No.

BASIC DESIGN STUDY REPORT
ON
THE PROJECT FOR CONSTRUCTION
OF
HINHEUP BRIDGE
ON
NATIONAL ROAD 13
IN
LAO PEOPLE'S DEMOCRATIC REPUBLIC

September 2006

JAPAN INTERNATIONAL COOPERATION AGENCY
GRANT AID MANAGEMENT DEPARTMENT

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PREFACE

In response to a request from the Government of the Lao People's Democratic Republic, the Government of Japan decided to conduct a basic design study on the Project for Construction of Hinheup Bridge on National Road 13, and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Laos a study team from March 21 to April 11, 2006.

The team held discussions with the officials concerned of the Government of Laos, 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 Laos 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 Lao People's Democratic Republic for their close cooperation extended to the teams.

September 2006

Masafumi Kuroki
Vice-President
Japan International Cooperation Agency

September, 2006

LETTER OF TRANSMITTAL

We are pleased to submit to you the basic design study report on the Project for Construction of Hinheup Bridge on National Road 13 in the Lao People's Democratic Republic.

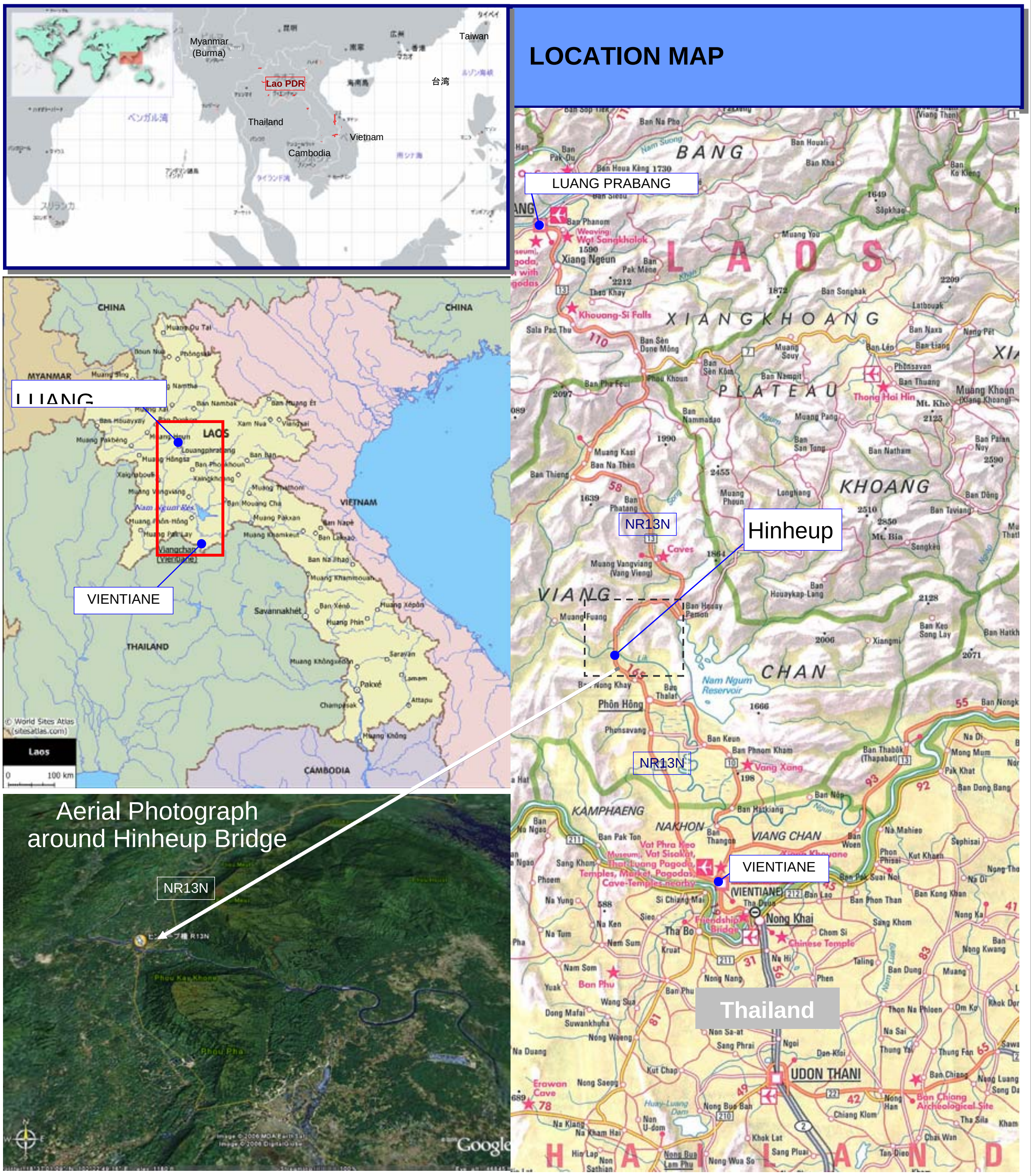
This study was conducted by the joint venture between Oriental Consultants Company Limited and Nippon Koei Company Limited, under a contract to JICA, during the period from March, 2006 to September, 2006. In conducting the study, we have examined the feasibility and rationale of the project with due consideration to the present situation of Laos 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,

