No.

BASIC DESIGN STUDY REPORT
ON
THE PROJECT
FOR
CONSTRUCTION OF A NEW HIGHWAY BRIDGE
AT MANAMPITIYA
IN
THE DEMOCRATIC SOCIALIST REPUBLIC
OF
SRI LANKA

JANUARY 2005

JAPAN INTERNATIONAL COOPERATION AGENCY
GRANT AID MANAGEMENT DEPARTMENT

GM
JR
05-010

BASIC DESIGN STUDY REPORT
ON
THE PROJECT
FOR
CONSTRUCTION OF A NEW HIGHWAY BRIDGE
AT MANAMPITIYA
IN
THE DEMOCRATIC SOCIALIST REPUBLIC
OF
SRI LANKA

JANUARY 2005

JAPAN INTERNATIONAL COOPERATION AGENCY
GRANT AID MANAGEMENT DEPARTMENT

PREFACE

In response to a request from the Government of the Democratic Socialist Republic of Sri Lanka, the Government of Japan decided to conduct a basic design study on the Project for Construction of A New Highway Bridge at Manampitiya and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Sri Lanka a study team from July 4 to August 2, 2004.

The team held discussions with the officials concerned of the Government of Sri Lanka, 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 Sri Lanka 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 Democratic Socialist Republic of Sri Lanka for their close cooperation extended to the teams.

January, 2005

Seiji Kojima

Vice-President
Japan International Cooperation Agency

January, 2005

Letter of Transmittal

We are pleased to submit to you the basic design study report on the Project for Construction of A New Highway Bridge at Manampitiya in the Democratic Socialist Republic of Sri Lanka.

This study was conducted by the joint venture between Oriental Consultants Company Limited and Nippon Koei Company Limited, under a contract to JICA, during the period from July, 2004 to January, 2005. In conducting the study, we have examined the feasibility and rationale of the project with due consideration to the present situation of Sri Lanka 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.

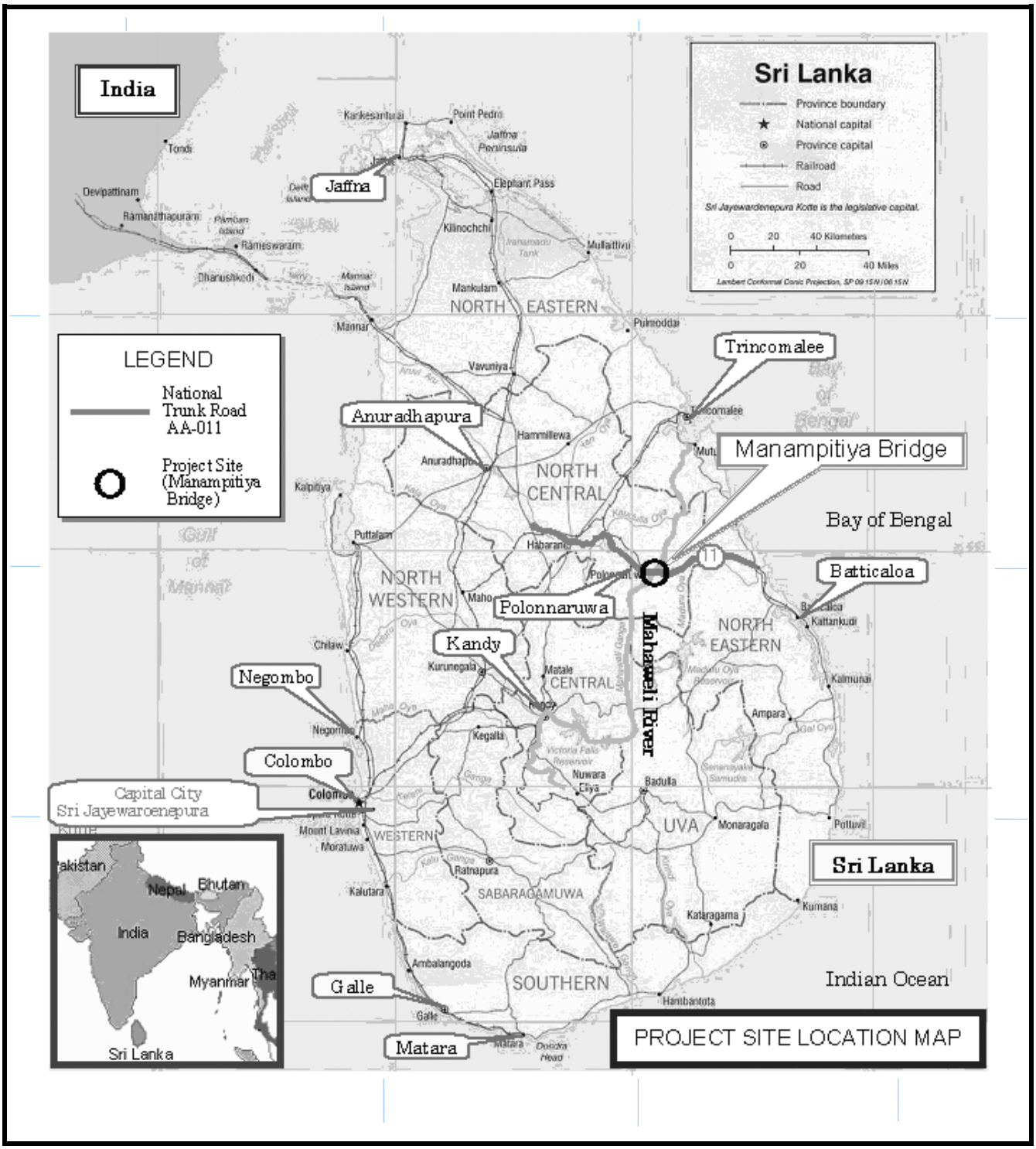
Very truly yours,

Keigo Konno

Chief Consultant,

Basic design study team on
The Project for Construction of A New
Highway Bridge at Manampitiya

The joint venture between
Oriental Consultants Company Limited and
Nippon Koei Company Limited


India
Sri Lanka
Province boundary
National capital
Province capital
Railroad
Road
Sri Jayewardenepura Kotte is the legislative capital.
0 20 40 Kilometers
0 20 40 Miles
Lambert Conformal Conic Projection, SP 09 15N / 06 15N
LEGEND
National Trunk Road AA-011
Project Site (Manampitiya Bridge)
Jaffna
Trincomalee
Anuradhapura
Manampitiya Bridge
Batticaloa
Polonnaruwa
Kandy
Negombo
Colombo
Capital City
Sri Jayewarcenepura
Galle
Matara
Mahaweli River
Bay of Bengal
Indian Ocean
NORTH EASTERN
NORTH CENTRAL
NORTH WESTERN
CENTRAL
WESTERN
SABARAGAMUWA
UVA
SOUTHERN
Pakistan
Nepal
Bhutan
India
Bangladesh
Myanmar
Tha
Sri Lanka
PROJECT SITE LOCATION MAP

Perspective of A New Highway Bridge at Manampitiya

List of Tables and Figures

[List of Tables]

Page

Chapter 2

Table 2.2.1 Objective Facilities ····· 2-9
Table 2.2.2 Road Alignment Specification ····· 2-10
Table 2.2.3 Unit Weight by Material Type ····· 2-11
Table 2.2.4 Incremental Factors by Load Combination ····· 2-13
Table 2.2.5 Freeboard under slab bottom for design ····· 2-15
Table 2.2.6 Modulus of elasticity for concrete ····· 2-17
Table 2.2.7 Allowable tensile stress of prestressing steel for prestressed concrete ····· 2-17
Table 2.2.8 Alternatives for new bridge construction point ····· 2-19
Table 2.2.9 Alternatives for types of basic bridge structure by bridge alignment plan ···· 2-20
Table 2.2.10 Specific superstructure alternatives and applicable span ····· 2-25
Table 2.2.11 Pier alternatives and comparison of their characteristics ····· 2-26
Table 2.2.12 Foundation alternatives and a comparison of their characteristics ····· 2-28
Table 2.2.13 Facilities to be relocated ····· 2-49
Table 2.2.14 Temporary sites for work ····· 2-50
Table 2.2.15 Quality Control Methods (1 to 2) ····· 2-54
Table 2.2.16 Quality Control Methods (2 to 2) ····· 2-55
Table 2.2.17 Progress control standards ····· 2-56
Table 2.2.18 Sri Lanka laws concerning employment ····· 2-58
Table 2.2.19 The number of days off & Holidays ····· 2-59
Table 2.2.20 Construction machinery of MAGANEGUMA ····· 2-61
Table 2.2.21 List of Construction machinery of major enterprises ····· 2-62
Table 2.2.22 Procurement channels ····· 2-63
Table 2.2.23 Survey results on fine aggregates ····· 2-65
Table 2.2.24 Implementation Schedule ····· 2-68
Table 2.3.1 Responsibilities of Recipient Country ····· 2-69
Table 2.5.1 Approximate Project Cost ····· 2-73
Table 2.5.2 Approximate Costs to be borne by Sri Lankan Government ····· 2-74
Table 2.5.3 Operation & Maintenance for Project Road ····· 2-74
Table 2.6.1 Climatic region and biological features ····· 2-75
Table 2.6.2 List of protected area under the management by the DWC ····· 2-77
Table 2.6.3 List of fauna and flora around the project site ····· 2-78

Page

Table 2.6.4 Water quality of the Mahaweli River and underground water ····· 2-79
Table 2.6.5 Changes in population size ····· 2-79
Table 2.6.6 Changes in the paddy production ····· 2-80
Table 2.6.7 The number of fishing village and household ····· 2-80
Table 2.6.8 Changes in the fishery production ····· 2-81
Table 2.6.9 Poverty ration of each province ····· 2-81
Table 2.6.10 Schedule of the IEE ····· 2-87
Table 2.6.11 Schedule of the Public Consultation by the RDA ····· 2-88
Table 2.6.12 Allowable Noise Level at Laeq'T ····· 2-90
Table 2.6.13 Allowable Noise at Laeq'T in Industrial Area ····· 2-91
Table 2.6.14 Summary of the check items in the JICA's Guidelines ····· 2-93

Chapter 3

Table 3.1.1 Direct Project Effects ····· 3-1
Table 3.1.2 Indirect Project Effects ····· 3-2

[List of Figures]

Page

Chapter 2

Figure 2.2.1 Selection Process Flow Chart ····· 2- 7
Figure 2.2.2 Project Scope ····· 2- 9
Figure 2.2.3 Approach Road Standard Section ····· 2-10
Figure 2.2.4 Bridge Cross Section ····· 2-11
Figure 2.2.5 Embedding of Footing Levee crown ····· 2-13
Figure 2.2.6 Geological longitudinal map and embedment level of pile ····· 2-14
Figure 2.2.7 Determination of bridge construction point ····· 2-21
Figure 2.2.8 Determination of span allocation ····· 2-22
Figure 2.2.9 Examination process of pier location and span allocation ····· 2-23
Figure 2.2.10 General View ····· 2-31
Figure 2.2.11 Approach Road (Left Bank) ····· 2-32
Figure 2.2.12 Approach Road (Right Bank) ····· 2-33
Figure 2.2.13 General View of Superstructure ····· 2-34
Figure 2.2.14 General Plan for A1 Abutment ····· 2-35
Figure 2.2.15 General Plan for P1 Pier ····· 2-36
Figure 2.2.16 General Plan for P2 Pier ····· 2-37
Figure 2.2.17 General Plan for P3 Pier ····· 2-38
Figure 2.2.18 General Plan for P4 Pier ····· 2-39
Figure 2.2.19 General Plan for P5 Pier ····· 2-40
Figure 2.2.20 General Plan for A2 Abutment ····· 2-41
Figure 2.2.21 Work Flow for Project ····· 2-43
Figure 2.6.1 Climatic Classification in Sri Lanka ····· 2-76

Abbreviation

Authorities & Agencies

ADB	Asian Development Bank
CEA	Central Environmental Authority
DWC	Department of Wildlife Conservation
ERD	Department of External Resources, Ministry of Finance
GOJ	the Government of Japan
GOS	the Government of the Democratic Socialist Republic of Sri Lanka
JICA	Japan International Cooperation Agency
LTTE	Liberation Tigers of Tamil Eelam
MA	Ministry of Mahaweli, River basin Development and Rajarata development, Mahaweli Authority
MOH	Ministry of Highways
NEA	National Environmental Act
NEMO	National Equipment & Machinery Organization
PAA	Project Approving Agency
PC	Provincial Committee
PP	Prescribed Projects
RCDC	Road Construction & Development Company
RDA	Road Development Authority
UK	United Kingdom
UNDP	United Nations Development Program

Others

凹	Sag
凸	Crest
%	Percent
σ ck	Specified Concrete Strength
σ pu	Tensile Strength
σ py	Yield Strength
A/P	Authorization to Pay
BS	British Standard
CBR	California Bearing Ratio
cm	Centimeter
EIA	Environmental Impact Assessment
EMP	Environmental Management Program
Esp	Young's Modulus
GDP	Gross Domestic Product
ha	Hectare
IEE	Initial Environmental Examination
JPY	Japanese Yen
kg	Kilogram

kgf/cm^2	Kilogram force per square centimeter
km	Kilo
km^2	Square kilometer
km/h	Kilometer per hour
kN/m^3	Kilo Newton per cubic meter
m	Meter
m^2	Square meter
m/s	Meter per second
m^3/sec	Cubic meter per second
mm	Millimeter
m.p.h	Meter per hour
MSL	Mean sea Level
N	n-value, Newton
N/mm^2	Newton per square millimeter
ODA	Official Development Assistance
OJT	On the Job Training
PC	Prestressed Concrete
pcu	Passenger Car Unit
PMU	Project Management Unit
Rs.	Rupee
T	Thickness
TOR	Terms Of Reference
US$	American dollar

SUMMARY

Railways and motor vehicles on roads are the principal inland means of transportation, with the latter being the predominant means, accounting for 94% of total passenger transport and 98% of the total freight transport in Sri Lanka. The road density of the country is about 1.5 km/km^2, of which about 23% is paved. The former is the highest and the latter is low among South Asian countries. The current number of registered vehicles has increased at an annual rate of 6% since 1999 to approximately double the number registered in 1990, and the increase is continuing. On trunk roads, there are as many as 3,900 old bridges constructed 50 to 100 years ago during the rule of the United Kingdom (hereinafter referred to as "UK"), and they are still being used. Most of them, however, are not only suffering such problems as superannuation, insufficient road width, faulty alignment of access roads, but also facing many difficulties to be solved to cope with existing and future traffic volumes.

The goals of the Government of the Democratic Socialist Republic of Sri Lanka (hereinafter referred to as "the GOS) based on the National Physical Planning Policy (September 2002) are that "to prepare a National physical Planning Policy that would provide a framework to achieve an integrated and mutually complementary sectoral and regional development pattern and spatial structure for the future development of the country." According to this plan, northern central provinces and eastern provinces including Anudarapura, Trincomalee, Dambulla and Polonnaruwa are designated as candidates for development as large urban areas in addition to the Greater Colombo Metropolitan Area. In particular, nine cities, including principal cities along the National Highway 11 on which this bridge is located, Polonnaruwa and Batticaloa, have been designated as key cities in the early development promotion area. Improvement will be made, centering around these nine cities functioning as the center of urban infrastructure development activities for the coming three decades. This is expected to contribute to medium to long-term economic development.

Many bridges that remain on the trunk roads are impassable for large vehicles such as construction machinery and container cars, because of narrow width, superannuated and unstable structure, decreased load-carrying capacity through corrosion of steels, etc. Facing this situation, the Road Development Authority (hereinafter referred to as "RDA"), which is the competent authority of management and maintenance work for highways of Sri Lanka, is proceeding with rehabilitation of bridges sequentially, beginning with those requiring renewal urgently. Actually, however,

Sri Lanka has to rely on financial aids from other countries because of the substantial amount of funds needed for bridge rehabilitation. In this situation, in September 2002, the GOS requested the Government of Japan (hereinafter referred to as "the GOJ) for grant aid for basic design studies on four bridge projects:

1) Construction of the new highway bridge at Manampitiya (291 m)
2) Reconstruction of the Kotugoda bridge (36.6m)
3) Reconstruction of the Ruwanwella bridge (46m)
4) Construction of Kinaiya bridge

In response to this request from the GOS, the GOJ dispatched a preliminary study team during the period from February 10 to March 10 2004. As regards the request, above-mentioned "4)" was excluded because of the security situation. As a result of the narrowed-down preliminary study, it was determined that above-mentioned "2)" and "3)" could be implemented technically and financially by Sri Lanka, and it was decided that above-mentioned "1)" would be objective of the basic design study. The existing Manampitiya Bridge, which was constructed originally as a railway bridge, has subsequently been used also as a bridge on the East-West trunk road, National Highway 11, of Sri Lanka. As a railway-highway bridge with track laid as a simple road deck, it is closed to vehicles while trains cross. In addition, its limited width has forced vehicles to take turns crossing. This bridge has therefore become a bottleneck.

On the basis of the study results, a study team was dispatched during the period from July 4 to August 2 2004. It engaged in discussions with Sri Lankan counterparts, conducted a field survey, and collected data. After returning to Japan, the study team reviewed the road alignment, road geometric design, pavement type, bridge location, bridge length, bridge type, and construction method on the basis of the field survey results. Then, the team drafted a basic design for the bridge, including an access road, calculated the approximate quantities for each work item, developed a construction plan and an estimate of project costs. After conducting a briefing on the basic design in Sri Lanka from October 24 to November 4 2004, the results were summarized in the basic design study report.

The outline of basic structure of the bridge and access road for the Manampitiya New Trunk Highway Bridge Construction Project, as based on the results of basic design study, is shown in the table below.

Details for Construction of A New Highway Bridge at Manampitiya

Type of facility		Bridge (Name: A New Highway Bridge at Manampitiya)	Polonnaruwa, northern central province
Details of new bridge construction	Bridge type	PC6 spans continuous girder box	
	Bridge length	53.0m + 55.0m + 4 x 48.5m = 302.0m	
	Bridge width	1.5m (sidewalk) ＋ 2 × 3.7m (carriageway) ＋ 1.5m (sidewalk) = 10.4m	
	Structures	① Foundation：7 Pile foundations （cast-in-place concrete piles： ϕ 1.0m） ② Substructure：Reversed T-type abutments (A1, A2)：2 abutments、wall-type piers (P1-P5)：5 piers ③ Superstructure：PC6 spans continuous girder box ④ Accessory facilities：Wall-type railings, expansion joints, shoes, drainage ⑤ Bridge surface：Concrete pavement （T=5 cm）	
	Access road	Left bank ：246m（Concrete pavement：T=25 cm） Right bank：182m（Concrete pavement：T=25 cm） （Culvert box：5.0 m width x 2.5 m height）	

The implementation process for this grant-aid project includes about 4.5 months for detailed design and about 28 months for construction (including tendering). The approximate project cost is estimated at ¥1.082 billion (¥1.08 billion to be borne by Japan and ¥2 million to be borne by Sri Lanka）.

The annual cost of maintaining the new bridge, including the access road after implementation of the project, will amount to approximately 330,000 rupees (about ¥360,000), which accounts for about 4.2% of the Polonnaruwa regional government's bridge maintenance budget, which is about 7.8 million rupees or about ¥8.5 million. The maintenance technology includes daily inspections and minor repairs, and every 10 years pavement repair, repair of the bridge surface and drainage system, which is not technically difficult. It is felt that Sri Lanka can execute these maintenance services satisfactorily.

Direct and indirect effects from implementation of this project are summarized in the table below.

1） Direct effects

Direct effects of the project

Present status and issues	Proposed countermeasures	Expected effects and degree of improvement
① In order to use the existing bridge as a railway-highway bridge, which means it is closed to vehicles while a train is passing. As a result, traffic bottleneck occurs.	The new highway bridge will be constructed on the upstream side of the existing bridge.	The new bridge will eliminate traffic bottleneck and access throughout the year.
② Narrow width of the existing bridge is restricted alternating vehicular crossing. As a result, vehicle retention time waiting for passage of oncoming vehicles is increasing.	The bridge is planned to be wide enough for two lanes to enable two-way traffic.	The new bridge will eliminate the vehicle retention time. As a result, movement of passenger and physical distribution will be assured and will expand transport volume.
③ The track on the existing bridge is improved as a modified simple road deck. As a result, runs performance and safety feature are poor while crossing the bridge.	The new highway bridge and approach road are planned as a straight and a continuity alignment.	Separated from the railway bridge, the new bridge will assure traffic safety by ensuring a stable speed.

2） Indirect effects

Indirect effects of the project

Present status and issues	Proposed countermeasures	Expected effects and degree of improvement
① Growth of social economic in grain belt has stagnated.	It will be improved to ensure smooth traffic flow as the new highway bridge.	Transport route will be improved between the System C area and the western area. As a result, the new highway bridge will contribute greatly to the social-economic development of its area.
② Serious delay of improvements in urban infrastructure.	It will be selected as an early development promotion area.	As regards the regional development policy, the progress of the peace process will promote rehabilitation of the northeastern area.

As the project is expected to offer the considerable effects as described above, implementation of Japan's Grant Aid is expected to be meaningful. It is confirmed that the Sri Lankan counterpart will have no basic problems in terms of personnel and funds for operation and maintenance of this project. To make this project more effective, due attention must be paid to the following points:

(1) Thorough checking for scouring around existing piers at the end of rainy season

The pier location of the new bridge is planned on an extension of the river flow direction relative to the existing piers. The reason is to prevent scouring of existing piers. Particularly during swelling of river water in the rainy season, scouring, including river-bed scour, may occur around existing piers due to changes in the flow caused by the existence of the new bridge piers on the upstream side. At the end of the rainy season, therefore, regular maintenance must be thorough, including checking of the river bed around existing piers for any scouring.

(2) Enforcement of regulations prohibiting speeding and overloaded vehicles

It is naturally expected that smoother road alignment will lead to speeding and overloaded vehicles traveling on the bridge. Principal causes of damage to bridges and related structures are speeding vehicles hitting the structure and wear on the deck from overloaded vehicles. It is therefore necessary for the Polonnaruwa Office of the RDA to prevent speeding and overloaded vehicles by strengthening speed regulations and by installing a vehicle platform scale.

(3) Environmental and social considerations

When executing a Japan's Grant Aid scheme, proper consideration must be given to the natural and social environment and the impacts on them minimized. As for the natural environment, when the IEE of the GOS determines there are no significant impacts, it is sufficient to prepare an EMP for construction and to adhere to this EMP when construction is being carried out.

As for the social environment, in order to realize a project design that will avoid involuntary resettlement, it is only necessary that the related facilities of the sand mining groups be slightly shifted. Note that these groups are operating illegally in the national park, but after discussions prior to the Project these groups have agreed to move its facilities upstream. Note that consideration is also being given to the bo tree orchard as well as to other social aspects in the design of the Project.

