11/15 (Mon)	Sasaki, Shikano, Tada, Suzuki	Meeting with MOPWH on Draft Final Report and draft of M/M, Report to OECF Nairobi office	Nairobi
9	11/16 (Tue)	Sasaki, Shikano, Tada,	Visit to Account Controller of MOPWH, Signing of M/M	Nairobi
		Suzuki	Collection of additional data	
10	11/17 (Wed)	Sasaki, Shikano, Tada, Suzuki	Leave Kenya for Japan	London
11	11/18 (Thu)	Sasaki, Shikano, Tada, Suzuki	Move from London to Narita	on board
12	11/19 (Fri)	Sasaki, Shikano, Tada, Suzuki	Arrived at Narita	

Appendix-III List of Officers Met in Kenya

1. Embassy of Japan

Mr. Masahiko HORIE	Minister Counsellor
Mr. Kiyoshi SAKAI	First Secretary

2. Japan International Cooperation Agency (JICA)

Mr. T. NAGASHIMA	Resident Representative, Kenya Office
Mr. Sumio AOKI	Deputy Director, Kenya Office
Mr. Yuji KASHIHARA	Assistant Resident Representative, Kenya Office
Mr. Ichiro TAMBO	

3. Overseas Economic Cooperation Fund (OECF)

Mr. Shuhei SEYAMA	Ex-Chief Representative, Nairobi Office
Mr. Yoshio NAGAMINE	Chief Representative, Nairobi Office

4. Ministry of Public Works and Housing

Mr. S.S. Lesrima	Permanent Secretary
Eng. S.M. Kiguru	Engineer-in-Chief
Eng. K.M. Kithyo	Provincial Works Officer (Coast)

5. Department of Road

Eng. Mwasi	Chief Engineer
Eng. J.M. Wanyoike	Chief Superintending Engineer
Eng. K. Ndiritu	Chief Superintending Engineer
Eng. D.O. Maganda	Chief Superintending Engineer
Eng. M.O.A. Bajabar	Sr. Superintending Engineer
Mr. J.J. Nyapiedho	Accounts Controller
Mr. H.N. Kiragu	Bridge Engineer
Mr. Sumitaka KURINO	Ex-Superintendent Engineer (JICA Expert)
Mr. Kazuyoshi SAKAI	Superintendent Engineer (JICA Expert)
Mr. Abdul Rahman	District Maintenance Officer
Mr. Ali Duhmy	Officer-in-Chief

6. Ministry of Finance

Mr. Jamen L. Lavuna	Under Secretary

MINUTES OF DISCUSSIONS

BASIC DESIGN STUDY ON THE CONSTRUCTION PROJECT OF NEW SABAKI BRIDGE IN THE REPUBLIC OF KENYA

In response to a request from the Government of Republic of Kenya (the Government of Kenya), the Government of Japan decided to conduct a Basic Design Study on the Construction Project of New Sabaki Bridge in the Republic of Kenya and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to the Republic of Kenya the study team, which was headed by Mr. Masatoshi SASAKI, Manager of Maintenance Div., Honshu-Shikoku Bridge Authority, and is scheduled to stay in the country from 27 July to 26 August, 1993.

The team held discussions with the officials concerned of the Government of Kenya and conducted a field survey in the study areas.

In the course of discussions and field survey, both parties have confirmed the main items described on the attached sheets. The team will proceed to further works and prepare the Basic Design Study Report.

Nairobi, August 5,1993

Mr. Masatoshi SASAKI Leader Basic Design Study Team JICA	Mr. S. S. Lesrima Permanent Secretary Ministry of Public Works and Housing

ATTACHMENT

1. Objective
The objective of the Project is to construct new Sabaki bridge along side the existing one for improvement of the traffic capacity over Sabaki River and for acceleration of development in the Tana River basin , in accordance with The Third Highway Sector Program based on the National Development Plan.

2. Project site
The Project site as shown in Annex-I is located near the existing Sabaki bridge along the B8 road about 8 km north of Malindi in Coast Province.

3. Executing Organization
Roads Department in the Ministry of Public Works and Housing is responsible for the administration and execution of the Project.

4. Items requested by the Government of Kenya
The contents of the request originally made by the Government of Kenya was understood by both sides, that is construction of a new Sabaki bridge, 2 span prestressed concrete box girder bridge totaling 110 m long. The new bridge will be located along side the existing and approximately 25 m down stream from the existing bridge.

The Kenyan Side strongly requested that the approach road with a minimum length connecting the bridge to the existing road at each side will be incorporated into the Project. The study team will convey the request to Japanese Government for its consideration.

Notwithstanding above clause the final components of the Project will be decided after the further studies.

5. Confirmation of Requested Items
After discussion on above items between the Government of Kenya and the study team, the followings were finally confirmed by both sides.

   1) Appropriate configurations of the proposed bridge will be finalized based on the results of the study.

   2) Bridge design will be conducted in accordance with engineering standards acceptable by both sides.

(43)

6. Item requested by the study team

The study team requested MOPW&H to be responsible for refinement of the project scope of Tana Basin Road taking into account final scope of the works for New Sabaki Bridge Construction, in case the latter is executed in Grant Aid program.

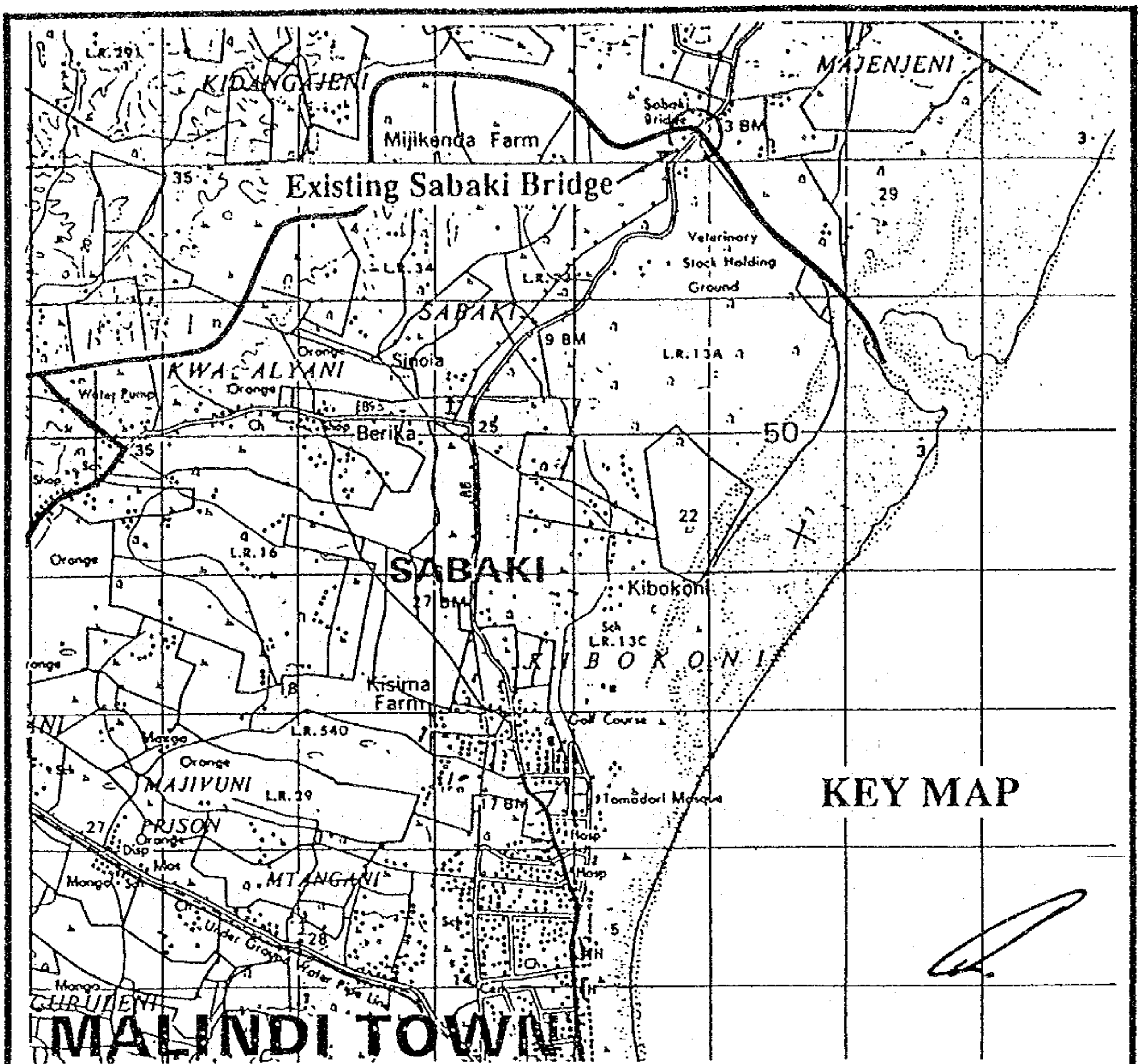
7. Japan's Grant Aid system

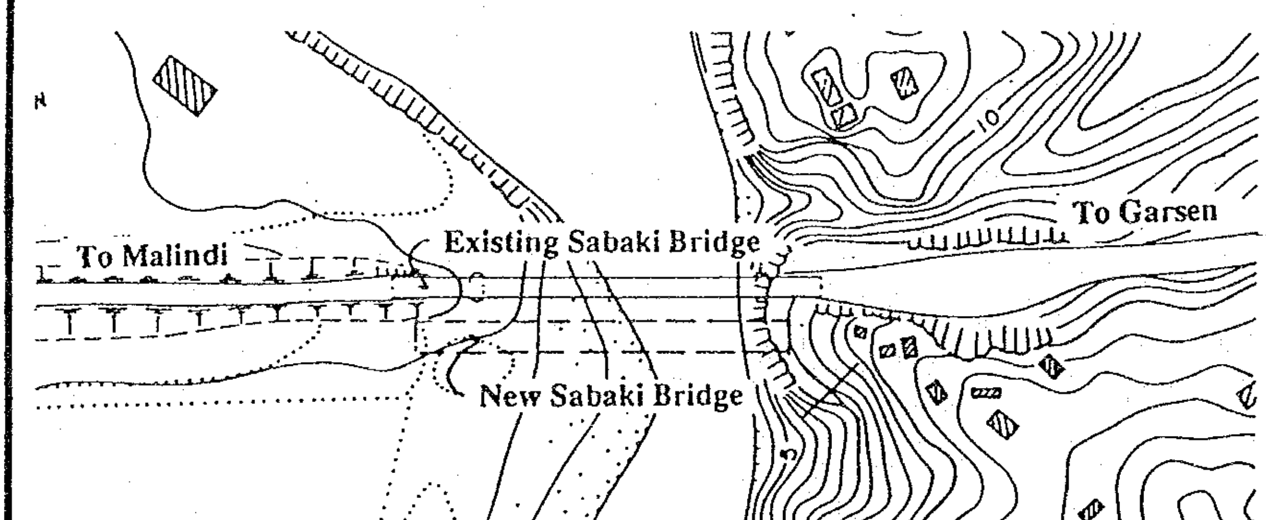
1) The Government of Kenya has understood the Japan's Grant Aid system explained by the team.