Masaaki Tatsumi
Chief Consultant,
Basic Design Study Team on
the Project for Construction
of Hinheup Bridge on National Road 13
Joint venture between
Oriental Consultants Company Limited
and
Nippon Koei Company Limited

Lao People's Democratic Republic



Location Map

Perspective of New Hinheup Bridge	Computer Graphic Designed by Oriental Consultants Co., Ltd.	September 2006

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Abbreviations

AASHTO	American Association of State-Highway and Transportation Officials
ADB	Asian Development Bank
ADT	Average Daily Traffic
B/D	Basic Design
CBR	California Bearing Ratio
DBST	Double Bitumen Surface Treatment
DCTPC	Department of Communications, Transport, Post and Construction
D/D	Detailed Design
DOR	Department of Roads (of MCTPC)
DRP	Detailed Resettlement Plan
EA	Environmental Assessment
EDL	Electricite du Laos
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
ESD	Environmental Social Division (of MCTPC/DOR)
GDP	Gross Domestic Products
IDA	International Development Association (World Bank)
IEE	Initial Environmental Examination
JICA	Japan International Cooperation Agency
LCR	Land Acquisition and Compensation Report
MCTPC	Ministry of Communication, Transport, Post and Construction
OCTPC	Office of Communications, Transport, Post and Construction
PC	Prestressed Concrete
PCU	Passenger Car Unit
P.D.R.	People's Democratic Republic
PMD	Project Monitoring Division (of MCTPC/DOR)
RC	Reinforced Concrete
ROW	Right of Way
RMF	Road Maintenance Fund
SBST	Single Bitumen Surface Treatment
SIDA	Swedish International Development Agency
SSL	Standard Span Length
STEA	Science, Technology and Environment Agency
TOR	Terms of References
TRRL	Transport and Road Research Laboratory
UXO	Unexploded Ordnance

Summary

The Lao People's Democratic Republic (hereinafter referred to as Lao PDR) is a landlocked country heavily dependent on road transport, which accounts for approximately 94 percent and 77 percent of all passenger and freight traffic, respectively. Although total road length in Lao PDR is 33,900km and the development of roads is a key objective, the country's road network still lags behind its requirements. For example, road density is only 0.14km/m^2, which is approximately half the value of its neighbor Vietnam. In northern Lao PDR, road density is a mere 0.01km/m^2. In addition, all-weather roads only account for 13.7% of all roads in both the country as a whole and in the north.