Table of Contents

Preface
Letter of Transmittal
Location Map / Perspective
List of Tables & Figures
Abbreviations
Summary

Page

Chapter 1 Background of the Project ····· 1 - 1

Chapter 2 Contents of the Project ····· 2 - 1
2-1 Basic Concept of the Project ····· 2 - 1
2-2 Basic Design of the Requested Japanese Assistance ····· 2 - 2
2-2-1 Design Policy ····· 2 - 2
2-2-2 Basic Plan ····· 2 - 7
2-2-3 Basic Design Drawings ····· 2 - 30
2-2-4 Implementation Plan ····· 2 - 42
2-2-4-1 Implementation Policy ····· 2 - 42
2-2-4-2 Issues on Implementation of the Project ····· 2 - 47
2-2-4-3 Responsibility for Implementation ····· 2 - 50
2-2-4-4 Consultant Supervision ····· 2 - 50
2-2-4-5 Quality Plan ····· 2 - 52
2-2-4-6 Procurement Plan ····· 2 - 57
2-2-4-7 Implementation Schedule ····· 2 - 67
2-3 Obligations of Recipient Country ····· 2 - 69
2-3-1 Obligation of Government of Sri Lanka ····· 2 - 69
2-3-2 Requests to the Government of Sri Lanka ····· 2 - 70
2-4 Project Operation and Maintenance Plan ····· 2 - 71
2-4-1 Maintenance Method ····· 2 - 71
2-4-2 Maintenance System ····· 2 - 71
2-5 Project Costs Estimation ····· 2 - 73
2-5-1 Construction Cost ····· 2 - 73
2-5-2 Operation and Maintenance Cost ····· 2 - 74
2-6 Environmental and Social Consideration ····· 2 - 75
2-6-1 Present Status of the Natural Environment ····· 2 - 75
2-6-2 Present Status of the Socio-economic Condition ····· 2 - 79
2-6-3 Needs of the Project ····· 2 - 82
2-6-4 Guideline for Environmental Consideration of the Project ····· 2 - 83

Page

2-6-5 Specific Requirements in Environmental and Social Considerations ····· 2 - 86
2-6-6 Findings/ Confirmation by the Basic Design Study Team ·· 2 - 87
2-6-7 Overall Evaluation and Further Issues to be Confirmed ···· 2 - 91

Chapter 3 Project Evaluation and Recommendations ····· 3 - 1
3-1 Project Effects ····· 3 - 1
3-2 Recommendations ····· 3 - 2

(Appendices)

1. Member List of the Study Team ····· A- 1
2. Study Schedule of the Study ····· A- 2
3. List of Parties Concerned in Sri Lanka ····· A- 3
4. Minutes of Discussions (M/D) ····· A- 4
5. Cost Estimation Borne by Sri Lanka ····· A-29
6. Geological Data ····· A-31

CHAPTER 1

BACKGROUND OF THE PROJECT

CHAPTER 1 BACKGROUND OF THE PROJECT

Railways and motor vehicles on roads are the principal inland means of transportation, with the latter being the predominant means, accounting for 94% of total passenger transport and 98% of the total freight transport in Sri Lanka. The total length of national roads (A through E class) in Sri Lanka is approximately 27,200 kilometers. The road density of the country is about 1.5 km/km^2, of which about 23% of this total is paved. The former is the highest and the latter is low among South Asian countries. The current number of registered vehicles has increased at an annual rate of 6% since 1999 to approximately double the number registered in 1990, and the increase is continuing. There are as many as 3,900 old bridges on trunk roads, built 50 to 100 years ago during the rule of the United Kingdom (hereinafter referred to as "UK"), and still in use. Most of them, however, not only have such problems as superannuation, insufficient road width, faulty alignment of access roads, but also difficulty of coping with current and future traffic volumes.

The basic policy of the Government of the Democratic Socialist Republic of Sri Lanka (hereinafter referred to as "the GOS") Development Plan is to promote a market economy and expedite economic growth through privatization of industry. Accordingly, development of the transport sector has been given a high priority and road development is viewed as a key measure to support the distribution functions of the market economy. As a part of this Plan, Japan has provided grant aid for bridges under the control of the RDA, specifically three projects including the Project for Reconstruction of Victoria Bridge from 1988 to 2001, the Phase 1 Project for Reconstruction of Five Bridges from 1998 to 2000 and the Phase 2 Project for Reconstruction of Gampola Bridge and Muwagama Bridge from 2000 to 2003.

Despite these efforts, many bridges along the trunk roads remain impassable for large vehicles such as the construction machinery and container cars, because of such problems as narrow width, superannuated and unstable structures, and decreased load-carrying capacity due to corrosion of steel. Facing this situation, the RDA, which is the competent authority for road administration in Sri Lanka, is proceeding with rehabilitation of bridges sequentially, beginning with those requiring urgent renewal. Actually, the country has to rely on financial aid from other countries because of the substantial sums required for bridge rehabilitation. Against this background, in September 2002, the GOS has requested the Government Japan (hereinafter referred to as "the GOJ") for grant aid for basic design studies for the

following four bridge projects:

1) Construction of the New Highway Bridge at Manampitiya (291 m)
2) Reconstruction of the Kotugoda Bridge (36.6m)
3) Reconstruction of the Ruwanwella Bridge (46m)
4) Construction of the Kinaiya Bridge

In response to a request from the GOS, the GOJ dispatched a preliminary study team during the period from February 10 to March 10 2004. As regards the request, above-mentioned "4)" was excluded for security reasons. As a result of narrowed down preliminary study, it was determined that above-mentioned "2)" and "3)" can be implemented technically and financially by Sri Lanka and it was decided that above-mentioned "1)" would be objective of the basic design study.

The objective of this study is to implement the necessary basic design by verifying the validity of the construction plan of the bridge concerned as proposed in the preliminary study and by reviewing the project content and the scope of cooperation appropriate as the grant-aid on the basis of comparison with projects of other donors in terms of costs and technological requirements.

CHAPTER 2

CONTENTS OF THE PROJECT

CHAPTER 2. CONTENTS OF THE PROJECT

2-1 Basic Concept of the Project

The GOS requested grant-aid cooperation on the following four bridges from the GOJ in September 2002:

- Construction of the New Highway Bridge at Manampitiya (291 m)
- Reconstruction of the Kotugoda Bridge (36.6m)
- Reconstruction of the Ruwanwella Bridge (46m)
- Construction of the Kinaiya Bridge

The GOJ dispatched a Preparatory Study Team, in February 2004, for three bridges other than the Kinaiya Bridge, which was excluded because of security reasons. As it was determined in the Preparatory Study that the Kotugoda and Ruwanwella Bridge Projects can be implemented independently by the Sri Lankan Government, the Manampitiya Bridge was chosen as the objective of a basic design study. The basic design study was carried out from July 2004 on the basis of the results of the Preparatory Study.

The Manampitiya Bridge, which is currently used as a railway-highway bridge, causes longer vehicle crossing times due to retention of vehicles while trains cross, the alternation of traffic (vehicles traveling in on direction, then the vehicles traveling in the other) because of the narrowness of the road, and because of road closures during floods that occur every two to three years in the rainy season, resulting in bottlenecks. Demand has been placed on reduction of transport time.

Batticaloa Port facing the Indian Ocean is located east of the Manampitiya Bridge. The population in this province is about 500,000. In addition, excellent paddy cultivation and upland farming are thriving along the route on which the new highway bridge is located. For this province, the bridge is a highly vital part of the grain transport route. Polonnaruwa province near this bridge has a population of about 400,000. Specifically, the System C area, a leading farm belt in Sri Lanka with a population of 120,000, uses this Manampitiya Bridge for transport of the grain.

Therefore, conversion of the now inefficiently used railway-highway bridge to a highway bridge will contribute to stable transport. In addition, construction of a new trunk highway bridge is expected to contribute not only to elimination of bottlenecks

in east-west trunk road traffic, but also to development of the northeastern area (territory where antigovernment forces are strong) whose rehabilitation is expected along with the progress of the peace process. It will also alleviate the burden of travel for surrounding residents.

2-2. Basic Design of the Requested Japanese Assistance

2-2-1 Design Policy

The basic design policy for the Project, which is to be financed with Japan's Grant Aid, is described below and will apply to all aspects of the work for the construction of a new highway bridge at Manampitiya (hereinafter referred to as " the Project").

1) Basic Policy

The Project shall consist of the construction of a bridge, accessory facilities, and approach roads connecting the bridge to the existing road. The recipient country, when required, shall duly be responsible for undertaking countermeasures and obligations outside the scope of the Project such as land acquisition, relocation of public facilities (such as power lines and poles, telephone lines, and water supply lines), and resettlement of private properties in order to facilitate the successful completion of the Project.

2) Policy on New Bridge Construction

i) Natural conditions

a) Dry and rainy seasons

The rainy season generally lasts from October to February in Polonnaruwa where the new bridge will be built. It has been noted, however, that in the upstream region along the Mahaweli River the rainy season occurs in the opposite time of year from that of the Polonnaruwa region, where meteorological records indicate that there is little precipitation from March to September. In the dry season, the water level of the river remains is low enough to permit walking across. On the other hand, during the rainy season, despite the existence of five dams for flood control in the upstream region of the river, water levels become high enough to flood roads. Taking these natural conditions into account, the scheduling for

substructure work will be planned accordingly, and the selection of the erection method for superstructure shall be done to ensure that the rainy season does not affect implementation.

b) Temperature

Sri Lanka is located in a tropical zone. It is assumed that temperatures in the region where the Manampitiya Bridge will be located, 36m above sea level, will be between 26℃ and 31℃ based on the monthly average data from the meteorological observatory.

c) Precipitation

Monsoons that traverse the Indian Ocean to Bay of Bengal area are one of the main factors that cause rainfall. From mid May through October the southwest monsoon blows into Central Province, which is located in a mountainous highland region, bringing rainfall to the southwestern part of Sri Lanka. In the East and Northeast provinces of Sri Lanka, slight precipitation is commonly observed.

In October and November there are no monsoons, but there are periodic squalls in the southwestern, northeastern and eastern provinces, which experience tropical cyclones that frequently cause rain and stormy weather. From December to February, the northeast monsoon from the Bay of Bengal brings rainfall over the northeastern slope of the central highland region.

From March to midMay, there is a buffer period between the two types of monsoons and there is only a slight amount of rainfall in Northeastern Province.

d) Fauna and Flora

There are few fauna and flora in the Project area and no endangered or rare species. Note also that direct environmental impacts on wild animals such as elephants, birds, reptiles, etc are insignificant.

ii) Socioeconomic conditions

The population directly benefiting from the Project is an estimated 1,024,000 persons

residing in the districts of Polonnaruwa, Batticaloa and the System C area. These benefits will be realized once the construction of the new highway bridge at Mananpitiya is completed.

a) Construction industry and market

It is the basic policy of the Project that domestic products and/or procurement be given high priority. However, due to the lack of availability and concerns about quality and cost, some construction machinery will be procured from Japan and/or other countries. Accordingly, in order to be made the road weak because of flooding in all around bridge every year, the existing pavement has been applied concrete pavement. Therefore, concrete pavement shall be applied for the durability, benefits afforded and for cost efficiency reasons as well.

b) Local contractors

On-the-job training will effectively be employed and local contractors will gain experience on large-scale structures and/or PC girder bridges.

c) Capability of the implementation agency

Annual budget of Polonnaruwa office in RDA, which is composed of expenses for road maintenance and for bridge maintenance as well, has been certainly allocated every year. The Project should be planned suitable operation in consideration of after services.

Polonnaruwa office has been established a fundamental maintenance structure. However, the Project will be a long span bridge in RDA. In order to maintain smoothly, some engineers in RDA shall be transferred technical skill while the Project work.

iii） Characterization of the Project bridge

Multiple aspects of the new highway bridge will be an improvement in comparison with the existing bridge and are described below.

a) Cost efficient

Cost efficiency will duly be considered in the selection of the bridge style in order to meet the conditions of the Japanese grant aid program.

b) Maintainability and sustainability

① Concrete, which is relatively easy to maintenance, will be basically employed for the structure.
② Expansion joints will be utilized for easy clean up or removal.
③ An inspection hatch will be installed in the slab deck in order to inspect the insides of the main concrete girders.
④ To minimize the number of expansion joints, a continuous-girder type will be applied for the superstructure and joints will be located at both abutments.

c) Higher traffic capacity

The cross section will consist of two carriageways (3.7m x 2) and two sidewalks including handrail width(1.5m x 2).

d) Stability

New piers will be located in parallel with existing piers in order to minimize the risk of scouring and therefore result in a more stable structure for the existing bridge.

e) Aesthetic and environmental impact

In addition to the new bridge using a structural style that will be cost-efficient, it will also take into sufficient consideration the importance of aesthetics. As for environmental impacts, most will be temporary and during construction work, and can be mitigated taking into account the use and kinds of construction machinery.

iv) Construction method and schedule

In view of the fact that there is a five-month rainy season lasting from October to February in the Project area and that precipitation will reach 40% of the annual rainfall, construction methods that are not seriously affected by rough weather will be employed.

It is also essential that the rainy season be considered in construction scheduling, since preparation work and a temporary bridge will be implemented during that period. These will be indispensable tasks for total construction schedule control.

2-2-2 Basic Plan

The results of the basic design study and the Project components are shown in Figure 2.2.1.

Project components

- Main structure of the Mananpitiya Bridge
- Approach roads connecting with the existing roads and subsidiary road facilities

The Project scope has been defined in accordance with the following process flow chart based on "Design Policy" in 2.

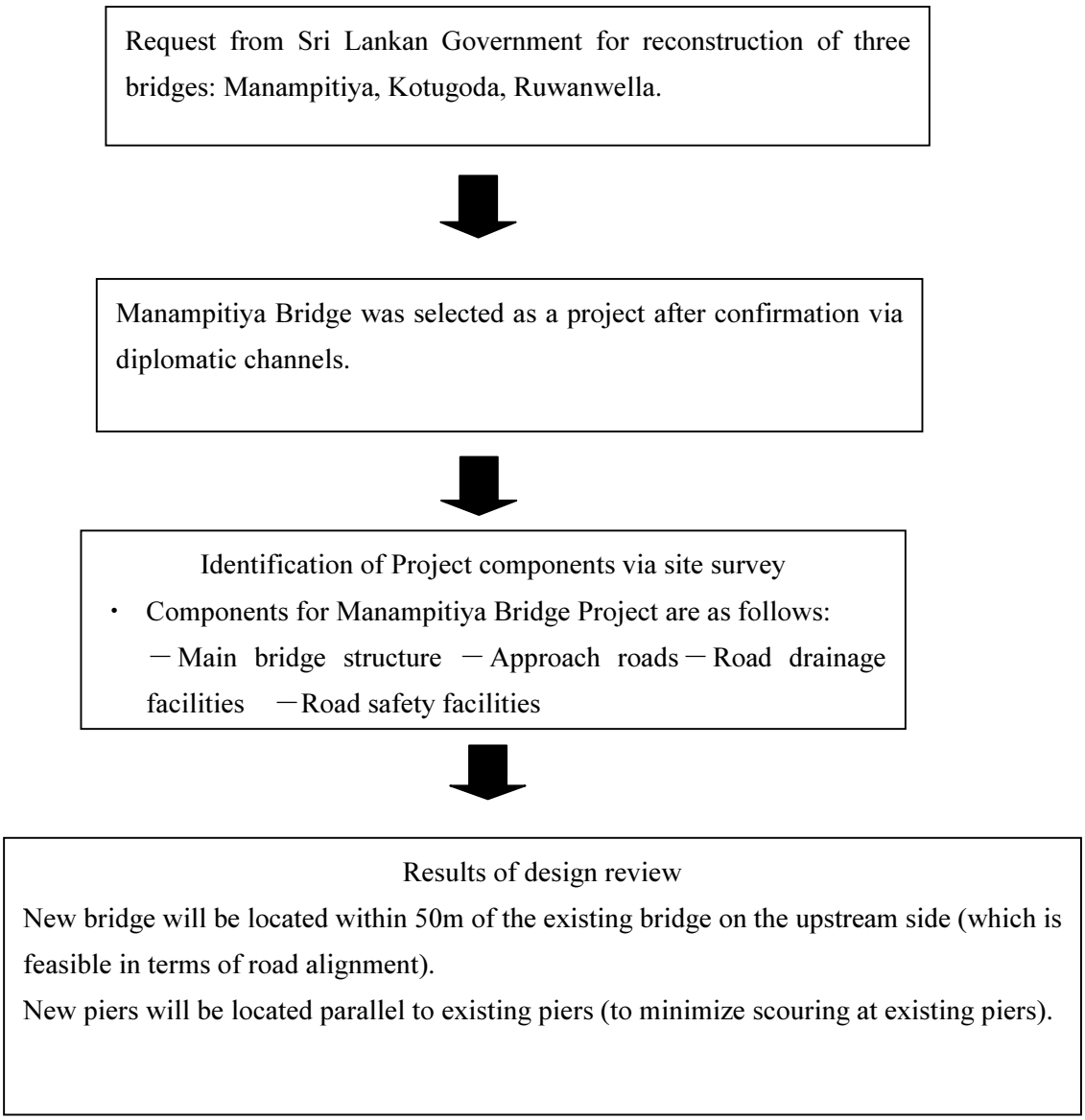


Figure 2.2.1 Selection Process Flow Chart

1) Overall Scheme for the Project Works

i) Outline of a new highway bridge

The construction plan for a new highway bridge at Manampitiya was drawn up based on the concepts described on 2.1. The main factors for the planning of a new highway bridge are as follows:

① The existing one-lane Manampitiya Bridge is used both as a railway and highway crossing. Therefore, when a train crosses the bridge, road vehicles and pedestrians are unable to use it, resulting in a bottleneck that greatly slows traffic flows (including bus and freight transportation). Therefore, a new highway bridge needs to be constructed to eliminate this bottleneck.

② The carriageway width of the existing bridge is insufficient for an A-class road. Therefore, the carriageway width of the new highway bridge will be 7.4m (3.7mx2) wide for the carriageway and 3.0m (1.5mx2)?? wide including curbs for sidewalks.

③ Thick sand has accumulated in the riverbed in the vicinity of the existing bridge. Therefore, the influence of scouring of the existing piers should be considered when constructing the new bridge.

④ Flooding by the Mahaweli River has influenced the area around the existing bridge. The road section has suffered some damage, including the washing away of asphalt and concrete pavement, and traffic is interrupted every two or three years. Therefore, the plan for a new bridge should consider the influence of flooding on the new approach roads.

⑤ A water supply facility of an educational institute, a bo tree, police facilities and some private houses exist around the current bridge. Moreover, some elephants live nearby. Therefore, impacts on the environment and society will have to be considered.

⑥ Because this project will be undertaken as a Japanese grant aid program, the plan for the new bridge and new approach roads must be examined with due consideration to construction features, cost efficiency and maintainability.

The objective facilities include construction of a new highway bridge, two approach roads, a culvert box on the right bank for drainage, and road safety facilities as shown in Table 2.2.1 and Figure 2.2.2.

Table 2.2.1 Objective Facilities

		New Manampitiya Bridge
Bridge length		302m
Approach road	Left bank	246m
	Right bank	182m
Total length		730m
Guard rails		520m
Width (sidewalk, carriageway)		Bridge: 1.5m+2@3.7m+1.5m Road: 3.0m+2@3.7m+3.0m
Superstructure type		PC 6-span continuous box girder
Substructure type	Abutments	Reversed T type: 2 abutments
	Piers	Wall type: 5 piers
Foundation type		Cast-in-place concrete piles (ϕ 1000mm)

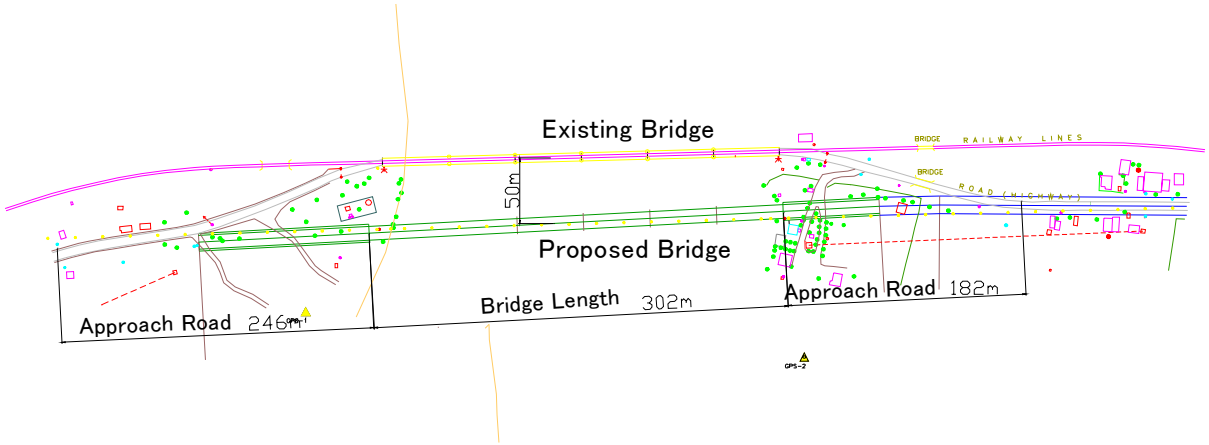


Figure 2.2.2 Project Scope

ii) Design Standard

c) Road

➢ **Applied design standard**

In principle, the Sri Lankan "Geometric Design Standards of Roads" shall be applied. On the other hand, Japanese Standards shall be applied for any situation not addressed in the Sri Lankan Standards.

➢ **Road Structure**

- Road Classification: A class road (R3)
- Design Speed : 70 km/hr (local flat area)
- Width : 2x3.7m=7.4m (Carriageway)
  : 3.0m (Shoulder as shown in Figure 2.2.2)

- Road alignment : See Table 2.2.2

Table 2.2.2 Road Alignment Specification

Item				Specification
Horizontal alignment	Minimum curve radius			205 m
Vertical alignment	Minimum curve radius	Crest	Grade 4%	3,000m (2,000m)
		Sag	Grade 4%	2,000m (1,500 m)
	Minimum curve length			160 m
	Maximum gradient			4 %
Maximum superelevation of curve				6%
Crossfall				2.0 %

Note:() indicates minimum value.