2) The Government of Kenya will take necessary measures, described in Annex-II for smooth implementation of the Project, in case that the Project is executed under the Japan's Grant Aid system.

8. Schedule of the Study

1) The study team will proceed to further studies in Kenya until 25 August, 1993.
2) JICA will prepare the Draft Report in English, which contains all the study results including the basic design of new Sabaki bridge, and send the study team to Kenya in order to explain the contents of the Draft Report at the beginning of November, 1993.
3) JICA will complete the Final Report in Japan and send it to the Government of Kenya by the end of December, 1993.





ANNEX-I LOCATION MAP

ANNEX-II

Following necessary measures should be taken by the Government of Kenya in case that Japan's Grant Aid is executed.

1) to provide data and information necessary for the Project.

2) to secure land necessary for the execution of the Project and provide enough space for construction, such as temporary offices, working areas, stock pile yards and others.

3) to demolish or remove the existing bridge and approach embankment, if required after the execution of works

4) to provide facilities for the distribution of electricity, water supply, telephone line and other facilities to the site.

5) to bear commission (banking charge) to the Japanese foreign exchange bank for the banking services based upon the Banking Arrangement.

6) to exempt taxes and to take necessary measures for customs clearance of the materials, equipment and supplies brought for the project at the ports of disembarkation in Kenya.

7) to accord Japanese Nationals whose services may be required in connection with the supply of products and the services under the verified contract such facilities as may be necessary for their entry into Kenya and stay therein for the performance of their work.

8) to maintain and use properly and effectively the facilities constructed under the Grant.

9) to bear all the expenses, other than those to be borne by the Grant, necessary for the execution of the Project.

MINUTES OF DISCUSSIONS
BASIC DESIGN STUDY ON THE CONSTRUCTION PROJECT OF NEW SABAKI BRIDGE IN THE REPUBLIC OF KENYA
(CONSULTATION OF THE DRAFT FINAL REPORT)

In July, 1993, Japan International Cooperation Agency (JICA) dispatched a Basic Design Study Team on the Construction Project of New Sabaki Bridge (hereinafter referred to as "the Project") to the Republic of Kenya, and through discussions, field survey, and technical examination of the results in Japan, has prepared the draft report of the study.

In order to explain and to consult Kenya on the components of the draft report, JICA sent to Kenya a study team, which is headed by Mr. Masatoshi SASAKI, Manager of Maintenance Div., Honshu - Shikoku Bridge Authority, and is scheduled to stay in the country from November 10 to 17, 1993.

As a result of discussions, both parties confirmed the main items described on the attached sheets.

Nairobi, November 16, 1993

佐々木 雅敏

Mr. Masatoshi SASAKI
Leader,
Basic Design Study Team,
Japan International Cooperation Agency

Eng. S.M Kiguru
Eng.-in-Chief
for Permanent Secretary
Ministry of Public Works
and Housing, Kenya

ATTACHMENT

1. Components of draft final report

The Government of Kenya has agreed and accepted in principle the components of the draft report proposed by the Team.

2. Japan's Grant Aid System

(1) The Government of Kenya has understood the system of Japan's Grant Aid explained by the Team.

(2) The Government of Kenya will take necessary measures, described in ANNEX for smooth implementation of the Project, on condition that the Grant Aid Assistance by the Government of Japan is extended to the Project.

(3) Kenyan side requested that the cost of demolition of the existing bridge would be undertaken by Japanese side if possible.
The Study Team will convey this request to Japanese Government.

3. Further Schedule

The Team will make the final report in accordance with the confirmed items, and send it to Government of Kenya by February, 1994.

ANNEX

Following necessary measures should be taken by the Government of Kenya in case that Japan's Grant Aid is executed.

1) To provide data and informations necessary for the Project.

2) To secure land necessary for the execution of the Project and provide enough space for construction, such as temporary offices, working areas, stock pile yards and others.

3) To demolish or remove the existing bridge and part of approach embankment as soon as possible after completion of the Project.

4) To provide facilities for the distribution of electricity, water supply, telephone line and other facilities to the site.

5) To bear commissions (banking charge) to the Japanese foreign exchange bank for the banking services based upon the Banking Arrangement.

6) To ensure prompt unloading and customs clearance at the port of disembarkation in Kenya and internal transportation therein of the products purchased under the Grant.

7) To exempt Japanese nationals from customs duties, internal taxes and other fiscal levies which may be imposed in Kenya with respect to the supply of the products and services under the verified contracts.

8) To accord Japanese nationals whose services may be required in connection with the supply of the products and services under the verified contract such facilities as may be necessary for their entry into Kenya and stay therein for the performance of their work.

9) To maintain and use properly and effectively the facilities constructed under the Grant.

10) To bear all the expenses, other than those to be borne by the Grant, necessary for the execution of the Project.

11) To coordinate in solving any issues related to the Project which may arise with third parties and inhabitants living around the Project area during implementation of the Project.

Appendix-V Drill Logs

DRILL LOG

HOLE NO. 1 SHEET NO. 1 OF 2

PROJECT	NEW SABAKI BRIDGE – KENYA			DEPTH	50.00 m	ELEVATION	
SITE	MALINDI	COORDINATE	: :	INCLINATION	VERTICAL	DRILL RIG	DANDO 150
AVERAGE CORE RECOVERY	N/A	DATE	FROM 5/8 TO 26/8/93	DRILLED	H. W.	LOGGED	J. O.

DATE	DEPTH	ELEVATION	ROCK TYPE OR FORMATION	COLUMN SECTION	DESCRIPTION	BIT & DIAMETER
5/8	0.00 – 4.00		SAND		Medium dense brown fine; with mica. With root fibres top 1m. Trace silty clay at bottom.	250mm
6/8	4.00		CLAY		Grey, 10cm thick	
	4.00 – 8.00		SAND		Loose and medium dense greyish brown fine and medium.	200mm (from ~7.5 m)
7/8, 8/8, 9/8, 10/8, 12/8, 13/8, 14/8	8.00 – 30.00		SAND		Medium dense and dense light brown/white angular medium and coarse.	150mm (from ~18 m)

DEPTH (m)	SAMPLE No.	S.P.T. N VALUES
1.00	B1	
1.50	D2	12
2.00	B3	
2.50	D4	12
3.00	B5	
3.50	D6	12
4.00	B7	
4.20	U8	U100 BLOWS: 42
4.50	D9, D10	
5.00	B11	9
5.50	D12	12
6.00	B13	16
7.00	B14	17
8.00	B15	20
9.00	B16, D17	40
10.00	B18	27
11.00	B19	28
12.00	B20	30
13.00	B21	26
14.00	B22	32
15.00	B23	25
16.00	B24	30
17.00	B25	27
18.00	B26	47
19.00	B27	32
20.00	B28	34
21.00	B29	31
22.00	B30	36
23.00	B31	32
24.00	B32	36
25.00	B33	37
26.00	B34	30
27.00	B35	32
28.00	B36	32
29.00	B37	35
30.00	B38	

※R.Q.D is Rock Quality Designation, R.Q.D=(Total length of cylindric cores longer than 10 cm)/(Total core length) × 100%
※LUGEON VALUE is l/min/m under injection water pressure of 10kg/cm²
※DEPTH and ELEVATION are in meter
※DIAMETER is in millimeter

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LOG FORM-B

HOLE NO.

Fig.

DRILL LOG

HOLE NO. 1 SHEET NO. 2 OF 2

PROJECT	NEW SABAKI BRIDGE - KENYA	DEPTH	50.00 m	ELEVATION	
SITE	MALINDI	COORDINATE	: :	INCLINATION	VERTICAL
				DRILL RIG	DANDO150
AVERAGE CORE RECOVERY	N/A	DATE	FROM 5/8 TO 26/8/93	DRILLED	H. W.
				LOGGED	J. O.

DATE	DEPTH	ELEVATION	ROCK TYPE OR FORMATION	COLUMN SECTION	DESCRIPTION
	37.00		SAND		Dense light brown angular coarse; trace fine quartz gravel. With rare angular and subround quartz and sandstone fragments upto 5cm across. With bivalve shells in zone 31.00-32.00m depth.
24/8, 25/8	47.0		SAND		Dense and very dense light brown medium and coarse.
	47.50		SILT		Very compact grey with green tinge, sandy, rare limestone fragments upto 2cm
26/8	50.00		SAND		Very dense angular coarse and very coarse. With rare angular and rounded sandstone and limestone fragments upto 4cm.
					END OF B/H

GROUNDWATER LEVEL (depth)	SAMPLE No.	S.P.T. N VALUES
		33
31.00	B39	39
32.00	B40	36
33.00	B41	38
34.00	B42	38
35.00	B43	38
36.00	B44	39
37.00	B45	35
38.00	B46	36
39.00	B47	
40.00	B48	35
		38
41.00	B49, D50	39
42.00	B51, D52	57
43.00	B53	59
44.00	B54	51
45.00	B55, D56	52
46.00	B57, D58	56
47.00	B59, D60	52
48.00	B61, D62	54
49.00	B63, D64	S (S) REFUSAL 15cm
50.00	B65, D66	S (SS) REFUSAL 10cm

DATE	TIME	DEPTH (M) HOLE	CASING	WRL
5/8/93	18.00	1.00	NIL	DRY
6/8/93	18.00	8.00	7.70	1.00
7/8/93	6.00	8.00	7.70	1.00
8/8/93	6.00	11.00	10.70	1.70
9/8/93	6.00	12.45	12.20	2.00
10/8/93	6.00	13.50	13.70	2.00
11/8/93	6.00	18.45	18.20	2.50
12/8/93	6.00	18.45	18.20	2.50
13/8/93	6.00	25.00	25.45	2.00
14/8/93	6.00	27.45	26.90	2.50
15/8/93	6.00	32.75	32.75	0.80
24/8/93	6.00	44.00	44.00	G.L.
25/8/93	6.00	44.00	44.00	G.L.
26/8/93	6.00	48.00	48.00	G.L.

LOG FORM-B

HOLE NO.

*R.Q.D is Rock Quality Designation, R.Q.D=(Total length of cylindric cores longer than 10 cm)/(Total core length) x 100%
*LUGEON VALUE is l/min/m under injection water pressure of 10kg/cm²
*DEPTH and ELEVATION are in meter
*DIAMETER is in millimeter

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Fig.

