NATIONAL DEPARTMENT OF ROADS AND BRIDGES
MINISTRY OF PUBLIC WORKS AND HOUSING
THE REPUBLIC OF MOZAMBIQUE

NO. 1

BASIC DESIGN STUDY REPORT
ON
THE PROJECT FOR RECONSTRUCTION OF BRIDGES
ON
THE MAIN NATIONAL ROADS
IN
THE REPUBLIC OF MOZAMBIQUE

DECEMBER 1996

JAPAN INTERNATIONAL COOPERATION AGENCY

CHODAI CO.,LTD

NIPPON KOEI CO.,LTD

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PREFACE

In response to a request from the Government of the Republic of Mozambique the Government of Japan decided to conduct a basic design study on the Project for Reconstruction of Bridges on the Main National Roads in the Republic of Mozambique and entrusted the study to the Japan International Cooperation Agency (JICA).

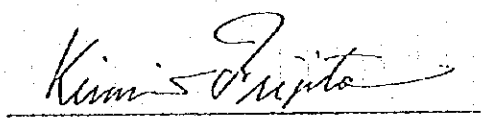
JICA sent to Mozambique a study team from February 21 to March 16, 1996 and May 11 to June 19, 1996.

The team held discussions with the officials concerned of the Government of Mozambique, and conducted a field study at the study area. After the team returned to Japan, further studies were made. Then, a mission was sent to Mozambique in order to discuss a draft basic design, and as this result, the present report was finalized.

I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between our two countries.

I wish to express my sincere appreciation to the officials concerned of the Government of the Republic of Mozambique for their close cooperation extended to the teams.

December 1996



Kimio Fujita

President

Japan International Cooperation Agency

December, 1996

Letter of Transmittal

We are pleased to submit you the basic design study report on the Project for the Reconstruction of the Bridges on the Main National Roads in the Republic of Mozambique.

This study was conducted by Chodai Co., Ltd. and Nippon Koei Co., Ltd. under a contract to JICA, during the period from February 16, 1996 to December 20, 1996. In conducting the study we have examined the feasibility and rationale of the project with due consideration to the present situation of Mozambique and formulated the most appropriate basic design for the project under Japan's grant aid scheme.

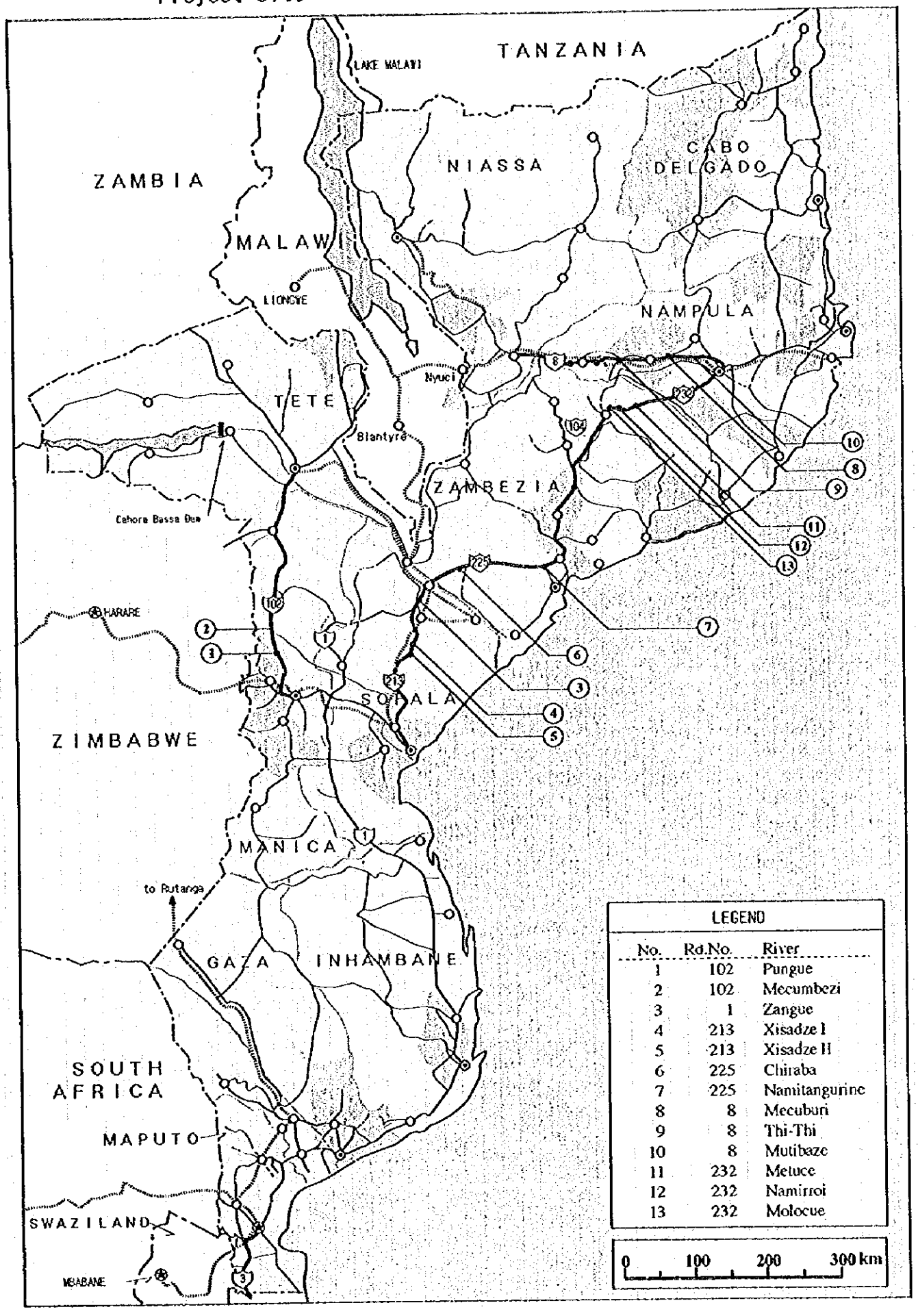
Finally, we hope that this report will contribute to further promotion of the project.

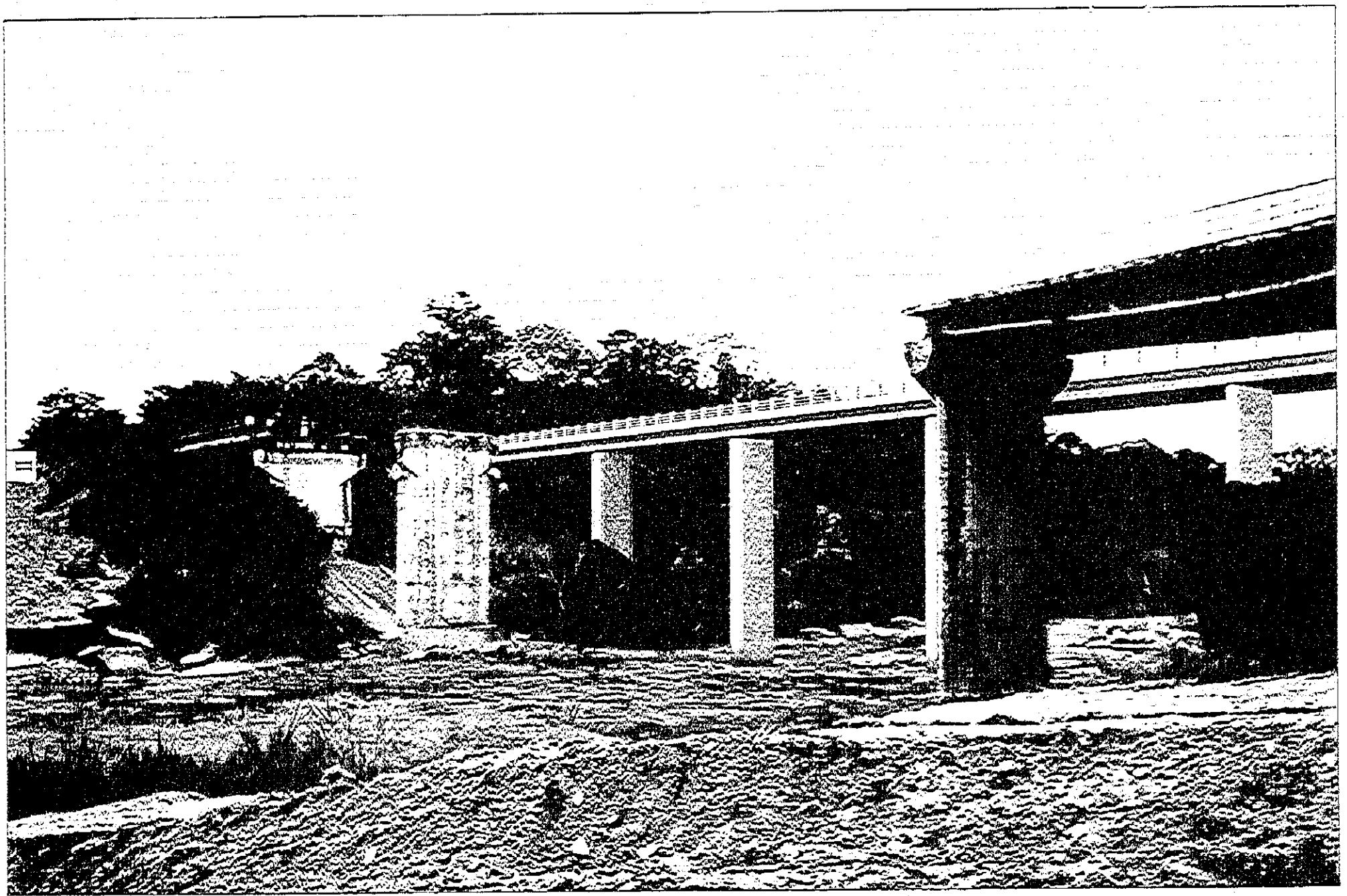
Very truly yours,

安井淳治

Junji YASUI
Project Manager
Basic Design Study Team on the Project
for Reconstruction of Bridges on
the Main National Roads in
the Republic of Mozambique
Chodai Co., Ltd.
Nippon Koei Co., Ltd.

Project Site





Chiraba Bridge

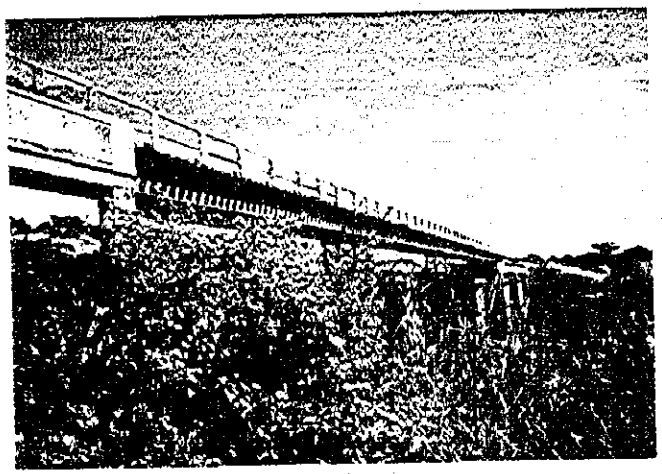


Photo-1 Pungue Bridge

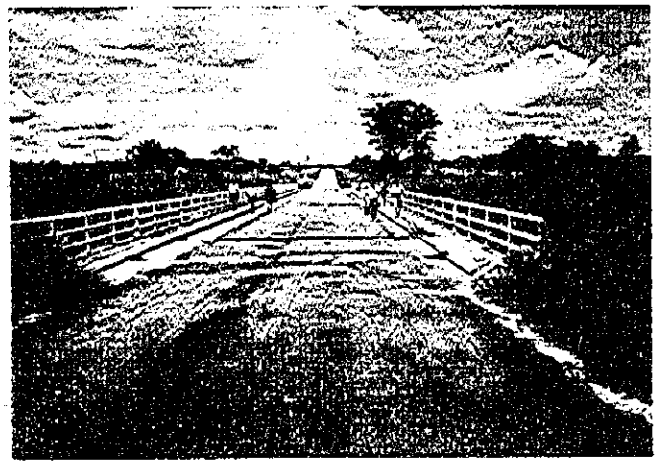


Photo-2 Mecmbezi Bridge

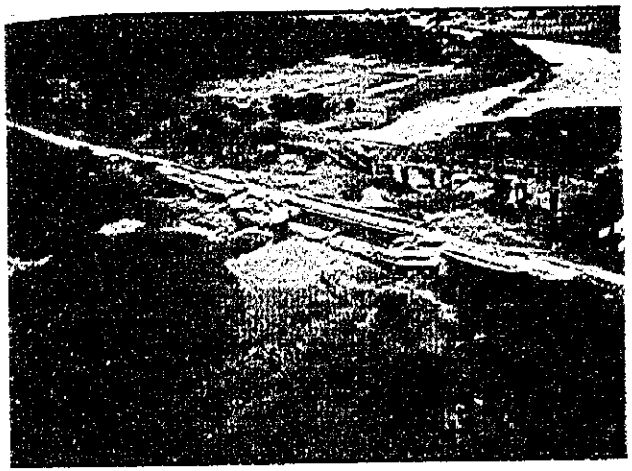


Photo-3 Zangue Bridge

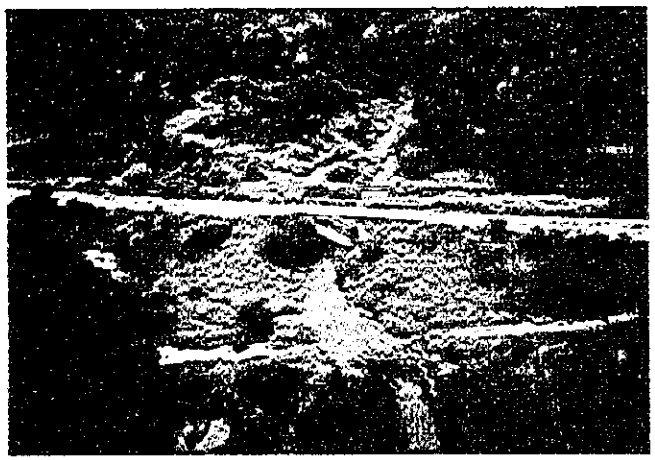


Photo-4 Xisadze I Bridge

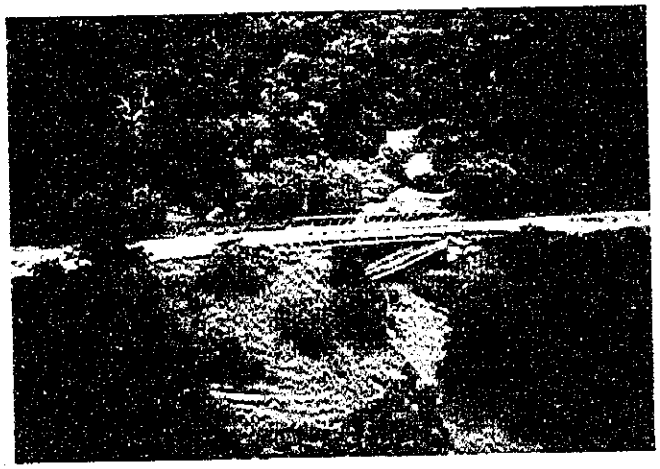


Photo-5 Xisadze II Bridge

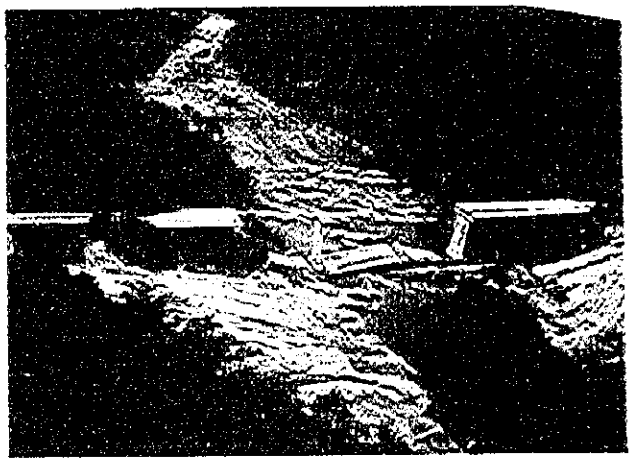


Photo-6 Chiraba Bridge

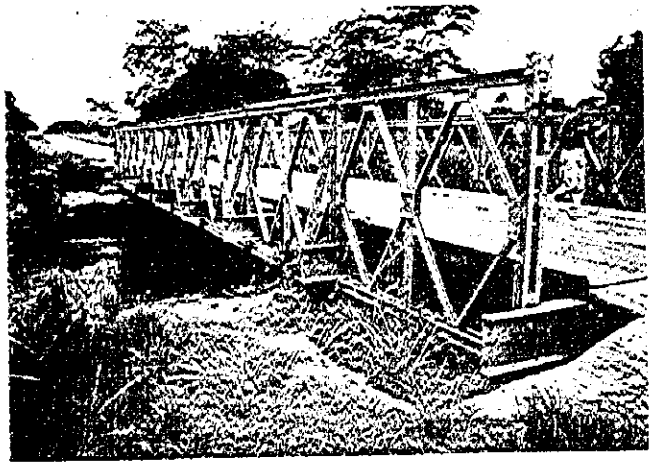


Photo-7 Namitangurine Bridge

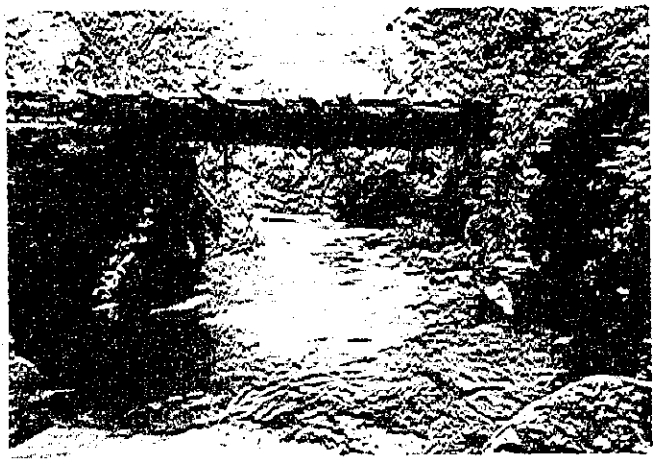


Photo-8 Mecuburi Bridge

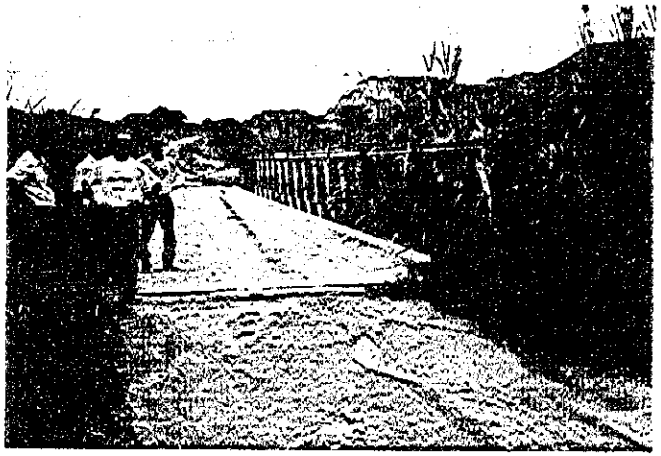


Photo-9 Thi-Thi Bridge

Photo-10 Mutibaze Bridge

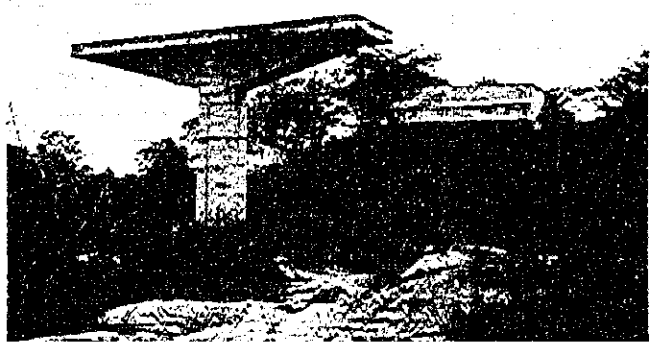


Photo-11 Metuce Bridge

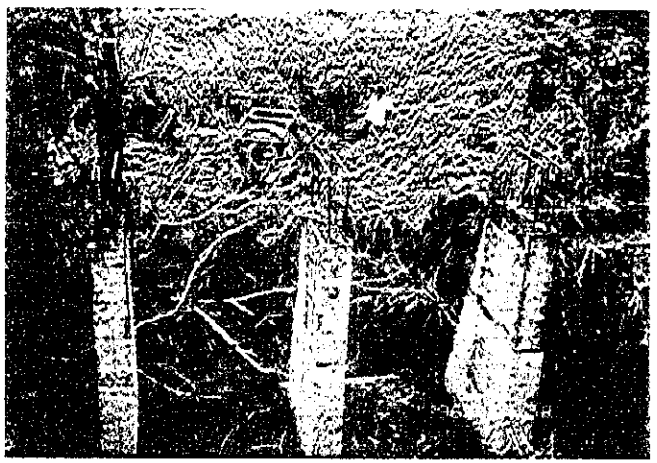


Photo-12 Namirroi Bridge

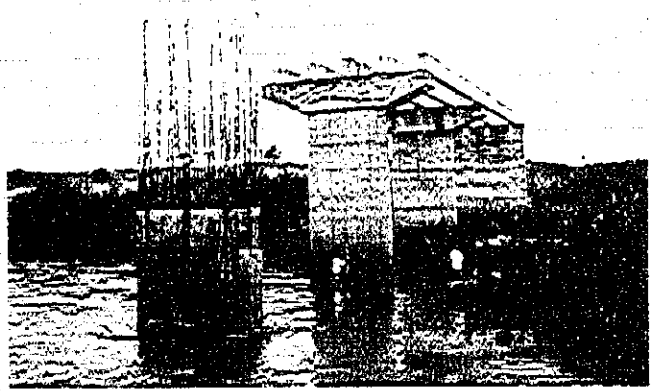


Photo-13 Molocue Bridge

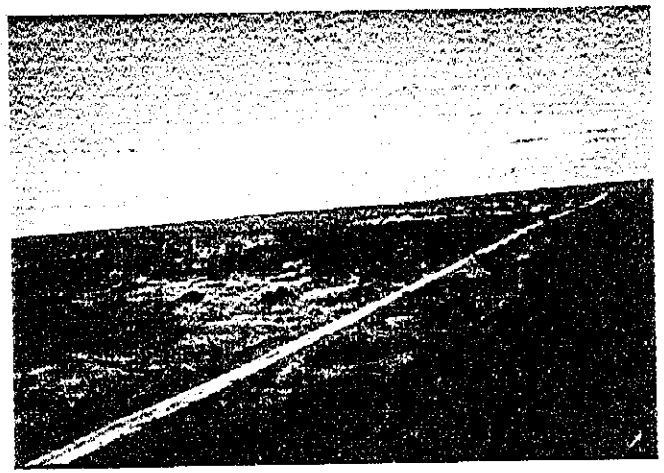


Photo-14 National Highway No213

Photo-15 National Highway No232

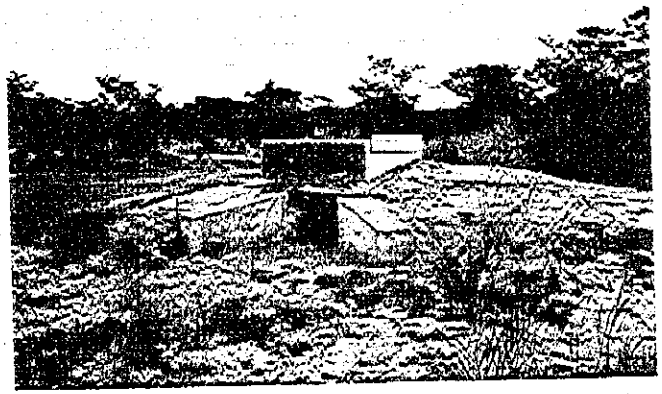


Photo-16 National Highway No8

Abbreviations

A. Authorities and Agencies

FRELIMO	:	Frente de Libertacae de Mozambique
RENAMO	:	Resistancia de National de Mozambique
PKO	:	Peace Keeping Operation
IDA	:	International Development Association
EEC	:	European Economic Community
SADC	:	South Africa Development Cooperation
MOPH	:	Ministerio das Obras Publicas e Habitacao
DNEP	:	Direccao Nacional de Estradas e Pontes
ECMEP	:	Provincial State Enterprise for Construction and Maintenance of Roads and bridges
MTC	:	Ministerio das Transporte e Communicasion
DNM	:	Direccao Nacional de Maritimo
JICA	:	Japan International Cooperation Agency

B. Other Abbreviations

ROCS	:	Roads and Coastal Shipping Project
REO	:	Routes of Emergency Opening
FRCU	:	Forward Road Cleaning Units
ODA	:	Official Development Assistance
PRN	:	National Reconstruction Plan
E/N	:	Exchange of Note
AHP	:	Analytic Hierarchy Process
RC	:	Reinforced Concrete
PC	:	Prestressed Concrete
σ 28	:	Concrete Compressive strength at 28 days
kg/cm2	:	Kilogram per Square Centimeter
BS444	:	British Standard 444

12V13	:	Prestressing Steel Wire
σ pu	:	Tensile Strength of Steel
N/mm2	:	Newton per Square Millimeter

Summary

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σ pu	:	Tensile Strength of Steel
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Summary

SUMMARY

Republic of Mozanbique is located on the east coast of the African continent, facing the Indian Ocean. The country has 0.8 million square kilometers of land area and the land is divided into three parts by Sabe River and Zambezi River. The population of Mozambique in 1991 was 16.1 millions. Since the independence in 1975, the country has continuously suffered by the internal war between the socialist regime (FRELIMO) and the resistance (RENAMO) until cease fire which was agreed to in 1992. With signing of the cease fire in October 1992, Mozambique started to reconstruct the country as a democratic nation.