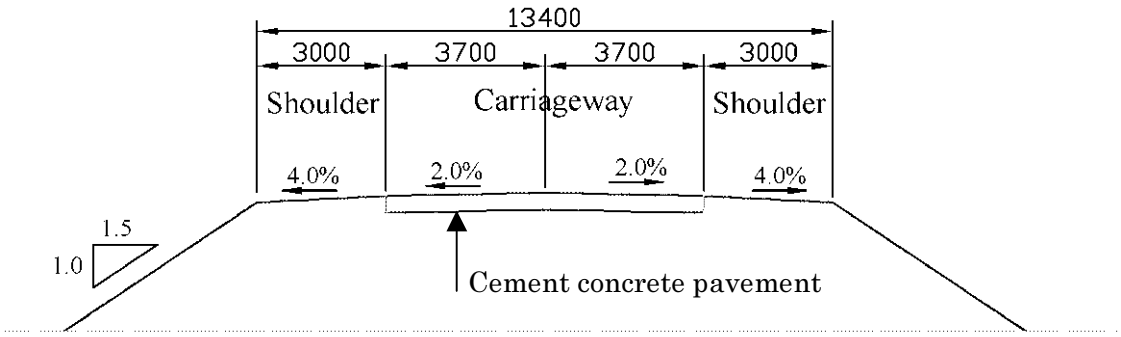


Figure 2.2.3 Approach Road Standard Section

d) Bridge

➢ Applied design standard

The HB30 unit for live loads (including dead loads) described in the Sri Lankan "Bridge Design Manual," which is based on BS5400 Part 2, shall be applied. The Japanese allowable stress design method shall be applied for examining bridge members.

➢ Bridge cross sections

The Sri Lankan standard for A-class roads shall be applied to cross-sections, which comprise a carriageway with two lanes and two sidewalks as indicated in Figure 2.2.4.

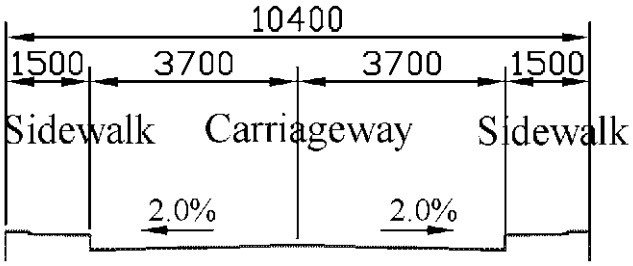


Figure 2.2.4 Bridge Cross Section

- **Design load criteria**

Design load, which will be based on Sri Lankan standards, is described below.

① Primary Load

- Dead load

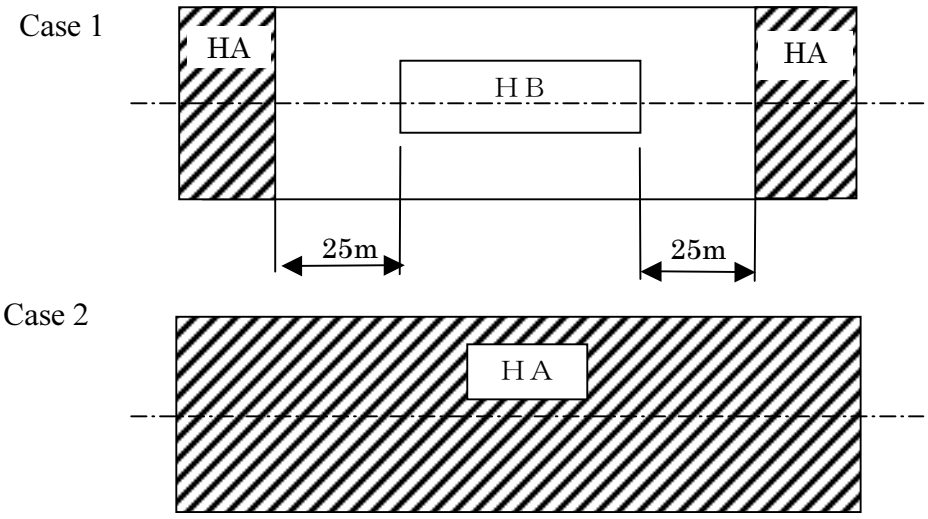
Dead load is the total sum of the bridge materials shown in Table 2.2.3.

Table 2.2.3 Unit Weight by Material Type

Material	Unit weight (kN/m^3)	Material	Unit weight (kN/m^3)
Iron, steel casting	77.0	Plain concrete	23.0
Cast iron	71.0	Cement mortal	21.0
Aluminum	27.5	Asphalt concrete	22.5
Reinforced concrete	24.5	Timber	8.0
Prestressed concrete	24.5		

- Live load and impact coefficient

The BS standard shall be applied. However, the one the heavier one of the two following cases shall be applied.



- Prestress force: To be considered.
- Influence by concrete creep: To be considered.
- Concrete shrinkage: To be considered.
- Thermal load: To be considered.
- Braking load: To be considered.
- Vehicle impact load: To be considered.
- Earth pressure: To be considered.
- Water pressure and collision load by debris: To be considered.
- Buoyancy and uplift: To be considered.

② Secondary load

The load that should be taken into account when loads are combined.

- Wind load: To be considered.
- Temperature variation: To be considered.

③ Particular load

Particular load is the load that should be taken into account depending on the bridge type, structural type, and bridge site conditions, including loads during construction, etc.

④ Construction load

➢ Incremental factors for allowable unit stress per load combinations

Table 2.2.4 indicates the incremental factors per load combination that shall be applied in the Project.

Table2.2.4 Incremental Factors by Load Combination

Load combination	Incremental Factor
Primary load	1.0
Primary load + Thermal load	1.15
Primary load + Braking load	1.25
Primary load + Vehicle impact load	1.5
Construction stage	1.5

➢ Design criteria for superstructure

- Bridge type: Concrete bridge for easy maintenance
- Width: Refer to Figure 2.2.4
- Live load: BS live load
- Cross-fall: 2.0%
- Bridge deck pavement: Cement concrete pavement
- Appurtenances: Not installed

➢ Design criteria for substructure

Substructure type

Abutment : Reversed T type

Pier : Wall type

Embedment : As for the strata of the bridge site, a sand layer consisting of river sediment has been observed to be 15m to 17m thick on the bearing stratum or rock mass. Surveying around the existing piers indicated almost no scouring. However, since various future situations should be considered in which river sand is excavated, the footing levee crown of piers is to be embedded to a minimum depth of 2m as shown in Figure 2.2.5.

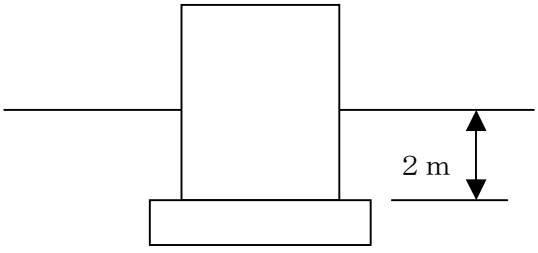


Figure 2.2.5 Embedding of Footing Levee crown

② Basic type of foundation

As a result of an investigation by boring, we have learned that there is a sand layer up to 15 – 17 m underground beneath riverbed with an N-value 10 – 20, and that bedrock as a bearing layer exists under the sand layer. Considering these geological conditions, pile foundations will be utilized as basic structures, and, to be more concrete, cast-in-place piles will be used depending on the ground condition, working load, and availability of construction machinery and materials, which will be investigated in detail in a later stage.

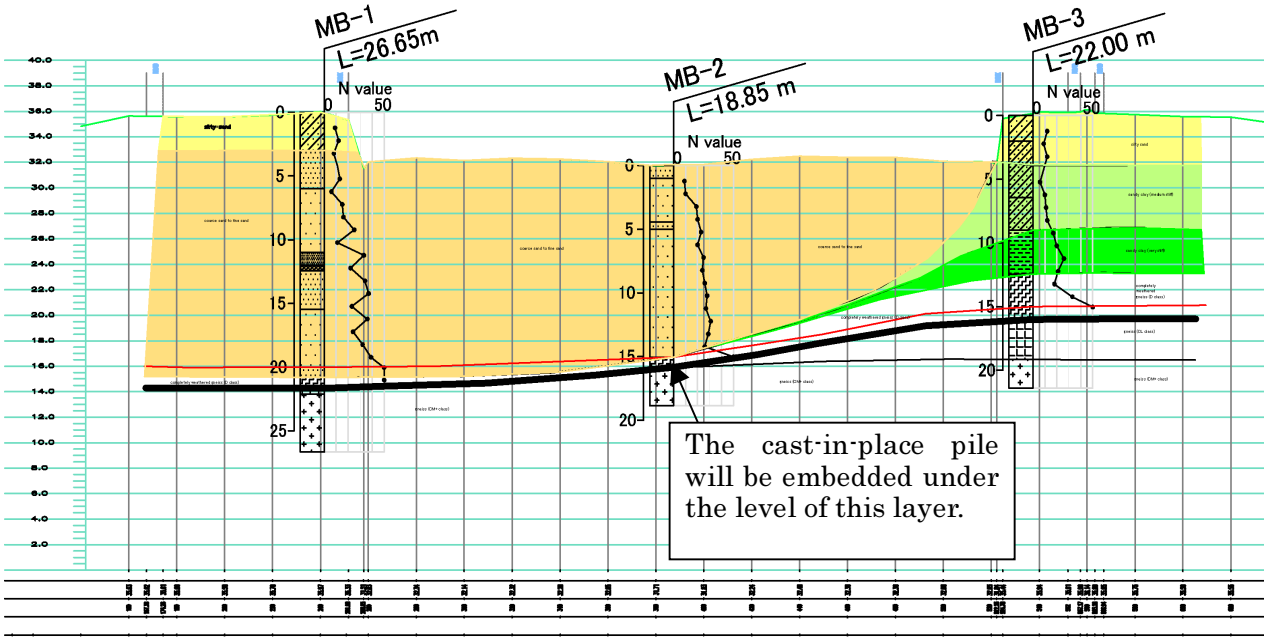


Fig 2.2.6 Geological longitudinal map and embedment level of piles

e) Hydrological condition and flood control

The bridge design standards in regard to hydrological conditions and flood control will basically follow those enforced in Sri Lanka, and be determined by hydraulic data for bridge design, and river conditions at the construction point.

➢ Impediment ratio of river flow

The Mahaweli River is diverted by a sandbank, which is almost equivalent to an island, located 200 – 800 meters upstream of the existing bridge. The river, which curves to the right in the downstream side, is 330m wide at a point 200m upstream from the existing bridge. The width is 265m, at its narrowest, at the existing bridge point. Therefore, the river flow velocity during a flood will be fastest at the existing bridge point. Because the construction of piers for the new bridge near the existing bridge will lead to deterioration of the impediment ratio

of river flow, and abnormal scouring is highly possible, the piers of the new bridge will be located on the same river-sectional position as those of the existing bridge.

To avoid a situation in which a high river flow impediment ratio leads to blocking by driftwood during a flood, and a consequent rise in the river water level that would damage the area neighboring the bridge construction point, the targeted river flow impediment ratio is 5% for bridge design, following the standards for riverside structures.

- **Freeboard under slab bottom (height of free space under slab bottom down to the high water level)**

The high water level in the flood of 1978 was 36.6 m above sea level around the existing bridge crossing point. This was 2 meters below the road surface level of the existing bridge. And the water flow velocity then was 1,986 m^3/s. Table 2.2.5 shows the standard for necessary freeboard under the slab bottom at a particular flow velocity, which is referred to in the Japanese instruction guide for standards for river management structures. The bridge design will provide for these standards in the Project. In addition, the new bridge will be planned so that the level of the bottom of its slab cannot be lower than the slab-bottom level of the existing bridge. This is to ensure the same minimum height against the high water level as the existing bridge.

Table 2.2.5 Freeboard under slab bottom for design

Bridge name	Velocity of river flow (m3/sec)	Freeboard under slab bottom (m)
Manampitiya Bridge	less than 2,000	1.0

- **Location of piers**

For economic and construction efficiency, the new bridge will be located near the existing bridge in the bridge construction project. Therefore, on determining the locations of piers, the conditions not only under new bridge but also under the existing bridge, including the impediment ratio of river flow and bridge span, will be considered, and the effect of the existing bridge will be considered in the construction phase and after completion of construction.

- **Embedment of piers**

The riverbed strata are composed mainly of fine sand. An actual site survey indicates no scouring effect. However, a depth of two (2) meters for embedment

of bridge foundation (piles) will be secured, in view of the fact that the riverbed can be expected to change due to the impact of development other than the national park, and the extraction of sand from the Mahaweli River.

f) Accessory facilities for new bridge

The following accessory facilities for the new bridge will be taken into account.

[1] Expansion joints: Expansion joints will be installed only to the abutment, and a steel-finger type of joint will be used because of expected high durability.

[2] Bearing: Rubber bearings (Type A) will be utilized, assuming that only prestressed-concrete slab will be installed.

[3] Safety fence: Assuming the construction of a long span bridge, a concrete wall railing will be utilized.

g) Pavement design standards

As for the pavement design standard, "*A Guide to The Structure Design of Roads under Sri Lankan Conditions April 1999 RDA*", which is now being adopted in Sri Lanka, will be utilized. By the way, this guide is originated from "*Transport & Road Research Laboratory, United Kingdom Road Note 31 of 1977*". However, if design necessity arises that is not covered by the Sri Lankan Guide, the Japanese *Technical Standards and Guide to Pavement Structures* should be utilized.

h) Traffic signs and safety facilities

Traffic signs and safety facilities will be installed following Sri Lankan standards (*The Gazette of Sri Lanka, Motor Traffic Act/Motor Traffic Signs*).

i) Material used and basic strength per unit area

[1] Concrete

As for the concrete, ready mixed concrete supplied from Sri Lankan concrete plant will be used. The following values obtained from cylinder strength tests will be referred to for its design strength.

- **Design strength (cylinder strength, 28-day strength)**

Prestressed-concrete slab, Prestressed-concrete floor slab	: σ ck=40 N/mm^2
Cross beam	: σ ck=40 N/mm^2
Reinforced concrete slab	: σ ck=24 N/mm^2
Structure of abutment and pier	: σ ck=24 N/mm^2

- **Modulus of elasticity**

Table 2.2.6 Modulus of elasticity for concrete

Design strength (N/mm2)	24	35	40
Modulus of elasticity for concrete (kgf/cm2)	2.5×10^5	2.95×10^5	3.1×10^5

[2] Prestressing-steel for prestressed concrete

Because prestressing-steel for prestressed concrete is not produced in Sri Lanka, those members will be imported from Japan or a third country. As for the main bridge-sustaining cable, prestressing-steel strands of T12.7mm will be utilized, and for the fundamental steel, ϕ32(SBPR930/1180) will be utilized, expecting its high workability on the construction phase.

Table 2.2.7 Allowable tensile stress of prestressing-steel for prestressed concrete

Status of stress	Allowable tensile stress	Notes
While prestressing	Smaller value between 0.8 σ pu and 0.9 σ py	σ pu: Tensile strength of prestressing-steel for prestressed concrete (N/mm2)
Just after Prestressing	Smaller value between 0.70 σ pu and 0.85 σ py	
Under working of design load	Smaller value between 0.60 σ pu and 0.75 σ py	σ py: Yield point of prestressing-steel for prestressed concrete (N/mm2)

- Ratio of relaxation in appearance : 5%
- Modulus of elasticity : Esp=2.0 x 10^6kgf/cm^2

[3] Reinforcing bar

In Sri Lanka, reinforcing steels are produced with diameters up to 25mm. Reinforcing steels of wider diameter are also available in the Sri Lankan domestic market, and those will be utilized in the Project. More specifically, the following type, whose specifications are regulated by BS (British Standards), will be utilized in the Project:

- Type : BS 4449 Type II Grade 460
- Yield strength : 460 N/mm^2

2) Project Facility Plan

i) Basic design policy for new bridge construction

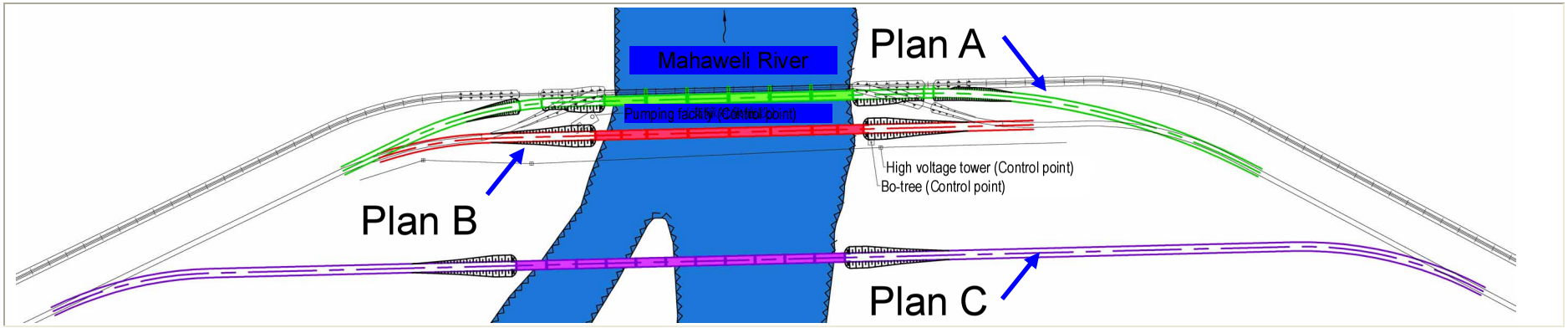
Based on the results of an actual site survey of the project target (existing) bridge, the project team suggests that the scope of the Project should include reconstruction of the Manampitiya bridge, construction of approaching roads on both sides (about 200-300m for each), and construction of retaining walls.

In drafting the plan of the new bridge project, its alignment, location, construction methods, and removal works will be examined to minimize the impact to the existing bridge and approaching roads as much as possible, and not so as to involve the necessity of large-scaled temporary works.

ii) Bridge construction point

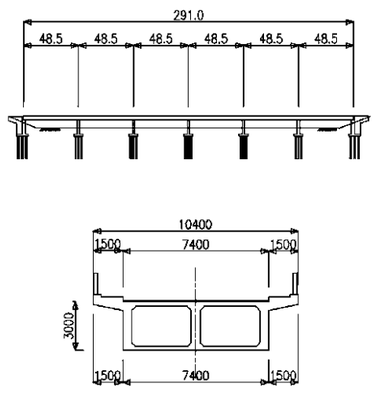
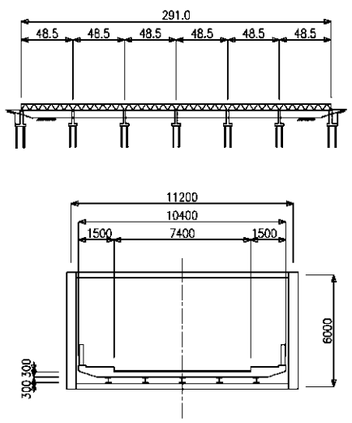
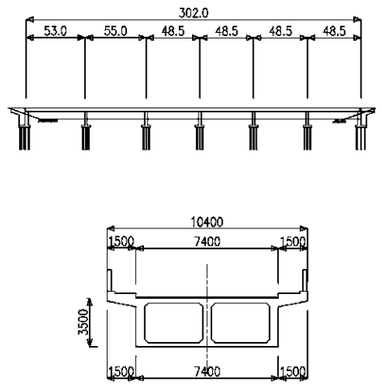
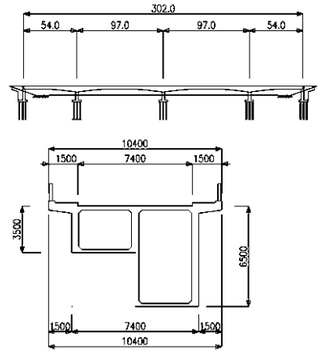
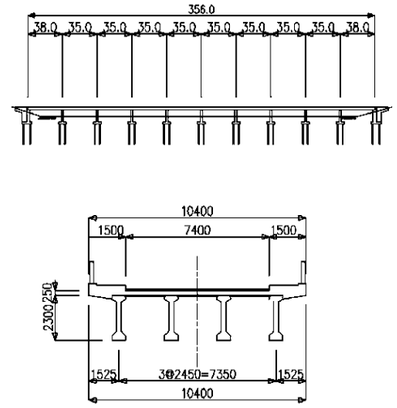
To prevent the alignment of the new bridge from crossing the railway, it is appropriate to locate the new bridge on the upstream side of the existing bridge. Table 2.2.8 presents several appropriate alternative locations, and a comparison of their characteristics. In addition, Table 2.2.9 shows the possible types of superstructure of the new bridge suitable for each alignment alternative, and a comparison of their characteristics. Based on the comprehensive evaluation for each alternative, the project team selected Alternative B as the appropriate alignment. Alternative C (200m off the existing bridge) would bring about the enhancement of bridge length and approach road length, leading to higher construction costs. Alternative A (locate the new bridge close to and parallel to the existing bridge) is not recommended because a neighboring structure is involved, and Project-related work would become complicated in the construction and maintenance phases due to the difference between the vertical alignments of the new bridge and existing railway bridge.