DRILL LOG

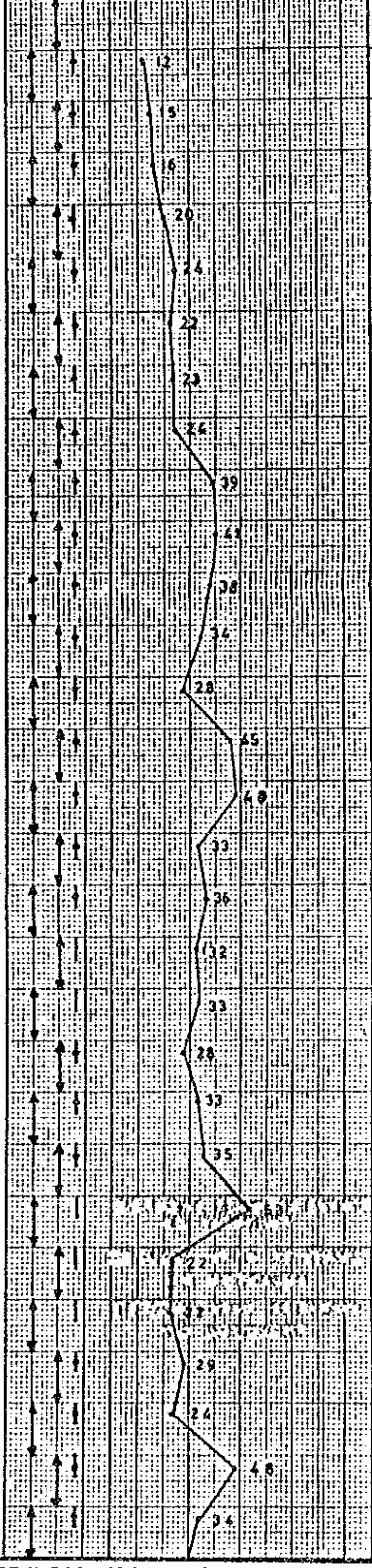
HOLE NO. 2 SHEET NO. 1 OF 2

PROJECT	NEW SABAKI BRIDGE – KENYA			DEPTH	40.00 m	ELEVATION	
SITE	MALINDI	COORDINATE	: :	INCLINATION	VERTICAL	DRILL RIG	DANDO 150
AVERAGE CORE RECOVERY	N/A	DATE	FROM 6/8 TO 20/8/93	DRILLED	F. K.	LOGGED	J. O.

DATE	DEPTH	ELEVATION	ROCK TYPE OR FORMATION	COLUMN SECTION	DESCRIPTION	BIT & DIAMETER
6/8	2.00		SAND		Medium dense, brown fine, with mica	250 mm
	7.45		SAND		Medium dense, brown fine and medium. Occasional white limestone, quartz fragments upto 4mm, rarely upto 1cm.	
7/8, 8/8	17.00		SAND		Medium dense and dense, brown fine, with mica. With rare grey sandstone and limestone fragments, quartz particles upto 4mm.	250 mm (to 9.00); 200 mm
	18.00		SAND		Dense brown fine, with mica, white limestone fragments upto 10 cm.	
9/8, 11/8	24.00		SAND		Medium dense brown medium and coarse, with some angular fine gravel.	
12/8	28.00		GRAVEL		Medium dense cream white/ light grey subangular fine, medium and coarse, limestone fragments occasionally upto 10cm; with rare bivalve shells; in sand matrix.	200 mm
13/8			SAND		Dense light brown angular medium and coarse; occasional grey fine grained sandstone fragments upto 12cm.	150 mm

GROUNDWATER LEVEL	SAMPLE No.
1.00	B1, D2
2.00	B3, D4
3.00	B5, D6
4.00	B7, D8
5.00	B9, D10
6.00	B11, D12
7.00	B13, D14
8.00	B15, D16
9.00	B17, D18
10.00	B19, D20
11.00	B21, D22
12.00	B23, D24
13.00	B25, D26
14.00	B27, D28
15.00	B29, D30
16.00	B31, D32
17.00	B33, D34
18.00	B35, [illegible]
19.00	B36, [illegible]
20.00	B37, D38
21.00	B39, D40
22.00	B41, D42
23.00	B43
24.00	B44
25.00	B45
26.00	B46, D47
27.00	B48, D49
28.00	B50, D51
29.00	B52, D53
30.00	B54

SAMPLES / S.P.T. N VALUES (10 30 50)



HOLE NO.

LOG FORM-B

Fig. 2

*R.Q.D is Rock Quality Designation, R.Q.D= (Total length of cylindric cores longer than 10 cm)/(Total core length) x 100%
*LUGEON VALUE is ℓ/min/m under injection water pressure of 10kg/cm²
*DEPTH and ELEVATION are in meter
*DIAMETER is in millimeter

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DRILL LOG

HOLE NO. 2 SHEET NO. 2 OF 2

PROJECT	NEW SABAKI BRIDGE _ KENYA			DEPTH	40.00 m	ELEVATION	
SITE	MALINDI	COORDINATE	: :	INCLINATION	VERTICAL	DRILL RIG	DANDO150
AVERAGE CORE RECOVERY	N/A upto 36.00m depth; 64%	DATE	FROM 6/8 TO 20/8/93	DRILLED	F. K.	LOGGED	J. O.

DATE	DEPTH	ELEVATION	ROCK TYPE OR FORMATION	COLUMN SECTION	DESCRIPTION	BIT & DIAMETER	GROUNDWATER LEVEL	CORE RECOVERY TCR %	FI	SAMPLES	RQD	SPT N VALUES (10 30 50)	DEPTH
16/8								D55				28	
	31						31.00	B56 D57				S (60) REFUSAL + 175mm	31
	32						32.00	B58 D59				S (50) REFUSAL + 150mm	32
	33		SAND		Very dense light brown medium and coarse, occasional sandstone, limestone fragments upto 3cm.		33.00	B60 D61				S (60) REFUSAL + 175mm	33
	34						34.00	B62 D63				S (60) REFUSAL + 150mm	34
17/8	35						35.00	B64 D65				S (73) REFUSAL + 175mm	35
	36 36.00					131 mm	36.00	B66 D67	NA		0	S (60) REFUSAL + 175mm	36
18/8	37		LIMESTONE		Moderately weathered horizontally machine broken 5-15cm spacing, white greyish brown silty sand pockets, medium-coarse grained, coralline.		36.70 37.00		0		10	30 BLOWS NO PENETRATION	37
	38 38.00						38.00		.04		12	30 BLOWS NO PENETRATION	38
	39 39.00		GRAVEL		Very dense white angular coral limestone fragments.		39.00		NA		0	30 BLOWS NO PENETRATION	39
	40 40.00		SAND		Very dense brown medium and coarse, trace fine subangular gravel.		40.00		NA		NA	30 BLOWS NO PENETRATION	40

END OF B/H

DATE	TIME	DEPTH (M) HOLE	CASING	WRL
6/8/93	6.00	0.00	NIL	DRY
	18.00	4.00	4.00	G.L.
7/8/93	6.00	7.00	7.00	G.L
	18.00	9.00	7.00	1.00
8/8/93	6.00	13.00	13.00	G.L.
	18.00	17.00	17.00	0.50
9/8/93	6.00	18.00	18.00	1.80
	18.00	20.00	18.40	G.L.
10/8/93	6.00	20.00	18.40	0.65
	18.00	21.00	18.40	0.50
12/8/93	6.00	23.00	23.00	0.40
	18.00	24.00	24.00	G.L.
13/8/93	6.00	27.00	26.75	1.00
	18.00	28.00	28.00	G.L
16/8/93	6.00	30.00	28.00	1.00
	18.00	33.00	33.00	G.L.
17/8/93	6.00	35.00	34.00	G.L.
	18.00	36.00	35.60	G.L.
18/8/93	6.00	36.00	35.10	G.L.
	18.00	40.00	35.10	G.L.
19/8/93	6.00	40.00	35.10	G.L.
	18.00	40.00	35.00	G.L.
20/8/93	6.00	40.00	35.00	G.L.

LOG FORM-B

HOLE NO.

* R.Q.D is Rock Quality Designation, R.Q.D = (Total length of cylindric cores longer than 10 cm)/(Total core length) × 100%
* LUGEON VALUE is l/min/m under injection water pressure of 10kg/cm²
* DEPTH and ELEVATION are in meter
* DIAMETER is in millimeter

\+ HAMMER BOUNCING

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Fig. 2

DRILL LOG

HOLE NO. 3 SHEET NO. 1 OF 1

PROJECT	NEW SABAKI BRIDGE – KENYA			DEPTH	20.00 m
SITE	MALINDI	COORDINATE	: :	INCLINATION	VERTICAL
AVERAGE CORE RECOVERY	76 %	DATE	FROM 6/8 TO 10/8/93	DRILLED	J. G.
ELEVATION		DRILL RIG	L/YEAR	LOGGED	J. O.

DATE	DEPTH	ELEVATION	ROCK TYPE OR FORMATION	DESCRIPTION	BIT & DIAMETER
6/8	0.50		SAND	Brown fine medium with some limestone gravel	150 mm
	3.60		GRAVEL	Loose becoming medium dense light brown/white angular medium to coarse, coralline limestone fragments in calcareous sand; with roots.	
	4.45		LIMESTONE	Slightly weathered with widely spaced fractures white medium – coarse grained, coralline. With occasional cavities upto 6cm across.	146 mm
7/8	8.50		LIMESTONE	Moderately weathered partly machine broken cream white medium coarse grained, coralline. With zones of coarse calcite cemented carbonate sands. With cavities few mm upto 5cm occasionally sand filled.	
8/8	10.20		LIMESTONE	Slightly weathered massive white medium-coarse grained, coralline; with small cavities upto 1cm, occasionally stained orange.	
	12.50		LIMESTONE	Moderately weathered machine broken vuggy cream white fine-medium grained, coralline. Cavities upto 3cm.	
	15.00		SAND	Medium dense white angular coarse quartz sand in carbonate matrix (much not recovered)	131 mm
9/8	16.00		SANDSTONE	Slightly weathered bedded, laminated with very closely and closely spaced subhorizontal partings; white coarse grained.	
	17.65		LIMESTONE	Moderately weathered with closely spaced fractures white, coarse grained recrystalliced coralline, with thin silty carbonate bands.	
	18.65		LIMESTONE	as above, highly weathered.	
	20.00		LIMESTONE	Slightly weathered cream white coarse grained coralline. Cavities upto 4cm.	
				END OF B/H	

GROUNDWATER LEVEL	CORE RECOVERY F.I.	SAMPLES	RQD	S.P.T. N VALUES	DEPTH
0.00					
1.00	NI	D1	0	N = 6	1
2.00		D2	0	N = 12	2
3.00		D3	0	N = 18	3
4.00	2		50	(34) REFUSAL + 0.15cm	4
5.00	0		70	(32) REFUSAL + 0.10cm	5
6.00	NI		12	(34) REFUSAL + 0.05cm	6
7.00	2		0	(37) REFUSAL + 0.05cm	7
8.00	0 / 1		80	(34) REFUSAL + 0.15cm	8
9.00	NI		38	(34) REFUSAL + 0.05cm	9
9.55	0		100		
10.05			100	(30) REFUSAL + 0.05cm	10
11.00			12	(51) REFUSAL + 0.15cm	11
12.00			0	(50) REFUSAL + 0.05cm	12
12.50	NI		0		
13.00		D4	0	N = 15	13
14.00		D5	0	N = 16	14
15.00		D6	0	N = 30	15
16.00	9		20	(46) REFUSAL + 0.15cm	16
17.00	8 / 5		0	(39) REFUSAL + 0.10cm	17
18.00	NI	D7	18	(48) REFUSAL + 0.15cm	18
19.00	1		18	(41) REFUSAL + 0.05cm	19
20.00	0		100	(48) REFUSAL + 0.10cm	20

DATE	TIME	DEPTH (M) HOLE	CASING	W.R.L.
6/8/93	6.00	NIL	NIL	DRY
	18.00	3.00	1.50	1.35
	6.00	6.00	3.00	1.40
7/8/93	6.00	6.00	3.00	1.45
	18.00	6.00	6.00	1.80
	6.00	9.55	7.20	4.20
8/8/93	6.00	9.55	7.20	4.20
	18.00	12.50	11.00	7.60
	6.00	15.00	14.35	7.65
9/8/93	6.00	15.00	8.80	7.65
	18.00	16.00	14.80	7.85
	6.00	20.00	14.80	9.10
10/8/93	6.00	20.00	14.80	8.45
	14.20	20.00	14.80	8.40
	15.00	20.00	NIL	9.15

HOLE NO.