Mozambique government has drawn up the National Reconstruction Plan to reconstruct the war-ravaged social infrastructure. On the other hand the government has plan to reconstruct road network by the aid from international community organized by IDA to implement ROCS Plan. The ROCS plan is implemented by the National Directorate of Road and Brides (DNEP) which is under the Ministry of Public Works and Housing (MOPH). Technical assistance to road section and training of the road engineer were implemented with hundred and forty four million US Dollars in ROCS-I Plan and roads are constructed with eight hundred fifteen million US dollars in ROCS-II Plan. Financial commitment, however are not sufficient to construct enormous scale of road network required for the Mozambique. The Mozambique government has been expecting external assistance from as many donors as possible.

Under these circumstances, Government of Mozambique requested to the Japanese Government the reconstruction and repair of 21 bridges on the main national roads which was destroyed by war or deteriorated by the natural calamity. In response to the request, JICA sent a study team to Mozambique and implemented a field survey from February 21 to March 16 and May 11 to June 19, 1996. A mission was sent to Mozambique in order to discuss a draft basic design and the mission proposed 13 bridges as a high priority bridges among the bridges requested by the Government of Mozambique. The selected 13 bridges are on the main national roads at Numpla, Zambezia, Sofala and Manica province. Both Japanese side and Mozambican side agree the content of basic design, i.e. location of bridges, type of bridges and extent of approach roads on October 1, 1996.

Bridges on the NorthSouth Corridor, international highway and urgency for safety reason were taken into consideration to give the high priorities for reconstruction and repair of bridges.

Design Concept for 13 Bridges

Bridge Name	Bridge Length (m)	Span Length (m)	Type of Super Structure	Type of Substructure	Type of Foundation	Approach Road (m)
Mecumbezi	77.4	25.0	PC Girder	-	-	-
Pungue	150.5	29.7	PC Voided Slab	Revert T Type Abutment Wall type Pier	Cast in Situ Pile Direct Footing	500.5
Zangue	144.3	20.0	H section steel Girder	Revert T Type Abutment Revert T Type Pier	Steel Pipe Pile	125.0
Xisadze-I	11.4	10.0	RC Voided Slab	Revert T Type Abutment		160.0
Xisadze-II	20.5	20.0	PC Voided Slab	Revert T Type Abutment		200.0
Chiraba	120.0	20.0	PC Voided Slab	Revert T Type Abutment Wall type Pier	Cast in Situ Pile Direct Footing	700.0
Namitangurine	30.0	14.5	RC Voided Slab	Revert T Type Abutment Wall type Pier	Direct Footing	220.0
Molocue	89.5	19.26	H section steel Girder	Revert T Type Abutment Revert T Type Pier	Direct Footing	0.0
Namirroi	82.43	20.0	H section steel Girder	Revert T Type Abutment Revert T Type Pier	Cast in Situ Pile Direct Footing	0.0
Metuce	103.3	20.0	H section steel Girder	Revert T Type Abutment Revert T Type Pier	Cast in Situ Pile Direct Footing	0.0
Mecuburi	30.0	14.5	RC Voided Slab	Revert T Type Abutment Wall type Pier	Direct Footing	180.0
Mutibaze	45.0	14.5	RC Voided Slab	Revert T Type Abutment Wall type Pier	Direct Footing	225.0
Thi-Thi	30.0	14.5	RC Voided Slab	Revert T Type Abutment Wall type Pier	Direct Footing	220.0

The Project reconstructs a number of bridges that are integral part of the operation of arterial highways, and thus makes a significant contribution to the mitigation of persistent bottlenecks in the national highway network. Main national roads in this project has two major characteristics, one is international highway connecting land-locked country to the major port on the east coast, another is the North-South Corridor connecting north and south. International roads play an important role in the national economy by earning the much needed hard currencies and creating employment opportunities. North-south corridor is the only road connecting populous area of northern territory and major port of Beira and Capital Maputo, contributeing to transport and distributing agricultural outputs. However, the current conditions of major highways are very poor, and many are nearly impassable during the rainy season. Because the existing highways do not function as a network, the vehicular traffic at present is virtually negligible in many sections. The highway routes, on which the bridges selected for the Project are located, play varying roles in the country's transportation network.

Mozambique requires huge capital outlays to develop a network of highways that will effectively service its vast land area. At the present moment, the country has no all-weather route which links the four northern provinces (Niassa, Cabo Delgado, Nampula and Zambezia), where more than 60% of the country's population resides, to the southern provinces, especially to the national capital throughout the year. In order to maximize the impacts of the present Project, it will be essential to improve the highways and related facilities. More specifically, the section between Incope and Caia and the section between Namacurra and Rio Ligonha are still in poor conditions and in need of improvement. Without the concurrent development of these sections, the rehabilitation of the bridges will not complete the north-south transportation axis. Moreover, it is necessary to provide more effective facilities to cross Zambezi River, the natural divider of the southern and the northern terrain. The full benefits of the Project will become manifest with these related investments.

Improvement of the roads related to this project are implemented by DNEP under the assistance by IDA. There are specialist from IDA in the DNEP and the management of road construction are well supervised. To make the project efficient, it is necessary to adjust and cooperate with the IDA project.

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Chapter 1 Background of the Project

CHAPTER 1 BACKGROUND OF THE PROJECT

The population of Mozambique in 1991 was 16.1 millions. Mozambique has 0.8 million square kilometers of land area. The country is located on the east coast of the African continent. It is bound by Tanzania and Malawi in the north, Zambia and Zimbabwe in the west, and south by South Africa and Swaziland. The land area extends over 2,000 km from north to south and 1,200 km from east to west. The border with the neighboring countries add up to 4,330 km and the coast line is 2,600 km long. The population is concentrated in the major cities of coastal provinces, such as Cabo Delgado, Nampula, Zambezia, Sofala, Inhambane and Maputo. The population has grown rapidly at an annual rate of 2.7 % during the period of 1989 - 1992, and will double its size within 25 years if the trend should continue.

Since the independence in 1975, the country has almost continuously suffered by the internal war between the socialist regime (FRELIMO) and the resistance (RENAMO). The civil war lasted for 17 years before the cease fire which was agreed to in 1992. More than 1.5 million people have taken refuge in neighboring countries. The economy was in tatters, and economic infrastructure like roads and bridges was either destroyed or deteriorated as result of poor maintenance. With the signing of the cease fire in October 1992, Mozambique started to reconstruct the country as a democratic nation.

Exhausted from the prolonged civil war, the Mozambique Government appealed for international assistance for reconstruction of the country. The United Nations dispatched PKF troop, and Japan also sent a self-defense force to participate in the PKO activities in Mozambique. Aided by the international community, transport of the demobilized soldiers and returning refugees was organized by the Government. The general election was held in October 1994 signaling the beginning of the end to political destabilization and civil disorder.

As the country began to regain a certain measure of stability, the World Bank (IDA), EEC and other nations intend to cooperate through financial support for the rehabilitation and reconstruction of war-ravaged infrastructure. Their financial commitments, however, are not sufficient, considering the enormous scale of destruction during the civil war. The Mozambique Government has been expecting external assistance from as many donors as possible. The Mozambique Government selected 21 bridges on major highways which were destroyed or deteriorated over the years, and requested the Japanese Government for a grant-aid for rehabilitation and reconstruction of bridges.

Chapter2 Content of the Project

CHAPTER 2 CONTENT OF THE PROJECT

The network of national highways in Mozambique was destroyed and deteriorated during the prolonged civil war. The Government is planning to reconstruct the highway network with financial aid from multilateral financing organizations. However, the road infrastructure which urgently needs rehabilitation and reconstruction is an enormous task both in terms of cost and the time required. Accordingly, the on-going rehabilitation plans are concentrated to open the roads and do not extend to the bridges. This situation leaves serious bottlenecks for land traffic.

The Basic Design Study Team visited Mozambique twice to discuss the rehabilitation of bridges on the main national roads. The bridges are on National Highway Routes No. 8 and 102, two important arteries connecting the land-locked SADC countries to the major international ports in Mozambique and on the National Highway Routes No. 232, 225, 1 and 213, the important north-south links of the country. The Study Team conferred with the representatives of the Mozambique Government to examine a number of bridges to be rehabilitated or reconstructed

2 - 1 OBJECTIVE OF THE PROJECT

The aim of the Project is to reconstruct or rehabilitate bridges that are bottlenecks in the transportation along major national highways. The bridges included in the Project have span lengths of 10m or more, are require higher level of construction technology. The reconstruction and rehabilitation of such bridges will improve traffic in the national highway network, and will greatly facilitate the mobility of goods and people in Mozambique.

2 - 2 BASIC CONCEPT OF THE PROJECT

As mentioned earlier, the national highway network in Mozambique was almost destroyed during the internal war fare. For example, there is no fully operational highway between Nampula, a major city in the northern region, and Beira, a major city in the central region. Moreover, land-locked SADC countries (Zimbabwe, Zambia, Malawi and South Africa) also want to reconstruct the highway network in order to obtain better access to the Mozambique ports on the Indian Ocean for the transportation of their goods. The Mozambique Government initially requested the Japanese Government for a grant-aid for the rehabilitation and reconstruction of 21 bridges. The study team evaluated the importance and the level of damage or deterioration of bridges. Through discussions with the representatives of the Mozambique Government, the Study Team proposed to exclude several bridges from the Project due to one or more of the following reasons.

1. Bridges that are handling the current traffic and require no urgent rehabilitation;
2. Bridges that are serviceable through normal maintenance works;
3. Bridges that will be receiving external finance in the near future; or
4. Bridges that are in need of rehabilitation, but that would not contribute to the traffic improvement of the road traffic, without the concurrent rehabilitation of other bridges

on the same road.

It is not enough to evaluate the importance of individual bridges, because bridge are parts of the highway network. The Study Team classified the bridges into three groups of the highway routes, and evaluated their importance and priority as groups in the highway network.

The following is the list of the bridges on the national highway routes that will serve the growth of international traffic, and those on the highway routes that will serve as the north-south axis in the national network.

1) Three bridges (Mecuburi, Thi-Thi and Mutibaze) on Route No. 8

Three bridges are on the international route connecting Malawi to the port at Nacala.

2) Two bridges (Pungue and Mecumbezi) on Route No. 102

Two bridges that are bottlenecks on the international route connecting Zambia and Malawi to the port at Beira.

3) Eight bridges (Metuce, Namirroi, Molocue, Namitangurine, Chiraba, Zangue, Xisadze I and Xisadze II) on Routes Nos. 232, 225, 1 and 213

The eight bridges are on the routes connecting the city of Nampula in the north to the port city of Beira. The Mozambique Government has given top priority to improve these north-south routes. The rehabilitation and reconstruction of eight bridges will contribute to improve the highway transport capacity for the north-south link.

2 - 3 BASIC DESIGN

2 - 3 - 1 Design Concept

(1) Aim of the Project

The Project aims to reconstruct or rehabilitate a number of bridges on the national highways that have been seriously damaged during the civil war. The highway routes selected for the Project are national highways with no alternative routes in the national road network. Reconstruction of thirteen bridges selected for the Project will assure the full operation of each national highway.

The three highway routes (Routes No. 1, 225 and 232) are the most important ones that connect the north and south regions of the country. Six bridges are selected for reconstruction and rehabilitation on these routes. The importance of the north-south routes has been recognized since the colonial period and the Mozambique governments have continued to invest in the development of these routes.

By reconstructing the six bridges, the Project will remove a part of the bottlenecks in the north-south routes. Full operation of these routes, however, will not be completed

without the construction of the bridge across the Zambezi river.

Moreover, the paved road is extremely limited in the three routes. During the rainy season, there roads are impassable at quite a few places. The Mozambique Government plans to improve the road conditions of these routes with external funds from EC and others. The effectiveness of the bridge reconstruction and rehabilitation depends largely on the progress of such road improvement.

(2) Project Policy

Existing bridges along the Project site which were destroyed or abandoned are relatively new, because some of them were either completed or were under construction before and during the civil war. Many of them were destroyed by bombs, but some of their components were not destroyed. The remaining portion of bridges which are judged safe and useful from the engineering point of view will be incorporated in the Project.

(3) Order of Bridge Reconstruction

The Basic Design Study Team ranks five groups of bridges using a number of socio-economic indicators. However, in the construction phase the priority for bridge construction will depend on the degree of urgency, the length of construction period and the progress of road improvement in the respective route. On the basis of the information collected during the field survey, the Study Team proposes the order of construction of bridges as shown below.

1) National Highway Route No. 8 (Mecuburi, Thi-Thi, and Mutibaze bridges)

Construction works and period are smaller than the other groups of bridges. The Mozambique Government scheduled to improve this route. The bridge reconstruction is opportune for the road improvement of the route.

2) National Highway Route No. 225 (Chiraba and Namitangurine bridges)

A temporary bridge was constructed upstream of the existing Chiraba bridge, but was washed away by flood. Passing across the river bed is hazardous even during the dry season. The Mozambique Government considers that the reconstruction of Chiraba Bridge is most urgent and requests its earliest reconstruction.

3) National Highway Route No. 102 (Pungue and Mecumbezi bridges)

Two bridges are on the route with one of the heaviest traffic volumes in Mozambique. The bridges are the bottleneck for the traffic on the route and unsafe for large vehicles to pass.

4) National Highway Routes No. 1 and 213 (Zangue, Xisadze I and Xisadze II bridges)

The completion of the Chiraba bridge reconstruction will make it easy to transport construction materials for this group of bridges.

5) National Highway Route No. 232 (Molocue, Namirroi, and Metuce bridges)

This route has high priority in the ROCS II Plan. The negotiation for the fund for reconstruction of the route from EC is scheduled in September 1996. The reconstruction of three bridges shall be coordinated with the road reconstruction schedule.

2 - 3 - 2 Basic Design

(1) Basic Design Policy

Basic Design for thirteen bridges was done by using the following standards (road width, design load, bridge type, river conditions, access road structure, etc.)

1) Bridge width

All bridges have two lanes with sidewalks on both sides. The standard cross-section of bridge width is shown in Figure 1. Where existing structures are used, the rehabilitation will be based on the existing bridges width.

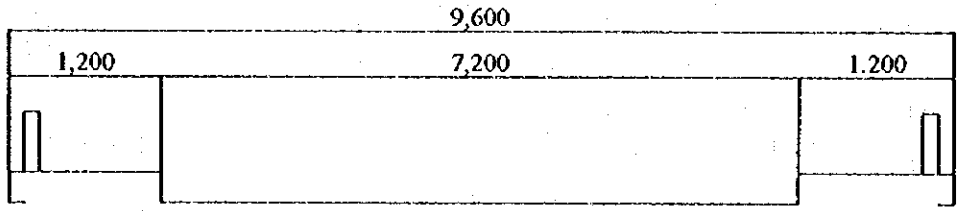


Figure 1 Bridge Width

2) Design load

Class-A 60t vehicle is used as design load for designing the bridges. The Japanese standards are applied for structural detail design .

3) Bridge type

Bridge types which require structural complexity and/or construction materials not available in Mozambique are avoided.

4) River conditions

Primary objectives of the project are rehabilitation or reconstruction of existing bridges. Accordingly, size and components of the new bridge should conform to the scale of original bridge. However, if the opening of the existing bridge is inadequate by the analysis of river discharge, the new bridge will be planned with a larger opening than the existing structure. The analysis of river discharge was carried out on seven bridges: namely, Zangue, Mecuburi, Thi-Thi, Mutibaze, Namirroi, Malela and Molocue.

5) Access roads

The Mozambique Government expect that the access roads to a bridge should be paved if they connect to the paved highway, but that they need not be if they connect to an unpaved highway.

(2) Design Standard of construction material

The basic design standards of the main construction materials for the Project are shown in Table 1.

Table 1 Standards of Main Construction Materials

Material	Types of Building Materials	Spec.	Quality Grade
Concrete	Pre-stressed concrete	C40	$\sigma 28$=320kg/cm^2
	Reinforced concrete (piers & walls)	C30	$\sigma 28$=240kg/cm^2
	Reinforced concrete (foundation)	C25	$\sigma 28$=200kg/cm^2
	Base concrete	C20	$\sigma 28$=160kg/cm^2
Steel	Reinforcement bars	BS 444	σ_{sa}=410N/mm^2
	PC cable	12V13	σ_{pu}=183KN/mm^2
	Structural steel	SM 490	σ_{ta}=490N/mm^2

(3) Utilization of Existing Structures

Most of the bridges were damaged by bombing during the civil war, but some of the remaining structures might be partially usable in the reconstruction. As long as they are considered as usable from the engineering point of view, they will be utilized in the basic design. Table 2 shows the utilization of the existing structures.

Table 2 Utilization of Existing Structures

Routes	Bridge Sites	Utilization of Existing Structures
102	Pungue	Construction of a new bridge.
102	Mecumbezi	Floor slabs and beams are repaired.
1	Zangue	Construction of a new bridge.
213	Xisadze I	Repair abutments and retaining walls.
213	Xisadze II	Repair abutments and retaining walls.
225	Chiraba	Construction of a new bridge.
225	Namitangurine	Construction of a new bridge.
232	Namirroi	The abutment foundation on the Molocue side will be utilized.
232	Metuce	Construction of a new bridge.
232	Molocue	Two abutments and two piers can be utilized.
8	Mecuburi	Construction of a new bridge.
8	Thi-Thi	Construction of a new bridge.
8	Mutibaze	Construction of a new bridge.

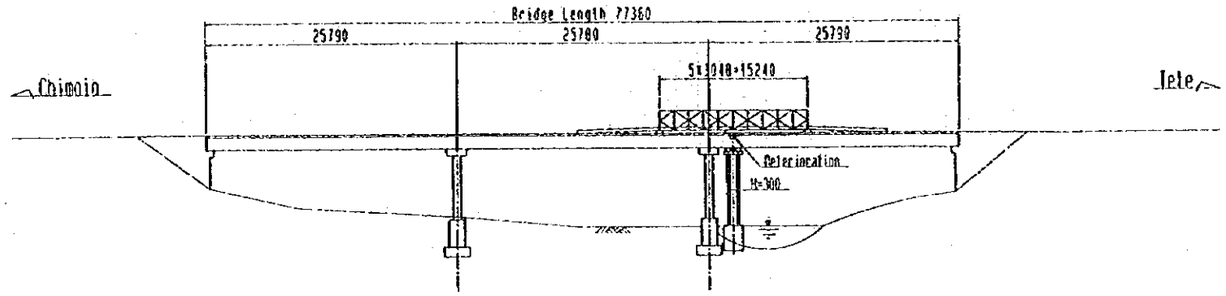
(4) Content of Rehabilitation and Reconstruction of Bridges

The design concepts for the thirteen selected bridges are summarized in Table 3.

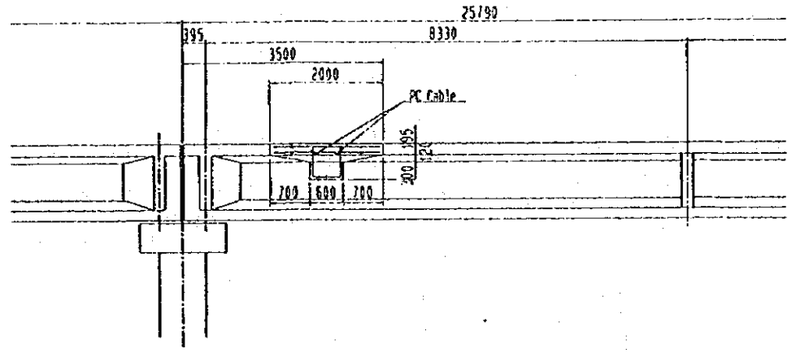
Table 3 Design Concepts for 13 Bridges

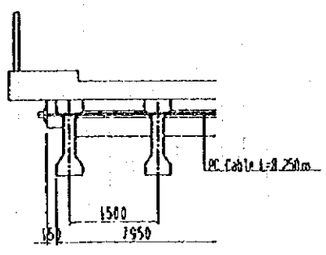
Bridges	Basic Design Concepts	Remarks
Mecumbezi	Strengthening of floor slabs and beams.	
Pungue	Construct a new bridge, same span length, downstream of the original bridge site. The superstructure, 30m long, requires either PC or steel beams. Coarse aggregates are available in the area and the bearing stratum for foundation is good, PC beams are recommended.	Located close to the Zimbabwe border and the mountains, where good aggregates are available. Most of the route is already paved and no serious transportation problem is expected.
Zangue	Construct a new bridge at the original bridge site. Because of the deep bearing stratum for the foundation, the reaction force of the superstructure must be reduced. A steel bridge with span length of 20m is recommended.	Aggregates are available in Caia. The construction materials and machines must be transported from Quelimane because Route 225 is not yet improved.
Xisadze I	Remove the destroyed beams from the river bed, repair the existing abutment and retaining walls, etc. Construct a reinforced concrete slab bridges at the original site of the existing bridge.	Aggregates are to be transported from Caia. Other construction materials and machines are to be transported from Quelimane.
Xisadze II	Remove the beams from the river bed. Repair the existing abutment and retaining walls, etc. Constructs a prestressed concrete slab bridge at the existing bridge site.	
Chiraba	Construct a new bridge downstream from the original bridge site. Coarse aggregates are available in the area and the bearing stratum for foundation is good, PC slab bridge is recommended.	Rocks are expected at the river bed on the downstream of the original bridge site. Aggregates are to be transported from Caia. Other construction materials and machines are to be transported from Quelimane.
Namitangurine	Construct a new bridge (span length of 15m and bridge length 30 m) with two-span reinforced concrete slab, at the existing temporary bridge site.	Aggregates transported from Caia. Other construction materials and machines brought in from Quelimane.
Molocue	Utilize existing piers, except the three in the middle that are scoured by the river. Light materials for the superstructure are recommended on the existing piers and abutments. Steel bridge is recommended.	Good aggregates are not locally available, thus precluding the use of PC bridges. Good bearing stratum is available in shallow depth.
Namirroi	Utilize the abutment foundation on the Molocue side. Steel bridge is recommended.	Good aggregates are not locally available, thus precluding the use of PC bridges. Good bearing stratum is available in shallow depth, however, piles are needed for substructure.
Metuce	Abutments and piers are leftover after the civil war. The deformation of these structures were noted during the field survey, indicative of the on-going scouring. New sub structure and steel bridge construction is recommended.	Good aggregates are not locally available, thus precluding the use of PC bridges. Good bearing stratum is available in shallow depth.
Mecuburi	Constructs a new bridge (span length of 15m and bridge length 30 m) with two-span reinforced concrete slabs, at the original bridge site.	Good aggregates are not locally available, thus precluding the use of PC bridges.
Mutibaze	Constructs a new bridge (span length of 15m and bridge length 45 m) with three-span reinforced concrete slabs, at the original bridge site.	Remove the existing structures of the original bridge.
Thi-Thi	Constructs a new bridge (span length of 15m and bridge length 30 m) with two-span reinforced concrete slabs, at the original bridge site.	Remove the existing structures of the original bridge.