Table 2.2.8 Alternatives for new bridge construction point



Summary	Plan A: Just beside existing bridge	Plan B: 50m upstream of existing bridge (Result of detailed design by RDA, and a plan suggested in preparatory study)	Plan C: 200m upstream of existing bridge
Main concept	- Locate new bridge just beside existing bridge, locate new piers at same river-sectional position as those of existing bridge, and avoid scouring by integrating the new and existing piers at each river-sectional position.	- Locate new piers at same river-sectional position as those of existing bridge, and secure sufficient distance between new and existing piers to avoid scouring of riverbed around the existing piers. - The changes to the original road link alignment will be limited to the minimum level.	- Secure distance between new and existing piers sufficient to avoid influence of scouring of riverbed around existing piers.
Bridge concept	- The span allocation will be constrained by structure of the existing bridge. - Care for the neighboring construction to the sub structures of the existing bridge will be required. - The bridge length: 291m. (△)	- The span will be the same or twice that of the existing bridge, so the river-sectional position of new piers and that of the existing piers coincide. - The bridge length: 302m. (○)	- Bridge span can be determined freely without any constraint. - The bridge length: 365m. (△)
Economical efficiency	- The same type of structures as the existing bridge will be required to decrease vertical difference between surface levels among the existing bridge and the new bridge. - Construction cost index: 1.1 (Truss type bridge assumed) (△)	- The span allocation can become economically efficient, and the length of new approach roads are shortest among the alternatives. - Construction cost index: 1.0 (box girder bridge with prestressed concrete slab assumed) (○)	- The bridge construction will be most reasonable, but, overall costs can be economically inefficient because the overall length of road facility in the project becomes longer. - Construction cost index: 1.07 (I-Beam prestressed concrete bridge assumed) (△)
Social, environmental Impact	- The alignment near new approach road may runs near the control point (residential house). (△)	- The impact on the residential house near the project site is small. - To avoid impacting the pumping facility and bo tree, countermeasures like rearrangement of alignment and structures will be necessary. - Although impact on high voltage wire would be small, sufficient investigation on the impact will be required, including impact in the construction phase. (△)	- The possibility that alignment near new approach road can run near the control point (residential house) will be low. - There will be an impact on the police office. (△)
Natural environmental Impact	- Because the project site will be limited within the area near the existing road and railway, influence on the fauna and flora will be small. (○)	- Influence on fauna and flora will be small. (○)	- The section which lies in the national park will become long, and Influence on the fauna and flora will increase. (△)
Overall evaluation	- Many problems predicted regarding neighboring construction and structures. (△)	- Economically most efficient (○)	- Inferior in aspect of economical efficiency (△)

Table 2.2.9 Alternatives for types of basic bridge structure by bridge alignment plan

	Plan A: Just beside the existing bridge (Span allocation will be equalized to that of existing bridge)		Plan B: 50m off the existing bridge (Span allocation will be almost same as that of existing bridge)		Plan C: 200 off the existing bridge (Far enough to avoid the influence to the existing bridge)
	A-1 Prestressed concrete box girder bridge (Constant in sectional structure)	A-2 Steel-truss bridge	B-1 Prestressed concrete box girder bridge (Constant in sectional structure)	B-2 Prestressed concrete box girder bridge (Changing in sectional structure)	C-1 Continuous I-Beam prestressed concrete bridge
Outline Figure					
General characteristics	- To locate the new alignment just beside existing bridge alignment, it's necessary to locate new piers at same river-sectional position as (on the extension line of) the existing piers. In addition, the new pier and the existing one will be integrated into one substructure by installing jointing-wall, securing smooth river flow. Span allocation will be forcefully constrained by that of the existing one. - Smoothness in the alignment curve will be secured at the approaching section. In addition, the length of approach road will be short. - Because the area surrounded by the new alignment and the existing alignment is narrowest among all alternatives, the environmental impact will be least.		- Because the new alignment will be located 50m upstream of the existing alignment, it's necessary to locate new piers at same river-sectional position as (on the extension line of) the existing piers, in order to avoid the influence to the riverbed around the existing piers (i.e., scouring of riverbed). - Smoothness in the alignment curve will be secured at the approaching section. In addition, the length of approach road will be short. - Because the area surrounded by the new alignment and the existing alignment is narrower than that under Plan C, the environmental impact will be less than Plan C.		- Because the new alignment will be located 200m upstream of the existing alignment, no influence on the existing bridge will be caused by construction of new bridge. Therefore, span allocation can be determined flexibly. - The length of approach road will be long. - Because the area surrounded by the new alignment and the existing alignment is larger than Plan A and B, the environmental impact will be also larger than them.
Span allocation	6 @ 48.5 = 291m	6 @ 48.5 = 291m	53 + 55 + 4 @ 48.5 = 302m	54 + 2 @ 97 + 54 = 302m	38 + 8 @ 35 + 38 = 356m
Basic Structure	- 6-span continuous prestressed concrete box girder bridge	- 6-span continuous steel-truss bridge	- 6-span continuous prestressed concrete box girder bridge (Constant in sectional structure)	- 4-span continuous prestressed concrete box girder bridge (Changing in sectional structure)	- 10-span continuous I-Beam prestressed concrete bridge
Construction characteristics	- On installing superstructures, the launched construction method will be suggested. - For the foundation, cast-in-place piles will be appropriate from the viewpoint of the economic and construction efficiency. - Neighboring construction will be involved. - Countermeasures required to avoid impact on control point (pumping facility) - Because there will be gap in level of surfaces, which is attributed to the difference in structural type, additional retaining wall works will be required.	- On installing superstructures, methodology involving supporting works with large-sized pipe and truck crane will be suggested. - For the foundation, cast-in-place piles will be appropriate from the viewpoint of economic and construction efficiency. - Neighboring construction will be involved. - High voltage wire will not impede the construction work. - Countermeasures required to avoid impact on control point (pumping facility)	- On installing superstructures, the launched construction method will be suggested. - As for the foundation, cast-in-place piles will be appropriate from the viewpoint of economic and construction efficiency. - Countermeasures will be required to avoid impact on control points (pumping facility, and bo tree) - High voltage wire can impede the construction work.	- On installing superstructures, the launched construction method will be suggested. - The construction period required for the superstructures will be long. - For the foundation, cast-in-place piles will be appropriate from viewpoint of economic and construction efficiency. - Countermeasures will be required to avoid impact on control points (pumping facility, and bo tree) - High voltage wire can impede the construction work.	- On installing superstructures, launching girder erection method will be suggested. - For the foundation, cast-in-place piles will be appropriate from the viewpoint of economic and construction efficiency. - High voltage wire will not impede the construction work. - Countermeasures will be required to avoid impact on control points (sand stock yard, and police office)
Economic characteristics	○	△	○	△	◎
Maintenance characteristics	- No maintenance work will be required except for accessory facilities like extension joints.	- Repainting will be required to maintain steel members. However, if atmospheric corrosion-resistant steel were utilized, no maintenance work will be basically required except for accessory facilities.	- No maintenance work will be basically required except for accessory facilities like extension joints.	- No maintenance work will be basically required except for accessory facilities like extension joint.	- No maintenance work will be basically required except for accessory facilities like extension joint.
Overall evaluation	- Some difficulties expected in the neighboring construction. - Some difficulties expected in installation of jointing-wall for integrating the new pier and the existing one. △	- Span at both ends is short and inadvisable for the river. In addition, construction cost is expensive. - Some difficulties expected in installation of jointing-wall for integrating the new pier and the existing one. △	- Most appropriate plan suggested from the viewpoint of economic and construction efficiency. ◎	- The construction cost is expensive, and the construction period is long. - The impediment ratio of river flow is minimum. △	- Unit price (per m^2) for one slab is cheap. However, because the bridge length is long, the construction cost is more expensive than Plan B-1. - Although the new alignment is far from the existing one, the impediment ratio of river flow will be increased due to the shortened pitch of span allocation. ○

Distance between an alternative alignment plan and control points

Alignment will be arranged so that distance to the pumping facility in the left riverside from alignment and distance to the bo tree in the right riverside from alignment can be same.

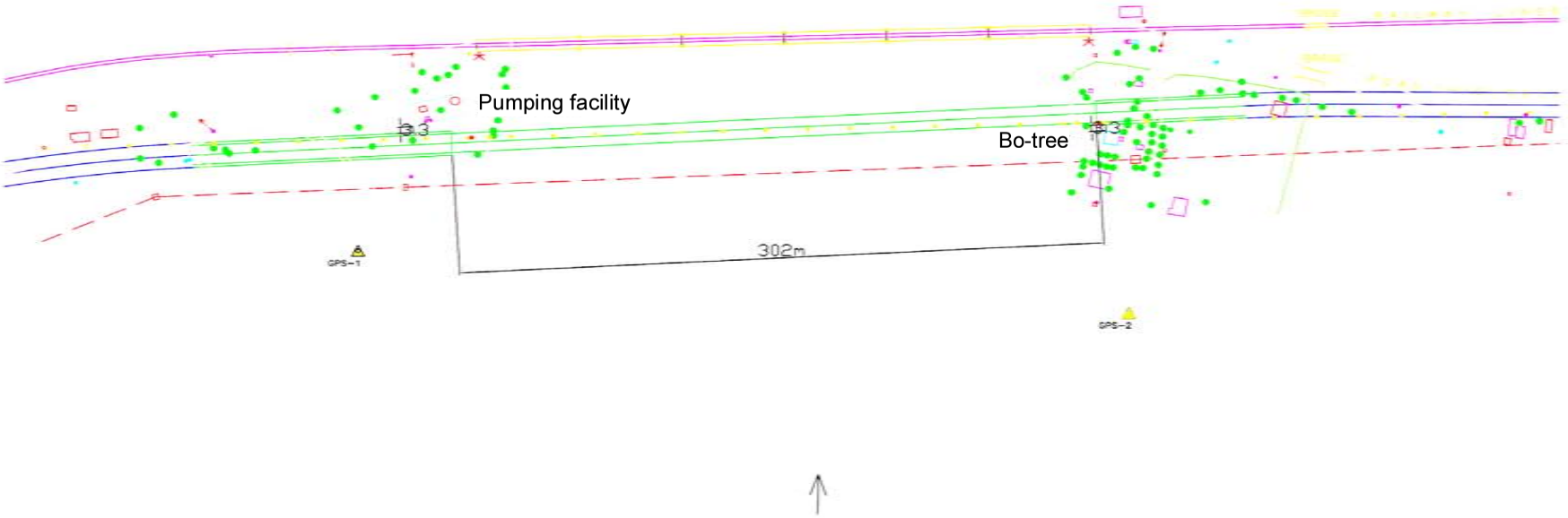


Fig 2.2.7 Determination of bridge construction point

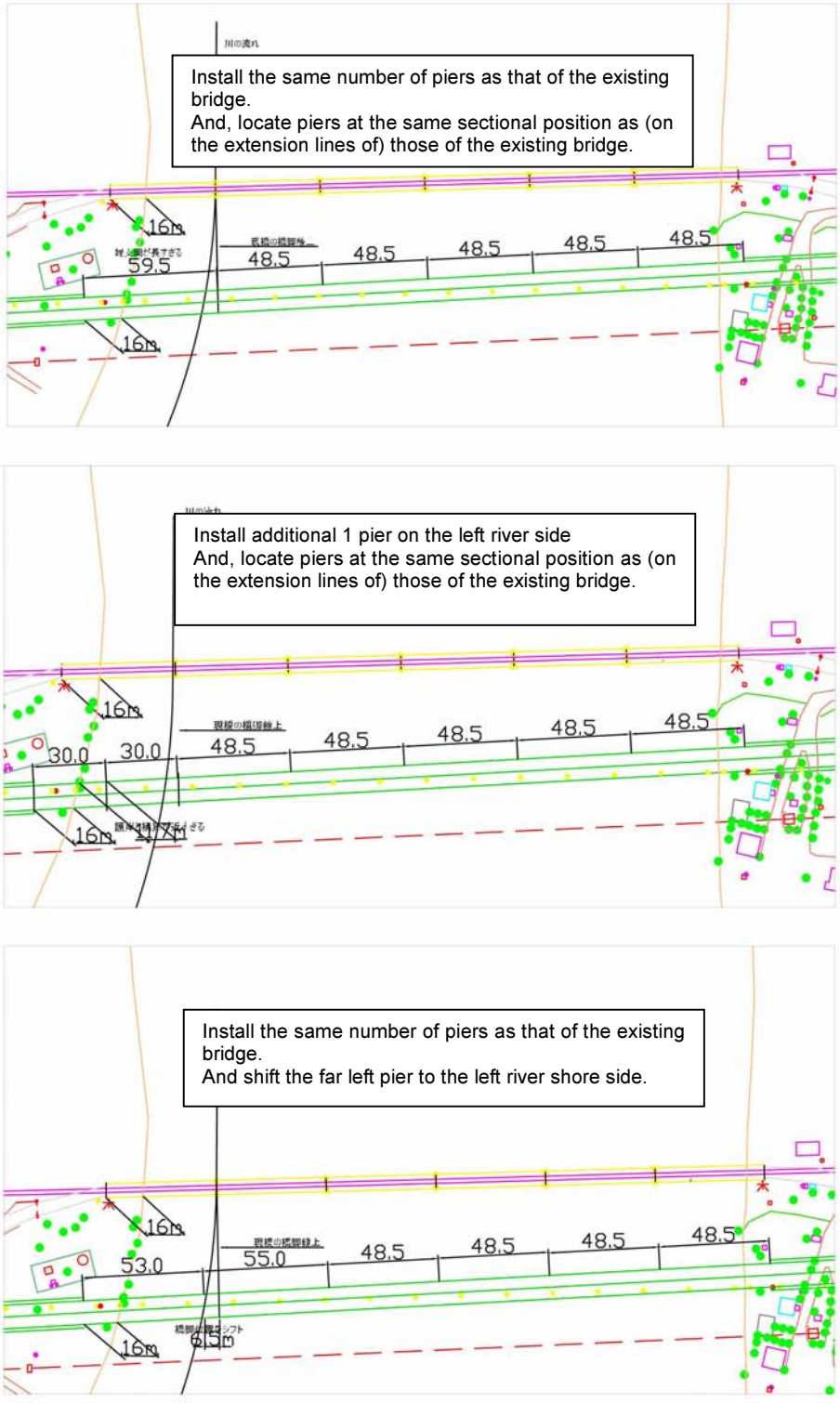


Fig 2.2.8 Determination of span allocation

iii) Examination of Bridge length, number of slabs, and each span

On determining the bridge length, same space (about 17m for each shore sides) between the shoreline of the river and abutment as one of the existing bridge will be secured and included into the new bridge length in both sides. Taking the control points (such as the pumping facility on the left side of the river, and the bo tree on the right side) into account, the bridge alignment will be as shown in Fig. 2.2.7, keeping a small diagonal direction to the existing bridge alignment. In addition, the existing bridge, whose length is about 291m, crosses the Mahaweri River at its narrowest width, and the new bridge will be constructed at a wider river section. Accordingly, the length of the new bridge will be about 302m.

Following the determined bridge length, the number of slabs and each span will be examined. Basic policy that controls span allocation will be to locate piers at the same river-sectional position as (on the extension line of) those of the existing bridge. On determining the location of piers, it should be taken into account that the river flow is diverted into two streams at the island (sandbank) located at about 70m off the existing bridge upstream, as shown in Fig. 2.2.8. Therefore, on determining the location of pier(s) near the left river shore, this river flow condition will be properly accounted for. The location of piers and allocation of spans will be determined along with the examination process shown in Fig. 2.2.9.

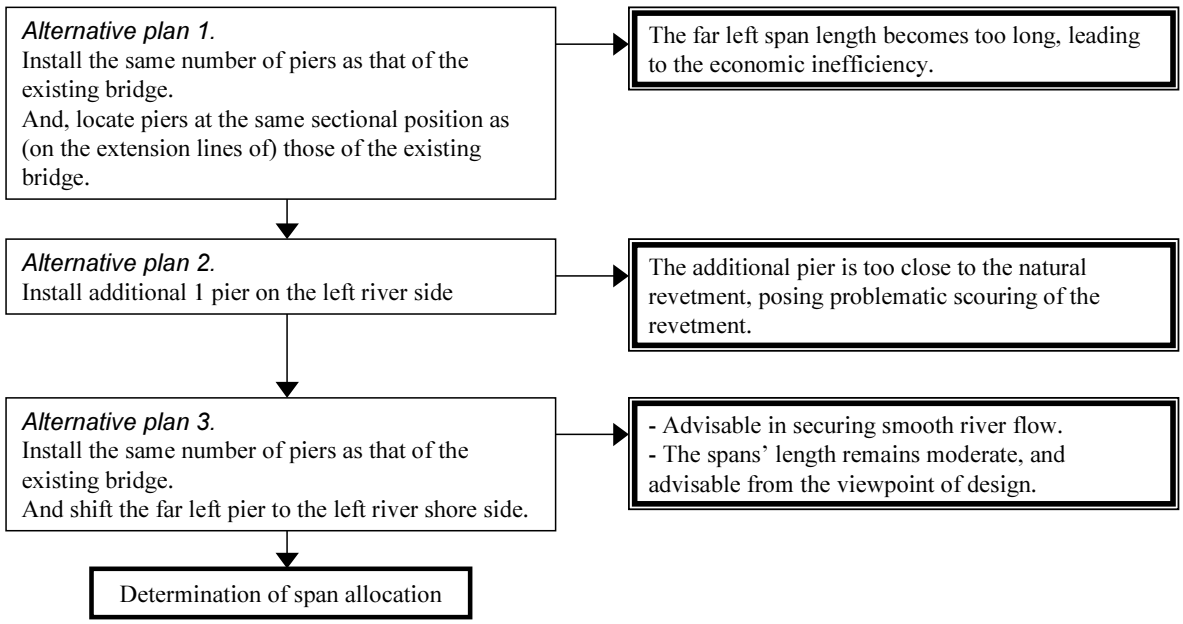


Fig. 2.2.9 Examination process of pier location and span allocation

iv) Basic type of superstructures

[1] Determination of basic bridge superstructure

The following aspects will be considered when determining whether the appropriate type of superstructure is a concrete or a steel bridge.

- Availability of machinery and materials necessary for implementation of facility with the superstructure.
- Overall efficiency, including both economic and construction efficiency; takes the implementation of substructure and foundation into account at the same time.
- Ease and low cost in maintenance phase
- Past performance of facilities with a particular substructure type in Sri Lanka, and the technology transfer

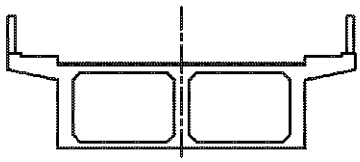
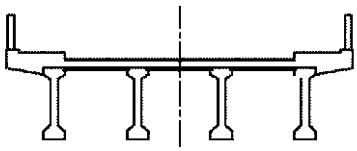
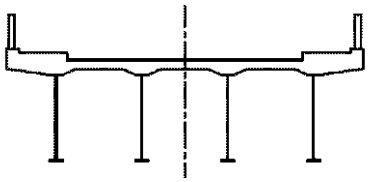
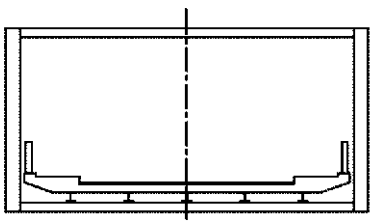
In view of the fact that the spans suggested so far in the alternatives remain about 48.5m, the concrete-intensive prestressed concrete structure will be suggested as the appropriate type of superstructure from the viewpoint of the cost required for production and import. In addition, it is certain that a bridge with a concrete-intensive superstructure will reduce the burdens in the maintenance phase, compared with that of steel-intensive superstructure.

[2] Determination of specific type of superstructure

Following the basic policy to locate piers at the same river-sectional position as those of the existing bridge, two general types of slabs will be considered. One is 55m-(or 48.5m-) span slab, and another is 97m-span slab. The alternatives of specific types for superstructure (slab), which cover one or two kinds of slabs structurally, are shown in Table 2.2.10. Note that, among the alternatives, the several-span continuous prestressed concrete box girder bridge type and the continuous steel I-beam bridge type cannot be utilized to the 55m-span slab. Among these alternatives, the prestressed concrete box girder bridge (basic span: 48.5m) will be suggested as appropriate from the viewpoint of economic and construction efficiency.

To secure the freeboard between the span bottom and high water level, most of these specific superstructures are required to be relatively high, leading to raising the vertical alignment (much higher than that of the existing bridge). Therefore, attention should be paid to curbing the height of the slab.

Table 2.2.10 Specific superstructure alternatives and applicable span

Specific types for superstructure (main slab)	Section of slab	Applicable span	Slab height / Span
Several-span continuous box girder bridge (including cantilever beam type)		20～200m	1/18
Continuous composite prestressed concrete slab bridge		20～45m	1/16
Continuous I-beam steel bridge		20～50m	1/18
Continuous steel truss bridge		40～150m	1/10

v) Determination of specific type of substructure

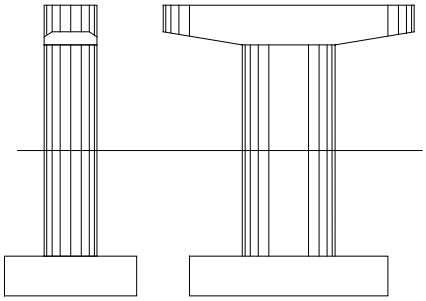
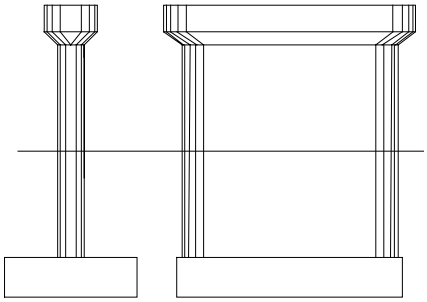
The basic policies for determining the specific type of substructure, which take the impact on the river and construction advantages into consideration, are as follows:

- Basically, the wall-type piers will be utilized, in view of the fact that the piers of the new bridge will be located close to the existing bridge. In addition, the new bridge piers will be installed at the same river-sectional position as those of the existing bridge, to avoid disturbing river flow, and minimize the impediment ratio of the flow.

- Because the riverbed is composed of sand layers, a 2.0m difference will be secured between the top level of pier footing and the riverbed level, taking measures against scouring.
- The bottom level of footing of abutments will be under the riverbed level, so that the abutments can remain stable even if the soils are scoured and removed in front of them. The reversed T-type abutment will be utilized in order to secure a 10m-height substructure.

Table2.2.11 shows alternative pier types and a comparison of their characteristics.

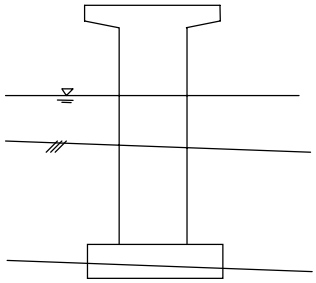
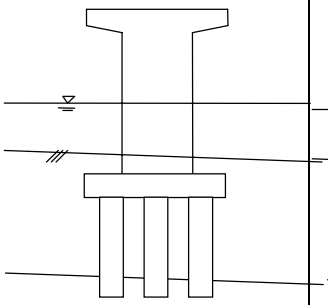
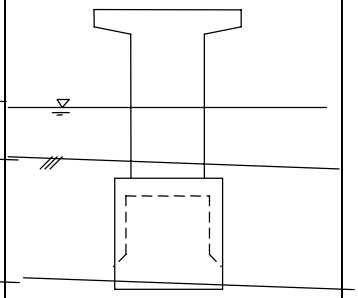
Table 2.2.11 Pier alternatives and comparison of their characteristics

	Plan 1 Cylindrical pier	Plan 2 Wall pier
Outline figure		
Structural characteristics	- Commonly used structure - Effective where direction of river flow changes frequently. - Width in the river-section becomes wider than that of the wall type pier. - Due to the large diameter of the cylinder, the river flow impediment ratio is worsened.	- Commonly used structure - Effective where direction of river flow doesn't change. - Width in the river-section becomes narrower than that of the wall type pier, curbing of river flow impediment ratio is worsened.
Construction characteristics	- The size of the supporting works for slabs becomes a little larger. - No other problem is expected in construction phase.	- No other problem is expected in construction phase.
Economic efficiency	△	○
Evaluation	△	○

vi) Determination of specific type of foundation

The geological study revealed that the bearing layer exists 15-17m underground beneath the riverbed, and that the sand layer, which consists of river sediment, lies on the bearing layer. Several alternatives such as driven steel-pipe piles, cast-in-place piles, and caissons will be suggested for the foundation installed in this underground level. Driven steel-pipe piles will be costly because the materials can be procured only by importing. The caisson foundation can lose stability when the riverbed around it is scoured and resisting force is produced by the water flow. On the other hand, cast-in-place piles are suitable for the underground level of the bearing layer on the bridge construction point, and facilities applying the foundation type have not brought about any problem so far in Sri Lanka. It is also important to realize that the foundation selection will make a meaningful difference in the degree of contamination of the river and water taken by the pumping facility. Table 3.2.12 shows the alternatives for foundation type and a comparison of their characteristics.