LOG FORM-B

Fig. 3

*R.Q.D is Rock Quality Designation, R.Q.D = (Total length of cylindric cores longer than 10 cm)/(Total core length) × 100%
*LUGEON VALUE is l/min/m under injection water pressure of 10kg/cm²
*DEPTH and ELEVATION are in meter
*DIAMETER is in millimeter

T.C.R. = Total Core Recovery
F.I. = Fracture Index

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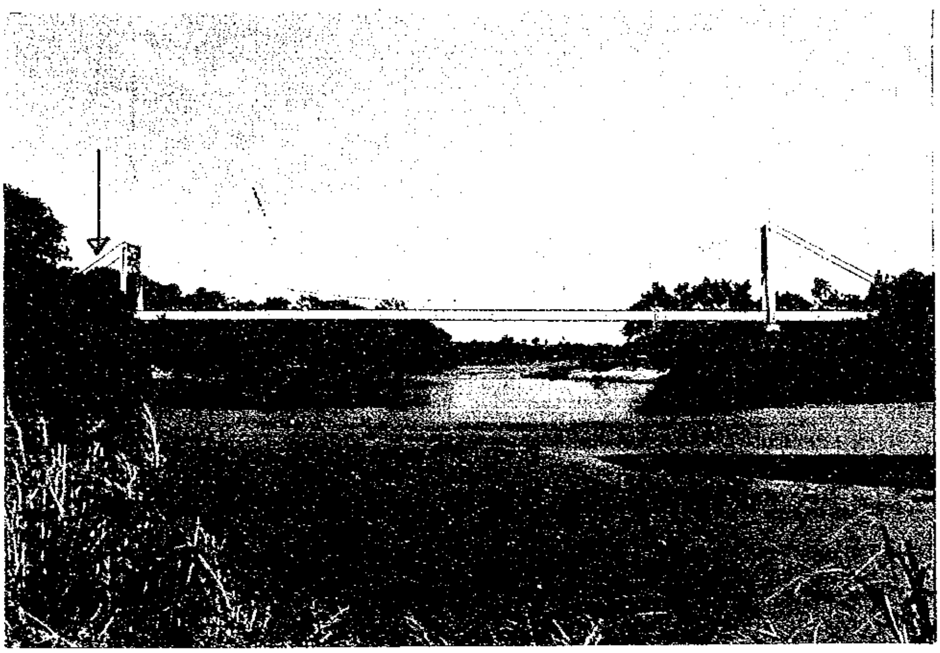
Appendix VI Estimated Future Traffic Volume

	Normal Traffic					Generated Traffic					Total					AADT	Remarks
	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)		
1993	126	139	157	37	33											492	
1994	131	143	163	38	34											509	
1995	137	148	170	39	35											529	
1996	143	153	177	41	36											550	
1997	149	158	184	43	37	37	40	37	9	7						701	New bridge and Malindi -
1998	155	160	191	45	38	39	40	38	9	8						723	Garsen road completed
1999	162	165	199	47	39	41	41	40	9	8						751	
2000	169	174	207	49	40	42	44	41	10	8						784	
2001	176	180	215	51	41	44	45	43	10	8						813	
2002	184	186	224	53	42	46	47	45	11	8						846	
2003	192	192	233	55	43	48	48	47	11	9						878	
2004	200	198	242	57	44	50	50	48	11	9						909	
2005	209	204	252	59	45	52	51	50	12	9						943	
2006	218	211	262	61	46	55	53	52	12	9						979	
2007	227	218	272	63	47	57	55	54	13	9	284	273	326	76	56	1,015	
	4.3%	3.2%	4.0%	3.9%	3.2%	25%	25%	20%	20%	20%							Growth rate
											1	1.5	1.5	5	8	4	P.C.U. factor
											284	410	1,630	608	224	3,156 P.C.U./d	

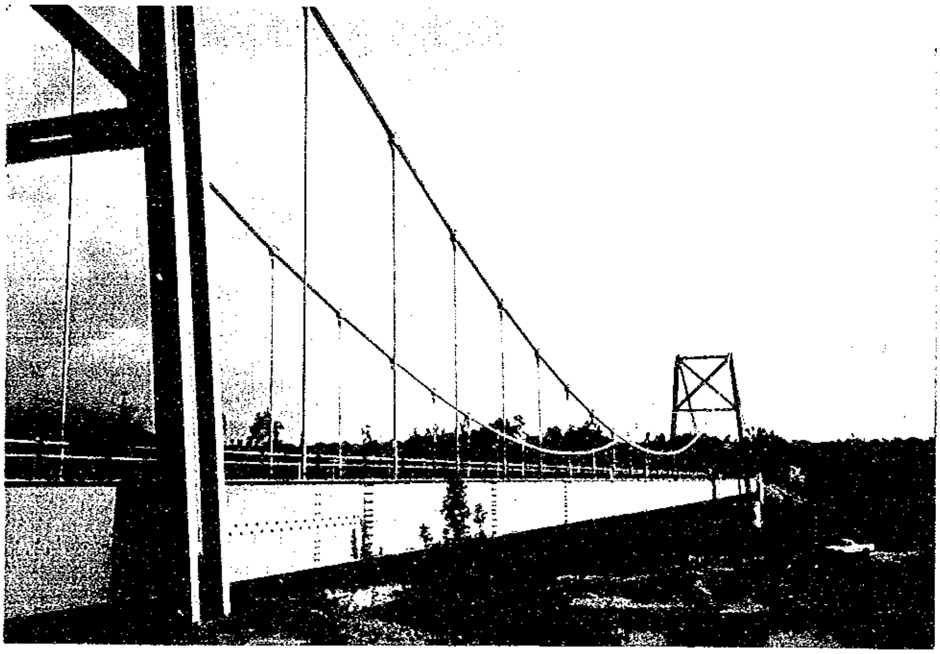
(1) Cars
(2) Light Vehicles
(3) Medium Vehicles
(4) Heavy vehicles
(5) Buses
AADT: Average annual daily traffic
P.C.U.: Passenger Car Unit



Sabaki bridge viewing from upstream.
Wires are broken at the arrow.

Viewing from Malindi side.
Sign board showing weight restriction and barrier for traffic control are seen.

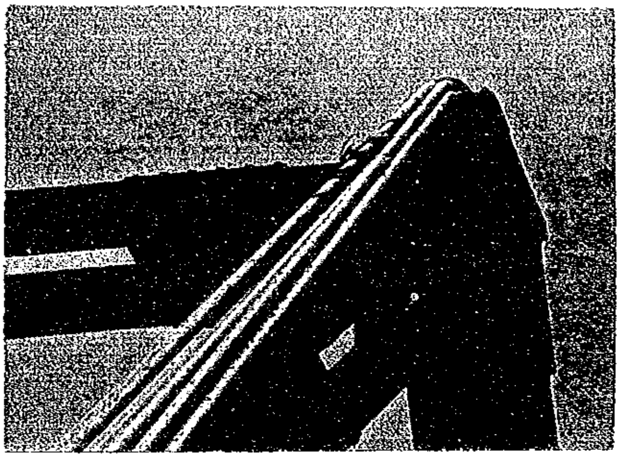
Close view on Malindi side.
Pedestrians walk on traffic lane

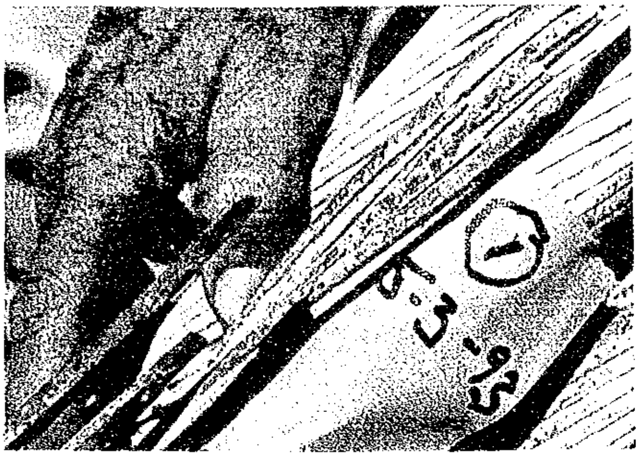


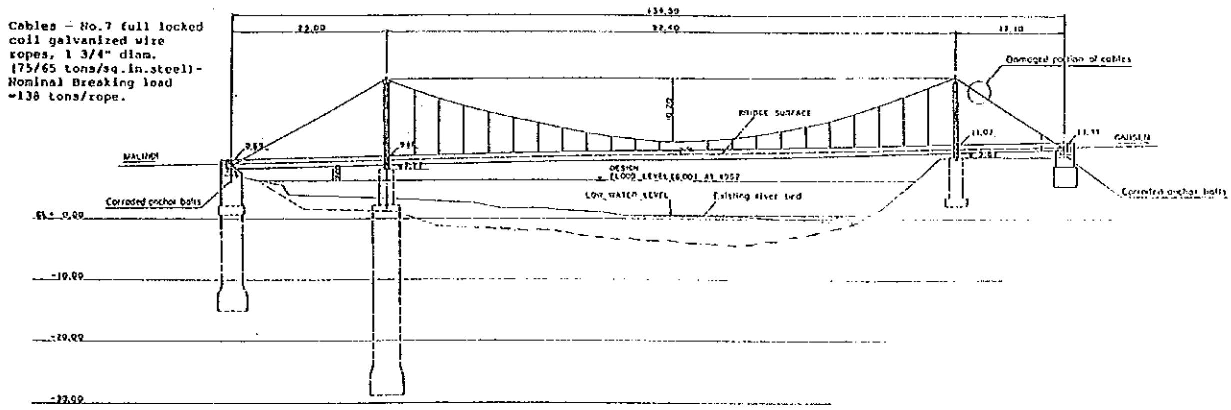
Viewing from upstream on Garsen side.
Power line on upstream.

Republic of Kenya	New Sabaki Bridge Construction Project

Ropes of broken wires on land side.