MECUMBEZI BRIDGE S=1/300

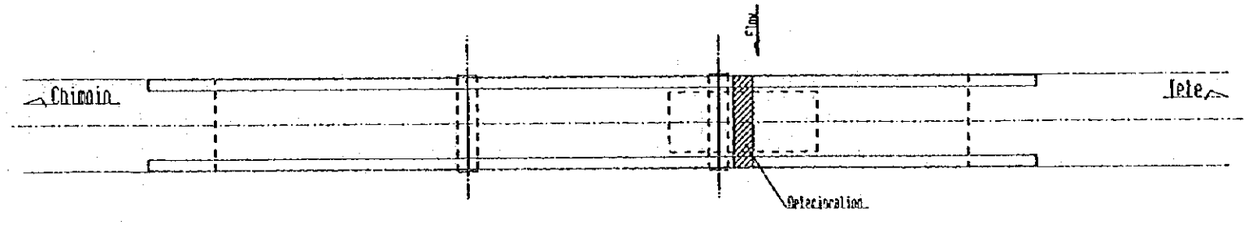


Elevation





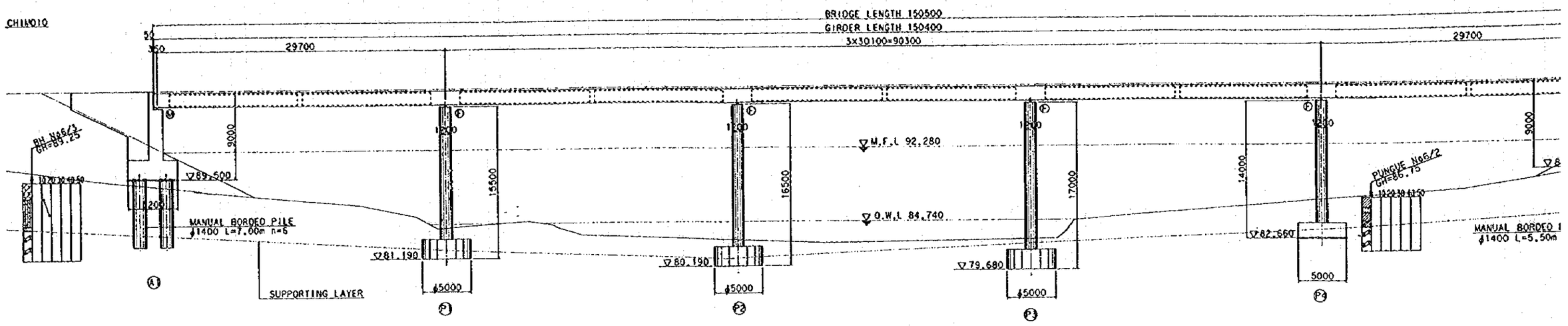
Detail S=1/50



Plan

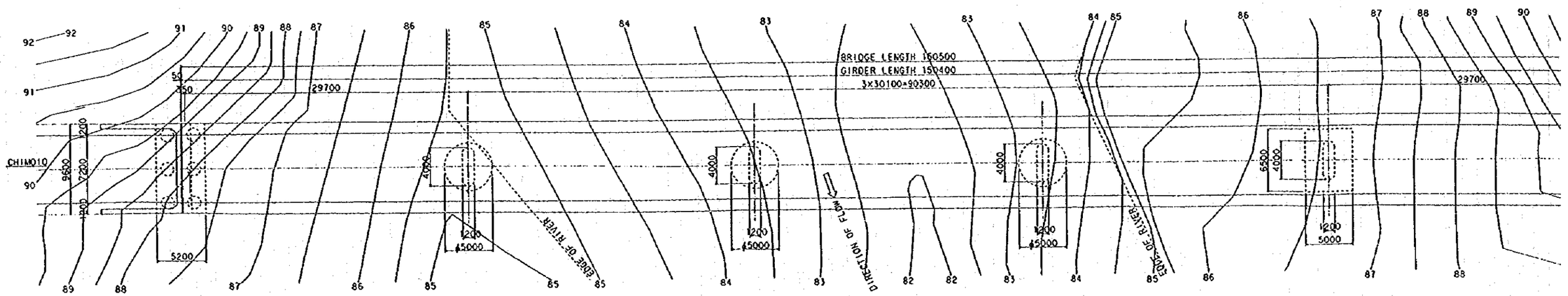
Figure-2 Mecumbezi Bridge

PUNGUE BRIDGE GENERAL VIEW S=1/200



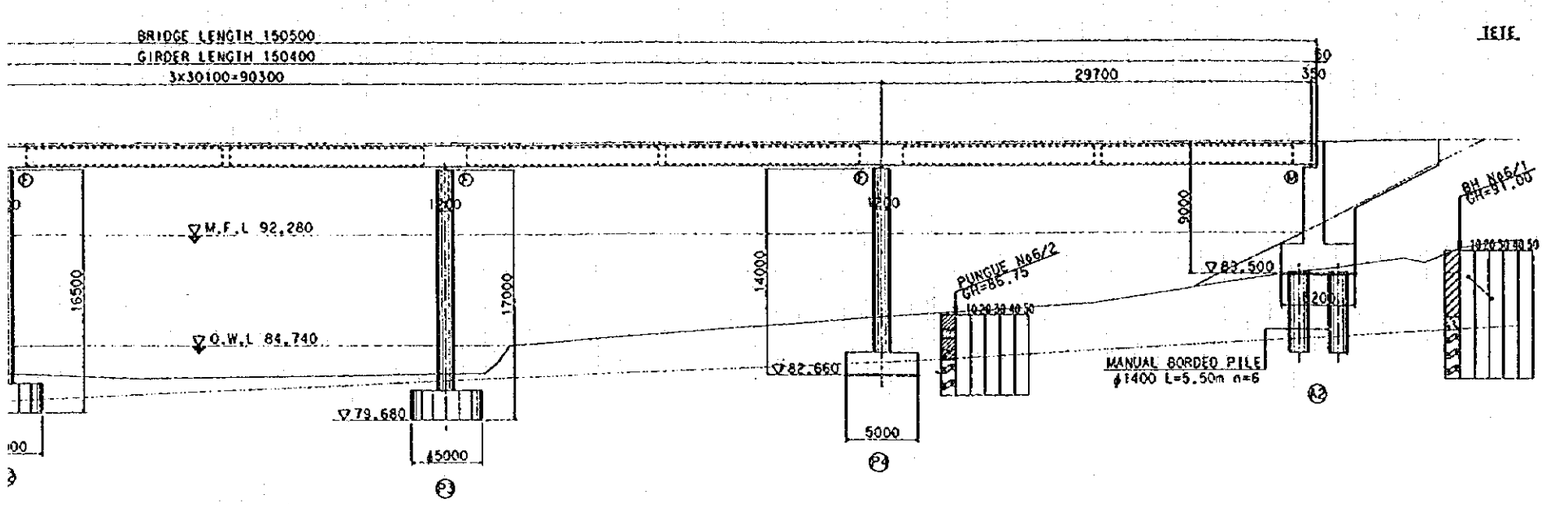
ELEVATION

GRADIENT					LEVEL				
PROPOSED HEIGHT		98.500	98.500	98.500	98.500	98.500			
GRAND LEVEL		89.10	86.71			86.86			
DISTANCE		0.000	30.100	30.100	30.100	30.100			
CHAINAGE		(A1) CH +62000	(P1) +62030.1	(P2) +62060.2	(P3) +62090.3	(P4) +62120.4			

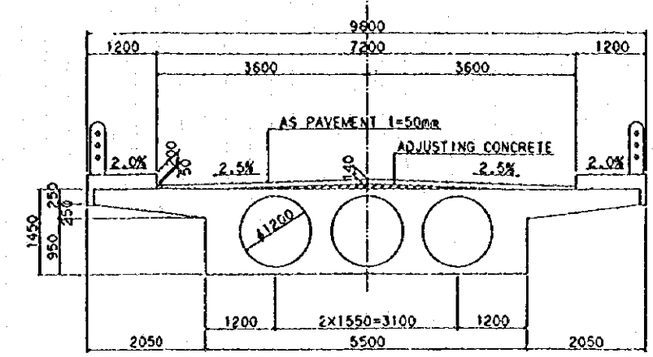


PLAN

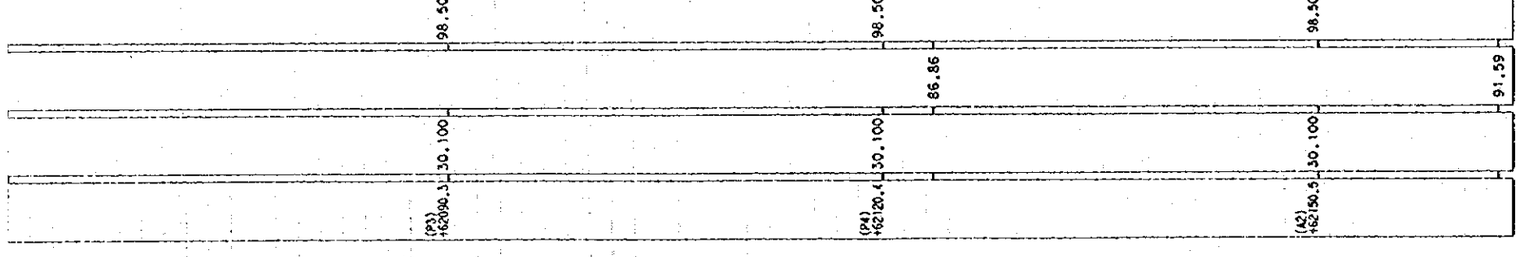
JNGUE BRIDGE GENERAL VIEW S=1/200

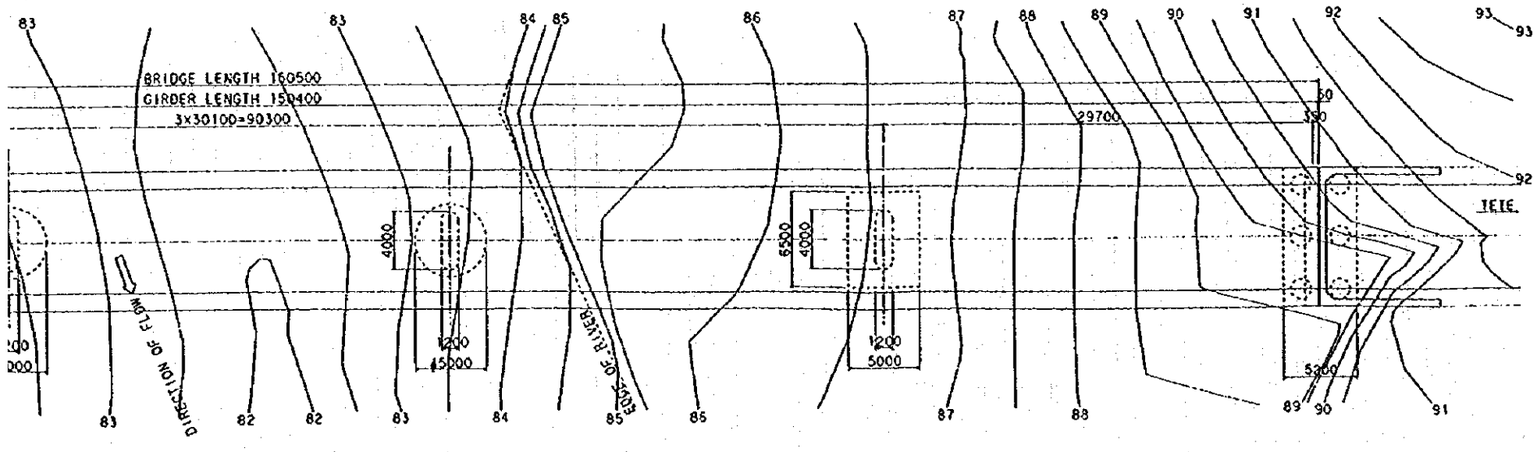


ELEVATION



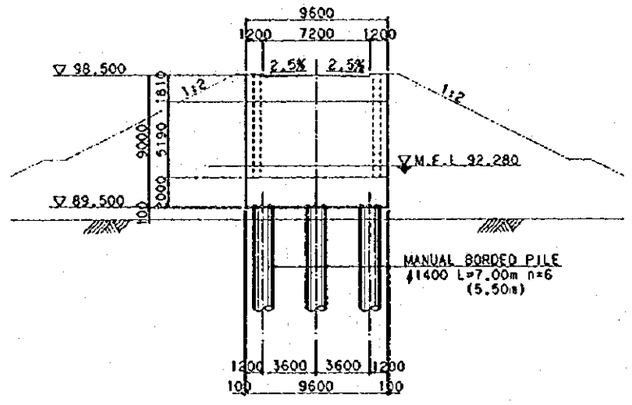
CROSS SECTION S=1/50



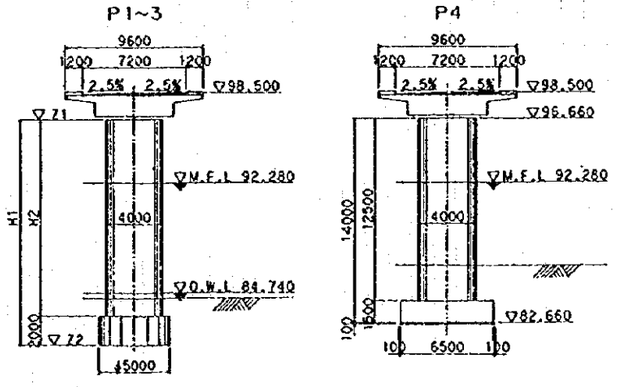


PLAN

ABUTMENT
A1(A2)



PIER

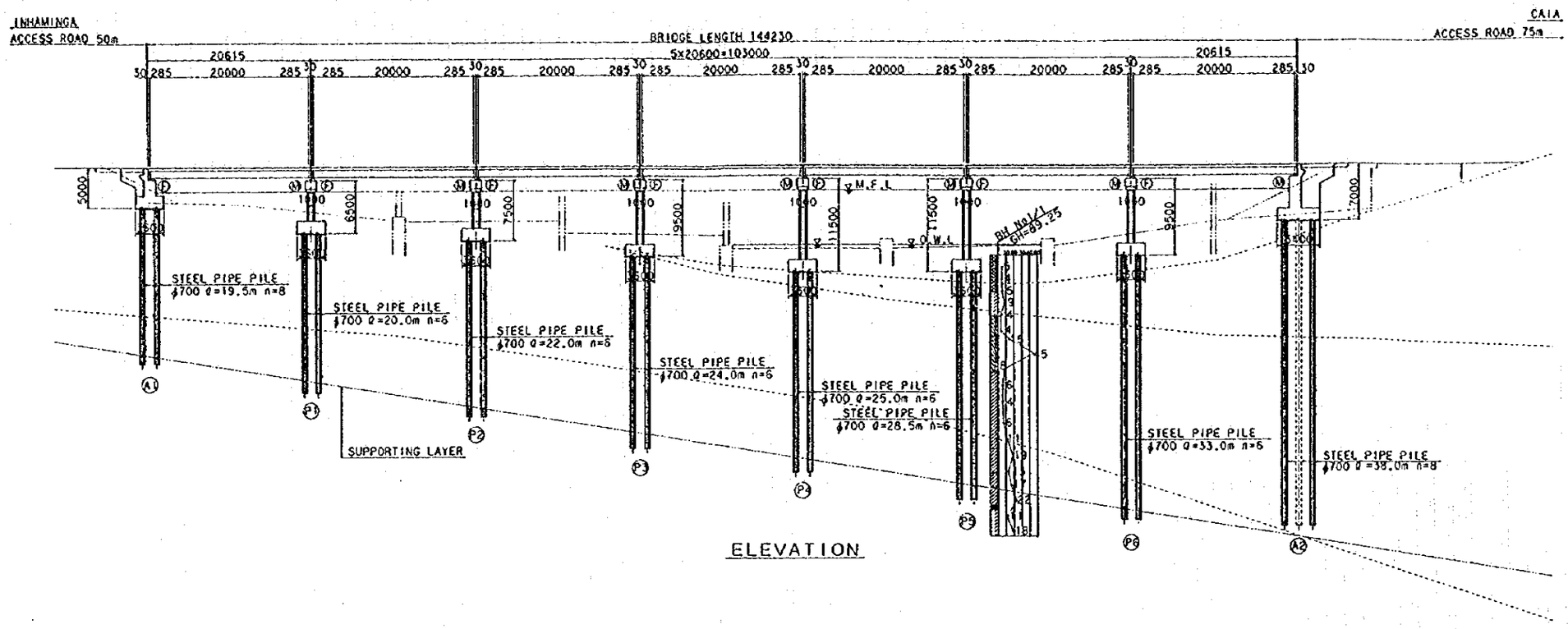


	P1	P2	P3
H1	15500	16500	17000
H2	13500	14500	15000
Z1	96.690	96.690	96.680
Z2	81.190	80.190	79.680

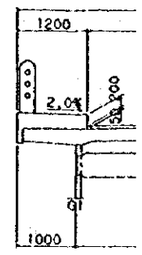
FRONT VIEW

Figure-3 Pungue Bridge

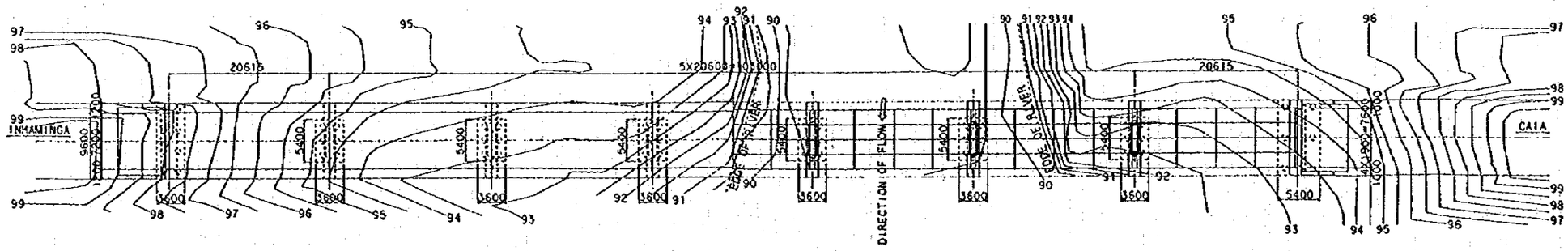
ZANGUE BRIDGE GENERAL VIEW S=1/300



ELEVATION

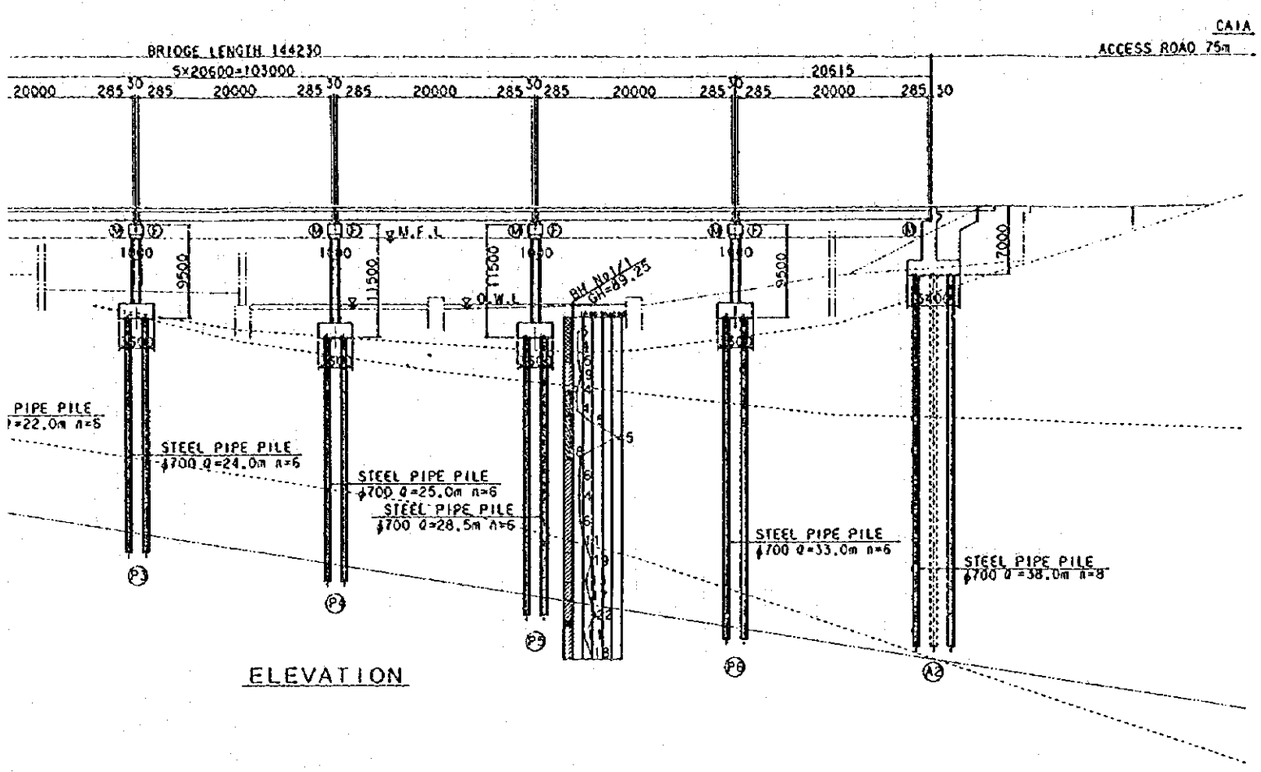


GRADIENT	100.400	LEVEL						
PROPOSED HEIGHT	100.400	100.400	100.400	100.400	100.400	100.400	100.400	100.400
GRAND LEVEL								
DISTANCE	0.000	20.615	20.600	20.600	20.600	20.600	20.600	20.615
CHAINAGE	(A1) +45000.000	(P1) +45020.615	(P2) +45041.215	(P3) +45061.815	(P4) +45082.415	(P5) +45103.015	(P6) +45123.615	(A2) +45144.230