On the other hand, the Greater Mekong Sub-Region (GMS) development program, which includes Lao PDR, Cambodia, Myanmar, Thailand, Vietnam, and Yunan Province of China, has been promoted by the Asian Development Bank (ADB) since 1992, and there are ongoing east-west and north-south corridor projects with the aim of developing the transport sector and economy of the GMS area. Note that in these projects Lao PDR plays a key role due to its location and role as a "land bridge".

Given the preceding, the Government of Lao PDR has been focusing on infrastructure development, which is a driving force for economic growth, and therefore development of the road network has been given high priority in the country's long-term national development plan (i.e., the "Socio-Economic Development Strategy for 2020 and 2010" established in 2001). Furthermore, the fifth five-year plan for the transport sector (2001-05) aims at improving major trunk national roads to the Class III level, which are roads with a 2-lane carriageway 3.5m in width on flat and rolling terrain. National Road13 (NR13), which is to be a Class III level road, is the nation's most important north-south corridor, extending from the Chinese border in the north to Vientiane Municipality and then to the Cambodian border at the southern tip of the country, passing through all the major cities of the country. Improvement of NR 13 to a 2-lane all-weather Class III road started in 1993 via funding from international donors and work on the southern portion was completed in 2001. The Japanese Government also contributed to this improvement by constructing approximately 70 permanent bridges as part of the "Project for Improvement of Bridges on NR13" under a grant aid scheme. Note that Hinheup Bridge is located on the northern portion of NR13, which is to be improved to a Class III road by 2020.

Hinheup Bridge is the last temporary bridge on NR13, and was opened to service

approximately 100 years ago. In 1981, its superstructure was washed away by a flood. The existing structure is a Bailey type of bridge and was constructed in the 1990s with UK funding. However, the present bridge superstructure does not fulfill the requirements of a national road. **First**, the width of the bridge is narrow and does not allow two-way traffic. **Second**, the pedestrian structure is defective and lacks connecting bolts, compelling pedestrians to walk on the carriageway and exposing them to danger. **Third**, the low stiffness of the superstructure to its span length causes severe vibrations when heavy vehicles pass. **Fourth**, the piers and their foundations have been damaged by flooding, increased traffic, and weathering. **Thus**, the present bridge structure is in danger of collapsing in the future should this damage become much worse. The collapse of the bridge would result in Vientiane being effectively cut off from the major cities of the north, as there is no viable alternate route, and this would have highly adverse economic impacts on the northern region.

Taking the above into account, the Government of Lao PDR (GOL) made a request to the Government of Japan (GOJ) for grant aid to reconstruct Hinheup Bridge. In response to this request, the Japan International Cooperation Agency (JICA) dispatched a Basic Design Study Team (the Study team) to Lao PDR from March 21, to April 12, 2006. After reconnoitering the site, the Study Team confirmed the necessity and validity of the request, as well as the fact that approximately 26 houses would be affected at the new bridge site located 50m upstream from the existing bridge, which was the original plan for the new bridge proposed by the GOL. In response to this, the Study Team prepared six alternatives for the location of the new bridge, including the original plan. Based on a comparison of the site investigation results, the Study team recommended an alternative where the new bridge would be situated approximately 200m downstream from the existing bridge, which was accepted by the GOL. Further investigations on topography, geology, socio-economic status, and procurement conditions were then executed for the selected alternative. After returning to Japan, the Study Team commenced preparing a basic design for the bridge applying data collected from its investigations and estimated project cost according to the construction plan formulated. The Study Team then presented the basic design results to the GOL between August 20th and 26th, 2006. After a series of discussions between the Study Team and the GOL regarding the basic design, the GOL accepted the basic design results and the work to be undertaken by the GOL in order to realize this. The following table summarizes the main content of the basic design.