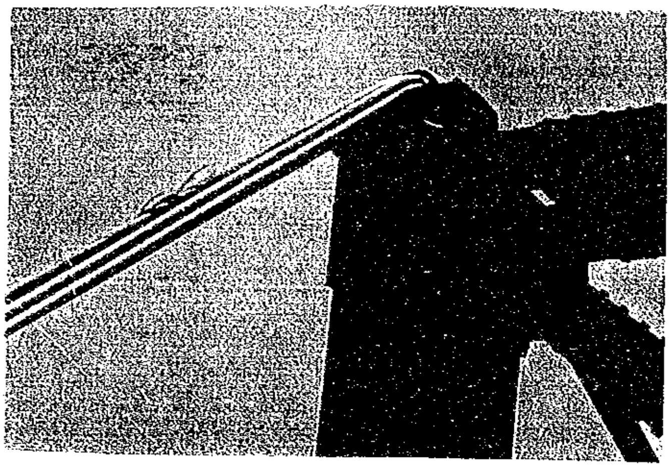


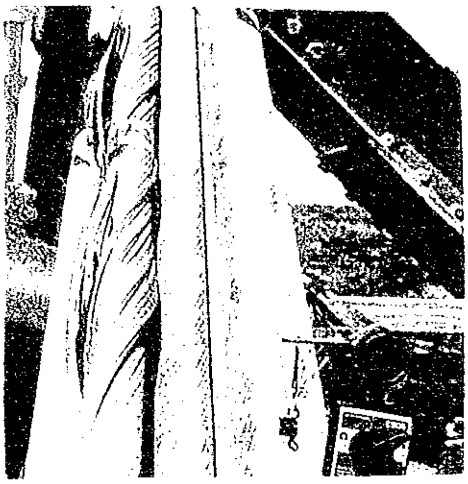




Two ropes are in very bad condition (wires broken) and another two ropes are getting serious in corrosion. The remaining is good in appearance.

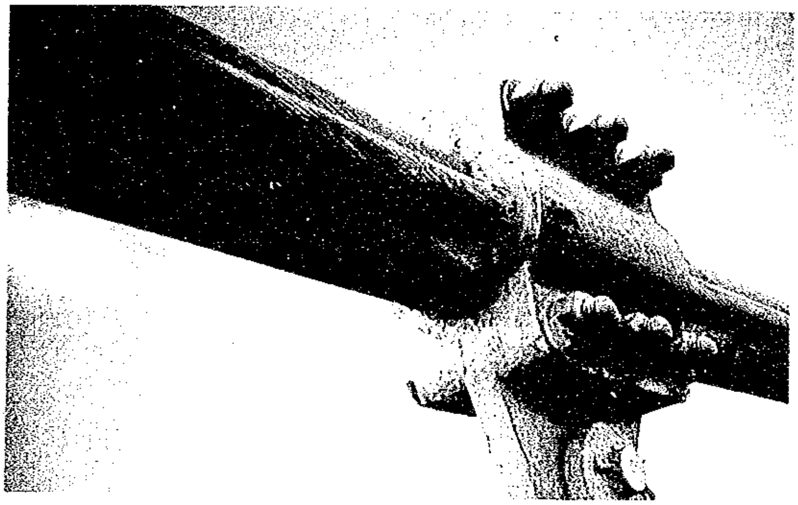
Republic of Kenya	New Sabaki Bridge Construction Project



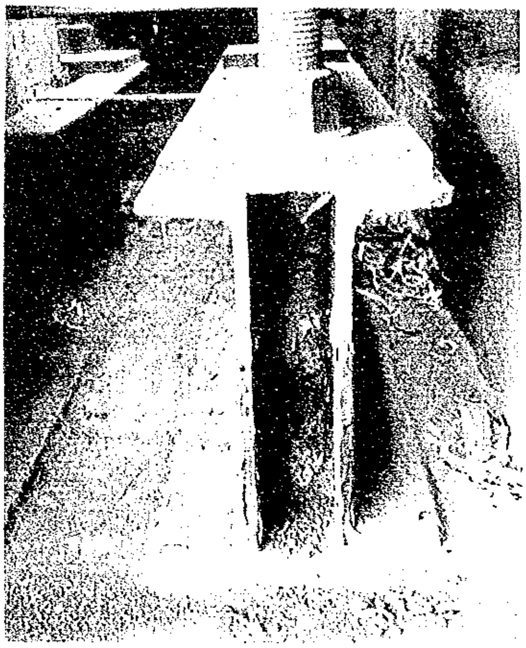


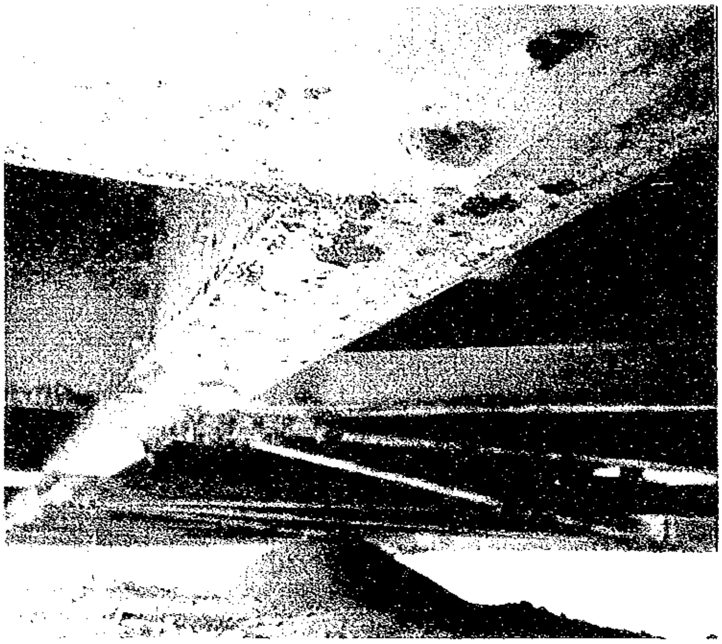
Ropes of broken wires on sea side

Two ropes are in very bad condition (many wires broken). Another two ropes have extensive corrosion. The remaining have light corrosion only.



No protective paint have been done.





Badly corroded anchor bolts for all bolts.

Rust under stiffening girder plate
on Garsen side.

Appendix-VIII Assessment of Bridge Length

1.1 Estimate of design flood discharge

1.1.1 Calculation Method

The following points were considered in determining the method of estimating the design flood discharge at the bridge site:

1) Most of the Sabaki river basin consists of semi-arid or arid zones, precipitation is low and the loss of water due to penetration and evaporation is great, so the annual runoff coefficient is an extremely low 2.3% (Revealed by The Study on the National Water Master Plan, JICA 1992). This figure is much lower than the margin of error when the flood discharge is calculated by runoff analysis, so for reasons of precision it is not appropriate to calculate the flood discharge by runoff analysis.

2) The water level at the location of the Sabaki bridge has not been measured regularly, and data from a nearby gauging station would have to be used for the flood analysis. However, since the flow capacity of the Sabaki river is low, overtopping occurs between the gauging station and the Sabaki bridge site when the flow is heavy and the plain area is inundated, so that discharge at the location of the bridge is lower than the discharge at the gauging station.

3) The highest recorded flood level at the location of the Sabaki bridge was recorded during the flood in November, 1961, at which time the old Sabaki bridge was washed away. There is a records of the maximum water level at the location of the Sabaki bridge at this time, so the largest recorded flood discharge can be estimated.

   Considering the above points, the design flood discharge (50-years probable flood discharge) at the location of the Sabaki bridge was calculated using the following procedure:

1) Estimate of the probable 50-years flood discharge (Q50') at key station.

   A key station was selected, and a probability analysis of the annual maximum discharge was conducted.

2) Estimate of the largest recorded flood discharge (Qm) at the location of the bridge

Based on the data for the water level at the time of the largest recorded flood at the bridge site, the flood discharge at this time was estimated using non-uniform flow calculation.

3) Estimate of the design flood discharge (probable 50-years flood discharge: Q50) at the bridge site.

The design flood discharge at the bridge site was estimated by determining the expansion rate from the above Q50', Qm and the recorded discharge at a selected gauging station at the time of the largest recorded flood at the bridge site (Qm'). The formula is as follows:

$$Q50 = Qm \times Q50' / Qm'$$

The above estimate procedure is shown on Figure A.VIII.1.

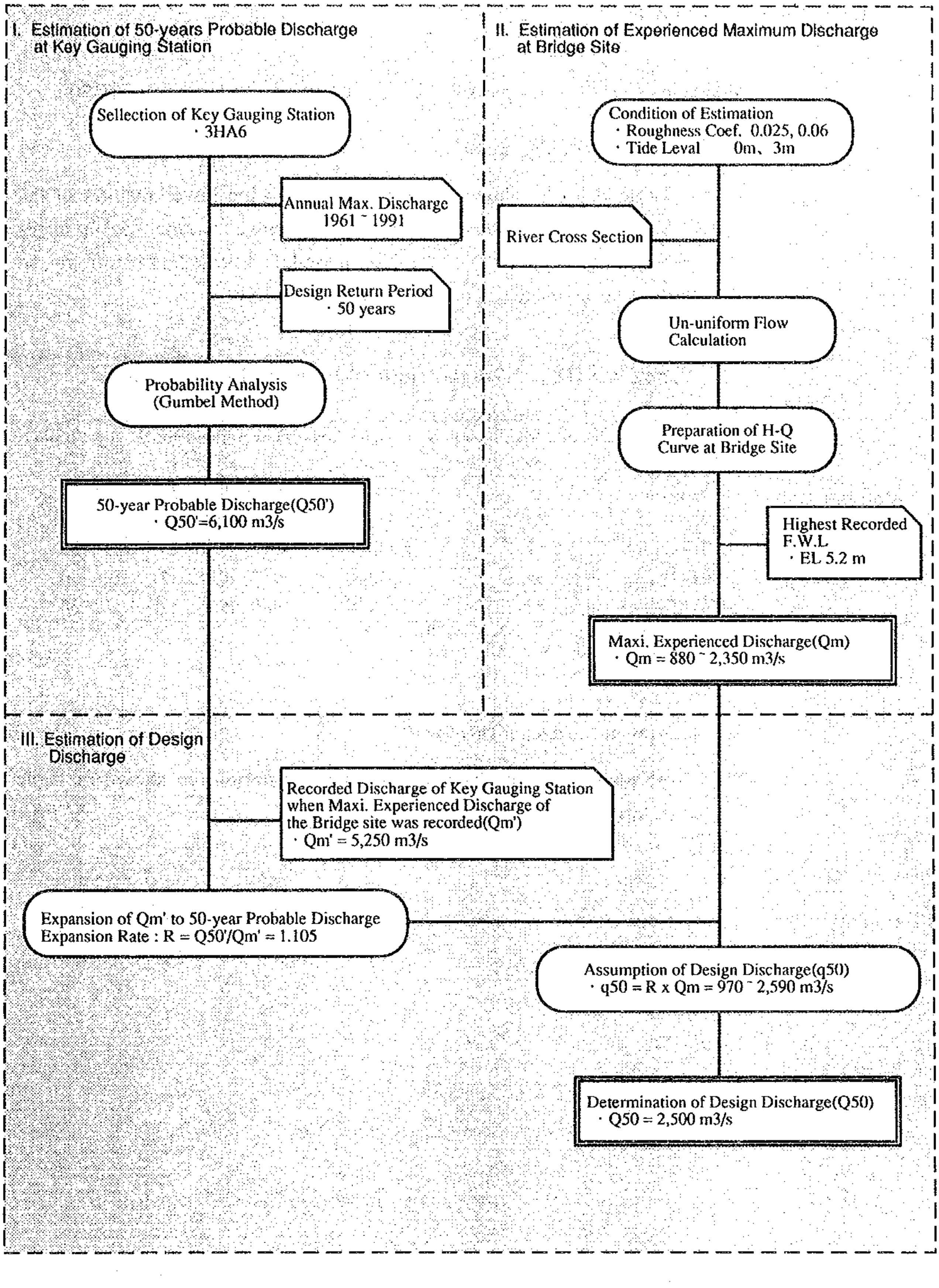


Figure A.VIII.1 Work Flow for Estimation of Design Discharge

1.1.2 Results of estimate

1) Estimate of the 50-years probable flood discharge at the key station (Q50').