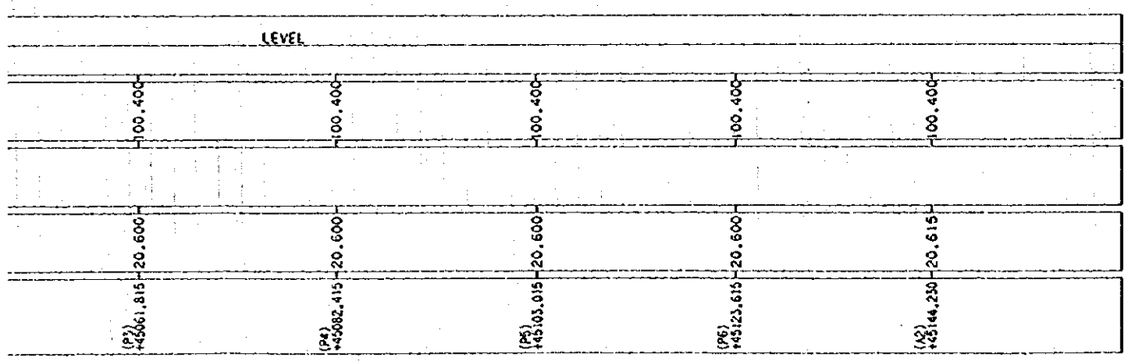


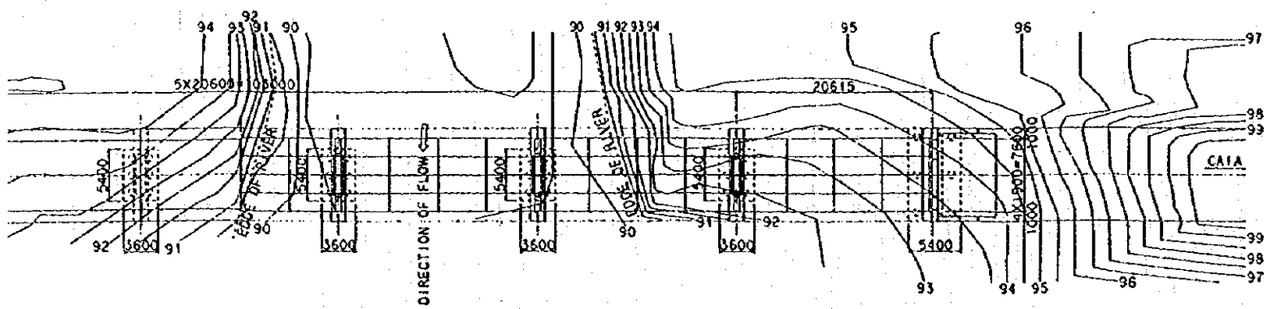
PLAN

BRIDGE GENERAL VIEW S=1/300

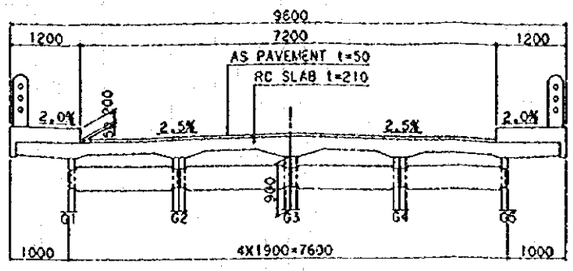


ELEVATION



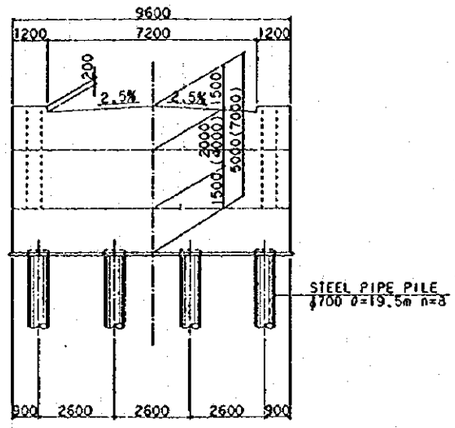


PLAN

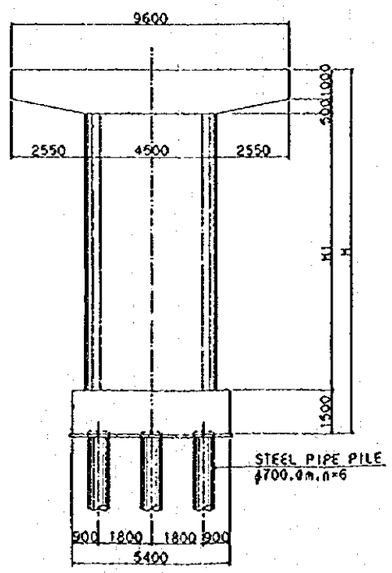


CROSS SECTION S=1/50

ABUTMENT
A1



PIER
P1~P6

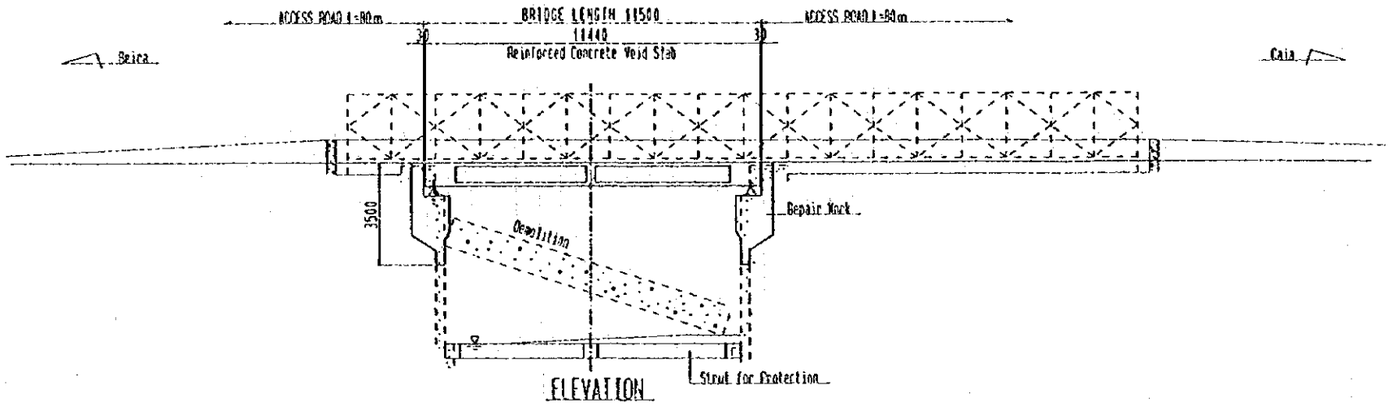


	H	H1	Q
P1	6500	3500	20.0
P2	7500	4500	22.0
P3	9500	6500	24.0
P4	11500	8500	25.0
P5	11500	8500	28.5
P6	9500	6500	33.0

FRONT VIEW S=1/100

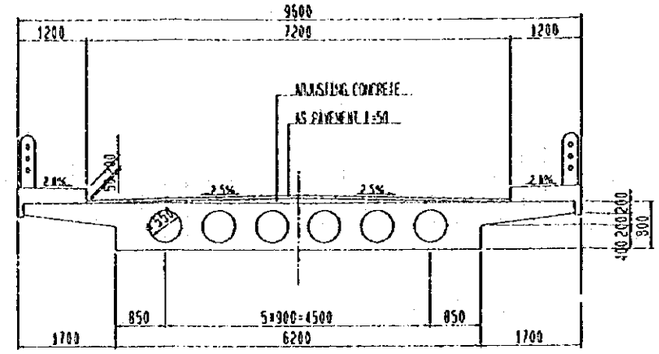
Figure-4 Zangue Bridge

XISAOZE I BRIDGE GENERAL VIEW S=1/100

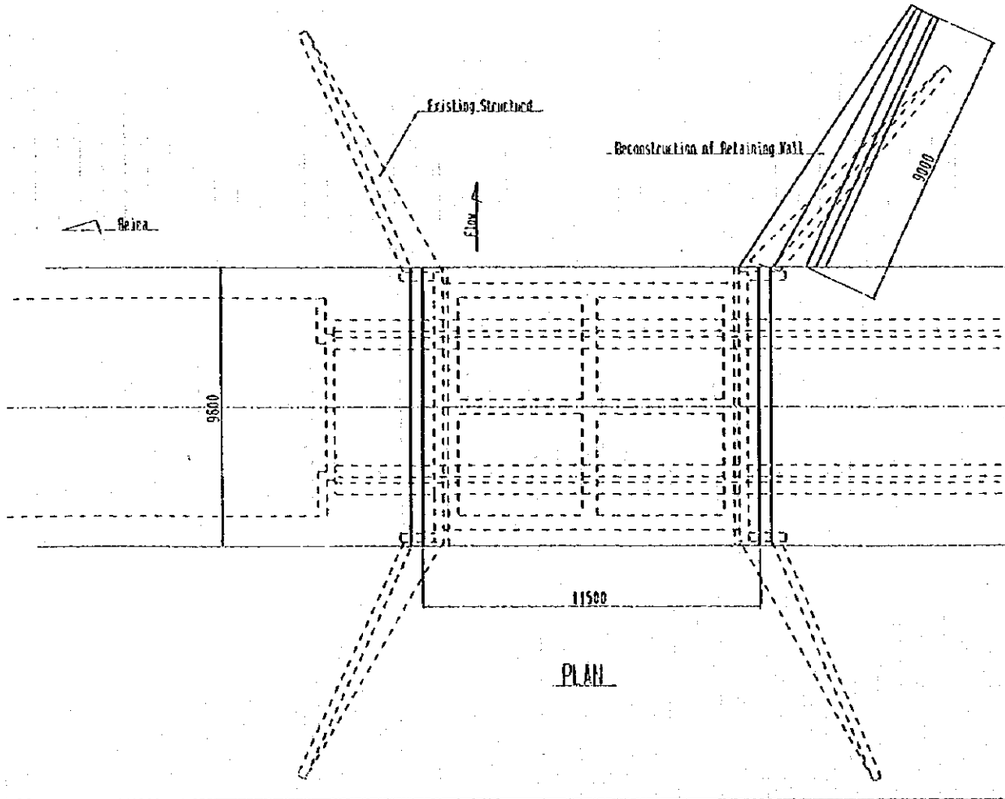


ELEVATION

GRADIENT	LEVEL		
PROPOSED HEIGHT	99.200	99.200	
DISTANCE	0.000	11.500	
CHAINAGE	CH+170m 000.200	CH+170m 11.500	

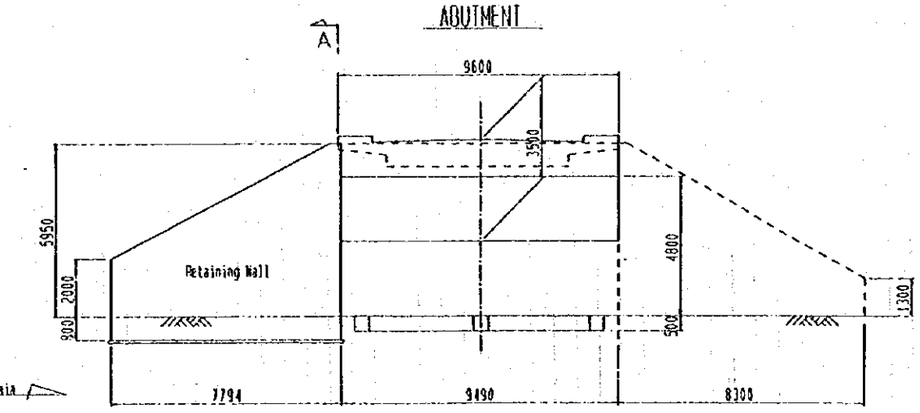


CROSS SECTION S=1/50

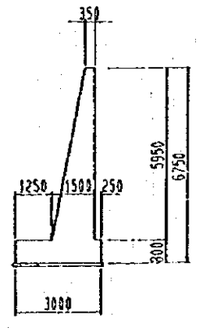


PLAN

ABUTMENT



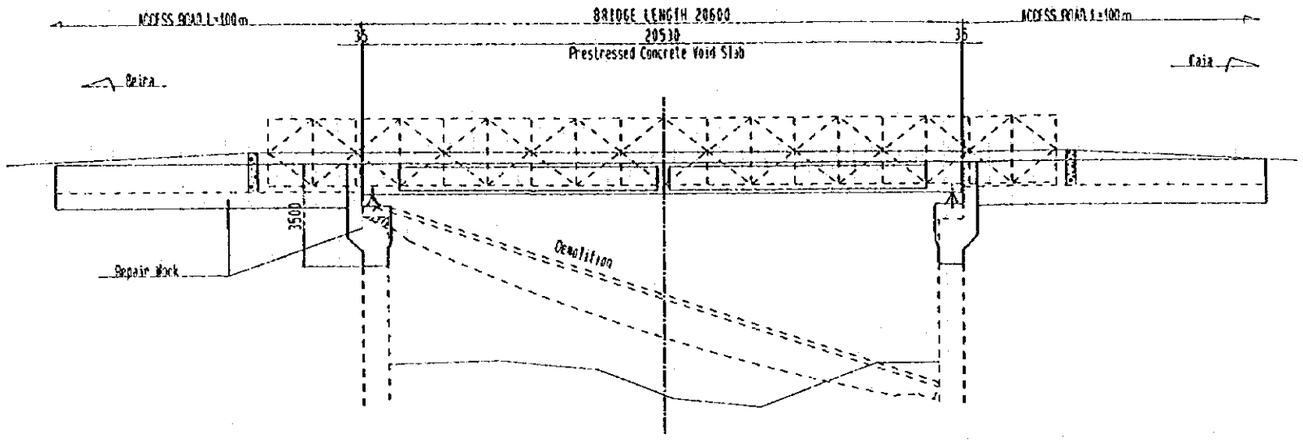
FRONT VIEW S=1/100



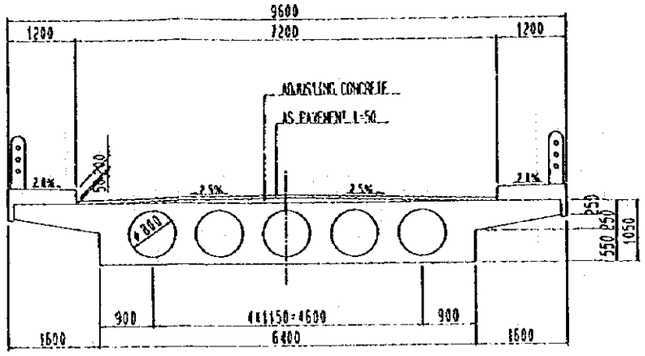
A-A

Figure-5 Xisadze-I Bridge

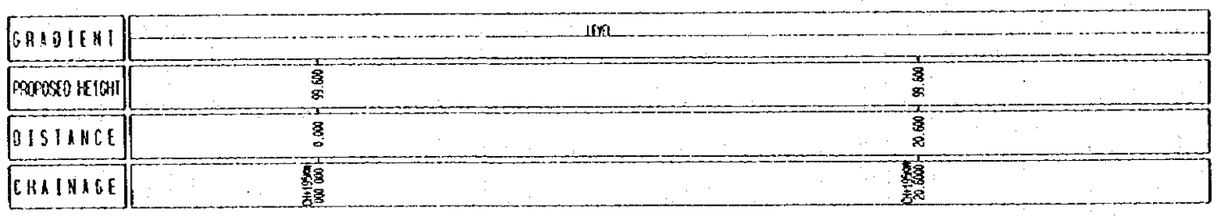
XISADZE II BRIDGE GENERAL VIEW S=1/100

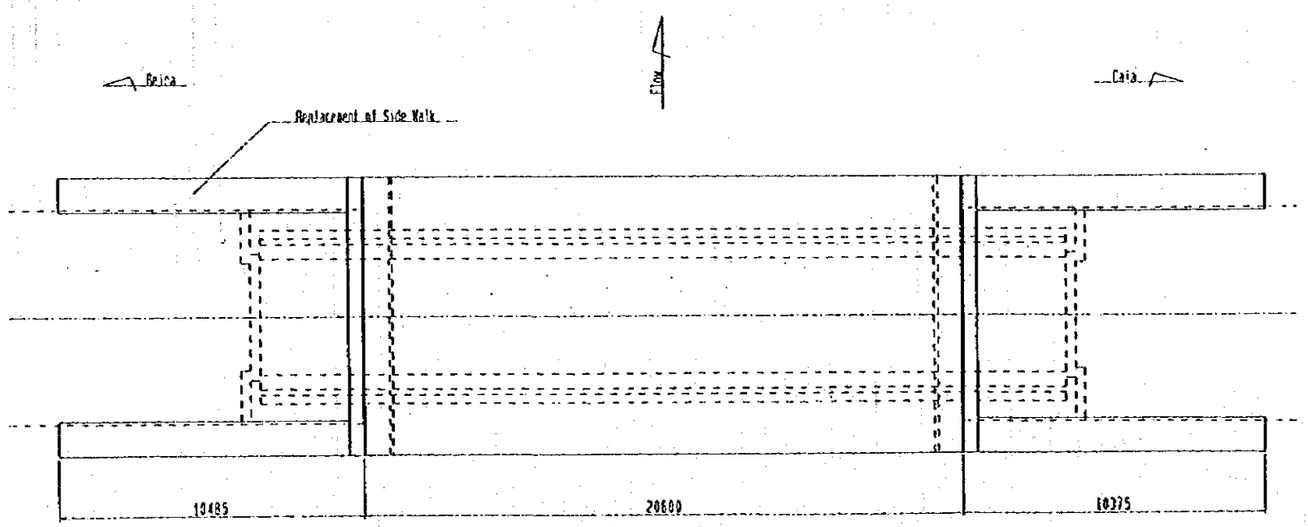


ELEVATION



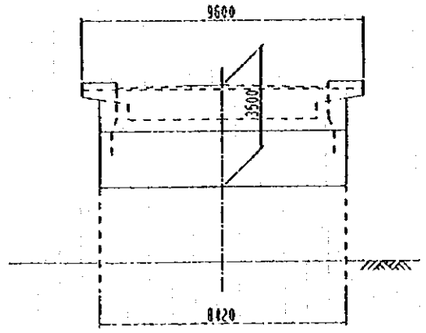
CROSS SECTION S=1/50





PLAN

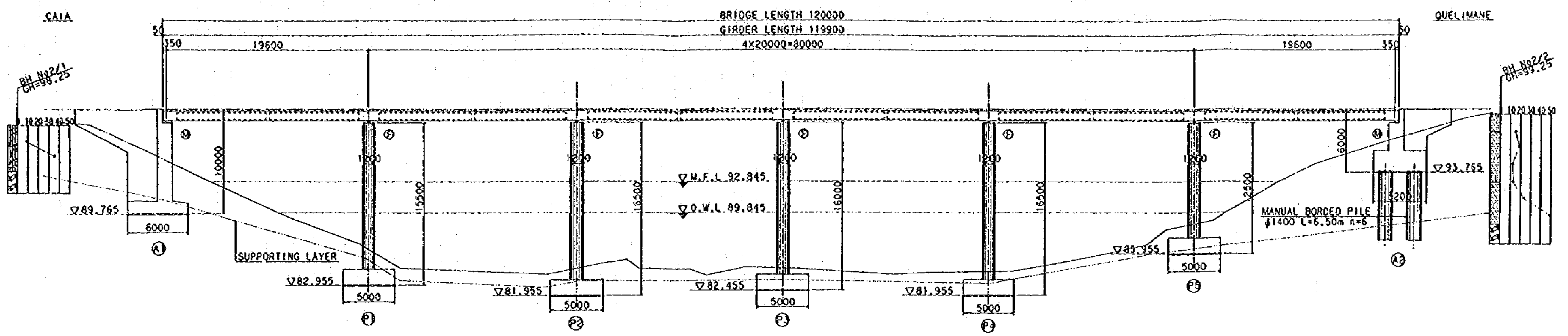
ABUTMENT



FRONT VIEW S=1/100

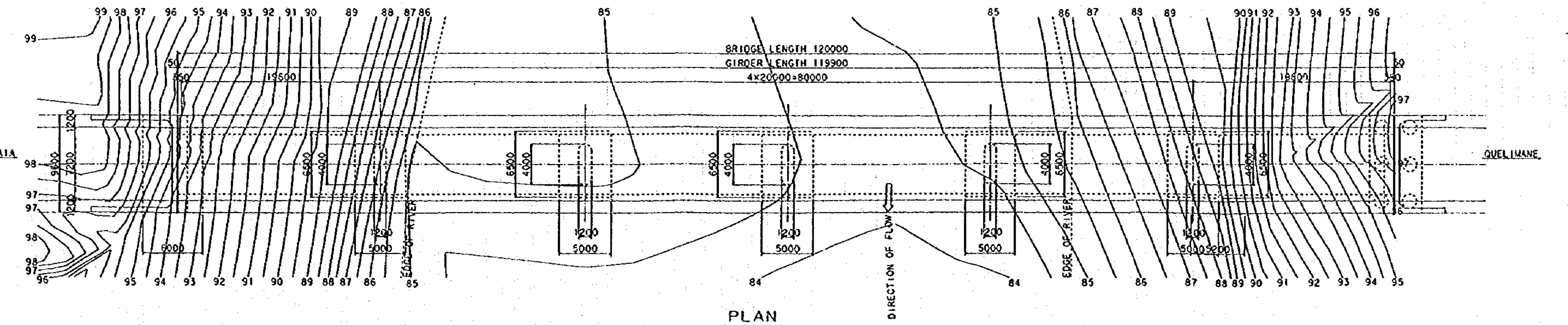
Figure-6 Xisadze-II Bridge

CHIRABA BRIDGE GENERAL VIEW S=1/200



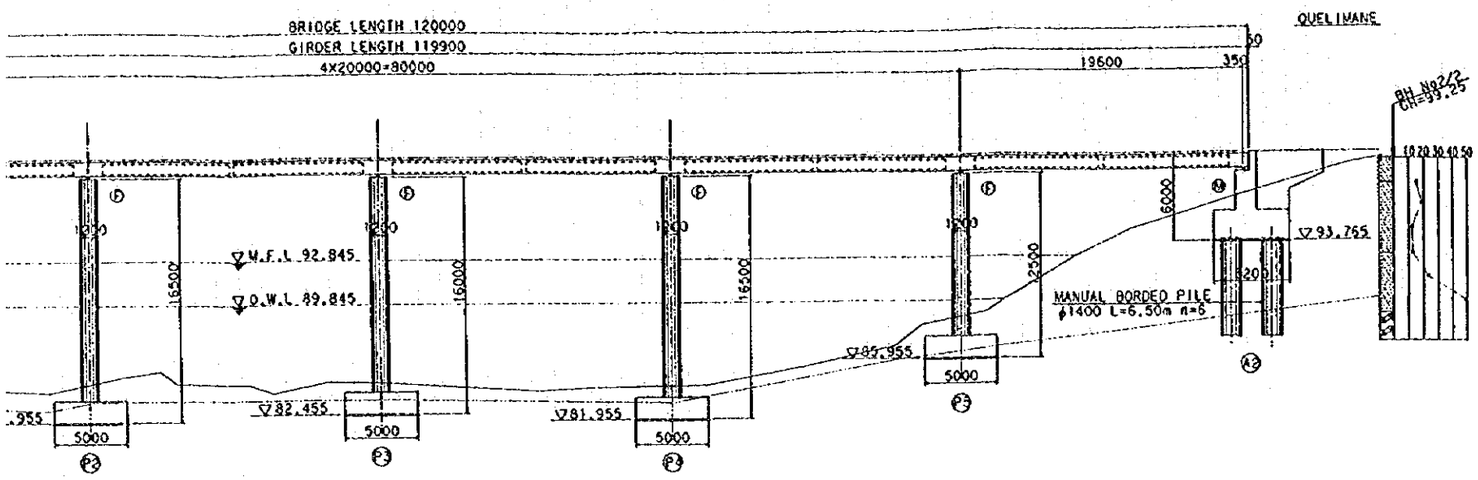
ELEVATION

GRADIENT		99.765									LEVEL									
PROPOSED HEIGHT		99.765			99.765			99.765			99.765	99.765				99.765			99.765	
GRAND LEVEL	98.13		89.64	86.85		84.48	83.95		85.33	84.54			84.27	86.85	88.14		89.06	94.51		99.04
DISTANCE		0.000			20.000			20.000			20.000	20.000				20.000			20.000	
CHAINAGE		(A1) +30000			(P1) +30020			(P2) +30040			(P3) +30060	(P4) +30080				(P5) +30100			(A2) +30120	