Bridge type		5 span continuous PC Box Girder Type
Bridge length/Span arrangement		195m＝30m＋3x45m＋30m
With formation		Total width: 10m Carriageway: 2-lane (2x3.50m) Shoulder: 0.50m at both ends of carriageway Footpath: 1.00m at both ends of inter width
Pavement		Asphalt concrete: 50mm
Abutment type		A1, A2 abutment: RC Box type（Spread foundation）
Pier type		P1, P2, P3, P4: RC Wall type（Spread foundation）
Approach road	Total Length	Right bank:485m, Left bank: 270m
	Formation	Total width: 11m Carriageway: 2-lane (2x3.50m) Shoulder: 2.00m at both ends (paved: 1.50m, unpaved: 0.50m)
	Pavement	Carriageway: DBST, Shoulder: SBST

In the case that the Hinheup Bridge is constructed under Japan's Grant Aid scheme, total Project cost would be approximately JY1,011 million, with the GOJ providing JPY981 million of this and the GOL supplying the remaining JPY30 million. The Project implementation period is estimated to about 30 months including the tendering stage. Although the Project will be implemented by the Ministry of Communication, Transport, Post and Construction (MCTPC), the completed facilities will be transferred to the Department of Communication, Transport, Post and Construction (DCTPC) of Vientiane Province for its operation and maintenance. The major maintenance activities for the bridge and its approach roads will include: (1) regular inspection of those facilities and minor repair works every year, (2) overlay of bridge and approach road surfaces every 10 years for the bridge and 5 years for the approach roads. The maintenance budget for the facilities shall be allocated from the Road Maintenance Fund (RMF), which comprises a fuel levy (150kip/litter and 2% of the fuel price), toll charges to be collected at one gate per province, overloading fines, and donor support. At present, although the demands of maintenance exceed the income of RMF, it is forecasted that this gap will disappear in 2009 by increasing the fuel levy 50% every year. Note that since there are two toll gates In Vientiane Province, it has been deemed that that the necessary budget for maintaining the new facilities can be secured.

The following direct and indirect effects are expected with the implementation of the Project.

The direct beneficiaries of the Project are expected to be the people living in both Vientiane Municipality and Vientiane Province, which has population of approximately 2,857 thousand people. The indirect beneficiaries of the Project consist of people living in surrounding areas with a population equivalent to approximately to 2,361 thousand people.

(1) Direct Effects

- Strengthening of the capacity for transport of the proposed bridge(10ton→25ton)、and thereby ensuring smooth and safe traffic passage on this section of road.
- Elimination of waiting time owing to the provision of a 2-lane carriageway, which will reduce the crossing time from a maximum of 2 minutes 40 seconds to 14 seconds.
- Improvement in pedestrian safety owing to the separation of the footpath from the carriageway with a curb.
- Alleviation of negative environmental impacts owing to a reduction in noise generated from vehicles running over present steel deck of the bridge

(2) Indirect Effects

- Stimulation of economic activity in the northern area of the country by improving accessibility and thereby increasing traffic volumes based on the strengthening of the transport capacity of the bridge.
- Promotion of economic activities near the bridge site from a result in the increase in traffic volume that will spur sales at shops around the bridge

The validity of the Project via the application of Japan's Grant Aid scheme has been confirmed from the viewpoints of suitability that took into account both the national long-term development plan and the transport sector development plan, and it is expected that the realization of the Project will contribute to poverty reduction and economic development in not only the northern area but for the country as a whole.

Contents

Appendices

CHAPTER 1

BACKGROUND OF THE PROJECT

Chapter 1 Background of the Project

The Lao People's Democratic Republic (hereinafter referred to as Lao PDR) is one of the least developed countries due to its low GDP per capita (US$340/capita) and high poverty rate (33%), which is partially a result of the country having an underdeveloped transport system and being landlocked with severe topography. However, the development program of the Greater Mekong Sub-Region (GMS), which consists of Lao PDR, Cambodia, Myanmar, Thailand, Vietnam, and Yunan Province of China, has been promoted by the Asian Development Bank (ADB) since 1992, and there are ongoing east-west and north-south corridor projects with the aim of developing the transport sector and economy of the GMS area. In these projects, Lao PDR occupies a key position on these routes due to its location and role as a "land bridge", and its rapid development is expected with the completion of these two corridors.