(1) Selection of key station

Table A.VIII.1 shows the key stations on the lower reaches of the Sabaki river. 3HA6 is the nearest to the bridge site, the measurements have been taken there over a long period, and little data is missing, so this was selected as the key station.

Table A.VIII.1 Gauging Station Along the Lower Sabaki

Gauging Station	Distance from Mouth (km)	Catchment Area (km^2)	Observation Peered (year)	Loss Ration (%)
3HA6	8	38,500	1961 - 1991 (31)	20
3HA8	36	35,700	1973 - 1982 (10)	40
3HA1	39	35,700	1949 - 1951 (3)	85
3HA2	55	35,400	1953 - 1957 (5)	90
3HA3	77	35,200	1951 - 1957 (7)	30

Note: Report on the Hydrology of the Sabaki River, 1973
Study on the National Water Master Plan, JICA 1992

(2) Annual Maximum Discharge

Annual maximum discharges at the key station are shown in Table A.VIII.2.

Table A.VIII.2 Annual Max. Discharge at 3HA6

No.	Year	Gauge Reading (E.L.)	Max. Discharge (m^3/s)	No.	Year	Gauge Reading (E.L.)	Max. Discharge (m^3/s)
1	1961	-	5,520	17	1977	4.7	6,400
2	1962	1.5	145	18	1978	3.0	1,500
3	1963	2.6	900	19	1979	3.2	1,800
4	1964	2.2	560	20	1980	2.4	540
5	1965	1.9	340	21	1981	3.9	3,600
6	1966	2.0	400	22	1982	4.1	4,100
7	1967	3.1	1,600	23	1983	1.7	220
8	1968	3.3	2,050	24	1984	3.2	1,800
9	1969	2.2	560	25	1985	2.7	1,050
10	1970	3.1	1,600	26	1986	3.6	2,600
11	1971	3.3	2,050	27	1987	1.2	68
12	1972	3.1	1,600	28	1988	3.3	2,050
13	1973	2.5	800	29	1989	3.4	2,150
14	1974	3.2	1,800	30	1990	3.4	2,150
15	1975	3.0	1,500	31	1991	2.3	560
16	1976	3.3	2,050				

(3) Estimate of 50-years Probable flood discharge (Q50') at 3HA6

By using the Gumble Method, a probable 50-years flood discharge (Q50') at 3HA6 was estimated and was about 6,100 m^3/sec as shown in Figure A.VIII.2.

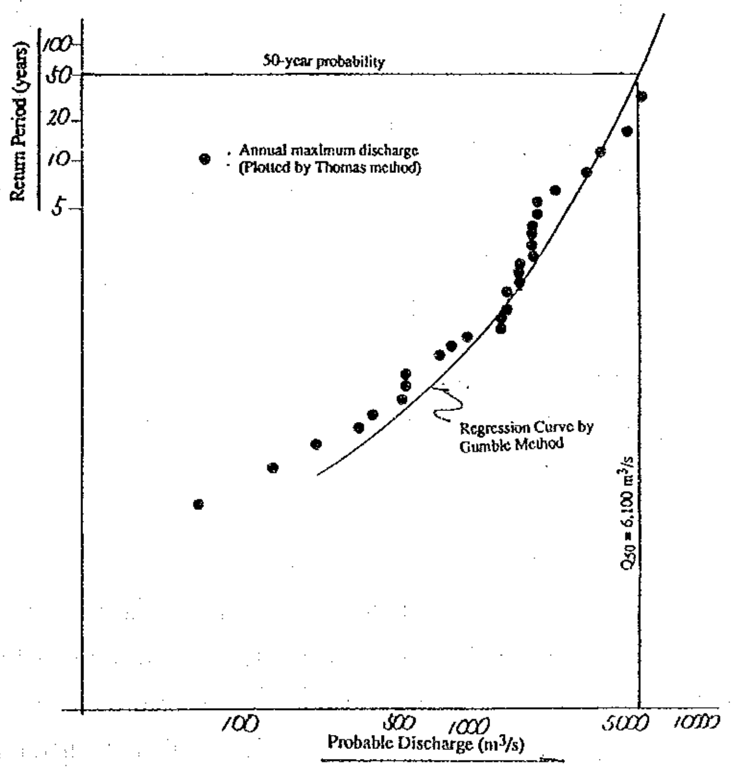


Figure A.VIII.2 Probable Flood Discharge by Gumbel Method

2) Estimate of the largest recorded flood discharge at the bridge site

The largest recorded flood at the location of the Sabaki bridge was in November 1961, at which time the old bridge, located upstream from the existing Sabaki bridge, was washed away. The flood level at this time was recorded as EL 5.2 meters.

Using cross-sections of the river obtained through the river cross section survey, the relationship between the water level and the discharge at the old bridge site is calculated using non-uniform flow calculation, and the largest recorded flood discharge will be estimated under the largest recorded water level.

The initial water level and coefficient of roughness, factors directly affecting the results of the non-uniform flow calculation, were set as follows:

(1) Coefficient of roughness

According to the coefficient of roughness classification for Kenyan rivers in the Roads Department's "Technical Data Manual for Design of Bridges, Volume 2 - Climatological Data", in its lower reaches the Sabaki river is classified as a "major stream - regular section with no boulders or bush", in which case the coefficient of roughness is within the range of 0.025 to 0.06. this value can also be considered appropriate in comparison to the values in Japan's Hydraulic Formula. since specifying the value within this range is difficult due to the lack of studies on the coefficient of roughness of the Sabaki river and the absence of other effective data, here it was decided to conduct the calculations with coefficients of roughness of both 0.025 and 0.06.

(2) Initial water level

The Sabaki bridge is located about 3 km from the mouth of the river, and as such was judged to be in a tidal area. According to records of tide levels in Malindi harbor near the mouth of the Sabaki river, the tide fluctuates between the range of 0 to 3 meters above sea level, so here calculations were conducted with the initial water level set at 0 and 3 meters.

Figure A.VIII.3 shows the relationship between the water level and the discharge at the old bridge site under the above conditions. According to this figure, it is concluded that when the discharge reaches 1,000 m^3/s the effect of the initial water level be neglected, and only the coefficient of roughness affects the water level.

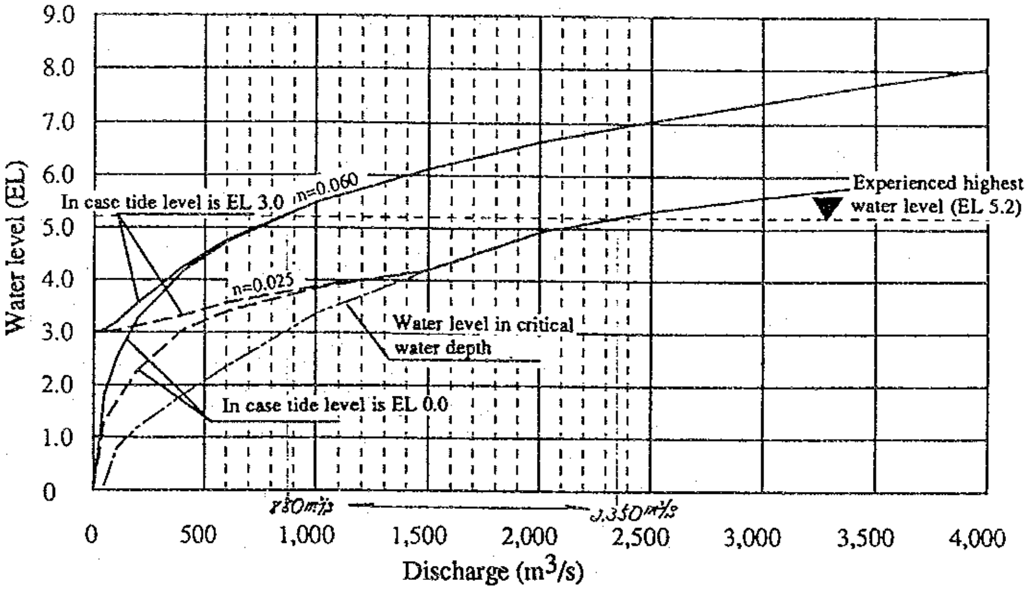


Figure A.VIII.3 Relationship Between Water Level and Discharge (H-Q Curve) at Sabaki Bridge Site

The largest recorded flood discharge (Qm) corresponding to the largest recorded flood level at EL 5.2 meters was estimated at between the range 880 m^3/s < Qm < 2,350 m^3/s, depending on the coefficient of roughness.

3) Estimate of the design flood discharge (probable 50-years flood discharge: Q50) at the bridge site.

The largest recorded flood discharge (Qm) at the old bridge site was converted to the design flood discharge using the following formula:

$R = Q50' / Qm'$

$Q50 = Qm \times R$

Where,

R = Expansion rate

Q50 = Design flood discharge at the bridge site.

Qm = Largest recorded flood discharge at the bridge site = 880 ~ 2,350 m^3/s.

Q50' = Probable 50-years flood discharge at the key station = 6,100 m^3/s

Qm' = Recorded discharge at the key station at the time of the largest recorded flood at the location of the bridge = 5,250 m^3/s.

Thus,

R = 6,100/5,250 = 1.105

Q50 = (880 - 2,350) x 1.105 = 970 ~ 2,590 m^3/s

Considering the reliability of the measurement data and the possible inaccuracy of the set conditions (coefficient of roughness, etc.), a high value within the above range should be used as the design discharge, so the value of Q50 = 2,500 m^3/s was adopted as the design flood discharge.

1.1.3 Determination of bridge length

1) Estimate of Required Bridge Length

In this section, the water level, velocity and characteristics of the flow (sub-critical flow, super-critical flow, critical flow, etc.) at the bridge site are studied by using non-uniform flow calculation and the bridge length and high water level as well as a possibility of demolishing the existing bridge are assessed accordingly.