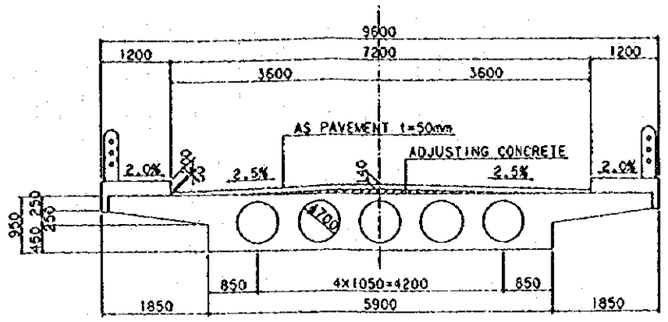


PLAN

CHIRABA BRIDGE GENERAL VIEW S=1/200



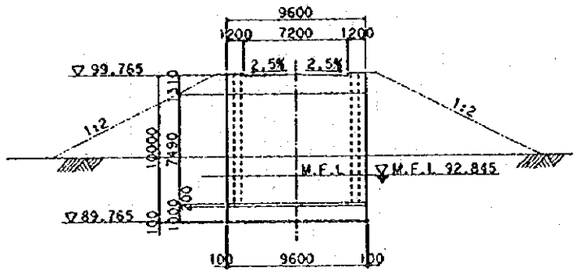
ELEVATION



CROSS SECTION S=1/50

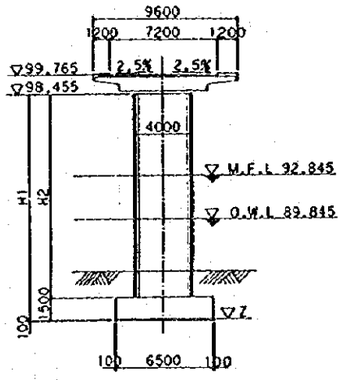
ABUTMENT

A1



PIER

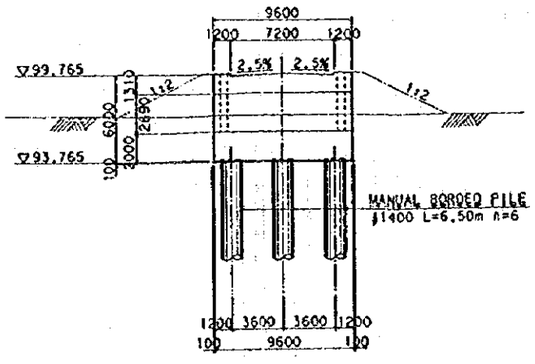
P1~P5



	P1	P2	P3	P4	P5
H1	15500	16500	16000	16500	12500
H2	14000	15000	14500	15000	11000
Z	82.955	81.955	82.455	81.955	85.955

PLAN

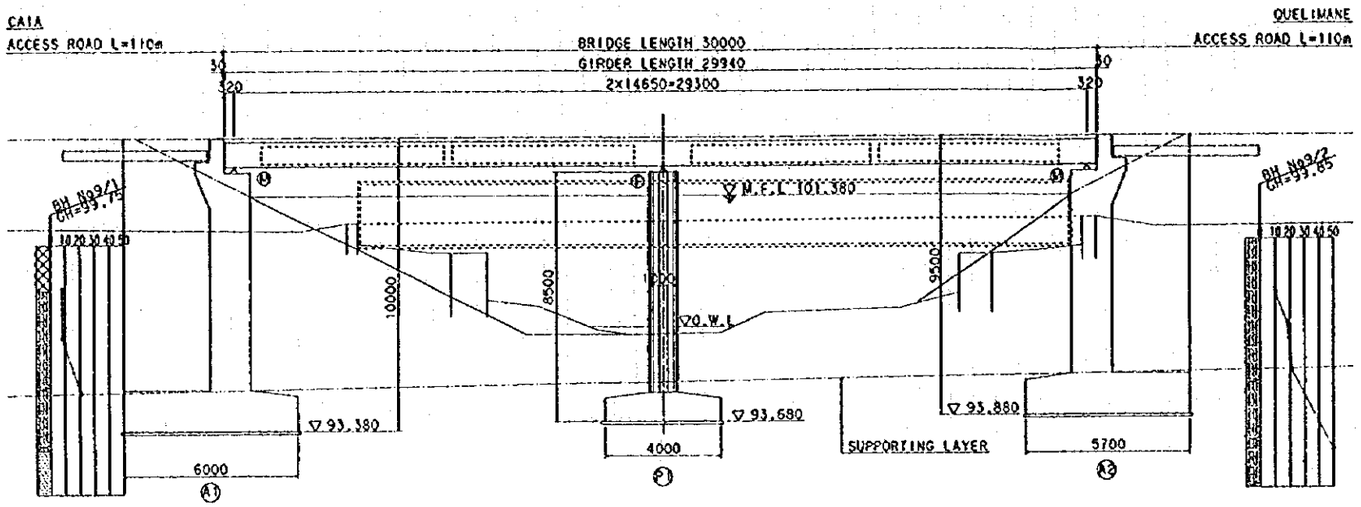
A2



FRONT VIEW

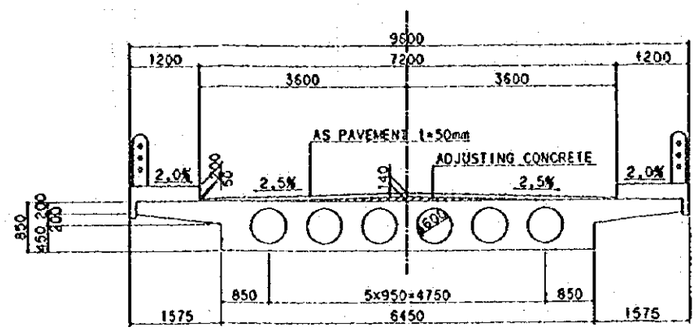
Figure-7 Chiraba Bridge

NAMITANGURINE BRIDGE GENERAL VIEW S=1/100



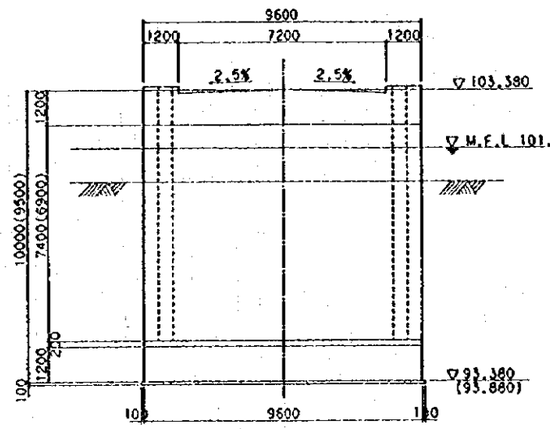
ELEVATION

GRADIENT	103.380	LEVEL	
PROPOSED HEIGHT	103.380	103.380	103.380
GRAND LEVEL			
DISTANCE	0.000	15.000	15.000
CHAINAGE	(A1) +143000	(P1) +143015	(A2) +143030

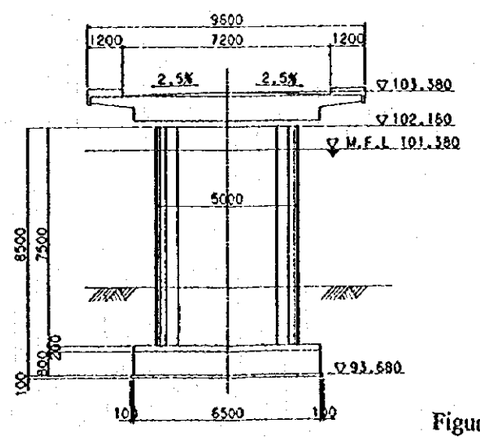


CROSS SECTION S=1/50

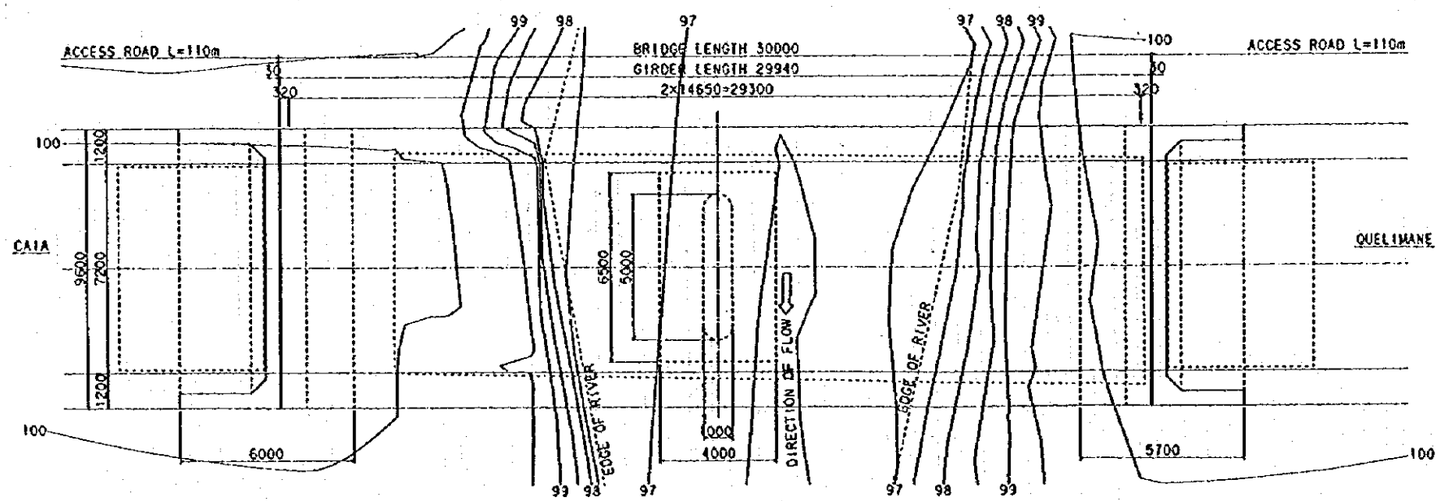
ABUTMENT
A1(A2)



PIER
P1



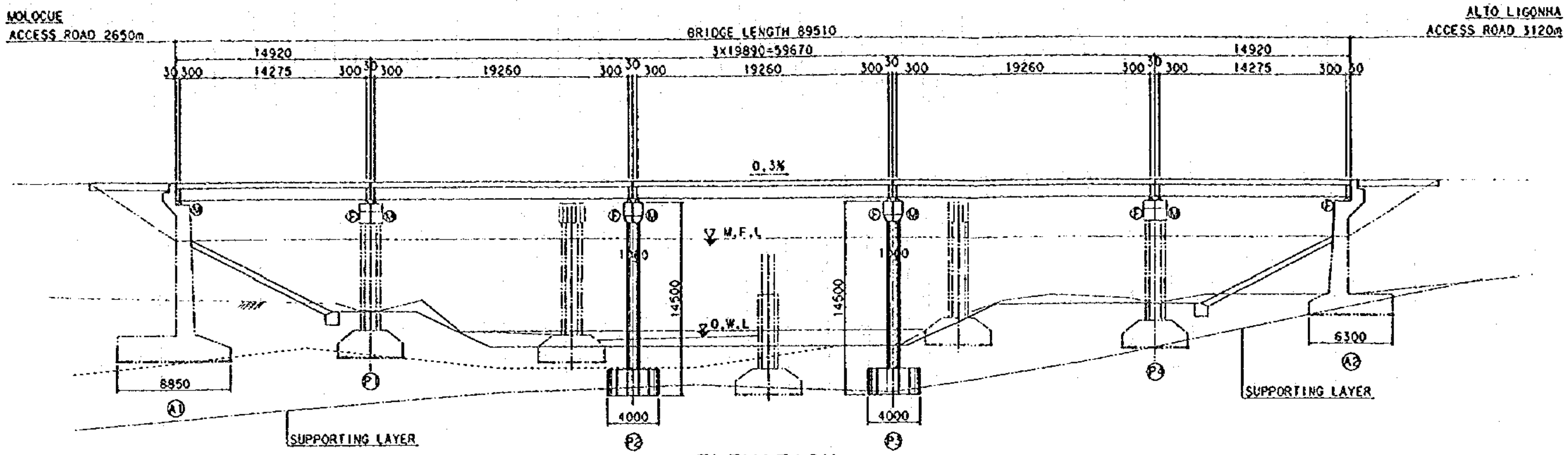
FRONT VIEW



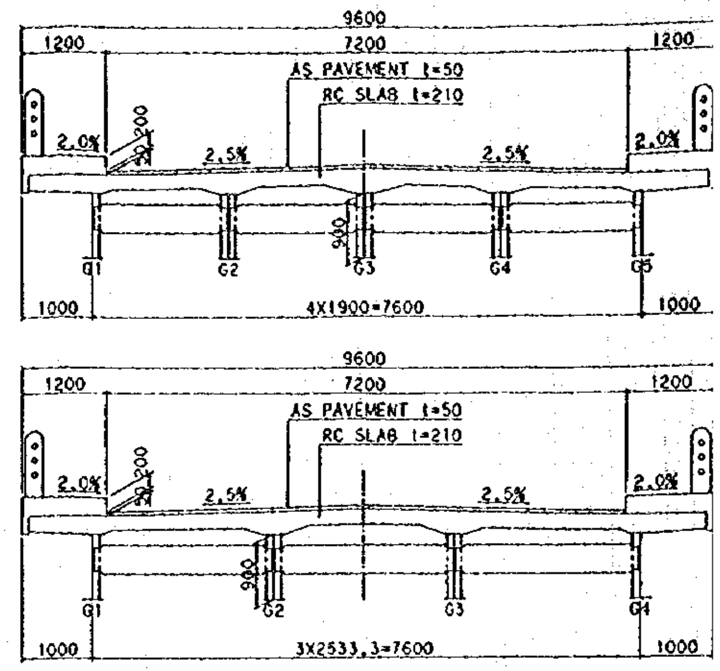
PLAN

Figure-8 Namitangurine Bridge

MOLOCUE BRIDGE GENERAL VIEW S=1/200

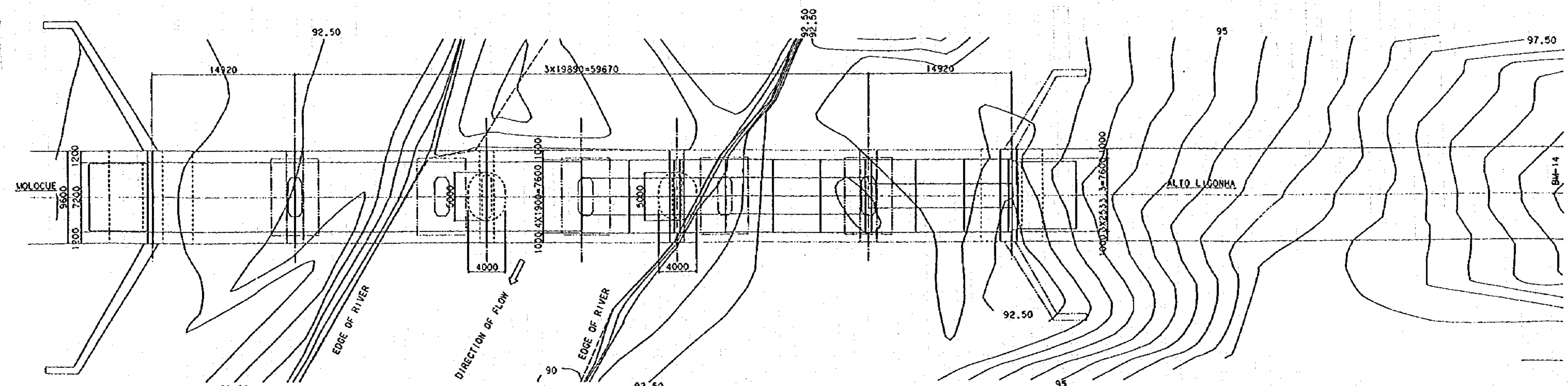


ELEVATION



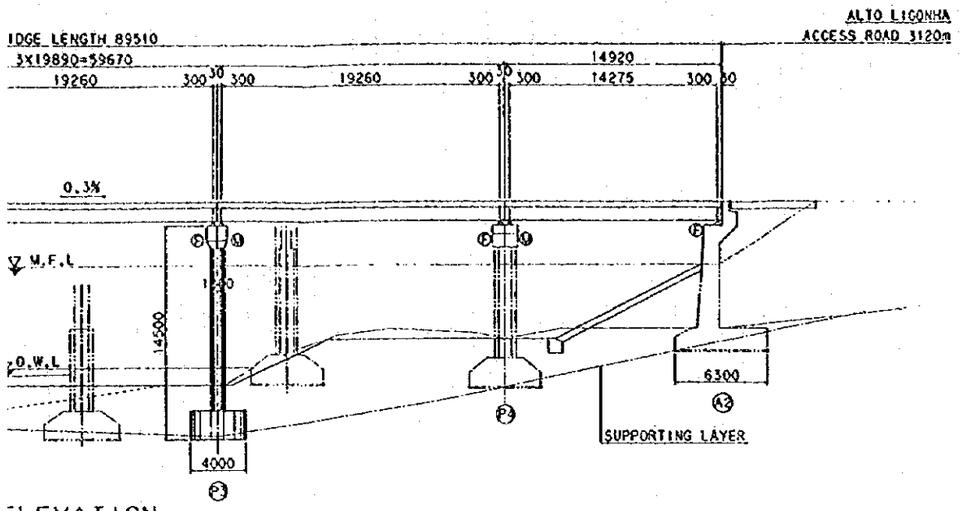
CROSS SECTION S=1/50

GRADIENT	0.3%					101.550	
PROPOSED HEIGHT	101.820	101.775	101.715	101.655	101.595	101.550	101.550
GRAND LEVEL	93.120	92.175	89.920	89.300	92.395	93.050	100.000
DISTANCE	0.000	14.920	19.890	19.890	19.890	14.920	56.200
CHAINAGE	CH +278.000	+292.920	+312.810	+332.700	+352.590	+367.510	BH-14 +423.710