Given this situation, the Government of Lao PDR (hereafter referred to as the GOL) has focused on infrastructure development, which is a driving force for economic growth, and has given high priority to road network development in its long-term national development plan. National Route 13 (NR 13), the route on which the Study bridge (i.e., Hinheup Bridge) is located on, is the nation's most important north-south corridor, extending from the Chinese border in the north to Vientiane Municipality and then to the Cambodian border at the southern tip of Lao PDR, passing through all the major cities of the country. Improvement of NR 13 to a 2-lane all-weather road started in 1993 via funding from international donors and the southern portion was completed in 2001. The Government of Japan (hereafter referred to as the GOJ) also contributed to this improvement by constructing approximately 70 permanent bridges in the "Project for Improvement of Bridges on NR13" via grant aid.

Hinheup Bridge is the last temporary bridge on NR13 and was opened to service approximately 100 years ago. In 1981, its superstructure was washed away and destroyed by a flood. The existing structure is a Bailey type of bridge and was constructed in the 1990s with funding from the UK. However, the present superstructure of the bridge does not fulfill the requirements for a national road. First, the width of the bridge is narrow and does not allow two-way traffic. Second, the pedestrian structure is defective and is missing connecting bolts, compelling pedestrians to walk on the carriageway and exposing them to danger. Third, low superstructure stiffness in relation to its span length results in sever vibrations when a heavy vehicle passes. Fourth, bridge piers and their foundations have been damaged by flooding, increased traffic, and weathering. Thus, the present bridge structure is in danger of collapsing in the future should this damage become much worse. The collapse of the bridge would effectively result in Vientiane being cut off from the major cities of the north, and this would have large adverse impacts on the economic activities and tourism of the northern region, as there is no alternative route.

The purpose of the Study is therefore to first confirm the validity of a request from the GOL for reconstruction of the Hinheup Bridge. Then, after this confirmation, to execute an appropriate basic design for a grant aid scheme subsequent to selecting the most appropriate location for the new bridge based on site reconnaissance data, to formulate an implementation plan for new bridge construction, and to estimate Project cost.

CHAPTER 2

CONTENTS OF THE PROJECT

Chapter 2 Contents of the Project

2.1 Basic Concept of the Project

2.1.1 Overall Goal & Purpose

The GOL established in 2001 its long-term national development plan the “Socio-Economic Development Strategy for 2020 and 2010”. This plan states as one of its development goals that development outcomes are equally delivered to all sectors of society. In response to the National Development Plan, the fifth five-year plan for the transport sector (2001-05) was formulated and has as one of its objectives the strengthening of sub-regional and provincial connections, as well as the improvement of NR13N to Class III standard by 2020. Note that the existing Hinheup Bridge is located on NR13N and is the last temporary bridge on NR13.

After carefully considering its policies, the GOL requested that Hinheup Bridge be reconstructed via Japan’s Grant Aid scheme. In response to this request, the GOJ decided to dispatch a Basic Design (BD) Study Team to determine the scope of works and the specifications for the new bridge. The overall goal of the Project is to have this bridge contribute to the socio-economic development and poverty reduction in the northern area as well as for the whole country, by ensuring the smooth and safe passage of vehicular and pedestrian traffic on NR 13N via the provision of a two-lane carriageway and footpaths.

2.1.2 Outline of the Project

In order to achieve the overall goals and purpose of the Project, the new Hinheup Bridge will therefore have a two-lane carriageway and footpaths passable during the rainy season instead of the existing narrow temporary bridge, which is unsafe for vehicles and pedestrians due to the previously stated deficiencies. The new bridge and its approach roads will be constructed approximately 200m downstream from the existing one. As mentioned before, this is to be implemented via Japanese Grant Aid and will therefore be executed by a Japanese contractor. The outline of the Project is as follows:

- Construction of a new Hinheup Bridge (Bridge length:195m)
- Approach roads to the new bridge from both banks (Total length: 755m)
- Necessary facilities for both of the major structures (e.g., drainage, etc.)