In the existing bridge, the approach road on the right bank is constructed on the flood plain, thus, strongly disturbing the natural river flow. When designing the new bridge, it is necessary to allow for a sufficient opening so that the design flood discharge can safely flow. This was done by postulating various bridge lengths and determining the flow conditions at the bridge site for the various flow cases using non-uniform flow calculation.

The results of the calculation are shown of Figure A.VIII.4, showing the relationship between the flow condition and bridge length at the bridge site. (Note: These calculations were conducted based on the premise that the existing bridge and the raised ground on which the approach road is constructed have been removed sufficiently so as not to affect the calculations.)

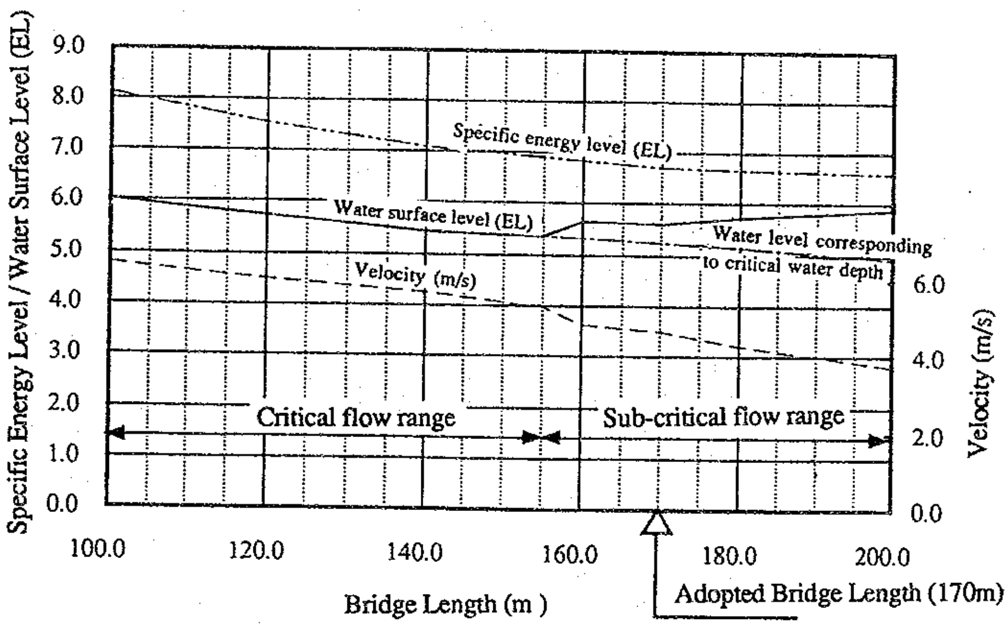


Figure A.VIII.4 Relationship Between Flow Condition and Bridge Length

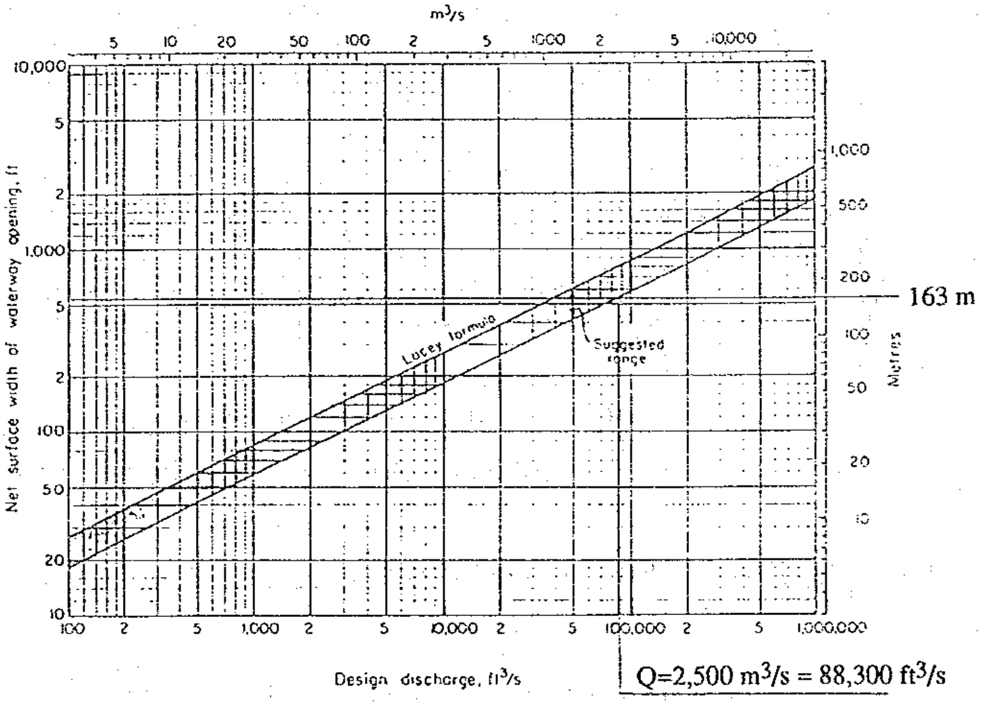
As can be seen in the diagram, with a bridge length of 160 meters and less, a critical depth arises at the new bridge site and the flow is a critical flow. In this case, the problem arises of increased inundation area upstream of the new bridge due to rising the water level, as well as super-critical flow directly downstream, resulting in scouring. With a length of over 160 meters, the flow is sub-critical and stable.

The rate of increase in the specific energy of the flow also increases below a bridge length of 160 to 170 meters, while the change is more gradual beyond this.

From the above considerations, it was decided to adopt a bridge length of 170 meters, deemed a length at which the flow at the bridge site is essentially stable.

Furthermore, according to the empirical formula for the design discharge and standard bridge length included in the "Guide to Bridge Hydraulics, Road and Transportation Association of Canada", a length of 170 meters is appropriate for a discharge of 2,500 m^3/s, as shown on Figure A.VIII.5.

As for the design flood-water level, a lowering of the water surface is generated by a reduced flow section at the bridge site with a bridge length of 170 meters, so the F.W.L. was set to 6.5 meters, interpolating the water levels up- and downstream (See Figure A.VIII.6).



Source: Guide to Bridge Hydraulic, Road and Transportation Association of Canada

Figure A.VIII.5 Lacey's Empirical Formula between Discharge and Waterway Opening

2) Assessment of possibility for demolishing the existing bridge.

The distance between the existing bridge's abutment on the left and right bank is approximately 110 meters, which is quite short when compared to the length of the new bridge, 170 meters, determined above. Since the new bridge will be located only approximately 20 meters downstream from the existing bridge, the new bridge could suffer adverse effects without a sufficient bridge opening at the existing bridge.

In this section, the flow conditions in the vicinity of the new bridge under the design flood discharge with and without the existing bridge cases are assessed.

The results are shown on Figure A.VIII.6. According to this figure, when the existing bridge is removed (including a part of the approach road on the right bank), the depth is lower than the critical depth at all points in the vicinity of the new bridge, and the water can flow in a sub-critical flow. On the other hand, if the existing bridge is not demolished, a critical depth arises there because of its narrow section and a backwater approximately 1 meter higher than the case without the existing bridge is generated upstream. Also, a super-critical flow is generated downstream and may reach the point of the new bridge. As a result, it was determined that there is a need to demolish the existing bridge, for the following reasons:

(1) As is an evident from the fact that the water level directly upstream of the existing bridge is above the height of the girder soffit, the specific energy of the flow (water level + velocity head) at the bridge site is already above the girder soffit. This means that the actual water level may rise above the girder soffit in localized places where the velocity is slow, such as on the upstream side of the abutments, and that the water level may rise to the girder soffit if driftwood gets caught, indicating that there is a high risk that the existing bridge may be washed away.

(2) A critical depth arises at the section of the existing bridge, i.e. backwater is generated and the energy of the flow is greater than without case, creating a hydraulic jump downstream as the super-critical flow changes to a critical flow and the energy dissipates. This super-critical flow and hydraulic jump increase the extent of undermining of the riverbed.

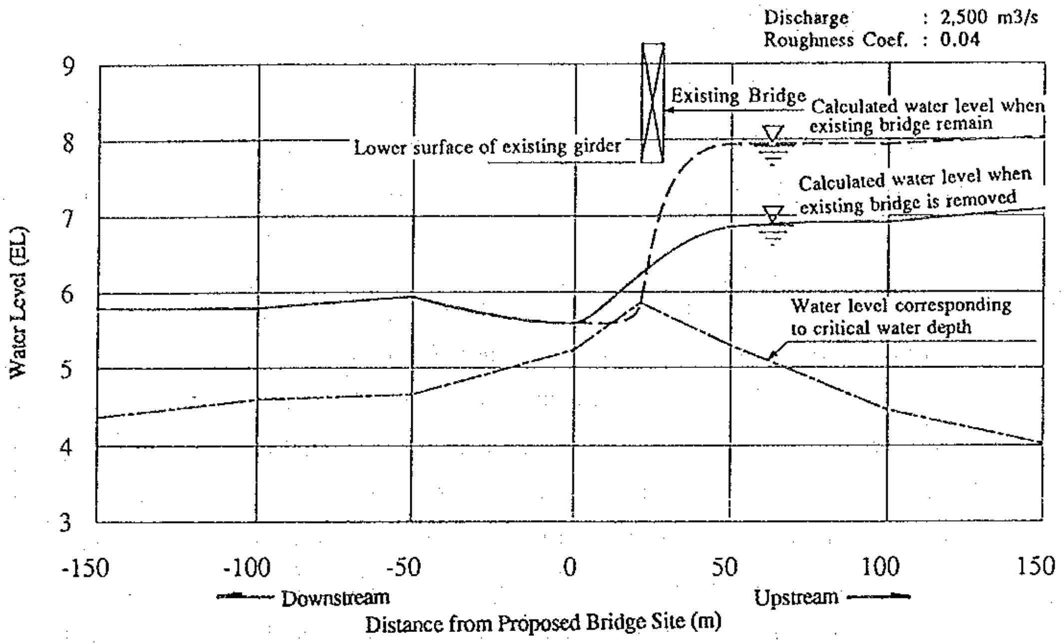
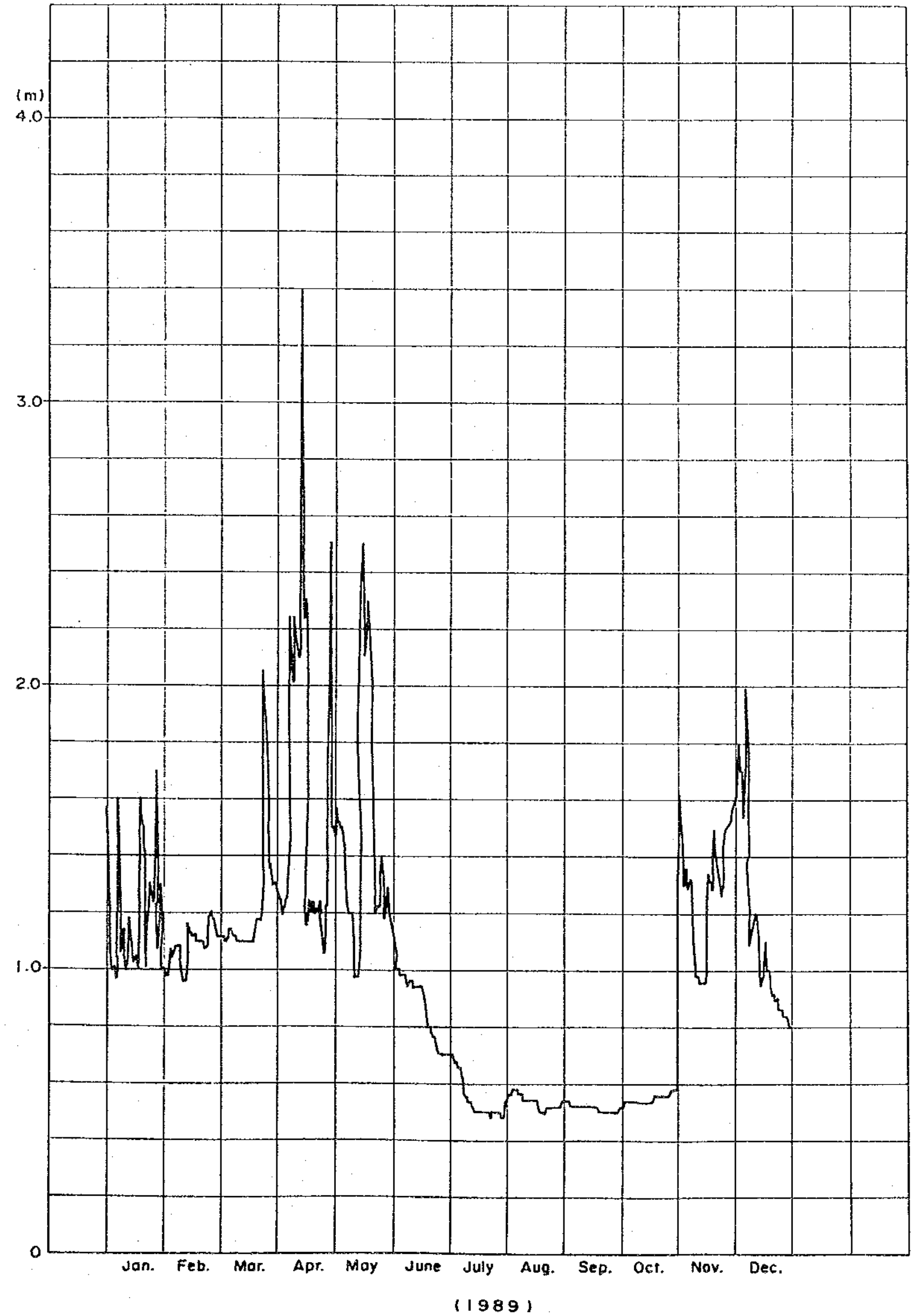