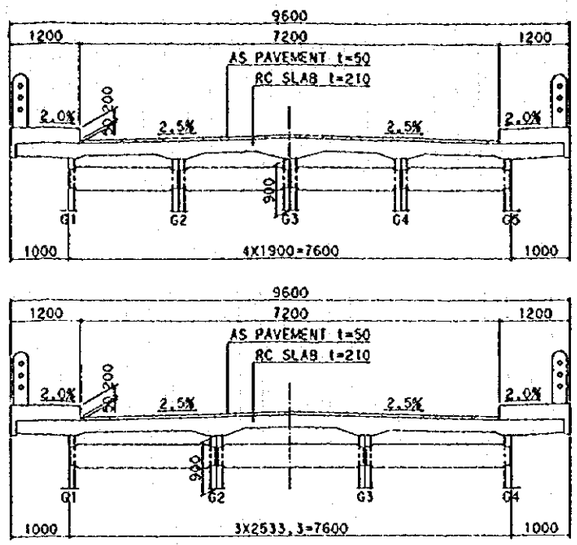


PLAN

MOLOCUE BRIDGE GENERAL VIEW S=1/200

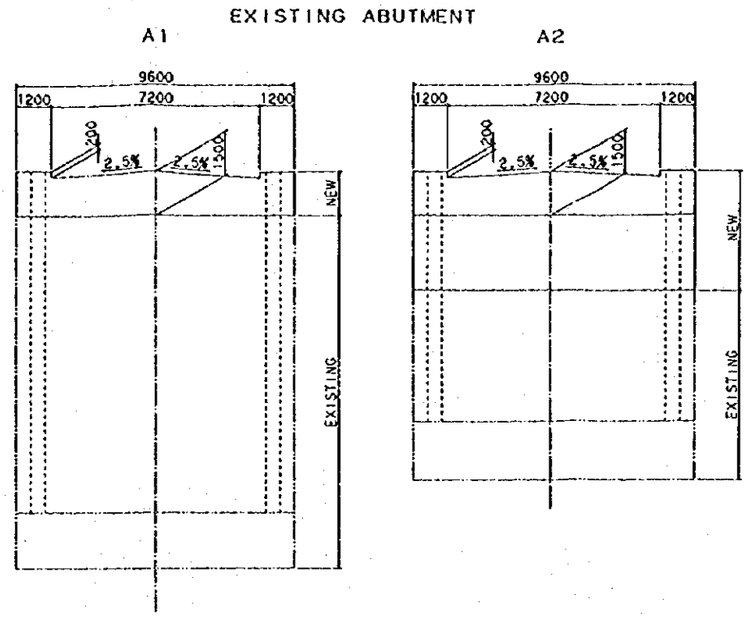


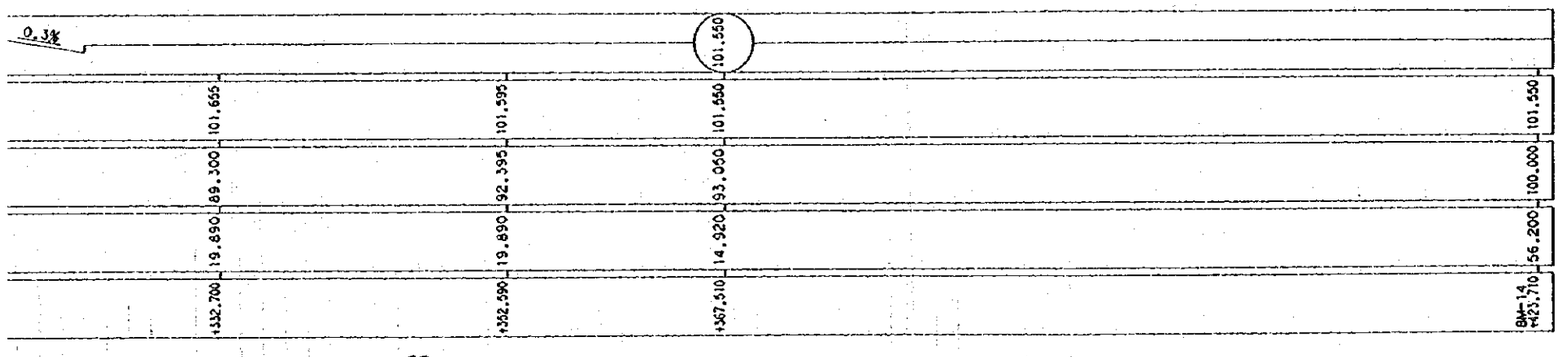
ELEVATION



CROSS SECTION S=1/50

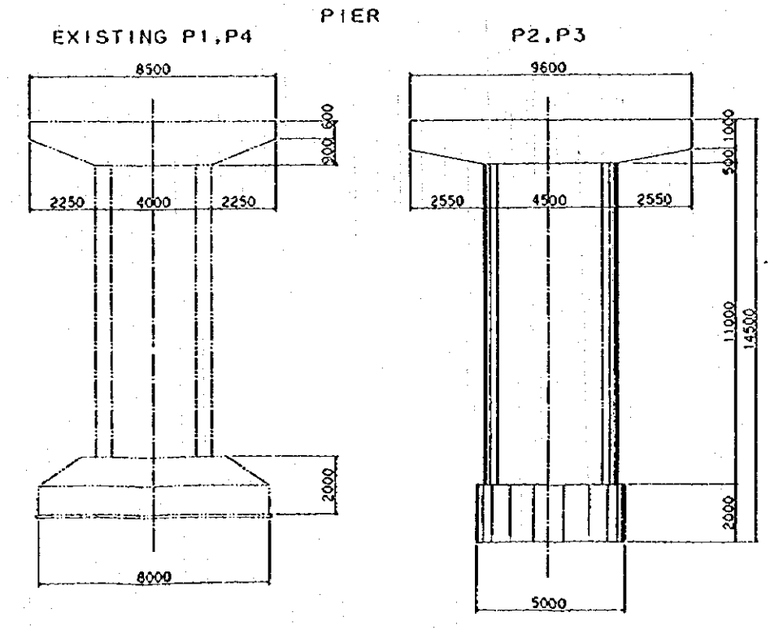
EXISTING ABUTMENT





PLAN

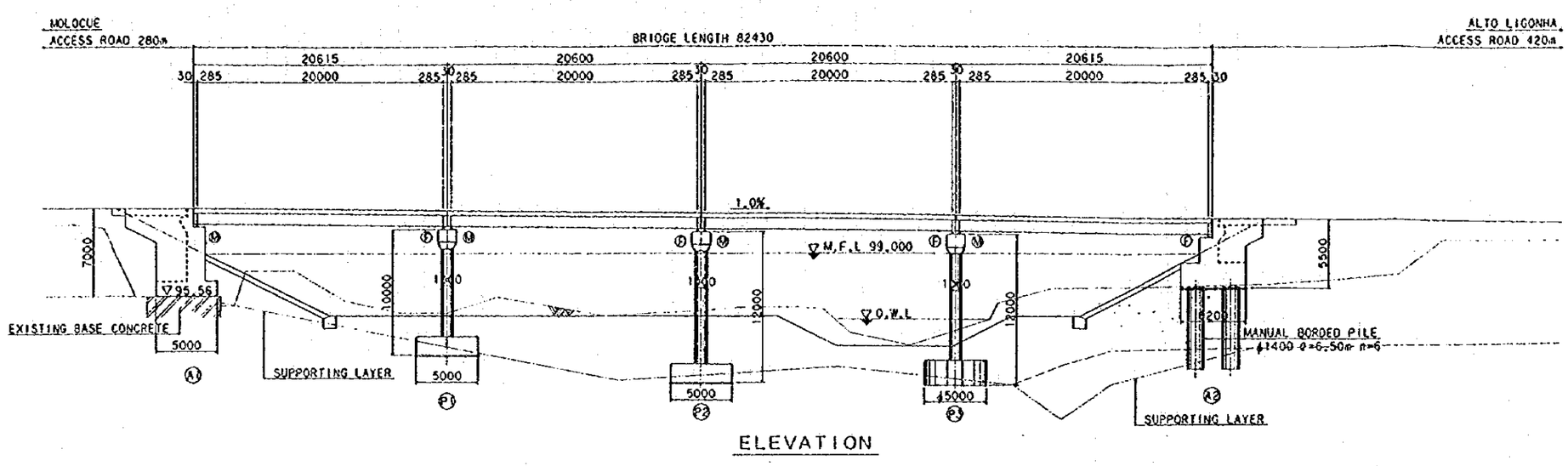
PIER



FRONT VIEW S=1/100

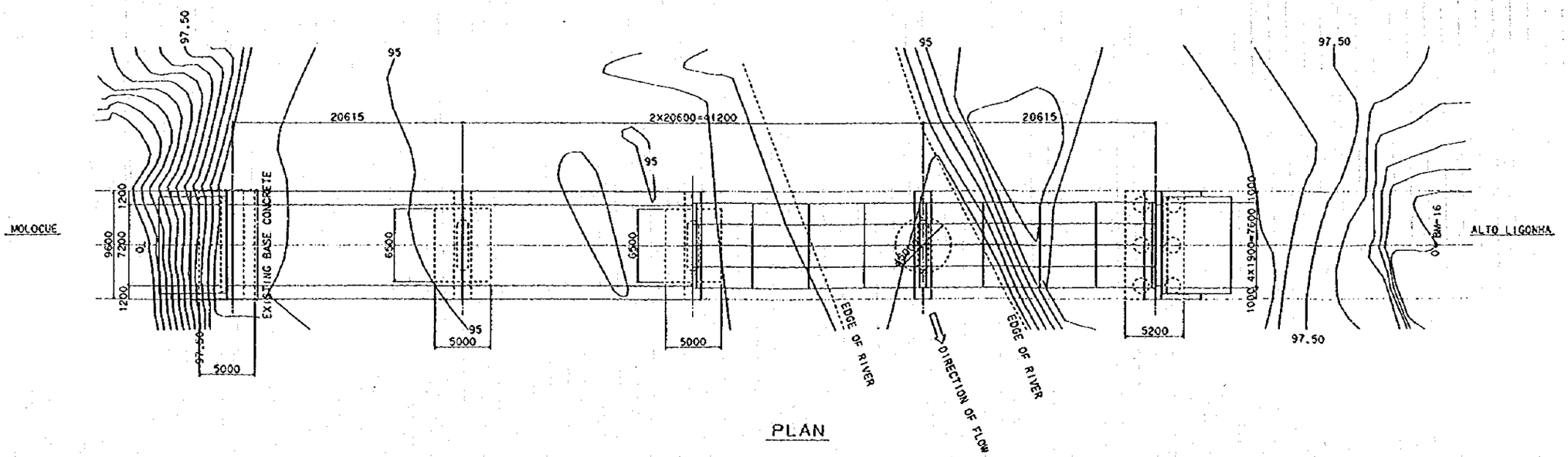
Figure-9 Molocue Bridge

NAMIRROI BRIDGE GENERAL VIEW S=1/200



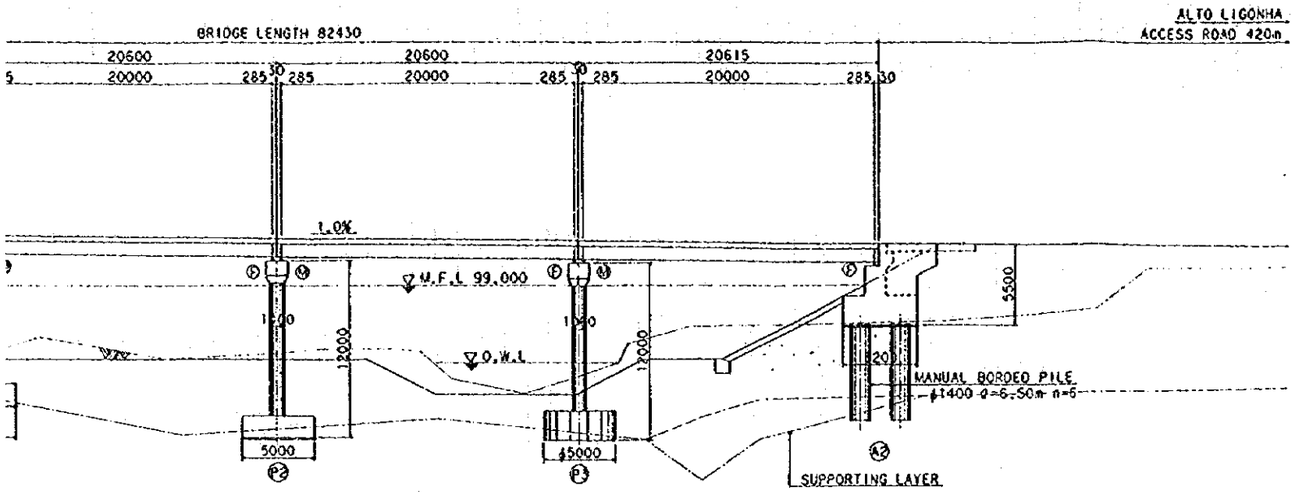
ELEVATION

GRADIENT	102.560	1.0%				
PROPOSED HEIGHT	102.560	102.354	102.148	101.942	101.736	101.486
GRAND LEVEL	95.560	94.300	94.500	92.800	96.500	100.000
DISTANCE	0.000	20.615	20.600	20.600	20.615	25.000
CHAINAGE	CH +302.830	+323.445	+344.045	+364.645	+385.260	BM-16 +336.260

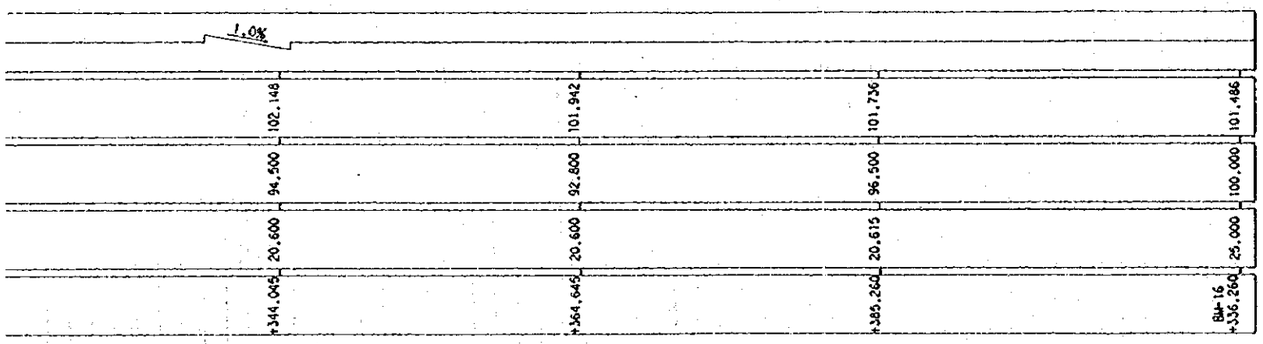


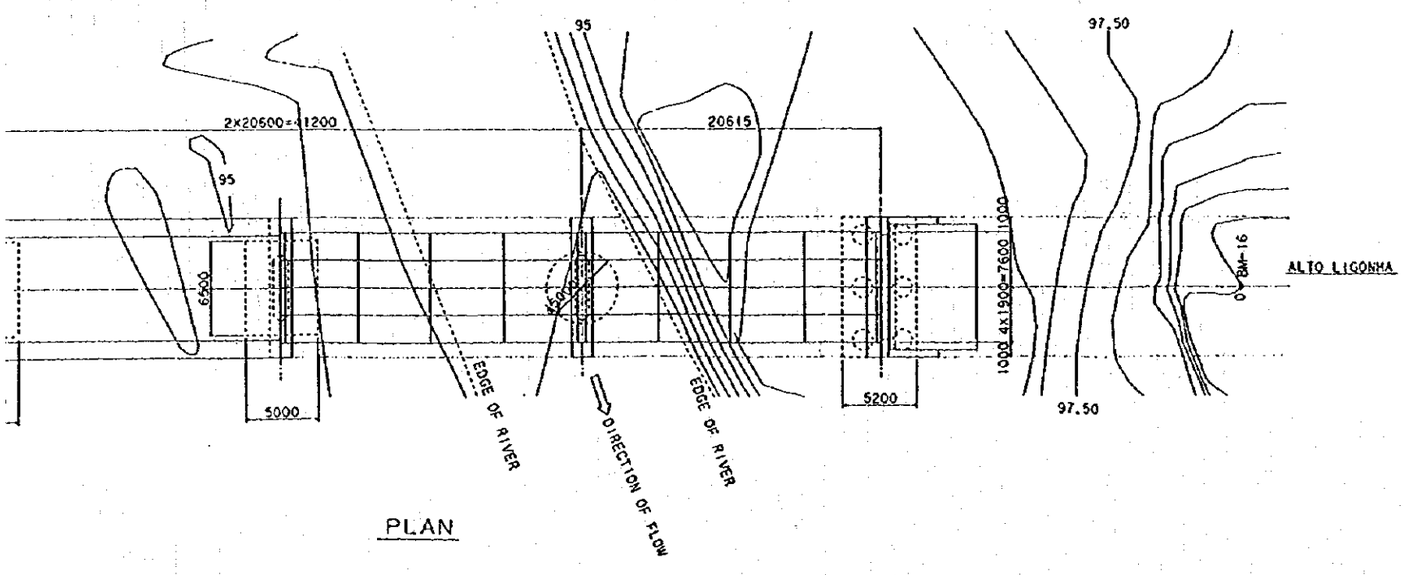
PLAN

NAMIRROI BRIDGE GENERAL VIEW S=1/200

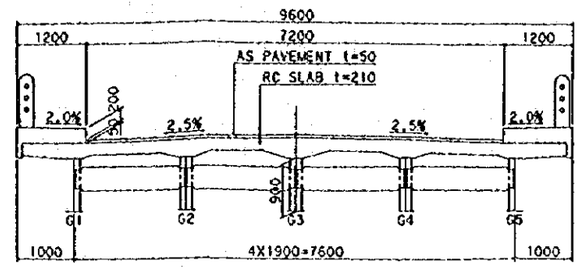


ELEVATION



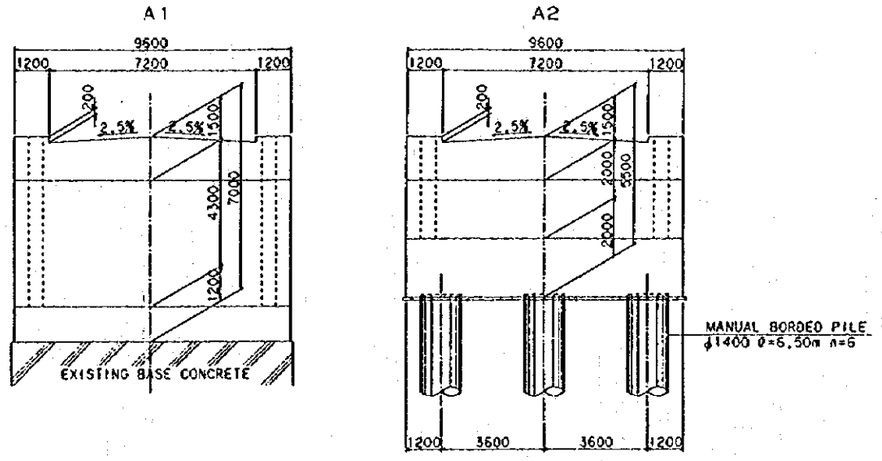


PLAN

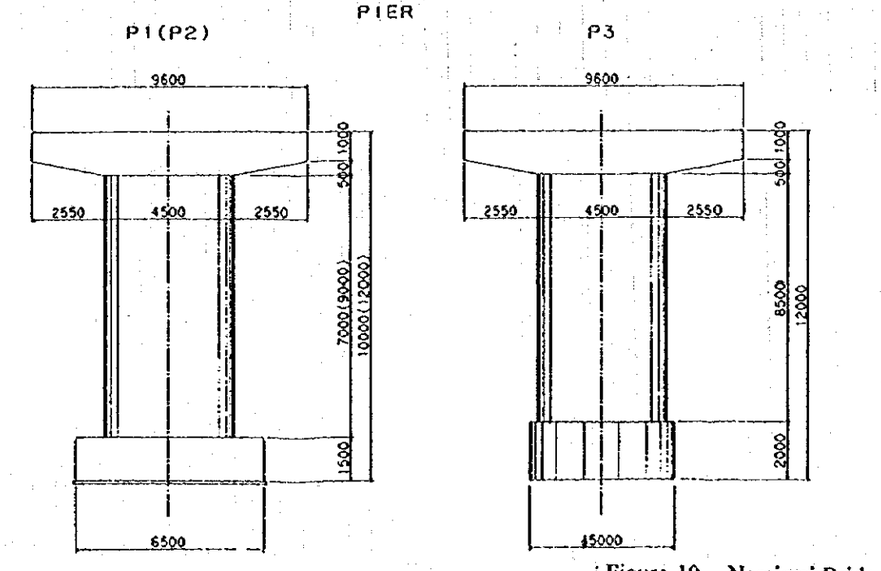


CROSS SECTION S=1/50

ABUTMENT



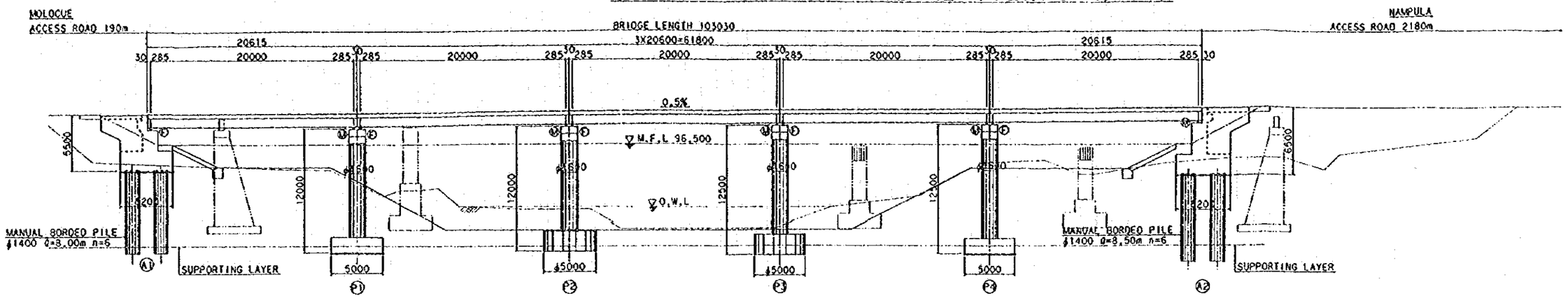
PIER



FRONT VIEW S=1/100

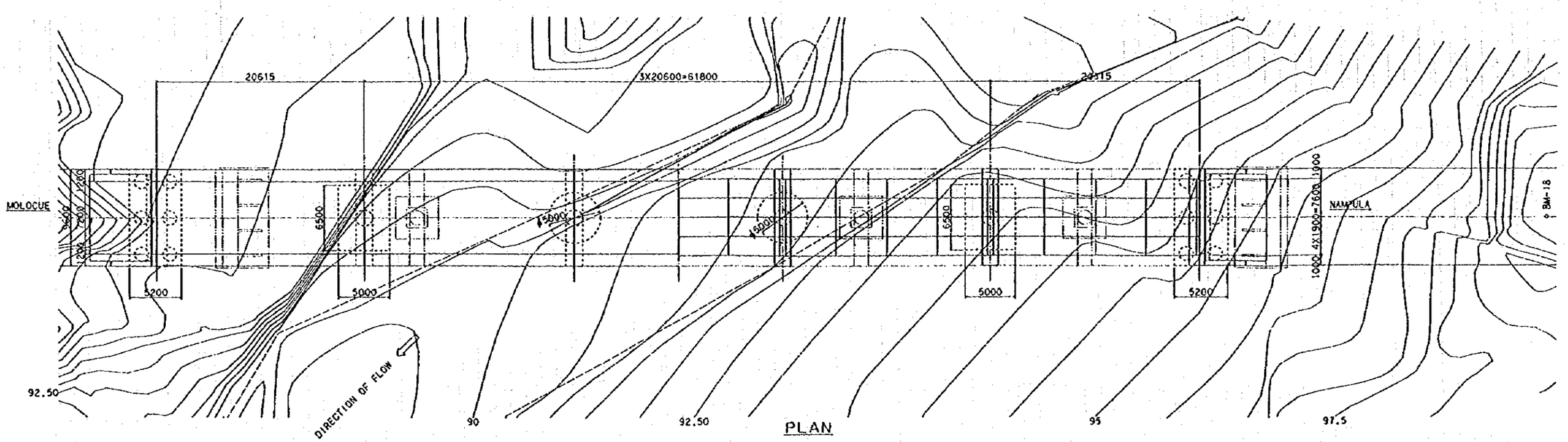
Figure-10 Namirroi Bridge

METUCE BRIDGE GENERAL VIEW S=1/200



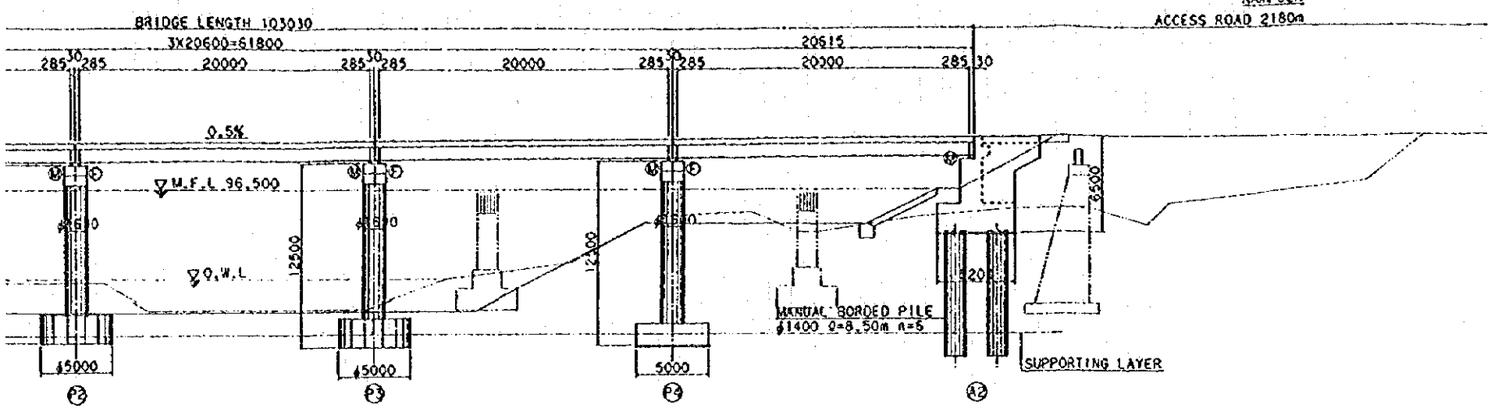
ELEVATION

GRADIENT		0.5%				100.000	
PROPOSED HEIGHT	99.485	99.588	99.691	99.794	99.897	100.000	100.000
GRAND LEVEL	94.600	92.800	90.200	88.600	94.800	94.900	100.290
DISTANCE	0.000	20.615	20.600	20.600	20.600	20.615	34.500
CHAINAGE	CH +335.350	+355.965	+376.565	+397.165	+417.765	+438.380	BM-18 +472.880