Table 3.2.12 Foundation alternatives and a comparison of their characteristics

	Spread foundation	Pile foundation	Caisson foundation
Outline figure			
Structural characteristics	- Taking advantage of bedrock as the bearing layer, this type provides a firm, stable foundation. - Scouring of riverbed will pose no safety problem because its stability does not depend on the horizontal resisting force from the first place.	- It's safe to say that the pile stability will be secured because the bearing layer is bedrock, and that the next layer up has sufficient thickness. - Foundation stability will be threatened. when the riverbed is scoured up to the level below the pier footing.	- The foundation cannot depend on the horizontal resisting force because of the high possibility of the sand layer being scoured. - Danger arises when the riverbed is scoured because the foundation becomes subject to the force of river flow.
Construction characteristics	- A large coffering works will be required because it is necessary to cut the bearing layer which exists at a deep underground level.	- Machinery for cast-in-place piles is available in the domestic market in Sri Lanka. - The size of coffering works will be smaller than that for spread foundation.	- Coffering by banking a temporary island will be required in the construction phase, leading to a worsening of the impediment ratio of river flow. - This type becomes difficult as the inclination of the bearing layer changes. - No special machinery is necessary.
Economic efficiency	△	◎	○
Evaluation	△	◎	○

vii) Determination of type of pavement

Concrete pavement will be utilized for the project facility in view of the fact that there is no asphalt plant near the site, that the total length of the approaching roads is no more than 428m, and that installation of a new plant solely for the project will increase construction costs remarkably. In addition, the Mahaweli River sometimes overflows the natural revetment and approaching road, and concrete pavement is effective in protecting roads subject to inundation..

However, it is necessary to take care that sufficient rolling is carried out because the pavement will be built on the embankment this time. Such a condition can lead to cracking of the pavement.

Pavement 5cm thick will also be built for the bridge surface. (This concrete will be cast together with concrete for slab structures.)

The thickness of the concrete pavement for the approaching roads will be 25cm, based on an estimate of less than 1,000 commercial vehicles in one direction per day. This is the standard stated in the "Guide to the cement concrete pavement" by the Japan Road Association.

viii) Determination of specific type of retaining wall

Retaining walls will be installed to secure the stability of abutments and the embankments around them.

The abutments of the existing bridge are far from the river shore, and a revetment is not installed. On the other hand, the Project will require revetment works for the protection of the new embankment and some control points (like the pumping facility, and bo tree) from flooding because the Project will involve high embankment works to realize the vertical alignment of the new bridge.

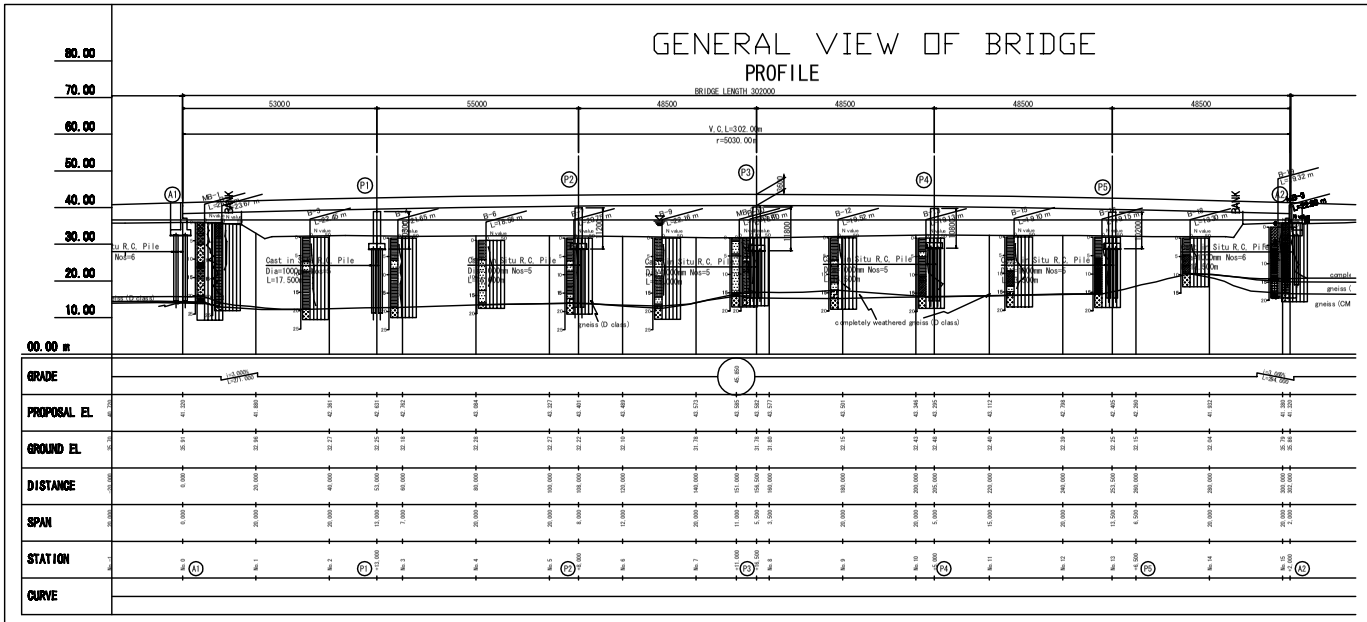
Generally used types of retaining walls are:

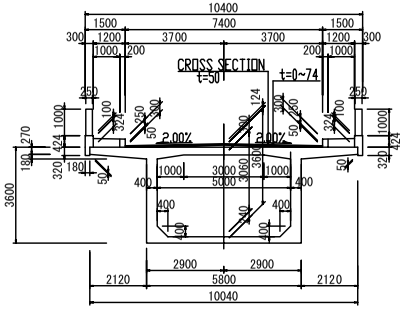
- Wet masonry work
- Reversed T-type concrete retaining wall
- Concrete crib work

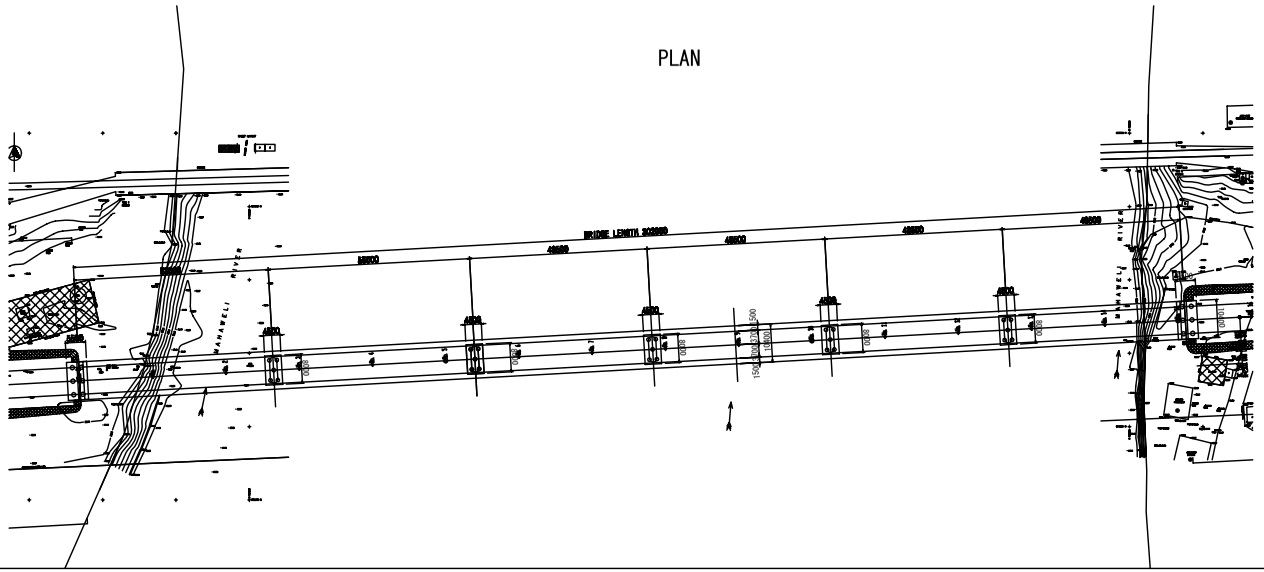
In the Project, wet masonry work, which is the most efficient economically, will be utilized, taking river conditions both upstream and downstream, the geological condition of the river shore, and the shape of substructures, fully into account.

2-2-3 Basic design drawings

Figure 2.2.10 General bridge plan
Figure 2.2.11 Approaching road (left bank)
Figure 2.2.12 Approaching road (right bank)
Figure 2.2.13 General plan for superstructures
Figure 2.2.14 General plan for A1 abutment
Figure 2.2.15 General plan for P1 pier
Figure 2.2.16 General plan for P2 pier
Figure 2.2.17 General plan for P3 pier
Figure 2.2.18 General plan for P4 pier
Figure 2.2.19 General plan for P5 pier
Figure 2.2.20 General plan for A2 abutment







DESIGN CRITERIA

ROAD CLASSIFICTION		B
TYPE		8-CONTINUANCE PC BOX GIRDER
BRIDGE LENGTH		302.0M
SPAN LENGTH		52.0+55.0+4@48.5
ROAD WIDTH		CARRIAGEWAY 7.40M, SIDE WALK 2@1.5M
PAVEMENT		RIGID PAVEMENT(CONCRETE)
LOGITUDINAL GRADIENT		AS SHOWN
CROSS SECTIONAL GRADIENT		AS SHOWN
DESIGN LIVE LOAD		HB30(BS 5400 PART2)
SKEWED ANGLE		90°00' 00"
DESIGN HORIZONTAL SEISMIC INTENSITY		N.A
TYPE OF SUB STRUCTURE		A1,A2; INVERTED T TYPE P1-P5 WALL TYPE
TYPE OF FOUNDATION		BORED PILE
GEOLOGICAL CONDITION OF SUPPORT		HARD ROCK
SUPER STRUCTURE	CONCRETE	?ck = 40N/mm2
	R-BAR	BS449 TYPE ? GRADE460
SUB STRUCTURE	CONCRETE	?ck = 24N/mm2
	R-BAR	BS449 TYPE ? GRADE460
APPLIED STANDARD		BS5400 PART2 "SPECIFICATION OF HIGHWAY BRIDGE" JAPAN ROAD ASSOCIATION (MAR.2002)

THE DEMOCRATIC SOCIALIST REPUBLIC OF SRILANKA
MINISTRY OF TRANSPORT AND HIGHWAYS

THE PROJECT FOR CONSTRUCTION OF A NEW HIGHWAY BRIDGE AT MANAMPITIYA

GENERAL VIEW

SCALE

DRAWNING No.

ORIENTAL CONSULTANTS COMPANY LIMITED
NIPPON KOEI COMPANY LIMITED

DRAWN BY	DESIGNED BY	PROJECT MANAGER	APPROVED BY

Figure 2.2.10 General View of Bridge

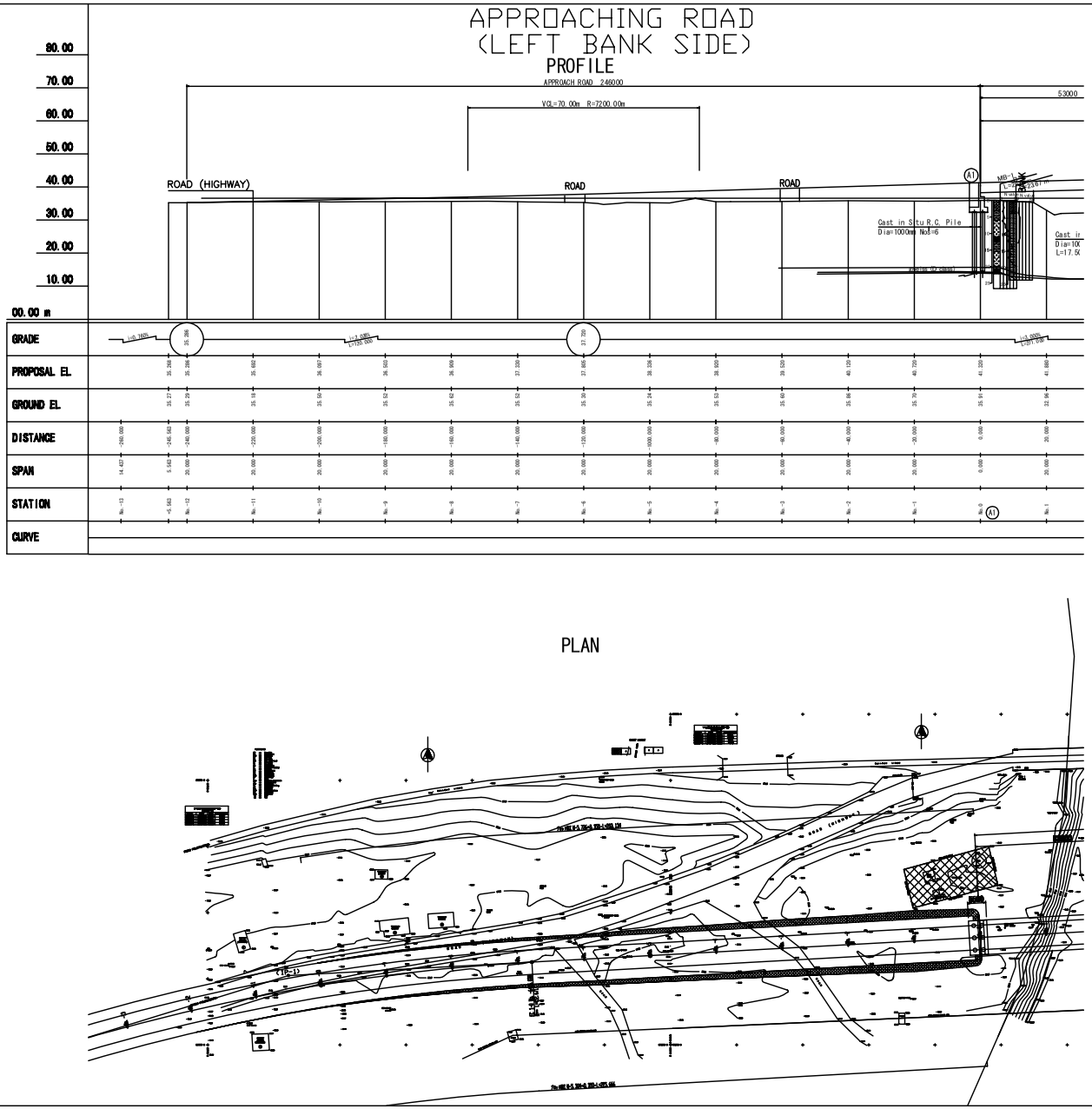
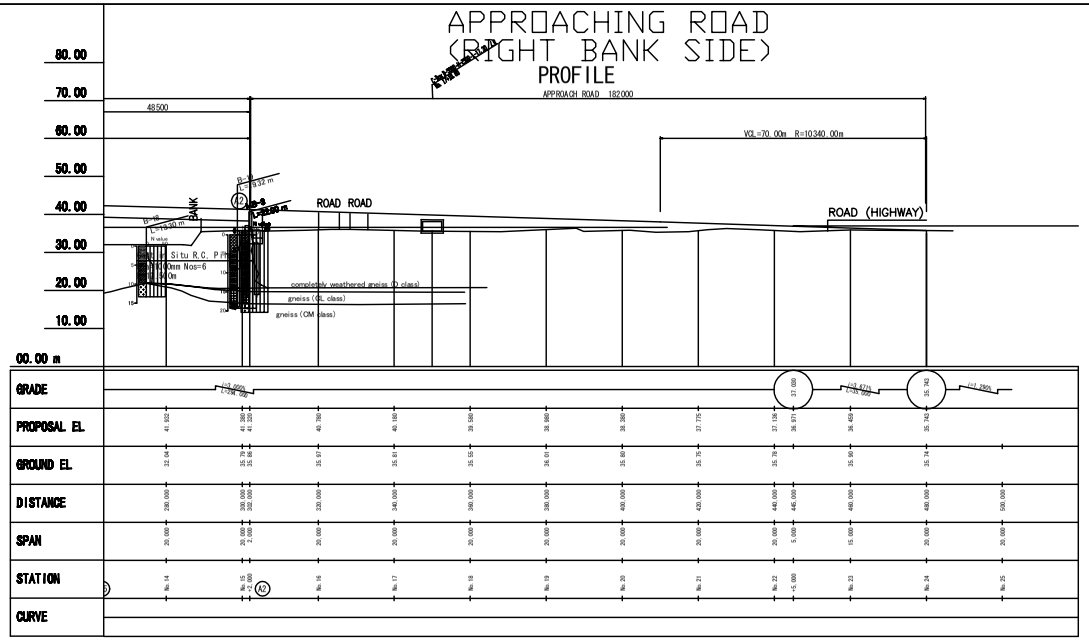


Figure 2.2.11 Approaching Road(Left Bank)

THE DEMOCRATIC SOCIALIST REPUBLIC OF SRILANKA MINISTRY OF TRANSPORT AND HIGHWAYS	
THE PROJECT FOR CONSTRUCTION OF A NEW HIGHWAY BRIDGE AT MANAMPITIYA	
APPROACHING ROAD (LEFT BANK SIDE)	SCALE DRAWNING No.
ORIENTAL CONSULTANTS COMPANY LIMITED NIPPON KOEI COMPANY LIMITED	

DRAWN BY	DESIGNED BY	PROJECT MANAGER	APPROVED BY



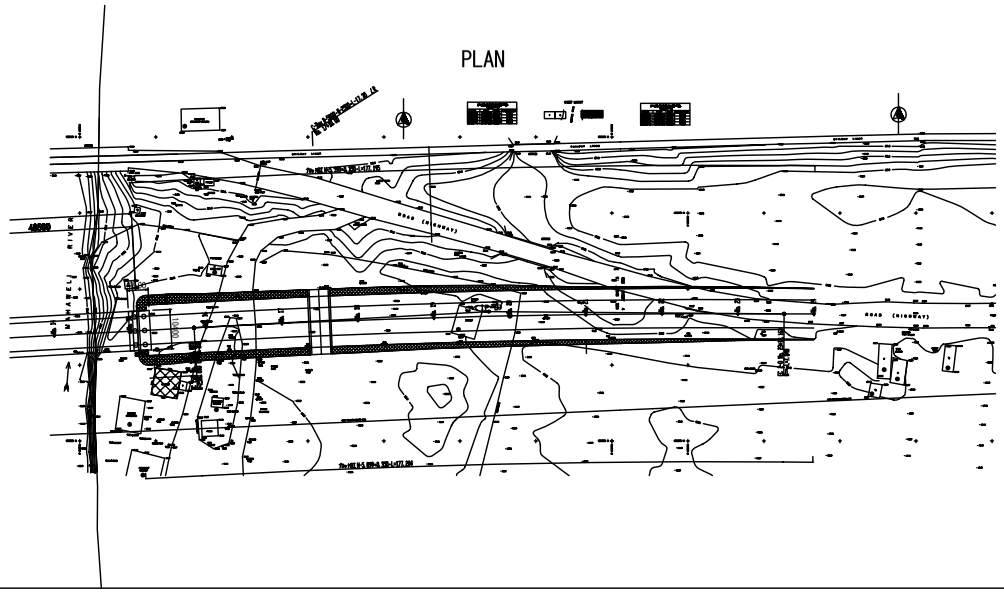
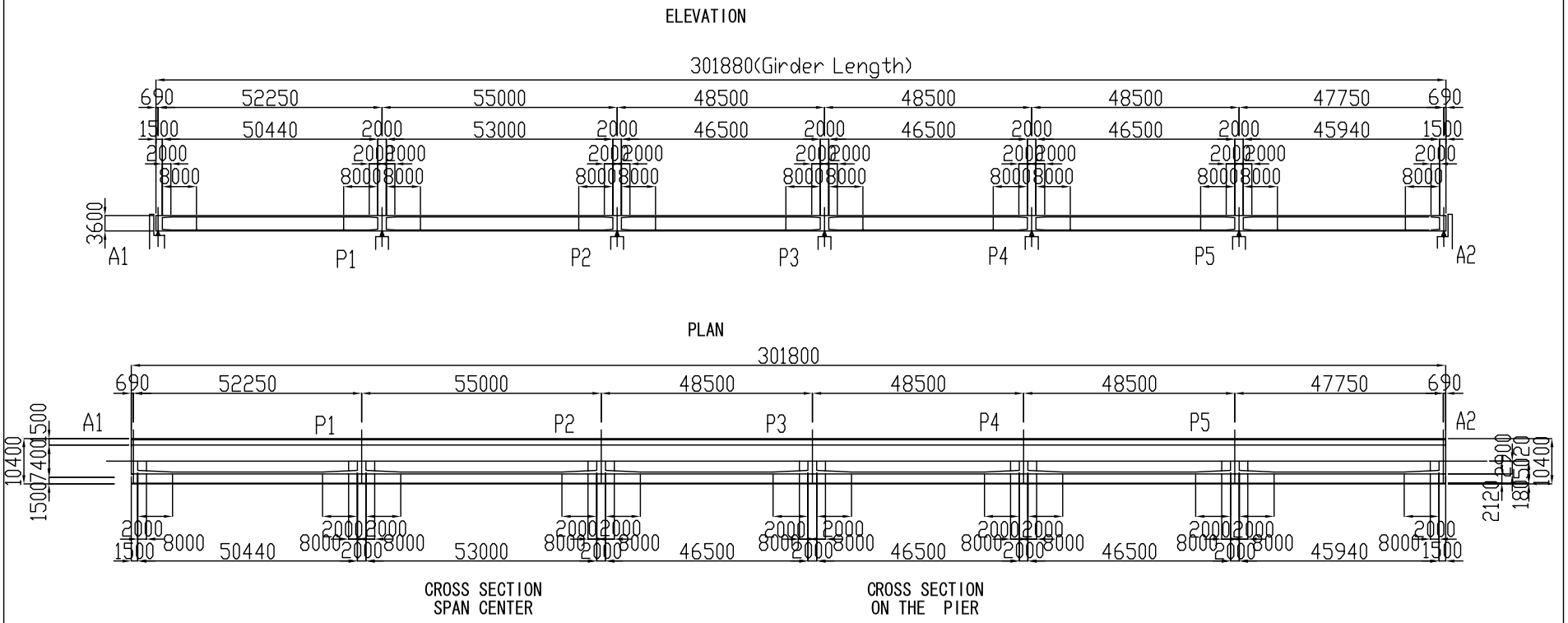