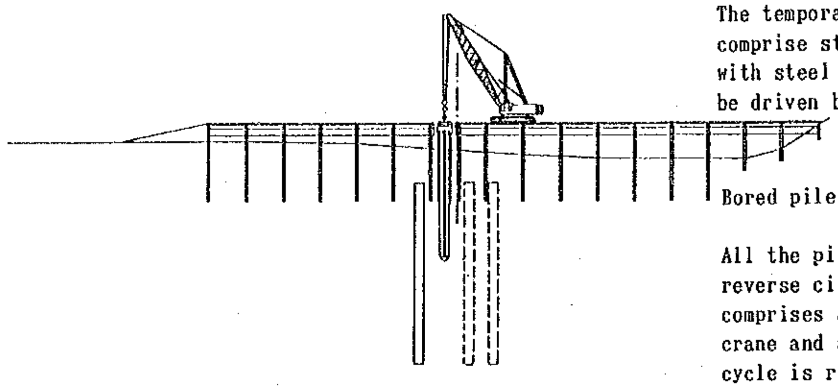
Figure A.VIII.6 Water Surface Profile in Vicinity of Proposed Bridge Site

Appendix-IX River Water Level at Gauging Station

3HA6



STEP 1



Temporary Bridge and Platform

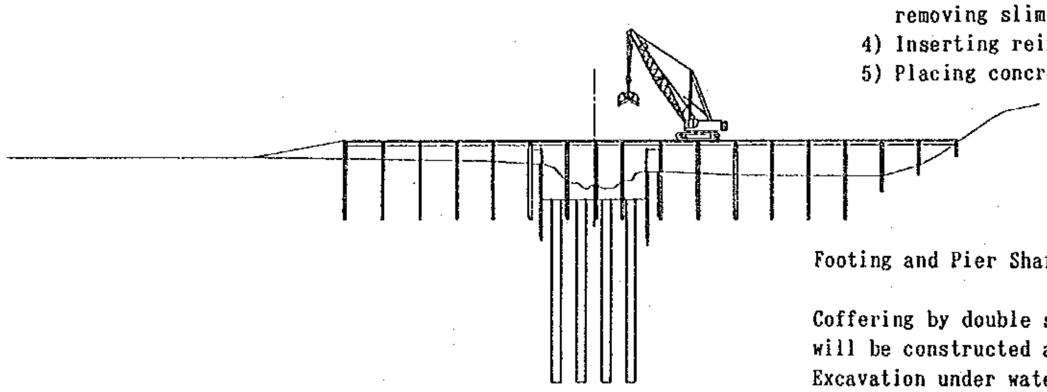
An eight-metre wide temporary bridge and a platform will be erected crossing main channel at height around MSL+6.0m for overwater construction of the bored piles and P1 pier and for the transportation of materials for the abutment construction on left bank.
The temporary bridge and platform comprise steel H-pile bent and beam with steel deck plate. H-plile will be driven by vibrating hammer.

Bored pile for the P1 pier

All the piles are constructed by the reverse circulation drill method which comprises a power unit, a crawler crane and a rotary table. A five-day cycle is required for the completion of one pile as described below.

1) Driving stand pipe by vibrating hammer
2) Drilling by reverse circulation drill
3) Measuring excavation depth and removing slime
4) Inserting reinforcing cage
5) Placing concrete by tremie method

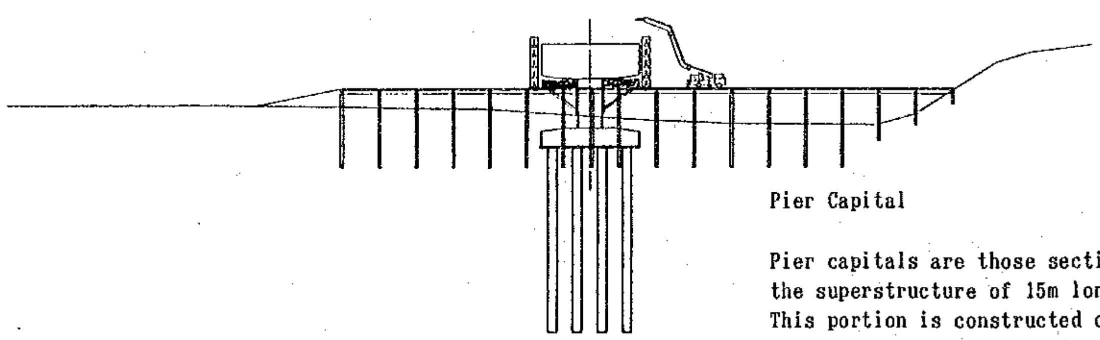
STEP 2



Footing and Pier Shaft

Coffering by double steel sheeting will be constructed around footing. Excavation under water will be executed by cram shell. Wales and bracings will be placed as the excavation proceed. The pile head will be trimmed before starting footing work.

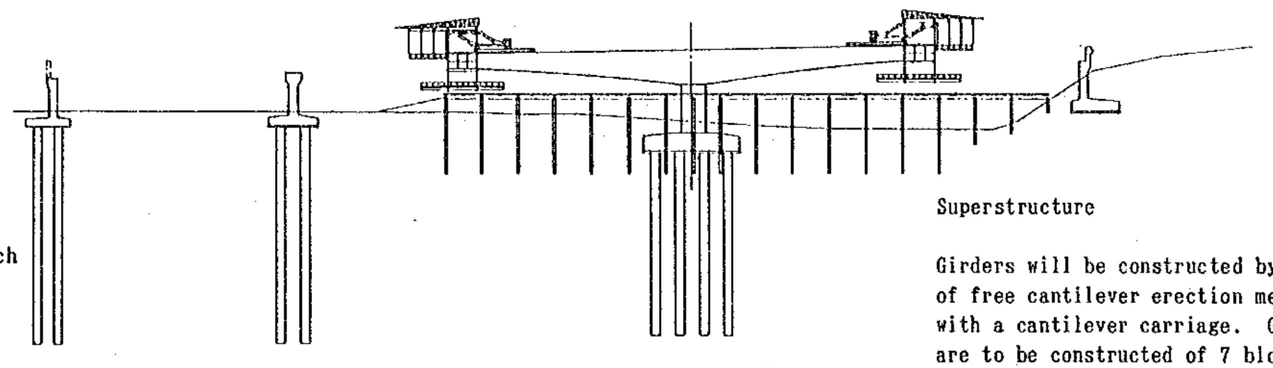
STEP 3



Pier Capital

Pier capitals are those sections of the superstructure of 15m long. This portion is constructed on a temporary supporting platform of a steel beam fixed to the pier shaft.

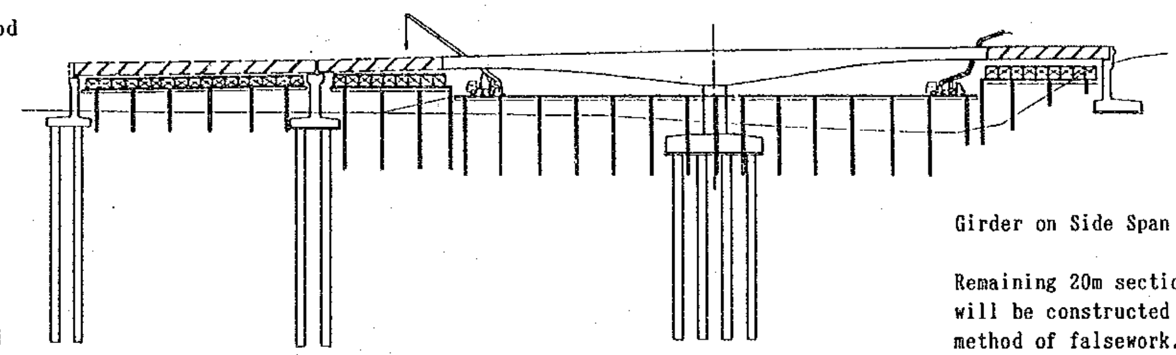
STEP 4



Superstructure

Girders will be constructed by means of free cantilever erection method with a cantilever carriage. Girders are to be constructed of 7 blocks on one side and working cycle of one block is expected to be 11 days. Cantilever carriages extend from the pier toward the abutments to construct 45m of girders.

STEP 5



Girder on Side Span

Remaining 20m section on both side will be constructed using conventional method of falsework.