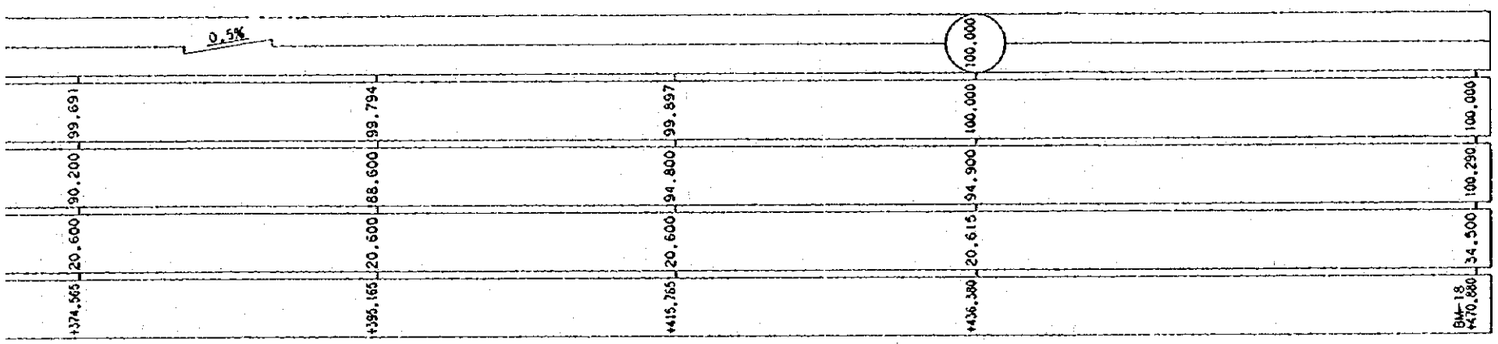


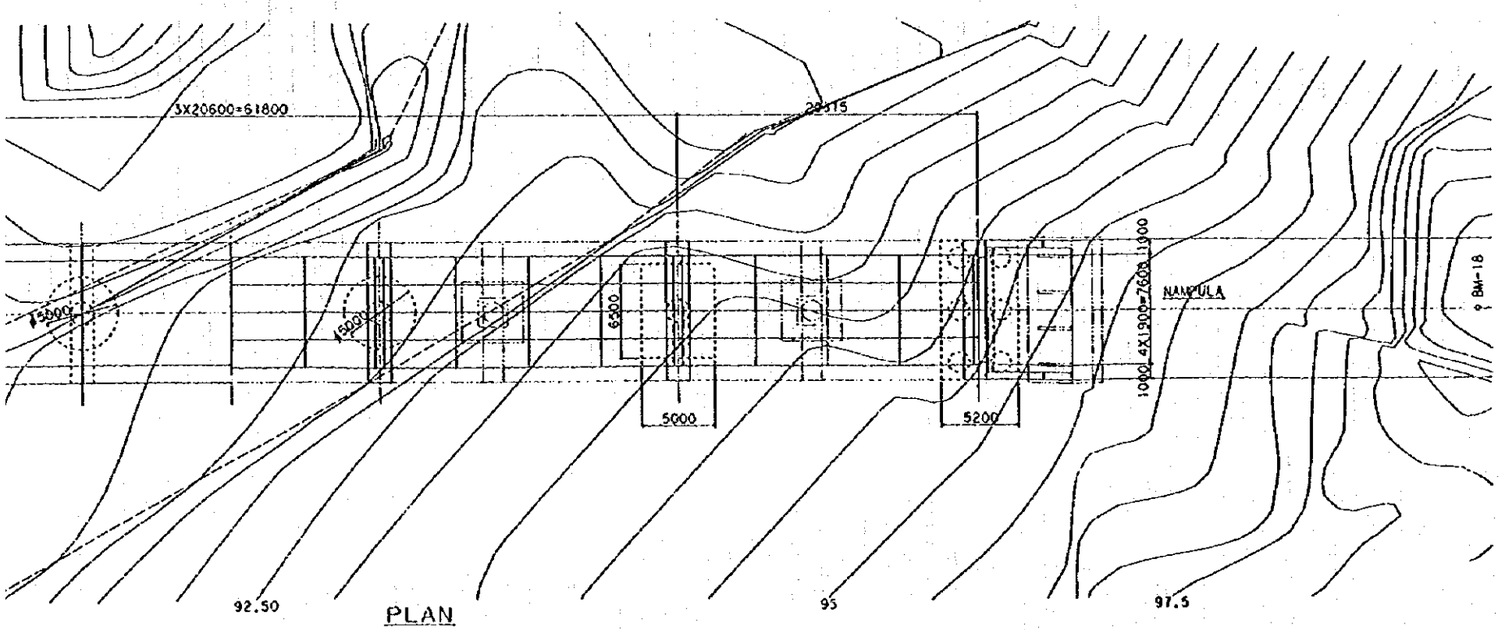
PLAN

METUCE BRIDGE GENERAL VIEW S=1/200

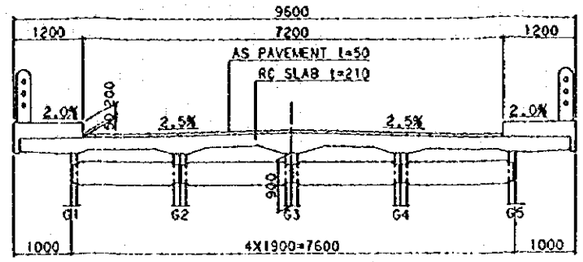


ELEVATION



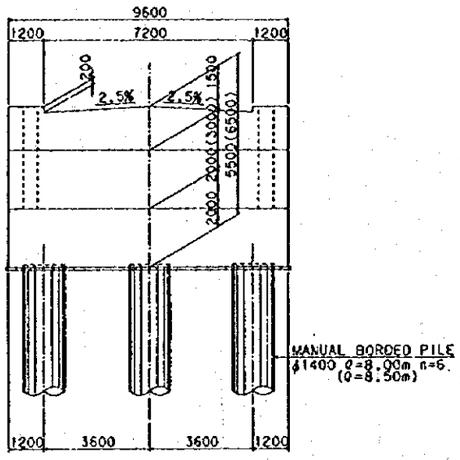


PLAN



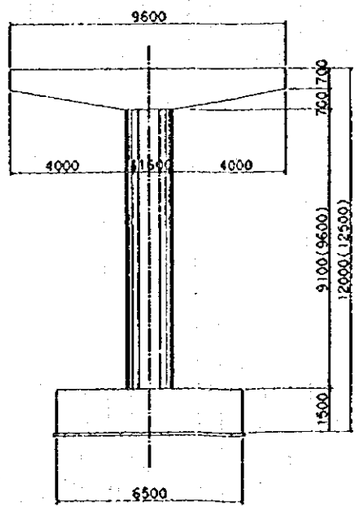
CROSS SECTION S=1/50

ABUTMENT
A1(A2)

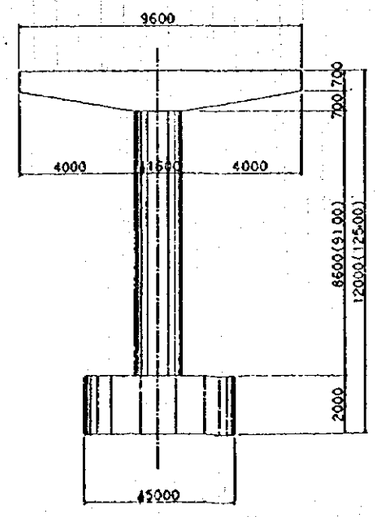


PIER

P1(P4)



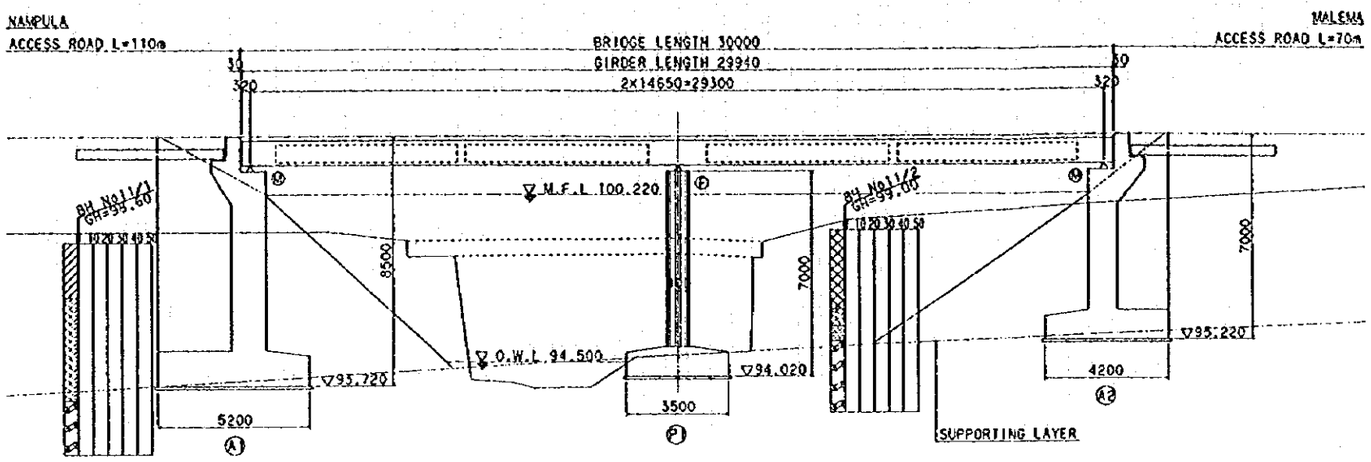
P2(P3)



FRONT VIEW S=1/100

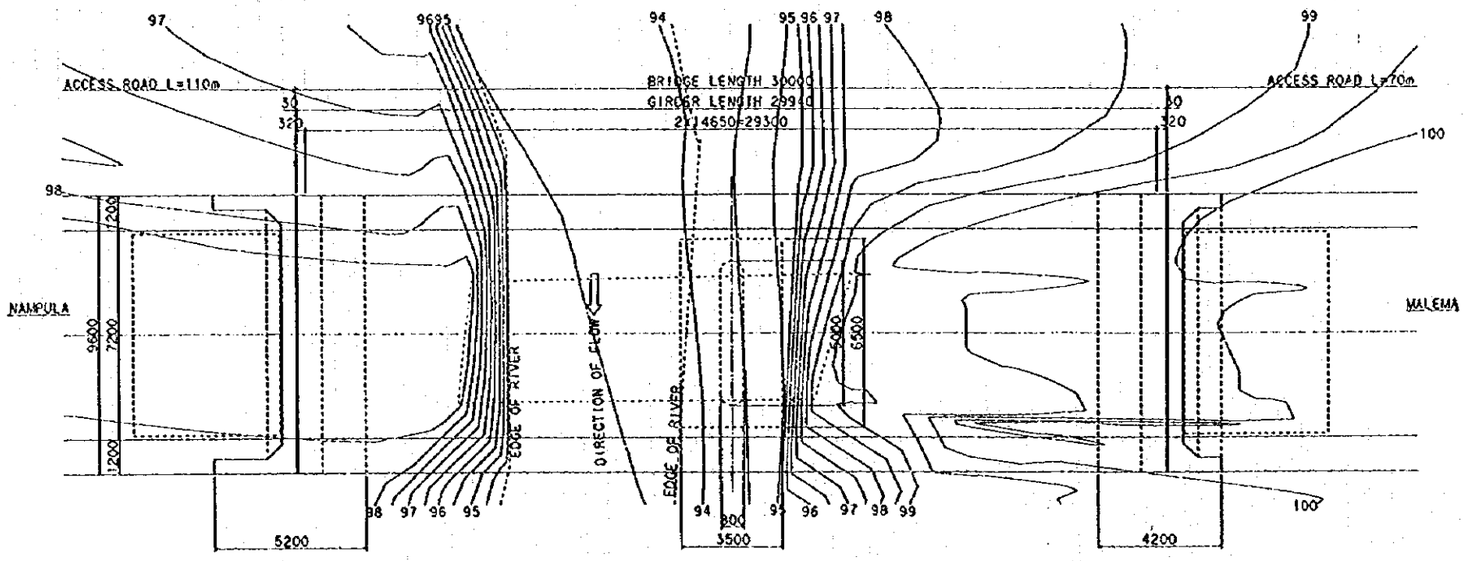
Figure-11 Metuce Bridge

MECUBURI BRIDGE GENERAL VIEW S=1/100

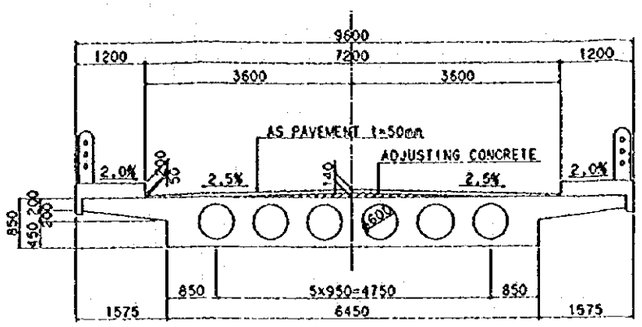


ELEVATION

GRADIENT	102.220	LEVEL	
PROPOSED HEIGHT	102.220	102.220	102.220
GRAND LEVEL			
DISTANCE	0.000	15.000	15.000
CHAINAGE	(A1) +289000	(P1) +289015	(A2) +289030

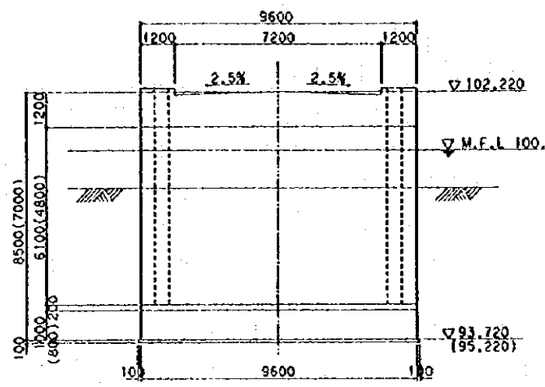


PLAN

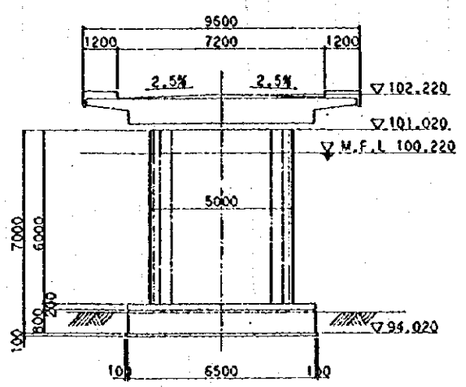


CROSS SECTION S=1/50

ABUTMENT
A1(A2)



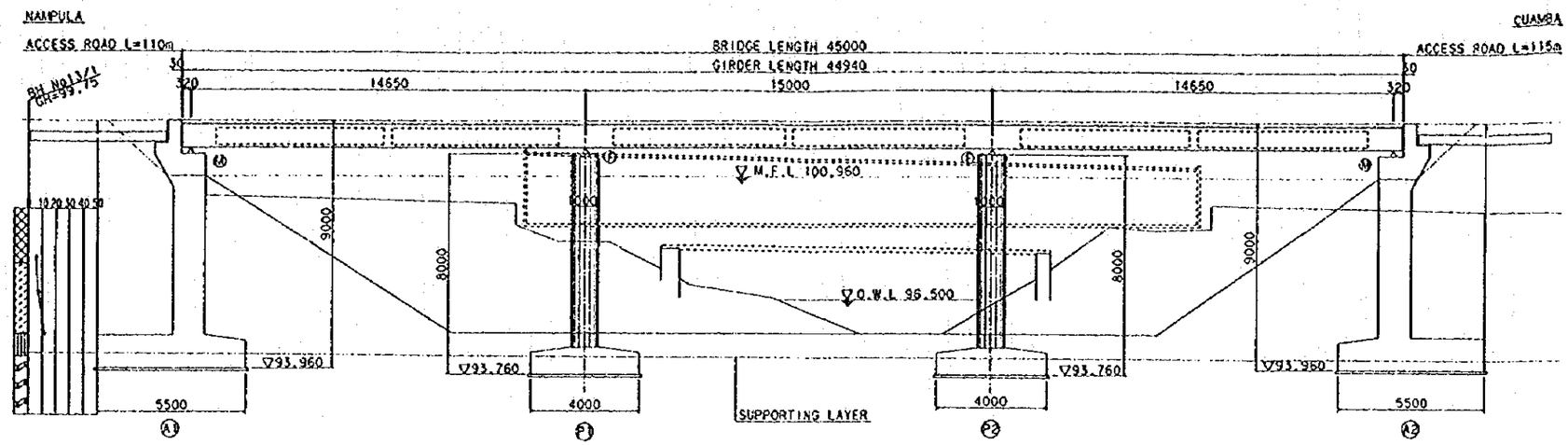
PIER
P1



FRONT VIEW

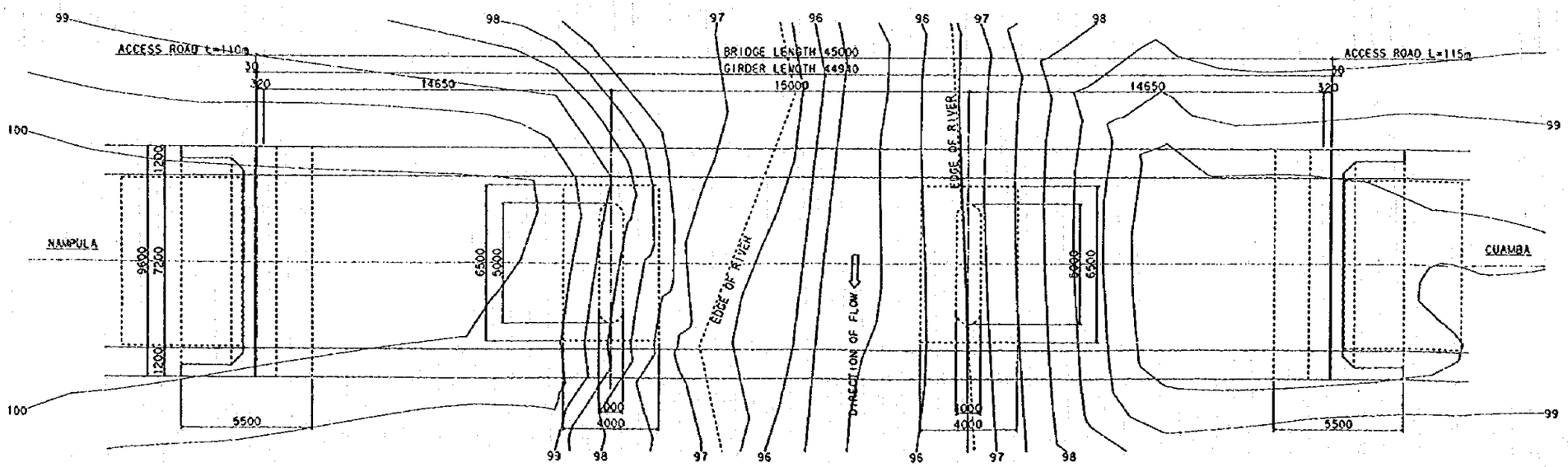
Figure-12 Mecuburi Bridge

MUTIBAZE BRIDGE GENERAL VIEW S=1/100

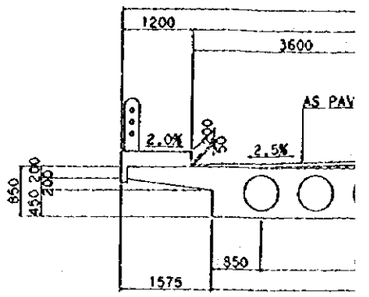


ELEVATION

GRADIENT	LEVEL			
PROPOSED HEIGHT	102.960	102.960	102.960	102.960
GRAND LEVEL				
DISTANCE	0.000	15.000	15.000	15.000
CHAINAGE	(A1) +240992.5	(P1) +241007.5	(P2) +241022.5	(A2) +241037.5