Figure 2.2.12 Approaching Road(Right Bank)

THE DEMOCRATIC SOCIALIST REPUBLIC OF SRILANKA MINISTRY OF TRANSPORT AND HIGHWAYS			
THE PROJECT FOR CONSTRUCTION OF A NEW HIGHWAY BRIDGE AT MANAMPITIYA			
APPROACHING ROAD (RIGHT BANK SIDE)	SCALE		
	DRAWNING No.		
ORIENTAL CONSULTANTS COMPANY LIMITED NIPPON KOEI COMPANY LIMITED			
DRAWN BY	DESIGNED BY	PROJECT MANAGER	APPROVED BY

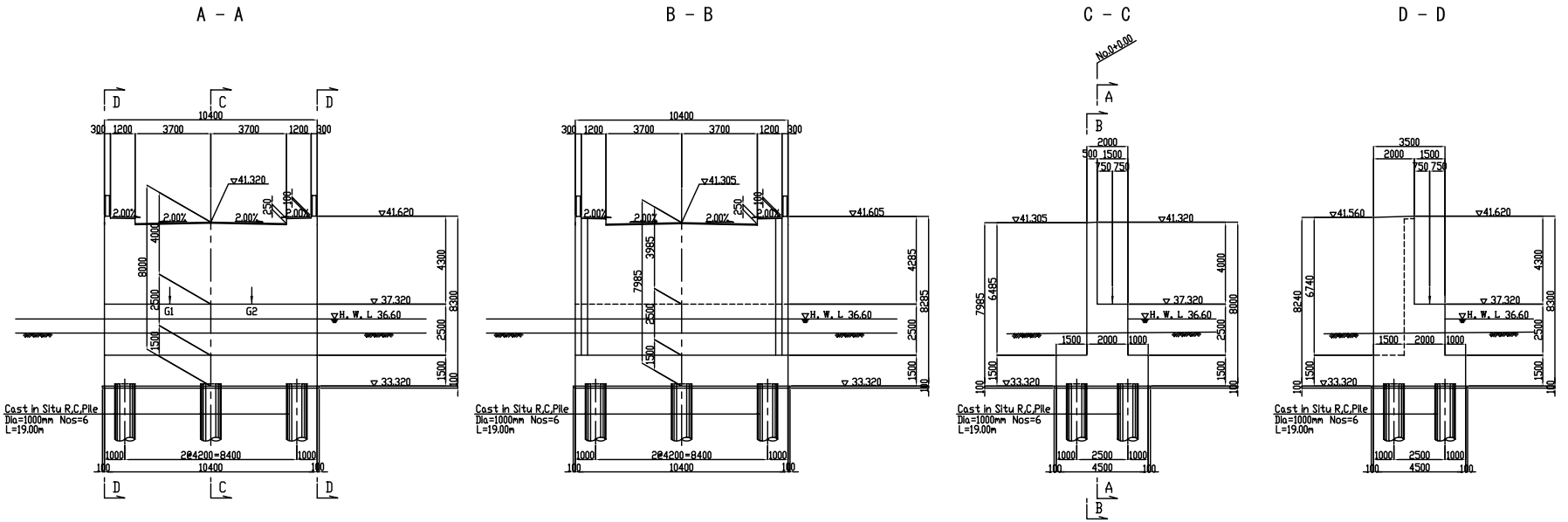
GENERAL PLAN FOR SUPERSTRUCTURES



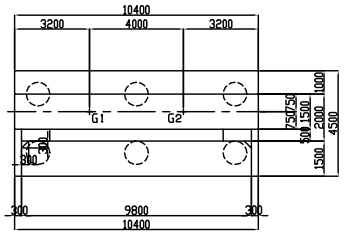
THE DEMOCRATIC SOCIALIST REPUBLIC OF SRILANKA MINISTRY OF TRANSPORT AND HIGHWAYS	
THE PROJECT FOR CONSTRUCTION OF A NEW HIGHWAY BRIDGE AT MANAMPITIYA	
GENERAL?PLAN?FOR SUPERSTRUCTURES	SCALE DRAWNING No.
ORIENTAL CONSULTANTS COMPANY LIMITED NIPPON KOEI COMPANY LIMITED	
DRAWN BY / DESIGNED BY / PROJECT MANAGER / APPROVED BY	

Figure 2.2.13 General Plan for Sperstructures

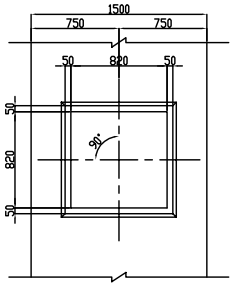
GENERAL PLAN FOR A1 ABUTMENT S=1:100



Plan



Shoe Details S=1:20



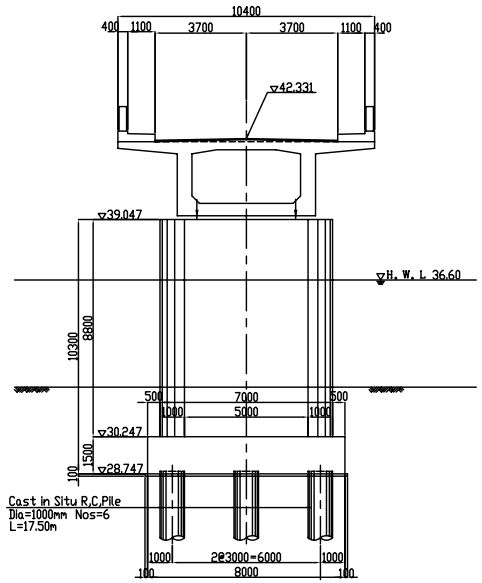
THE DEMOCRATIC SOCIALIST REPUBLIC OF SRILANKA MINISTRY OF TRANSPORT AND HIGHWAYS	
THE PROJECT FOR CONSTRUCTION OF A NEW HIGHWAY BRIDGE AT MANAMPITIYA	
GENERAL PLAN FOR A1 ABUTMENT	SCALE DRAWNING No.
ORIENTAL CONSULTANTS COMPANY LIMITED NIPPON KOEI COMPANY LIMITED	

DRAWN BY	DESIGNED BY	PROJECT MANAGER	APPROVED BY

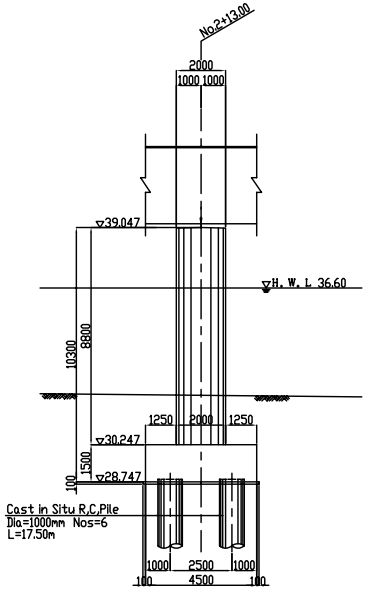
Figure 2.2.14 General Plan for P1 Pier

GENERAL PLAN FOR P1 PIER

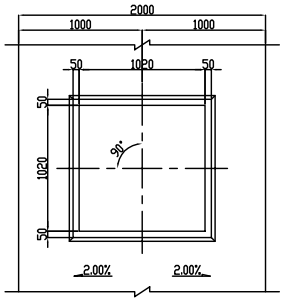
Front View



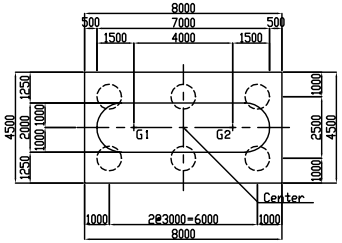
Side View



Shoe Details



Plan



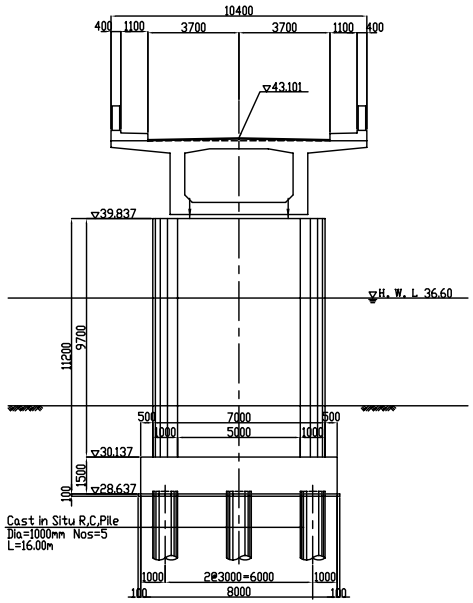
THE DEMOCRATIC SOCIALIST REPUBLIC OF SRILANKA MINISTRY OF TRANSPORT AND HIGHWAYS	
THE PROJECT FOR CONSTRUCTION OF A NEW HIGHWAY BRIDGE AT MANAMPITIYA	
GENERAL PLAN FOR P1 PIER	SCALE DRAWNING No.
ORIENTAL CONSULTANTS COMPANY LIMITED NIPPON KOEI COMPANY LIMITED	

DRAWN BY	DESIGNED BY	PROJECT MANAGER	APPROVED BY

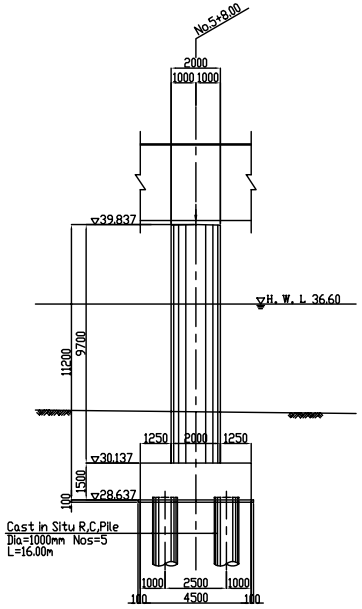
Figure 2.2.15 General Plan for P1 Pier

GENERAL PLAN FOR P2 PIER

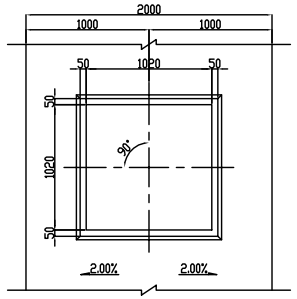
Front View



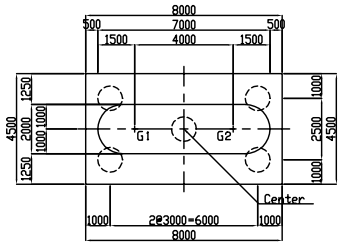
Side View



Shoe Details



Plan



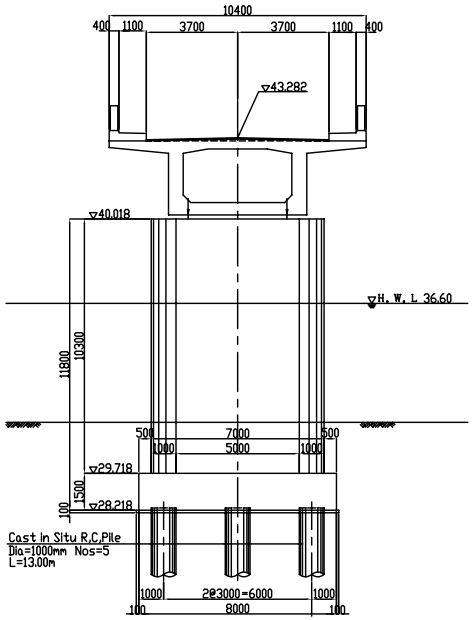
THE DEMOCRATIC SOCIALIST REPUBLIC OF SRILANKA MINISTRY OF TRANSPORT AND HIGHWAYS	
THE PROJECT FOR CONSTRUCTION OF A NEW HIGHWAY BRIDGE AT MANAMPITIYA	
GENERAL PLAN FOR P2 PIER	SCALE DRAWNING No.
ORIENTAL CONSULTANTS COMPANY LIMITED NIPPON KOEI COMPANY LIMITED	

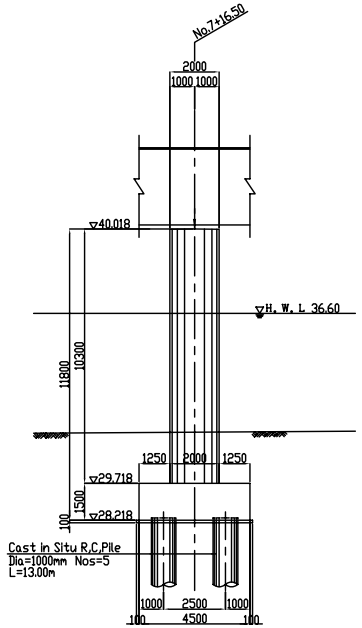
DRAWN BY	DESIGNED BY	PROJECT MANAGER	APPROVED BY

Figure 2.2.16 General Plan for P2 Pier

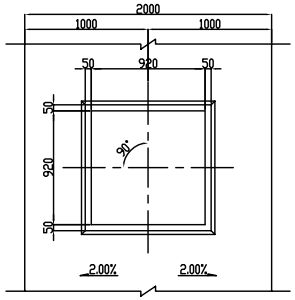
GENERAL PLAN FOR P3 PIER

Front View

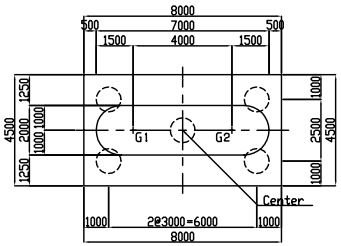




Shoe Details



Plan



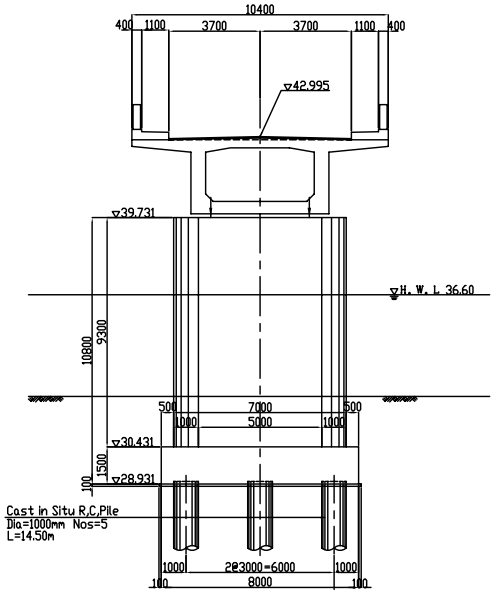
THE DEMOCRATIC SOCIALIST REPUBLIC OF SRILANKA MINISTRY OF TRANSPORT AND HIGHWAYS	
THE PROJECT FOR CONSTRUCTION OF A NEW HIGHWAY BRIDGE AT MANAMPITIYA	
GENERAL PLAN FOR P3 PIER	SCALE DRAWNING No.
ORIENTAL CONSULTANTS COMPANY LIMITED NIPPON KOEI COMPANY LIMITED	

DRAWN BY	DESIGNED BY	PROJECT MANAGER	APPROVED BY

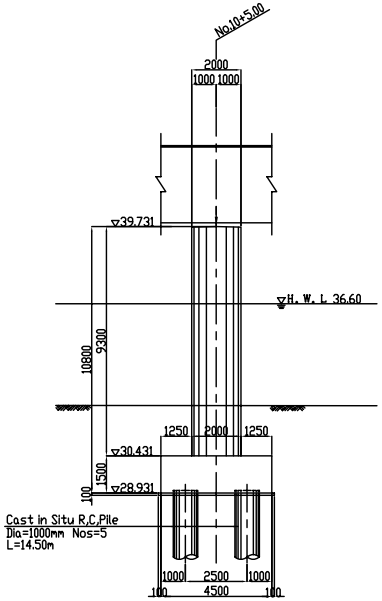
Figure 2.2.17 General Plan for P3 Pier

GENERAL PLAN FOR P4 PIER

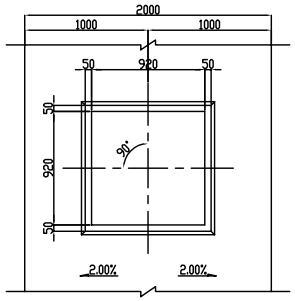
Front View



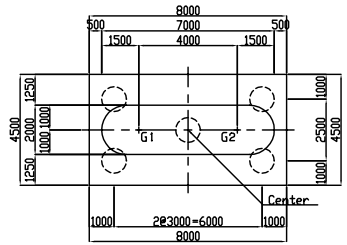
Side View



Shoe Details



Plan



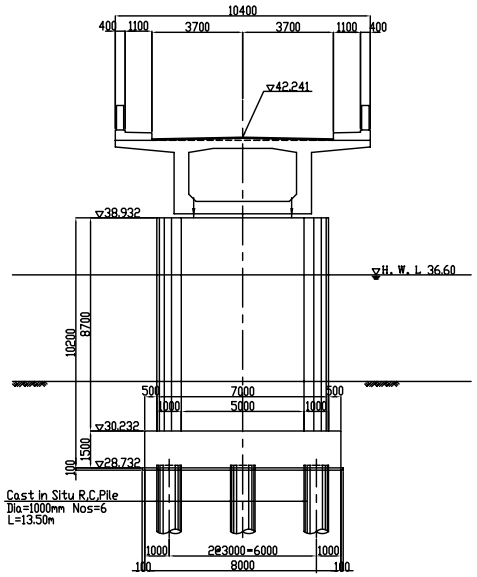
THE DEMOCRATIC SOCIALIST REPUBLIC OF SRILANKA MINISTRY OF TRANSPORT AND HIGHWAYS	
THE PROJECT FOR CONSTRUCTION OF A NEW HIGHWAY BRIDGE AT MANAMPITIYA	
GENERAL PLAN FOR P4 PIER	SCALE DRAWNING No.
ORIENTAL CONSULTANTS COMPANY LIMITED NIPPON KOEI COMPANY LIMITED	

DRAWN BY	DESIGNED BY	PROJECT MANAGER	APPROVED BY

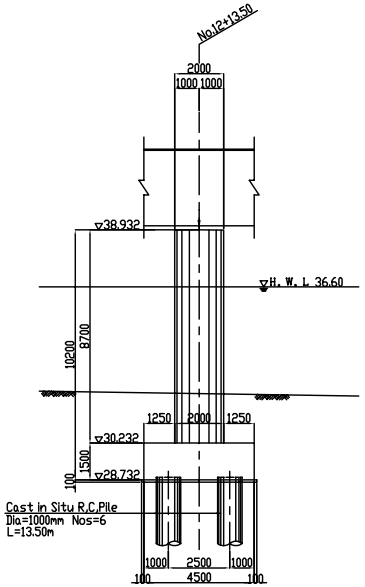
Figure 2.2.18 General Plan for P4 Pier

GENERAL PLAN FOR P5 PIER

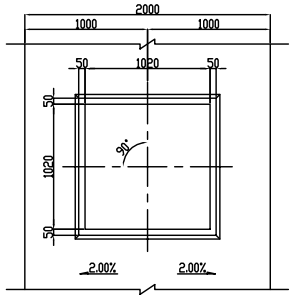
Front View



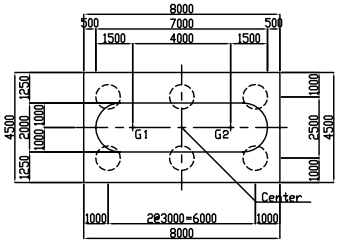
Side View



Shoe Details



Plan

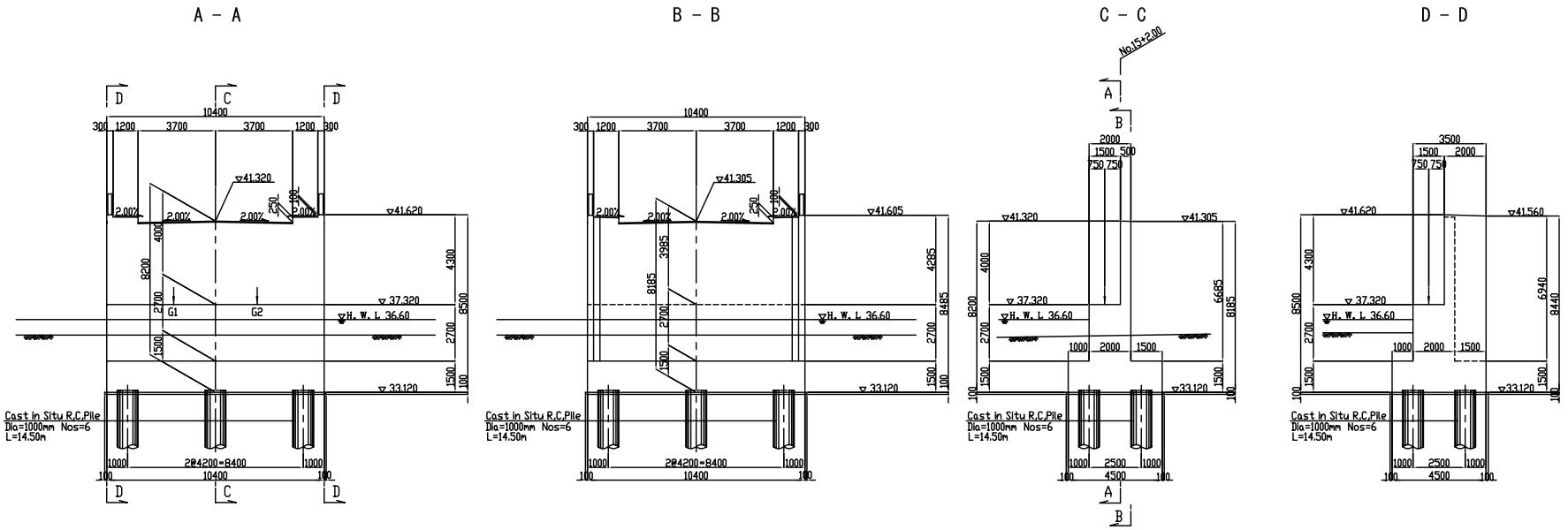


THE DEMOCRATIC SOCIALIST REPUBLIC OF SRILANKA MINISTRY OF TRANSPORT AND HIGHWAYS	
THE PROJECT FOR CONSTRUCTION OF A NEW HIGHWAY BRIDGE AT MANAMPITIYA	
GENERAL PLAN FOR P5 PIER	SCALE DRAWNING No.
ORIENTAL CONSULTANTS COMPANY LIMITED NIPPON KOEI COMPANY LIMITED	

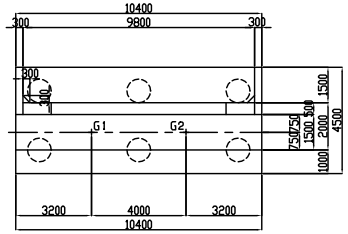
DRAWN BY	DESIGNED BY	PROJECT MANAGER	APPROVED BY

Figure 2.2.19 General Plan for P5 Pier

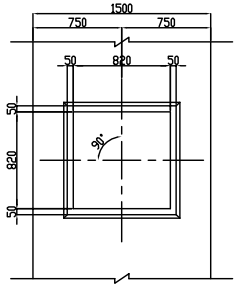
GENERAL PLAN FOR A2 ABUTMENT S=1:100



Plan



Shoe Details S=1:20



THE DEMOCRATIC SOCIALIST REPUBLIC OF SRILANKA MINISTRY OF TRANSPORT AND HIGHWAYS	
THE PROJECT FOR CONSTRUCTION OF A NEW HIGHWAY BRIDGE AT MANAMPITIYA	
GENERAL PLAN FOR A2 ABUTMENT	SCALE DRAWNING No.
ORIENTAL CONSULTANTS COMPANY LIMITED NIPPON KOEI COMPANY LIMITED	

DRAWN BY	DESIGNED BY	PROJECT MANAGER	APPROVED BY

Figure 2.2.20 General Plan for A2 Abutment

2-2-4 Implementation Plan

2-2-4-1 Implementation Policy

1） Basic Policy

ⅰ） Japan's Grant Aid Policy

Since it is planned to implement the Project with Japanese Grant Aid, the following will need to be taken into consideration:

- The use of local resources, including manpower and materials, should be maximized to promote the creation of jobs, promote technical transfers and stimulate the local economy in Sri Lanka.
- It is necessary for the Sri Lankan Government (the Client), the Consultant and the Contractor to stay in close touch with each other to ensure smooth implementation of the Project.