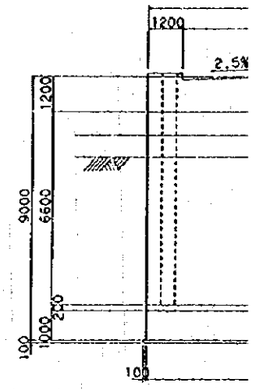


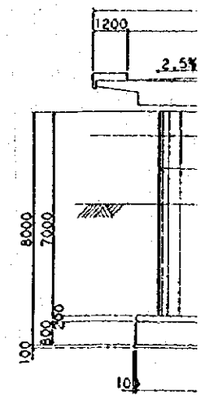
PLAN



CROSS SE

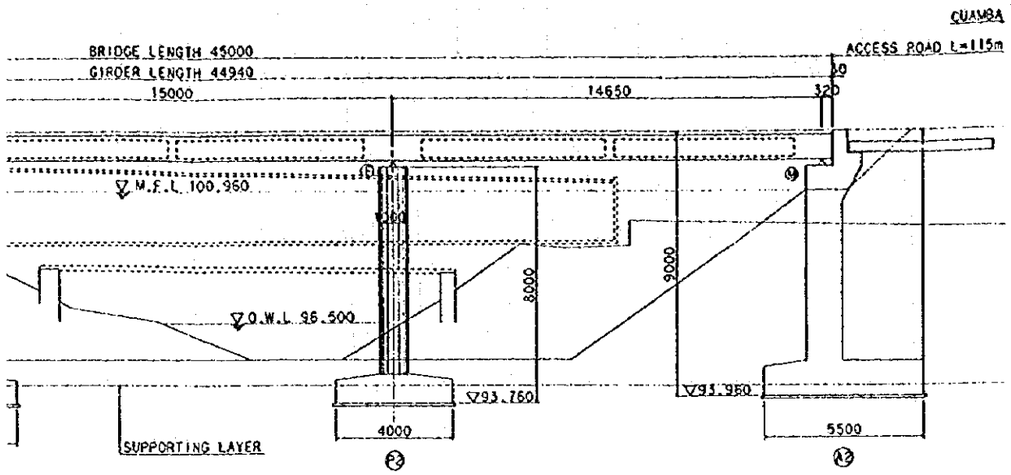
A



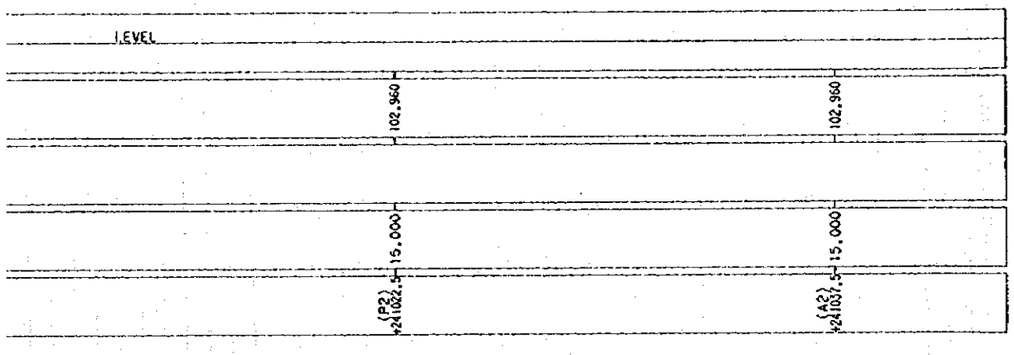


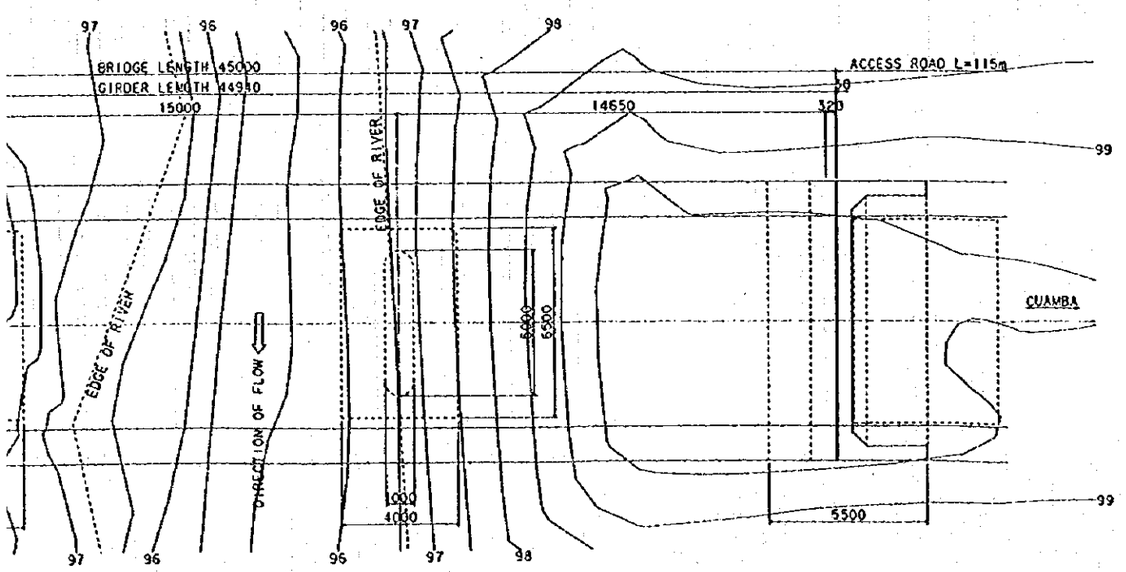
FRO

MUTIBAZE BRIDGE GENERAL VIEW S=1/100

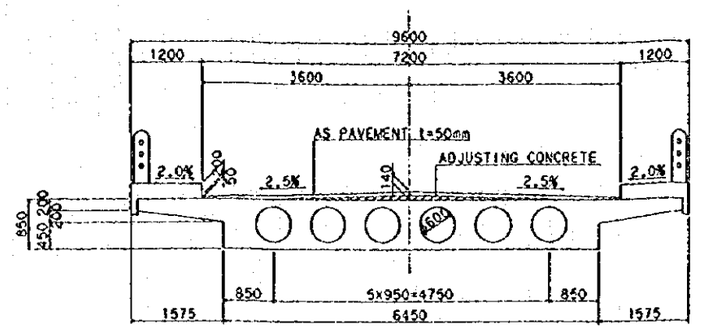


ELEVATION



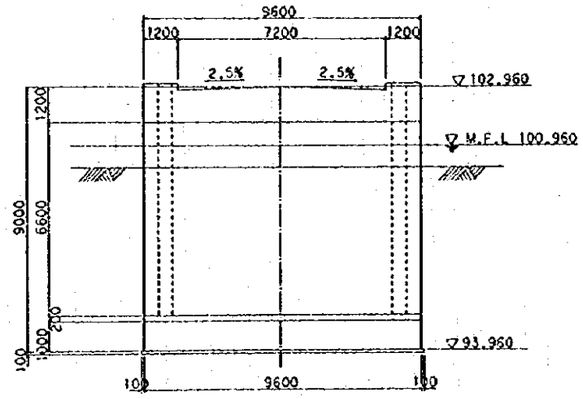


PLAN

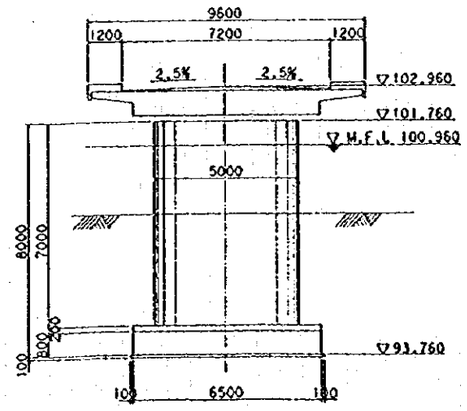


CROSS SECTION S=1/50

ABUTMENT
A1, A2



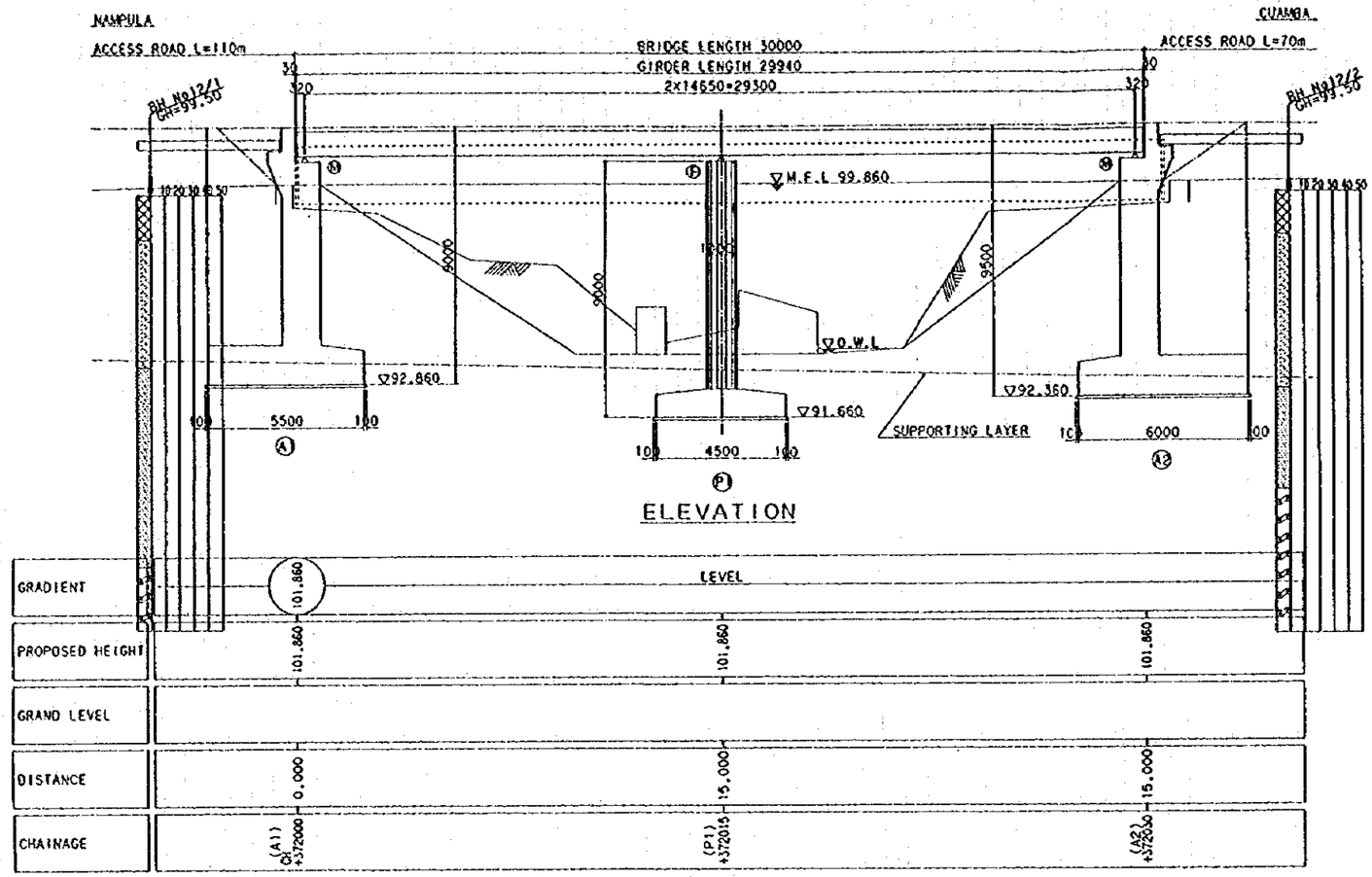
PIER
P1, P2

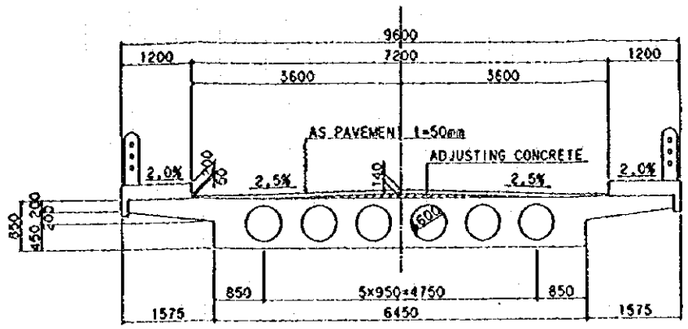


FRONT VIEW

Figure-13 Mutibaze Bridge

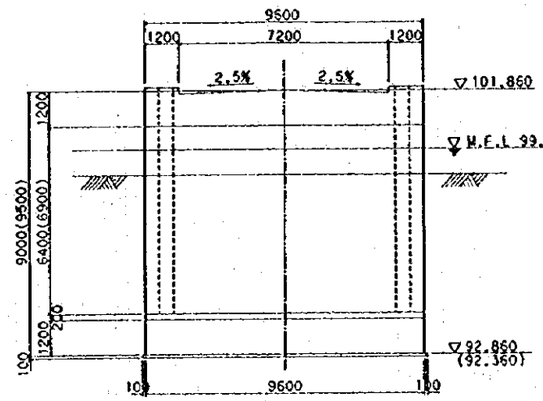
THI-THI BRIDGE GENERAL VIEW S=1/100



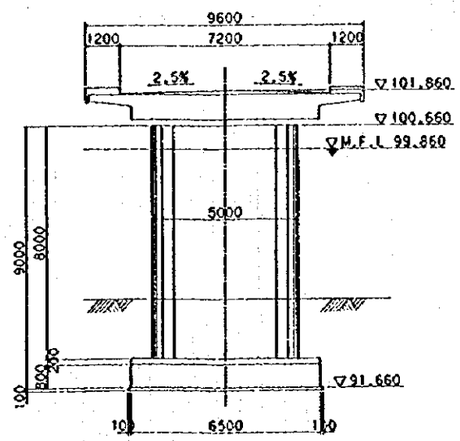


CROSS SECTION S=1/50

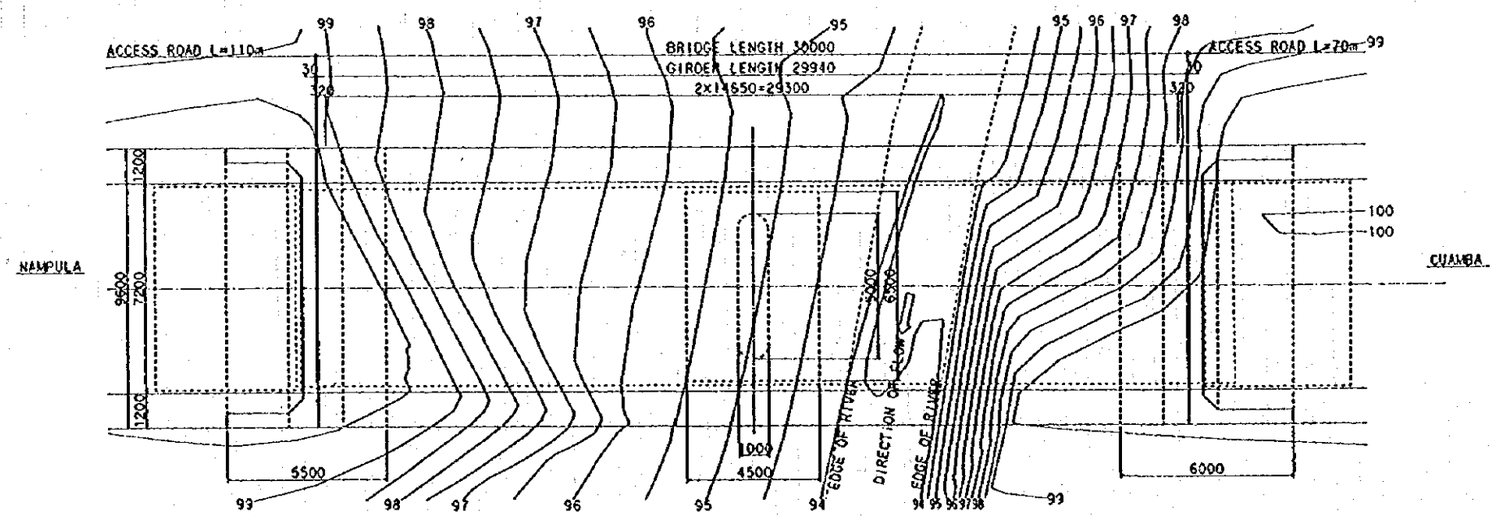
ABUTMENT
A1(A2)



PIER
P1



FRONT VIEW



PLAN

Figure-14 Thi-Thi Bridge

Chapter3 Implementation Plan

CHAPTER 3 IMPLEMENTATION PLAN

3 - 1 IMPLEMENTATION CONCEPT

After the official signing of the E/N between the Governments of Japan and Mozambique, the construction of bridges will be executed in accordance with the procedure of the Japanese Grant Program.

Thirteen bridges which will rehabilitated or reconstructed are located far apart from one another, sometimes exceeding 500 km. Therefore, construction works are divided into five packages by grouping the bridges according to the relevant highway routes. In order to reduce the construction period, large-scale and small-scale bridges are combined into groups to facilitate the efficient deployment of the construction machinery and workshop equipment. Construction works are carried out by two teams, and divided into two phases on the basis of the scale of necessary works and the construction cost per bridge group. Table 4 shows the construction plan by phase and base town.

Table 4 Construction Plan by Base Town

Phase	Base Towns	Routes	Bridges
Phase I	Nampula	8	Mecuburi
		8	Thi-Thi
		8	Mutibaze
Phase II	Quelimane	225	Chiraba
		225	Namitangurine
		1	Zangue
		213	Xisadze I
		213	Xisadze II
	Chimoio	102	Pungue
		102	Mecumbezi
	Nampula	232	Naminoi
		232	Metuce
		232	Molocue

3 - 2 CONSULTANT SUPERVISION

A Japanese consulting firm will be contracted to manage the project implementation on behalf of the Mozambique Government. The consultant will implement detailed designs, prepare and carry out public tender, and supervise the construction works, as stipulated in the Contract of Consultant's Services signed with the Mozambique Government.

(1) Detailed Design Work

The consultant will perform the following services.

- Geological field surveys
- Detailed designs
- Preparation of design drawings and the terms of reference
- Scheduling and cost estimation of construction works
- Preparation of tender documents
- Preparation of an operation and maintenance manual

The following is an additional description on some of the consultant services.

- Preparation of maintenance manual
  The consultant will prepare a manual for maintenance of the bridges.

  The time schedule for the detailed design work is 3 months for Phase I and Phase II.

(2) Public Tender

The consultant will perform the following services.

- Posting of the public tender
- Screening of the bidders
- Supervision of bidding
- Evaluation of the bids
- Facilitation of the contract

The time schedule for the public tender is 2.5 months for each phase.

(3) Engineering Services

The consultant supervises the construction works executed by the contractors. The supervision covers the following services.

- Checking and approval of the surveys
- Checking and approval of the contractor's works plan
- Quality control
- Management of the works schedule
- Inventory of the building materials used in the construction

- Safety management
- Inspection of the building materials brought in, and handing over of the completed bridges

The time schedule for the construction works is 10 months for Phase I and 30 months for Phase II. One full-time manager is assigned for the Phase I works and the Phase II works. Additional short-term engineers are assigned to supervise the substructure and superstructure works of large bridges.

The construction works to be financed by the Japanese grant are shown in Table 5 below.

Table 5 Construction Works Financed by Japanese Grant

Bridges	Location		Financed by Japanese Grant		
	Origin	Distance from Origin (km)	Approach Road (Origin side) (m)	Bridge (m)	Approach Road (Destination side) (m)
Pungue	Route EN 6	62.0	500.0	150.5	350.0
Mecumbezi	Route EN 6	46.0	0	77.4	0
Zangue	Matondo	45.0	50.0	144.2	75.0
Xisadze I	Dondo	170.0	80.0	11.5	80.0
Xisadze II	Dondo	195.0	100.0	20.6	100.0
Chiraba	Zambezi River	30.0	350.0	120.0	350.0
Namitangurine	Zambezi River	143.0	110.0	30.0	110.0
Metuce	Mocuba	333.4	0.0	103.3	0.0
Namirroi	Mocuba	302.8	0.0	82.43	0.0
Molocue	Mocuba	278.0	0.0	89.51	0.0
Mecuburi	Nacala	289.0	110.0	30.0	70.0
Mutibaze	Nacala	241.0	110.0	45.0	115.0
Thi-Thi	Nacala	372.0	110.0	30.0	110.0

3 - 3 PROCUREMENT PLAN

The Study team selected bridge types and organized the construction works in accordance with the availability of machinery and building materials in the country and from the neighboring countries. The Study Team collected the relevant information, regarding, contractors from the neighboring countries such as South Africa and Zimbabwe who may operate in Mozambique, and on the customs clearance regulations in the neighboring countries on through cargo. The contractor shall procure construction machinery and materials from the neighboring countries as much as possible, because their transportation costs could influence the total project cost.

Table 6 Procurement of Machinery and Materials

Items for Procurement	Japan	Mozambique	South Africa	Transportation	Reasons for Selecting Procurement Sources
Machinery					
Crawler cranes			○	Sea	Existing fleet of construction equipment in Mozambique is not available for hire. Because of their uncertain availability, the Project will procure from South Africa where all of the necessary equipment are available. The machines are in principle transported by sea to a Mozambican port and then by land to bridge sites.
Diesel hammers			○	Sea	
Backhoes			○	Sea	
Launchers			○	Sea	
Bulldozers		△	○	Sea	
Tractor shovels			○	Sea	
Motor graders		△	○	Sea	
Rollers			○	Sea	
Concrete Mixer trucks			○	Sea	
Dump trucks		△	○	Sea	
Generators			○	Sea	
Concrete mixers			○	Sea	
Breakers		△	○	Sea	
Jacks (PC)			○	Sea	
Jacks			○	Sea	
Crushers			○	Sea	
Materials					
Steel bars			○	Sea	Not locally available
PC steel plates			○	Sea	Not locally available
Sheaths			○	Sea	Not locally available
Anchoring			○	Sea	Not locally available
Cement			○	Sea	Local supply inadequate in quality and quantity
Gravel		○		Land	
Crushed stone		○		Land	
Sand		○		Land	
Steel forms			○	Sea	Technology inadequate to produce at the project site
Plywood forms			○	Sea	Relies mainly on imports
Timber			○	Sea	Not locally available
Scaffolds			○	Sea	Not locally available
Structural steel shapes	○		○	Sea	Not locally available
Supports	○		○	Sea	Not locally available
Joints	○		○	Sea	Joints easily wear out
Railing			○	Sea	Technology inadequate to produce at the project site

3 - 4 IMPLEMENTATION SCHEDULE

(1) Responsibility of Two Governments

The Mozambique and the Japanese Governments share the responsibility for project implementation as shown in Table 7.

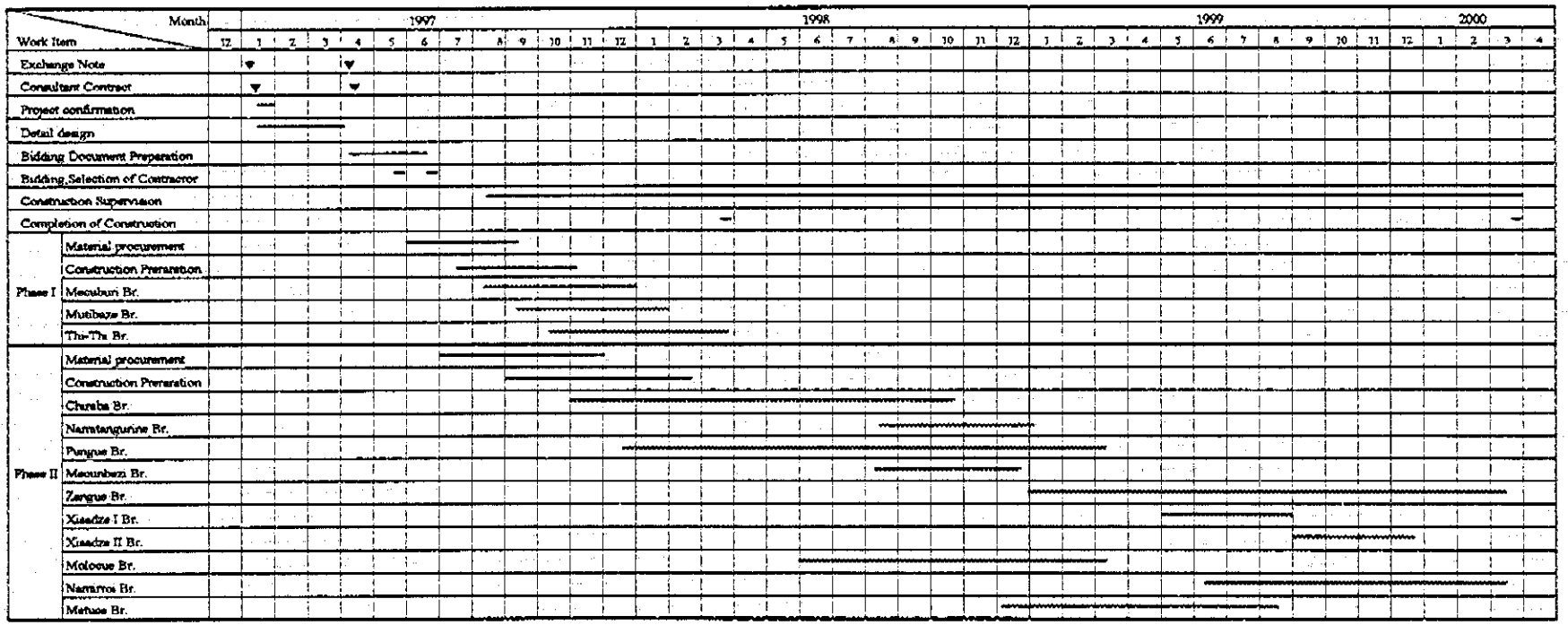
Table 7 Responsibility of Two Governments

Works	Requirements	Responsibility		Remarks
		Japan	Mozambique	
Procurement	Procurement and transportation	○		
	Customs clearance		○	
Site preparation	Provision of land for construction site facilities		○	offices, storage sheds, etc.
	Other preparations	○		
Right of way	Acquisition of right of way		○	
	Relocation or removal of obstacles		○	trees, utility poles, land mines, etc.
	Clearing and grubbing	○		
Construction	Setting and removal of diversion bridge.		○	
	Other works	○		

(2) Implementation Schedule

The Project will be implemented in two phases. The implementation schedules for Phases I and II are shown in Tables 8.

Table-8 Implementation Schedule



3 - 5 PROJECT COST ESTIMATION

(1) Expenditure by Mozambique Government

1. Land acquisition costs (work sites and access roads)
2. Costs of setting and removal of temporary bridge
3. Construction costs for approach roads (Metuce, Namirroi, Molocue Bridge)
4. DNEP shall issue documents that the contractor eligible to recover the tax portion from the Government of Mozambique

(2) Maintenance Costs

1. Labor cost:
2. Maintenance (railings, expansion joints, etc.): 299,800 US$
3. Bridge repainting (every ten years): 19,250 US$

(3) Conditions for Cost estimation

1.	Date of costing:	July, 1996
2.	Exchange Rates:	US$ 1 = ¥109.0 US$ 1 = 4.0372 SF rands
3.	Implementation:	The bridges will be constructed in two phases. Phase I involves a period of 15 months from January 1997 through March 1998. Phase II will cover three years from April 1997 through March 2000.
4.	Others:	The project will be implemented by the Japanese Government grant aid system.