ⅱ） Basic Policy on New Highway Bridge at Manampitiya

Construction of the new Highway Bridge at Manampitiya is to be undertaken in consideration of the characteristics the new bridge will have and its surrounding natural conditions.

- A temporary access road and platform for pier construction, which will commence on the left bank, shall be prioritized ahead of all work so that the construction schedule will stay on track as planned.
- Substructure work shall be completed during the first dry season before the River stream and high water rise to a level that would interfere with the construction work. It is essential to carefully plan the commencement of all work in accordance with the construction schedule and to strictly follow the planned schedule.
- Fabrication of the girders for the superstructure shall be completed just in time to start the substructure work. Erection of the girders shall be carried out on schedule whether it is the rainy or dry season.

The applied bridge style and construction method require that temporary bent piers in the River shall be in progress for mounting parallel to the substructure work.
It is vital to procure required materials, equipment, and labor on time, as well as to ensure careful management for work progress and safety control.

2）Construction Schedule

It is assumed that the Project period will be 24 months without tender procedure (28 months including tender procedure).

Preparation work in the rainy season, from October to February, will mostly commence with leveling and grading for a work yard on the left bank, machinery assembly, and a fabrication yard for the superstructure.

Substructure work, superstructure work, access road work, and pavement work will be executed in sequence .

3） Construction Method

i） Work Flow

The overall workflow for construction of a new highway bridge at Manampitiya is as shown in Figure 2.2.21.

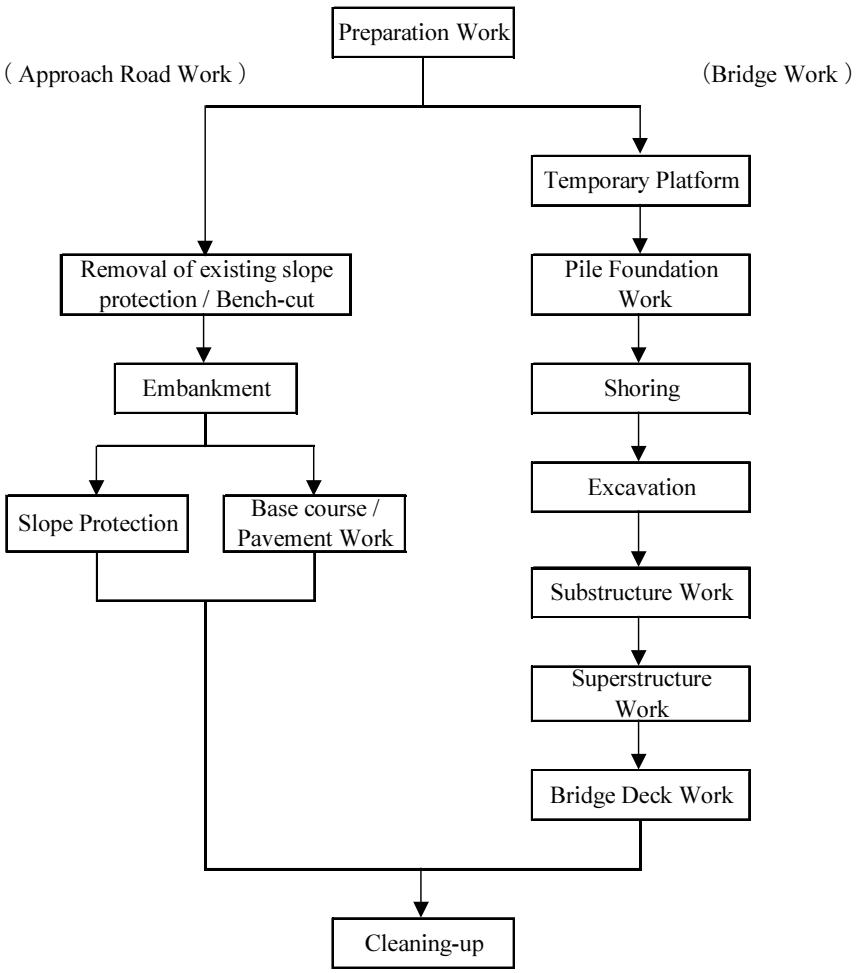


Figure 2.2.21 Work Flow for Project

ii） Bridge Work

a) Temporary Work Yard and Facilities

A temporary work yard for the site office and facilities, storage of materials and equipment, a workshop and an open space for fabrication and erection of the superstructure will be created on the left bank.

b) Temporary access road, bridge, platform and cofferdam

Prior to the substructure works, a temporary access road, which will be started from the left bank side toward the right bank side, will be built to cross the Mahaweli River. The access road will be built up by backfilling with a soil-gravel mixture and protected with gabions against erosion and/or collapse.

P1, P3 and P5 pier construction will be carried out with an island platform, which will be connected with access to the temporary bridge. A temporary platform is to be mounted for piers P2 and P4. Sheet piles will be employed for the cofferdam, and installation will begin after both the island platform and temporary platform are in place. Sheet piles will be driven firmly into the bearing stratum to prevent a sand boiling phenomenon.

The recorded high water level (+36.6m) defines the minimum height of temporary access, platforms and the cofferdam; it will be designed for +37.6m.

C) Foundation and Substructure Work

An all-casing method will be applied to the foundation pile work, with casing tubes used to fully prevent holes bored in sand layers from collapsing. Pile holes will be bored up to 1.5m deeper than the bearing rock layer, which is equivalent to the pile diameter, or to a stable bearing layer when the rock layer deteriorates. After pile hole boring to the specified depth, a pre-assembled reinforced-bar will be dropped off through the casing tubes and concrete pouring will commence in sequence. The casing tubes will be pulled away after concrete is cast to complete the piling work.

An open excavation method will be applied to A1, A2 abutments, and concrete work will follow. A parapet wall will be constructed after the superstructure is erected. Excavation and concrete work for piers P1 to P5 will be carried out inside the cofferdam where space is narrow and limited. Even though this will be dry season activity, rigorous safety and schedule control is required to set and maintain

the sheet piles for the cofferdam especially when its struts are reinstalled.
A series of critical tasks must follow the work flow, from the piling to the excavation. It is essential for critical path control to be tracked and always linked to the total progress control of the Project.

d) Superstructure Work

The extruded construction method will be applied for erection of the superstructure with concrete girders. Bent piers, which will sustain girders during the erection process, will temporarily be placed between the A1 abutment and P1, P2 piers in advance.

Girders will be launched for erection after the P3 pier is completed. The erection of the superstructure will continue in parallel to pier works whether it is in the dry or rainy season. It is essential for erection work to be carefully planned and carried out under strict quality control in order to provide high sustainability in the future.

After the girder erection work is completed, the parapet walls on the A1, A2 abutments will be cast and bridge accessory work, including surfacing concrete, handrail settings, and expansion joints, drainage setting, will be undertaken in sequence.

iii) Approach Road Construction

a) Embankment works

The approach road work with A1, A2 abutments will commence after the crane and/or other machinery for the superstructure erection is off the left bank. Embanking will be properly combined and repeatedly carried out with compaction work to reach the specified height. The base course and concrete pavement on the approach road slope require firm compaction to ensure quality, will follow in sequence.

b) Shoulder

A gravel finish on a firmly compacted base will be applied.

c) Slope

A stone masonry wall will be built.

d) Drainage Work

A box culvert will be employed to ensure smooth discharge for the approach road at the right bank where the flood flow will extend in the rainy season.

e) Facilities and Equipment for road safety

The installation of the guardrails, sign boards and the painting of traffic signs will be carried out after concrete pavement is completed

4） Utilization of Local Construction Industry

ⅰ） Consultants

There are a few private consultants and laboratories that possess the technical capability and skilled human resources needed to handle such tasks as land surveys, geological surveys, design, and environmental impact assessments. However, it will be vital to feed technical advice and/or instructions for quality control and progress control.

ⅱ） Contractors

The Technical capacity among local contractors has gradually been developed and improved as shown by the fact that there are two semi-governmental companies in operation that take care of fabrication as well as erection of PC-girders. Even though their quality control is still in need of improvement in comparison with the advanced countries, local contractors will have an opportunity to participate as subcontractors, except for the superstructure work, under the supervision and technical guidance of Japanese contractors.

5）Dispatch of Technicians and Engineers from Japan

The platform work in the River is very important for progress control of the bridge construction. Experienced scaffolders and erectors will be required for smooth implementation of the work. Moreover, erection of girders with the extrude

construction method will require experienced and skilled technicians and engineers who will be dispatched from Japan to ensure the safety, quality and schedule management of the Project, as well as to facilitate technology transfers to Sri Lankan technicians and engineers.

6） Implementation Agency

The RDA will be the Project implementation agency, and the Contract and Administration Section of the PMU on Japan's Grant Aid Project will be in charge of the Project.

2-2-4-2 Issues on Implementation of the Project

1） Customs duties and procurement for materials and machinery

In general, all construction materials and machinery to be procured for the Project will be exempt from taxes under the provisions of a tax exemption on Japan's Official Development Assistance program. However, it is of vital importance for RDA to evaluate and ensure taxation in advance for budgeting, since, on the import procedure in Sri Lanka, the contractor will not directly be exempted from tax payment, but be obliged to pay relevant taxes for the RDA, which will duly reimburse taxes to the Contractor as the responsible agency. It is strongly emphasized under these circumstances that the shipping list of materials and machinery shall be submitted to the RDA so it can evaluate and budget taxation based on regular procedures to reach an internal consent.

Since key machinery and equipment that will impact on both quality and schedule control (in particular PC-girder fabrication and erection phases) will be procured from Japan, it is required that the Sri Lankan side be closely involved to render smooth customs clearance and ensure timely implementation of the Project.

2） Bringing construction materials to the site

The Construction materials to be carried to the site will be transported mainly by land. Materials that are difficult to procure in Sri Lanka are to be imported from foreign countries and transported to the site via the port of Colombo in the case of import by sea or via Katunayake International Airport in the case of import by air.

ⅰ） By land

Nearly all materials procurable in Sri Lanka are found in the Colombo area, and imported materials are collected in the port of Colombo. It is therefore necessary to secure an access route from Colombo to the site.

ⅱ） By sea

All materials and equipment imported by sea from foreign countries are unloaded in Colombo Port to be transported by the inland route described above. In the case of procurement from Japan, it will take about 1.5 to 2 months for shipments from Japan to arrive at the site.

ⅲ） By air

Materials and equipment imported by air from foreign countries are unloaded at Katunayake International Airport to be transported into Colombo via Route A-3 and finally to the site via the above route. The distance between the Airport and Colombo is 34 km.

3）The Rainy Season and Schedule Implementation

The rainy season lasts from October to February in the Project area. It is vital to efficiently take advantage of the first dry season (March to September), since the Project is to commence in October at the start of the rainy season. Accordingly, at the beginning of the first dry season, utilization of the machinery from both local and the third country procurement will be a key element for pile foundation work and pier work.

Fabrication and erection of the superstructure is scheduled for the first and second dry season as well as the second rainy season. It will be required that concrete pavement work, including access road work and ancillary work, be completed by the end of the second dry season.

4）Relocation of Public Facilities Affecting Project Implementation

The Relocation and/or removal of electric power and telephone poles and water supply lines, if any, must be studied by the authorities concerned. Necessary procedures will be carried out with RDA in advance. Table2.2.13 provides a list of

public facilities to be relocated.

Table2.2.13 Facilities to be relocated

	Left Bank		Right Bank	
Item	Authorities concerned	Description	Authorities concerned	Description
Building	None	None	Department of Wildlife Conservation	① 2,3 houses of the sand supplier ⇒to be negotiated for settlement
Electricity	Ceylon Electric Board	High voltage: 33kV feeder to pumps of the National College of Education. To be confirmed with CEB	Ceylon Electric Board	② Low voltage: 230v feeder to a shed of police campsite. ③ Generator stand by for power failure
Telephone	None	None	Sri Lanka Telecom	④ Telephone line to a shed of police campsite.
Water supply	None	None	None	None
Others	Pulathisipura National College of Education	② Water pipe: φ 10cm, 0.75～1m depth embed. ③ Water in-take facility	Jayanthi Viharaya (Buddist Temple)	⑤ Banyan tree
	ADB National Water Supply & Drainage Board, Polonnaruwa	④Well by ADB: 2 pcs. at the main bridge 3 pcs. at the temporary yard		

The facilities shall be completely relocated by the end of March 2005 by the Sri Lankan side.

5）Temporary sites for work

During the work period, sites must be secured for temporary buildings and equipment and for storage of materials and equipment. Possible candidate sites and uses are shown in Table2.2.14.

Table2.2.14 Temporary sites for work

	Left Bank	Right Bank
Use	Site office, construction material storage yard, machine storage site, yard for superstructure fabrication and temporary yard.	Construction materials storage yard

6）Blocking traffic

During construction of the new bridge, the existing bridge will continue to be open for transit. There will be no need to block the existing traffic in general use. Traffic will be blocked however subject to approval of authorities concerned if required due to deadhead of large vehicles (during girder transport or erection), construction of a temporary approach road, and other purposes.

Traffic will be blocked, if necessary, at night when the traffic volume is small, and necessary notice boards, protection equipment, and traffic guides will be provided to ensure thorough safety measures.

2-2-4-3 Responsibility for Implementation

All construction work on the New Highway Bridge at Manampitiya will be executed by the Japanese side. The Sri Lankan side is responsibile for relocating public utilities before commencement of the construction on both banks of the River. On the left bank, those of the sand depot of the sand vender, high tension feeder, impact assessment on water supply line have been pointed out, and on the right bank, those of houses and sand depots of the sand supplier, bo tree, low voltage feeder and telephone line to a police campsite are listed.

2-2-4-4 Consultant Supervision

Under the detailed design consulting service contract, the consultant is to execute the bridge detailed design and prepare the tender documents. Entering into the construction phase, under the supervision consulting service contract, the consultant will dispatch one Japanese resident supervisor and one bridge engineer under short period assignment to render supervision and guidance for the construction work.

1） Detailed Design and Tender documents

- Project manager	General affairs related to detailed design and contract documentation
- Road engineer	Design of pavement and drainage, including access road
- Bridge engineer	Design of the New Bridge, including its foundation, substructure, and superstructure
- Tender documents engineer	Preparation of tender and contract documents, and execution of bidding and contracts

The detailed design comprises the design drawing and quantity calculation.

2）Supervision

- Project manager	General affairs related to supervision as a whole
- Resident engineer	Two supervising engineers will be resident on the site from commencement to completion of construction, and will be responsible for technical duties such as construction quality, procurement, process and safety management. One resident engineer will be in charge of road work and the other of bridge work.
- Bridge engineer	In charge of quality control (cable tension control and girder configuration control) and safety management for girder fabrication and erection of the new bridge

The Engineers will review and approve the technical documents submitted by the Contactor. These include the work implementation plan, procurement plan, work progress plan, quality control plan, finished work control plan, and safety and hygiene control plan.

The following are important supervisory points for the Project:

- Bridge work	- Foundation work -PC girders fabrication, tensioning of PC cable Extruded construction work of superstructure erection
- Access road work	- Compaction work with banking materials - Base course and concrete pavement work

2-2-4-5 Qualities Plan

Quality control of construction exerts considerable influence on the structural stability, the safety, and the durability of the structure. It is therefore essential for every stage of construction to be provided an adequate quality control.

Sri Lanka has its own design standards for roads and bridges based on the British Standard. However, these have not been regulated adequately in terms of the quality control as Sri Lankan Standards. Therefore, Japanese and British quality control standards and testing methods will be conformed to in this project.
The quality control methods are shown in Table-2.2.15 and Table-2.2.16.

1）Quality Control

Quality control items for major construction works are summarized below.

ⅰ）Earthworks

The embankment and the roadbed shall be built with high quality banking materials and sufficient compaction. It is noted that an upper layer for the sub-grade and the base course shall be built with high quality borrow materials.

ⅱ）Concrete Pavement

The Concrete pavement work will be implemented based on the Sri Lankan Standards in this project.

ⅲ）Concrete Structures

Since there is no concrete plant available in the neighborhood for the Project, a temporary concrete plant will be transported onto the site. Materials will be stored in a temporary stockyard, and an appropriate storage method shall be established to prevent them from exposure to rainwater.

ⅳ）Reinforcing Bars, Forms, and PC Cables

Reinforced bars (D<25mm) and materials for wooden forms are available in Sri Lanka. Thick bars (D>25mm), materials for metal forms and PC cables will be

imported from a third country. It is essential to store this steel in an adequate stockyard for protection from rusting and mud adhesion.

v）Pre-stressing of PC Cable

Supervision of pre-stressing of PC cable is an important control item to ensure the specified structural performance of PC concrete structures. PC cable must be prepared in the presence of consultant engineers.

vi）PC Grouting

PC grouting is an important method to prevent rusting of pre-stressed steel. Thorough supervision is essential to ensure correct filling.

Table 2.2.15 Quality Control Methods (1 of 2)

Type of Work	Item Concerned	Inspection, Testing, etc.	Frequency of Inspection/Testing
1) Earthworks Filling, base course, backfilling soil of structures	Material	Soil test of embankment materials - Specific gravity of soil particles - Soil water content - Particle size of soil - Liquid, plastic limits of soil - Soil compaction -Dry density - CBR test	Before implementation
	Daily Management	Embankment construction test - Control of compaction density (sand replacement method, etc.)	Immediately after implementation Once a day for each implementation layer
2) Concrete Pavement Works Concrete pavement slab	Material	Standard testing of materials - Cement test - Material property - Aggregates test -Particle size -Harmfulness -Stability -Wearing depth -Unit capacity weight - Additive and/or admixture test - Material physical property - Mixture -Slump -Air content -Compressive strength - Reinforcing bar test - Joint filling material test	Before implementation
	Daily Management	Concrete pavement slab -Particle size -Unit capacity weight - Surface moisture/fine aggregate -Fresh concrete/ -Consistency -Air content - Concrete temperature -Compressive strength	At implementation: Once a day for each implementation layer
3) Concrete Structures	Batching Plant	Weighing equipment, mixing efficiency - Static load test - Weighing controller - Dynamic load test - Mixing efficiency	Before implementation, monthly (every three months in the case of dynamic load)
	Materials	Cement, water - Checked by means of standard certificate Fine and coarse aggregate tests - Particle size - Specific gravity - Water absorption - Unit weight - Durability - Alkali-aggregate reaction	Before implementation and after change of materials
	Concrete standard test	Test mixing made to determine the mix proportion - Slump - Air content - Temperature - Strength of test piece	Before implementation
	Daily Management	Fresh concrete - Air content - Slump - Temperature	Initial consecutive five units. Subsequently, every $50m^3$ and at preparation of sample
		Concrete casting method - Casting method - Consolidation - Order of Placing - Curing method - Curing method - Removal Laitance	Witness inspection at placement
		Concrete sample - Sample compressive strength test - Preparation of the concrete control chart	Sample to be prepared once a day seven and 28 days after placement

Table 2.2.16 Quality Control Methods (2 of 2)

Type of Work	Item Concerned	Inspection, Testing, etc.	Frequency of Inspection/Testing
4) Reinforced bar, forms, PC cable	Materials	Check reinforced bars and prestressed cable by means of the mill sheet issued by the manufacturer - Quality - Tensile test - Bending test	Before implementation
	Inspection of Works, Daily Management	The following checks should be made after assembly: - Material size - Dimensions - Layout - Lap length - Concrete cover - Fixing condition - Connection joint treatment condition	Before placement of concrete: 100% inspection of each placement area
5) Pre-stressing of PC cable	Concrete strength check	- Concrete sample compressive strength	Before pre-stressing
	Pre-stressing equipment	- Calibration of jack and pump	Before pre-stressing, Every 50 pre-stressed cables With change of pre-stressing equipment
	Pre-stressing test	- According to the pre-stressing control chart	Before final pre-stressing
	Pre-stressing control	- Control of each cable - Control of cable group - Control of transverse pre-stressed cable	At pre-stressing Pre-stressing control chart
6) PC grouting	Mixing design	- Consistency - Bleeding ratio - Expansion ratio - Strength - Total salt content	Before use
	Daily Management	- Consistency – Temperature	Once a day, every five batches
		- Bleeding ratio - Expansion ratio - Compressive strength	Once a day
7) Staying Cable	Materials	- Mill sheet issued by the manufacturer, tension test, bending test	Before implementation
	Tension device	- Calibration of jack and pump	Before tensioning
	Tension test	- In accordance with the tension control chart	Before final tensioning
	Tension control	- Control of each cable	At tensioning (tension control chart)
8) Grouting for Staying Cable	Mixing design	- Consistency - Temperature - Bleeding ratio - Expansion ratio - Compressive strength	Before use
	Daily Management	- Consistency - Temperature - Bleeding ratio - Expansion ratio - Compressive strength	At treatment with grouting

2） Progress Control

A sample of the progress control standard for each step is shown in Table 2.217.

Table 2.2.17 Progress control standards

Construction	Type	Item	Standard value	Remarks
Earthwork	Base-course preparation	Design height	+2 cm to -5 cm	20m interval
		Width	More than the design value	
	Granular base course	Design height	±3 cm	
		Deviation from the design height at 2 points within 20 m distance	2 cm or less	
		Finish thickness	90% of design value	
		Width	More than the design value	
Pavement work	Concrete pavement slab	Width	Less than 2.5cm	40m each
		Thickness	Less than 0.8cm	100m each
		Roughness	σ 1<2.4mm	Per lane
Foundation	Spread foundation	Base height	Less than the design height	4m mesh
Concrete structures	Footing	Design height	±5 cm	
		Thickness	±75 mm or ±3%	
	Piers, abutments, retaining walls	Plane position	±30 mm	
		Design height	-30 mm to +10 mm	
		Crown height, crown width	±30 mm	
		Section dimensions	-10 mm to +20 mm or±2%	
	Slabs	Bridge length	-25 mm to +30 mm	
		Width	0 to +20 mm	
		Slab/curb height	-25 mm to +25 mm	
		Thickness	0 to +20 mm	
Pre-stressed concrete structures	Post-tensioned girders	Member length	-25 mm to +30 mm	
		Section dimensions	-25 mm to +25 mm	

2-2-4-6 Procurement Plan

1） Labor conditions

ⅰ） General

Though described as a Buddhist country, Sri Lanka has other religions. Understanding and coordination with local religions and practices in the course of labor management is considered the greatest factor for successful completion of the project.

ⅱ） Construction engineers

Among construction technicians, engineer-class technicians are graduates from two universities; Peradenia University and Moratuwa University. Every year, about 1,500 are graduated from these universities, of which about 100 are civil engineers. Apart from these universities, each district has an average of one vocational college and one industrial high school. The graduate technicians every year.

ⅲ） Laborers from third countries

In Sri Lanka, the GOS is also making efforts to introduce excellent technology from overseas. Therefore, third-country nationals can rather easily obtain work visas The number of foreign enterprises operating in the country increases yearly, particularly companies from India, Korea, China, Singapore, U.S., and Europe as well as Japan. However, ordinary laborers have difficulty entering to work.

ⅳ） Sri Lanka Laws concerning employment

a) General

There is an employment law covering enterprises that employ local laborers, and employers must comply with two laws: one titled “Engineering Trade” and one titled the “Shop and Office Employee’s Act.”

b) Laws concerning employment

The essential provisions of those laws to be noted for employment are abstracted and summarized in Table-2.2.18.

Table－2.2.18　Sri Lanka laws concerning employment

①	Wage system	● Two systems exist: ENGINEERING TRADE（hereinafter called "ET"） and HOPE&OFFICE EMPLOYEE (hereinafter called "SOE"). ● ET and SOE include following occupations; ET… technical （electric engineer, mechanical engineer, civil engineer, building engineer, service engineer, store keeper）, physical labor (earth worker, driver, carpenter, cleaner, guards SOE…Clerical （clerk, typist, office worker）. ● Note that the above classification is interpreted differently among enterprises and thus not absolute.
②	Work hours	45 hours per week
③	Days off and legal holidays	● *Poyaday,* a religious holiday linked with the full moon cycle, will be calendared in on different days of the year. Legal holidays will publicly be announced in the official gazette. ● All workers are allowed one day off per week. Workers receiving monthly pay are allowed to have days off equivalent to nine legal holidays. If they work on such a day off, the payment for the day is doubled. In addition, a substitute holiday is allowed later. ● If they work on a holiday or festival day, the payment is multiplied by 1.5 for initial eight hours and doubled for hours exceeding eight hours.
④	Annual vacation	● Absence with leave for 14 days is allowed for workers generally working 288 days a year. For SOE, special absence with leave for seven days is additionally allowed.
⑤	Absence due to sickness	● When a medical certificate of a designated medical doctor is submitted within one year of service, absence due to sickness for 7 to 14 days is allowed. Payment during this period is guaranteed.
⑥	Absence due to accident	● In case of injury due to accident while on duty, absence due to accident is allowed for 7 days a year. Absence exceeding the 7-day period is covered by labor insurance.
⑦	Overtime compensation	● Hourly overtime rate is calculated as follows for those receiving monthly pay: ・ET…Overtime per hour＝Monthly payment／200 hours ・SOE…Overtime per hour＝Monthly payment／240 hours ● Hourly rate for overtime compensation is calculated as follows for those receiving daily pay ・ET…Overtime pay per hour＝Daily pay/8 hours ・SOE…vertime pay per hour＝Daily pay/8 hours ● Overtime compensation is equivalent to 1.5-fold payment.
⑧	Retirement, disemployment	● Retirement and disemployment must always be justified by proper reason. Reasons are classified as follows in terms of law and practices:

		(A) Lay-off : Downsizing because of surplus manpower because the peak time of work is over. (B) Resignation : Retirement due to the worker's own reason. (C) Vacation of post : When the worker is absent from the job without approval for a long time (D) Termination : When the worker's performance is inadequate or causes an accident ● For (A), the disemployment list and statement of reason must be submitted to the Labor Standards Office. When the Office issues approval of disemployment, the company submits "One Month Notice" to the staff concerned for disemployment. ● For (D), the company disemploys the worker immediately and reports it to the Labor Standards Office.
⑨	Pension program	● Employees Provident Fund (EPF) and Employees Trust Fund (ETF) have been enforced as the pension program ● Each of employer and employee will bear installment as below. (A) EPF: Employer = 12% of total wages, Employee = 8% (B) ETF: Employer = 3% of total wages

Source: Labour Code of Sri Lanka, Ministry of Employment and Labour, 2004

c) Days off and legal holidays

The number of days off and legal holidays, which are referred to in working days of year 2004 calculation, are shown in Table-2.2.19. It is noted that *Poyaday* will be calendared in differently each year.

Table 2.2.19 The number of days off & Holidays (Year 2004) (Unit: day)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Calender day	31	29	31	30	31	30	31	31	30	31	30	31	366
Weekday	20	18	23	19	19	21	21	22	21	20	21	23	248
Sat	5	4	4	4	5	4	5	4	4	5	4	4	52
Sun	4	5	4	4	5	4	4	5	4	5	4	4	52
Holiday	2	2	1	3	4	1	2	1	1	1	1	2	21
Holiday (excl. double count)	2	2	0	3	2	1	1	0	1	1	1	0	14

* PBM (Public, Bank, Mercantile) Holiday, 2004 data

2） Construction Equipment and Machinery

ⅰ） General

The feasibility of procuring construction machinery from government agencies and private enterprises with machinery in Sri Lanka is an important consderation.

Private enterprises generally own their own construction machinery. Some specialize in offering leasing services.

ⅱ） Governmental agencies （RDA)

Some announcements state that leasing machinery owned and administered by RDA, will be applicable exclusively for their own projects. Leasing from the RDA is practically not feasible, however, because available units are quite limited when most of machines are frequently used for road maintenance.

The National Equipment & Machinery Organization (NEMO), which has been established under the Ministry of Housing, owns a few graders, excavators, trailers and trucks, but this source cannot be relied on.

Under these circumstances, government agencies shall not be subject to procurement of construction machinery.

ⅲ） Semi-Governmental agencies （RDA）

The Road Construction and Development Company (RCDC), which had been directly contracted for RDA projects as a semi-governmental enterprise, was closed in April 2004. RDA is currently in transition, subcontracting implementation of their projects to private companies.

Maganeguma, another semi-governmental enterprise under jurisdiction of RDA, is engaged in the administration of machinery that RDA owns. A list of this machinery is provided in Table-2.2.20. However, since availability is quite limited because most of the machinery is frequently in use for road maintenance works, it is generally difficult to arrange leasing of machinery.

Under these circumstances, semi-governmental agencies shall not be subject to procurement of the construction machinery.

Table 2.2.20 Construction machinery of MAGANEGUMA

Item		Capacity	Quantity	Ownership
1	* Dump truck	7ton	60	MAGANEGUMA
2		3.5ton	54	MAGANEGUMA
3	* Cargo truck	14ton	5	RDA
4	* Back hoe	2ton	12	RDA
5	* Truck crane	P&H	1	MAGANEGUMA
6	*Wheel Crane	40ton	1	MAGANEGUMA
7	* Crawler Crane	45ton	2	MAGANEGUMA
8		30ton	2	MAGANEGUMA
9	* Bulldozer	8ton D4	2	MAGANEGUMA
10		21ton D8	1	MAGANEGUMA
11	* Wheel loader	1.4m3	3	MAGANEGUMA
12		1.8m3	4	MAGANEGUMA
13	* Vibrating roller	10-12ton	2	MAGANEGUMA
14		6ton	6	RDA
15	* Tire roller	8-20ton	9	RDA
16	* Motor grader	3.1m	4	MAGANEGUMA
17	* Asphalt finisher	2.4m-5m	4	MAGANEGUMA
18	* Macadam roller	8-12ton	20	MAGANEGUMA
19	* Compressor	5m3/min	8	RDA
20		7m3/min	5	RDA
21		10m3/min	5	RDA
22	* Generator	200kva	2	RDA
23		100kva	2	RDA
24		10kva	2	RDA
25	* Electronic Vibration hammer	60kW	1	RDA
26		232kW	3	RDA
27	* Trailer	40ton	2	RDA
28		32ton	2	RDA
29	* Concrete Mixer Truck	5-6m3	3	RDA
30	* Soil compactor	600-800kg	10	RDA
31	* Water Tank Truck	5,500-6,500L	3	RDA
32	* Welder	300A	2	RDA
33	* Winch	2ton	3	RDA
34	* Asphalt sprayer	200ltr	4	MAGANEGUMA
35	* Asphalt plant	30ton/h	3	MAGANEGUMA

ⅳ） Procurement from private construction, leasing companies

There will be no major issues on procurement of ordinary machinery for construction, even though there is concern that small availability in terms of numbers of units and low efficiency in operation has been noted.

Some specialized machinery needed for extraordinary purposes, such as a crane with 100-ton capacity, a vibro hammer specified for deep range driving and/or removal of piles, may be available from domestic channels. Procurement from third countries will be considered for this specialized machinery if necessary.

Machinery owned by private companies is commonly second-hand. Moreover, the

companies suffer from constant shortages of mechanical parts in domestic stock. In fact that mechanical parts are imported from foreign countries when urgently needed. Securing back-up channels for emergency machinery leasing is vitally important, as is careful consideration of overseas procurement sources for anticipated needs when the projects suffer from tightened implementation schedules.

Machinery owned by major private enterprises in Sri Lanka is listed in Table2.2.21.

Table 2.2.21 List of Construction machinery of major enterprises (MAGA)

Item		Capacity	Quantity
1	* Dump truck	10ton	30
2		4ton	10
3		2ton	4
4	* Cargo truck	4ton	5
5	* Back hoe	0.7m3	6
6		0.4m3	4
8	* Clamshell	0.6m3	3
11	* Truck crane	45ton	1
12		25ton	2
14	* Truck Crane	15-16ton	1
15		4.8-4.9ton	1
17	* Crawler Crane	50ton	1
18		35ton	2
19	* Bulldozer	8ton	2
22	* Wheel loader	1.4m3	6
23		1.8m3	4
24	* Vibrating roller	10-12ton	3
25		3-4ton	6
26		1ton	12
27	* Tire roller	8-20ton	2
28	* Rammer	60kg	many
29	* Motor grader	3.1m	1
30	* Asphalt finisher	2.4m-5m	2
31	* Macadam roller	8-12ton	2
32	* Compressor	5m3/min	10
33		7m3/min	15
35	* Generator	200kva	2
36		100kva	6
37		50kva	10
38		10kva	6
39	* Water pump	150mm	4
40	* Electronic Vibration hammer	60kW	1
44	* Trailer	32ton	1
45		20ton	1
46	* Concrete vibrator	1kw	many
47	* Concrete Breaker	30kg	4
48	* Portable conc. mixer	0.50m3	20
49	* Concrete Mixer Truck	5-6m3	30
50	* Concrete Plant	30m3/h	3
51	* Concrete bucket	0.6m3	many
52	* Soil compactor	600-800kg	10
53	* Water Tank Truck	5,500-6,500L	4
54	* Welder	300A	30
55	* Winch	2ton	2
56	* Asphalt sprayer	200ltr	2
57	* Asphalt plant	30ton/h	1

There are 33 leasing companies for construction machinery in the Colombo area. However, only around 13 companies deal in a wide range and variety construction machinery. Most of the leasing companies specialize in small-scale machinery such as back hoes and graders; only a few possess large-scale machinery. It is noted that, with the exception of small-scale machinery, procurement from leasing companies will cost more than procurement from construction companies.

v） Domestic and overseas procurement

It is important to look into overseas procurement for construction machinery of limited supply in Sri Lanka.

Table2.2.22 shows procurement channels for machinery from domestic and overseas sources.

Table2.2.22 Procurement channels

	Item	Q'ty	Specification	Domestic	Imported
Ⅰ.	Earth Work, Cofferdam Work				
1	back hoe	4	0.7m3	○	
2	dump truck	8	11.0t	○	
3	crawler crane	2	60t mechanical		○
4	truck crane	2	25t	○	
5	truck crane	2	45t		○
6	vibro hammer	2	90kw		○
7	electric generator	2	400KVA		○
8	water-jet	2	150kg/cm2		○
9	clamshell bucket	2	0.6m3		○
10	giant rock breaker	2	600kg		○
11	rock breaker	6	B30		○
12	crawler drill	2	150kg		○
13	air compressor	4	7m3	○	
14	submersible pump	4	φ4″	○	
15	submersible pump	12	φ6″		○
16	electric generator	4	45KVA	○	
17	road roller	2	1.0t	○	
18	impact tamping rammer	2	60kg	○	
19	earth auger machine	2	φ1200		○
20	hydraulic jacked pile driver	2	φ1200		○
21	φ1200 casing	2	φ1200		○
22	hammer grab bucket	2	φ1200		○
23	core barrel bucket	2	φ1200		○
24	slurry plant	2			○
25	tremie pipe	2			○
26	welding machine	4		○	
27	gas cutter	2		○	
Ⅱ.	Concrete Work, PC Work				
28	electric generator	2	75KVA	○	
29	concrete mixer	2	0.5m3	○	
30	batching plant	2	0.5m3		○
31	cement silo	2	200t		○
32	aggregate weigher	2	Double scalepan		○
33	agitator car	6	5.0m3	○	
34	concrete bucket	4	0.5m3	○	
35	crawler crane	2	60t mechanical		○
36	concrete pump	2	90m3/h	○	
37	electric vibrator	16	φ48mm		○
38	electric vibrator	8	φ58mm		○
39	electric converter	12			○
40	bar cutter	2	C-42	○	
41	bar bender	2	B-42	○	
42	submersible pump	4	φ4″	○	
43	welding machine	5		○	
44	electric generator	2	250KVA	○	
45	jet washer	2			○

	Item	Q'ty	Specification	Domestic	Imported
Ⅲ.	Road Construction Work				
46	road roller	1	10.0t	○	
47	road roller	1	1.0t	○	
48	distributor	1	1000L	○	
49	macadam roller	1	10.0t	○	
50	asphalt finisher	1	4.0t	○	
51	rubber-tyred roller	1	10.0t	○	
52	watering cart	1	2000L	○	
53	bulldozer	1	D-4	○	
54	motorgrader	1	3.5m	○	
55	asphalt cutter	1		○	
56	core piece cutter	1		○	
Ⅳ.	PC-girder fabrication, Extruded Construction Method				
57	rolley hoist	1	2.8ton		○
58	portal crane	4	5t		○
59	air vibrator	12			○
60	electric vibrator	8	φ58mm		○
61	electric converter	12			○
62	bar cutter	2	C-42		○
63	bar bender	2	B-42		○
64	hydraulic jack	8	60t		○
65	journal jack	14	30t		○
66	hydraulic pump	8	C-42		○
67	jack & pump for tensioning	2	195t		○
68	jack & pump for steel bar	2	φ32mm		○
69	grout mixer	2			○
70	grout pump	2			○
71	form units	1			○
72	concrete pump	2	90m3/h		○
73	jack for extrusion	2	170ton-500stroke		○
74	hydraulic unit	1			○
75	prestressing steel bar	4	φ32mm,L=20m		○
76	tensioning bracket	2			○
77	reaction pedestal	2			○
78	guide beam jack	2	50ton-200stroke		○
79	bent piers	1			○
80	sliding expansion bearing	4			○
81	vertical jack	2	600ton-70stroke		○

vi） Points on machinery maintenance

Materials such as fuels, oils and greases must be imported into Sri Lanka. Fuels to ensure availability of supplies in sufficient quantity to meet demand. Since certain machines commonly require specified oils/greases, it is essential to examine beforehand the sources of imports of these special materials, if necessary, when machines are selected.

3） Construction materials

i）General

It is fundamental policy in the Project that utilization of domestic products and/or domestic procurement will be highly prioritized. Quality and availability surveys of the domestic market will provide necessarily information for selection of construction materials .

ii） Cement

Domestic cement suppliers are listed below. Due to reasons related to public security, at present, cement production in Sri Lanka is limited to two plants, one in the west and the other in the south. In general supply (production) cannot meet demand, and the situation requires imports from India, Malaysia, and South Africa.

- Mahaweli Marine Co. Ltd.
- Ruhunu Cement Co. Ltd.
- St. Anthony Connoliadated Ltd.
- Jayan Jaya Traders
- Expo Lanaka Commodition Ltd.
- Mascon Ltd., Lanka Cement Ltd.
- L.N.T. Co.

iii）Ready-mixed concrete

There are no ready-mixed concrete plants in the city of Anuradhapura, Dambulla where expected delivery time would be less than two hours to the construction site of the Manampitiya Bridge. A batcher plant will be set up at the construction site.

ⅳ）Coarse aggregates（for concrete and asphalt use）

In fact, there are crusher plants in the Project area, coarse aggregates for concrete and asphalt use are available from a local commercial network.

Alkali-aggregate reaction shall be examined by means of chemical testing prior to utilization of the materials to ensure material quality in terms of alkalic reactivity.

ⅴ）Fine aggregate（for concrete and asphalt use）

Survey results indicate that fine aggregates, which will be produced from the Mahaweli River at the construction site, are acceptable for concrete and asphalt use. Table–2.2.23 shows the results of the survey on fine aggregates.

Table 2.2.23　Survey results on fine aggregates

Survey point	・River sand from the Mahabeli River: at sand bank at 500m～1km downstream from the Bridge
Description	・Sand collection is ongoing for small-scale building construction. （Approved by Geological Surveying Mine Bureau, Ministry of Environment ・Official permit required by DWC prior to sand collection for the Project
Stock/ Supply	・Sufficient. No major concern for demand from the Project
Result	・Quality and supply are acceptable for the Project.

ⅵ）Embankment material

Three different sites for collecting material were confirmed for supplies of embankment and backfilling material. RDA states that the land where these sites are located is owned by the government and that no permits are required to obtain materials.

In addition, it was confirmed through sample testing on material physical behavior that two of the spots have an ample supply sufficient for the Project and that the materials are acceptable for embankment and backfilling.

ⅶ）　Asphalt (bituminous material)

There are no asphalt plants within a range of the construction site of the Manampitiya Bridge where delivery time would be acceptable. Either an asphalt plant should be set up at the site or employment of cold asphalt mixture should be examined as an option.

To obtain asphalt, the contractor must apply for purchase to the Ceylon Petroleum Corporation, a state-run enterprise. Asphalt of special specification is brought in from third countries such as Singapore, but others are produced domestically. The supply for this project is enough to meet demand.

viii） Steels (re-bars, steel members）

Similarly to the case of cement, domestic production of re-bars is not enough to meet demand and the material standard is restricted. BS-based products are imported in large quantity from South Africa and Singapore. Other steel members are available in Sri Lanka, except for special and large steels.
It is noted that a recent procurement boom in China has led to a sharp rise in prices, that affects the supply- demand balance in the domestic market of Sri Lanka.
Leasing companies providing steel materials and equipment for temporary works are not available in Sri Lanka

ix）Wood materials

Wood materials are widely available in Sri Lanka, except for plywood for special forms and plywood 15 mm thick or more. The quality is relatively satisfactory and thus fully applicable for bridge construction.

x） Others

Bricks and roof tiles are widely available in Sri Lanka. Special materials such as PC-cable for bridge construction has to be imported.

2-2-4-7 Implementation Schedule

The Project will be implemented as shown in the schedule below (Table 2.2.24) after the conclusion of the Exchange of Notes.

1） Detailed Design

The design drawing and tender documents will be prepared for the detailed design work after the conclusion of the consulting agreement.

2） Tender and Contract

The contract agreement will be directly between the Government of Sri Lanka and the Japanese contractor. Selection of the contractor will be based on an open tendering addressed to Japanese contractors.

The items for prequalification of contractors will be discussed beforehand with the Government of Sri Lanka for approval. A consulting company on behalf of the implementing agency of the Government of Sri Lanka will handle prequalification.

Opening of tenders and the determination of the successful tenderer will be done in the presence of staff from the Government of Sri Lanka, the consulting company, tenderers, and witnesses representing JICA. The construction service agreement will be concluded after tender evaluation and determination of the successful tenderer.

In parallel with the conclusion of the construction service agreement, the Government of Sri Lanka will conclude banking arrangements as soon as possible with a Japanese authorized foreign exchange bank in order to receive aid funds from the Government of Japan and to make payments to the Japanese contractor. The banking arrangement is the basis on which the Government of Sri Lanka will issue the Authorization to Pay (A/P) necessary for the reception of aid funds from the Government of Japan and advance payment to contractors, as well as for application to obtain an export license from the Ministry of Economy, Trade and Industry (METI).

After the above, verification of the contract is then necessary. Verification means that the GOJ must verify the appropriateness of the contract as an object of grant aid.

Specifically, the Japanese Ministry of Foreign Affairs receives the contract from the GOS and determines its appropriateness for verification. The Japanese contractor will implement the contract after receiving the verified contract and A/P.

ｉ） Construction Work

Beginning with mobilization, preparation works, main work for bridge construction consists of the temporary bridge and cofferdam, foundation work, substructure work, superstructure work (girders/bridge deck), access road work, ancillary work and finished up with site cleaning and demobilization.

The rainy season lasts from October to February in the Project area. It is vital to efficiently take advantage of the first dry season to implement pile foundation work, substructure work.

Table-2.2.24 Implementation Schedule