2.1.3 Environmental & Social Considerations

2.1.3.1 Necessity for Environmental & Social Considerations

In a Grant Aid scheme, *"JICA Guidelines for Environmental and Social Considerations"* state that conducting an Environmental Assessment (EA) by the recipient country is a precondition for the GOJ to undertake a BD study. This chapter outlines the general procedures for the EA and involuntary resettlement, which is often one of the main constraints in road development projects in Lao PDR. The chapter also confirms the present condition of environmental compliance for the Project and makes recommendations for future action.

2.1.3.2 IEE/EIA Systems in Lao PDR

(1) Environmental Regulations & Laws in Lao PDR

EA procedures are stipulated in Environmental Protection Law 2001(EPL) and Environmental Impact Assessment Regulation 2002(EIAR). The Science Technology & Environmental Agency (STEA) is the agency responsible for addressing environmental protection. Note that STEA requires line Ministries to prepare EA regulations for their respective sectors as part of the EPL. For example, MCTPC has prepared EA regulations for road development projects (2003) and an EA Guideline (1999). According to the EPL and EIAR, the general procedure for an EA is as follows:

- The project owner (including private project developers) submits a Project Description (PD) to STEA through the Development Project's Responsible Agency (DPRA).
- STEA conducts a screening of the PD to separate those projects that require no EA from those projects that require an EA. There are two types of EA; namely, an Initial Environmental Examination (IEE) and an Environmental Impact Assessment (EIA).
- For those projects exempted from an EA, STEA shall issue an environmental compliance certificate within 15 days after receiving the PD from the project owner.
- All projects not exempted from an EA must undertake an IEE. Based on the information in the IEE, STEA will decide whether an EIA is required for a project. Within 40 days after receiving the IEE report from the project owner, STEA shall issue an environmental compliance certificate for the project if an EIA is not required.
- If the IEE report concludes that no EIA is needed, an Environmental Management Plan(EMP) must be developed within the IEE report, which must have the following contents:
    - Measures to prevent and minimize environmental impacts

- Programs for environment control and monitoring
- Responsibilities, organization, schedule and budget for implementation of the EMP and other issues that the DPRA may deem necessary for the protection of the environment.

- During the IEE process, if it is found that the project needs an EIA, the IEE report shall contain TOR for the scooping of a subsequent EIA.

(2) IEE/EIA Procedures for Road Development Projects

In order to streamline the environmental screening process for road projects, MCTPC categorizes projects into two categories: Category I and II based on the "*Environmental Guidelines (1999)*" and "*Regulations on Environmental Impact Assessment of Road Projects in Lao PDR (2003)*". Category I projects are exempted from any type of EA.

<**Category I**: Projects with potentially no environmental impacts>

- Routine road maintenance projects involving the clearing of grass and the cleaning of the road surface, drainage facilities, culverts, bridges, and other related road elements.
- Road maintenance projects with the purpose of keeping a road in its designated condition, which includes periodic and emergency maintenance works.

<**Category II**: Projects potentially having adverse environmental impacts>

- New construction or major rehabilitation within a Right of Way (ROW).
- New construction or construction outside the original ROW.
- Construction in environmentally sensitive areas such as human settlements, protected areas, areas of historical and cultural value, etc.

Note that every new road construction project is a subject to an EA (IEE or EIA).

In this Project, the Department of Roads (DOR) of MCTPC is the owner and the Environmental Social Division (ESD) is the DPRA. ESD was established under the DOR in 2002, and it has the authority to collect comments on proposed projects from related agencies and to conduct preliminary project assessments for EA screening and the IEE. STEA then makes a final decision considering ESD's comments. Although ESD is under DOR, it addresses all MCTPC projects taking into account environmental and social considerations. The EIA/IEE procedure for Lao PDR is as shown in Figure1.3.1.

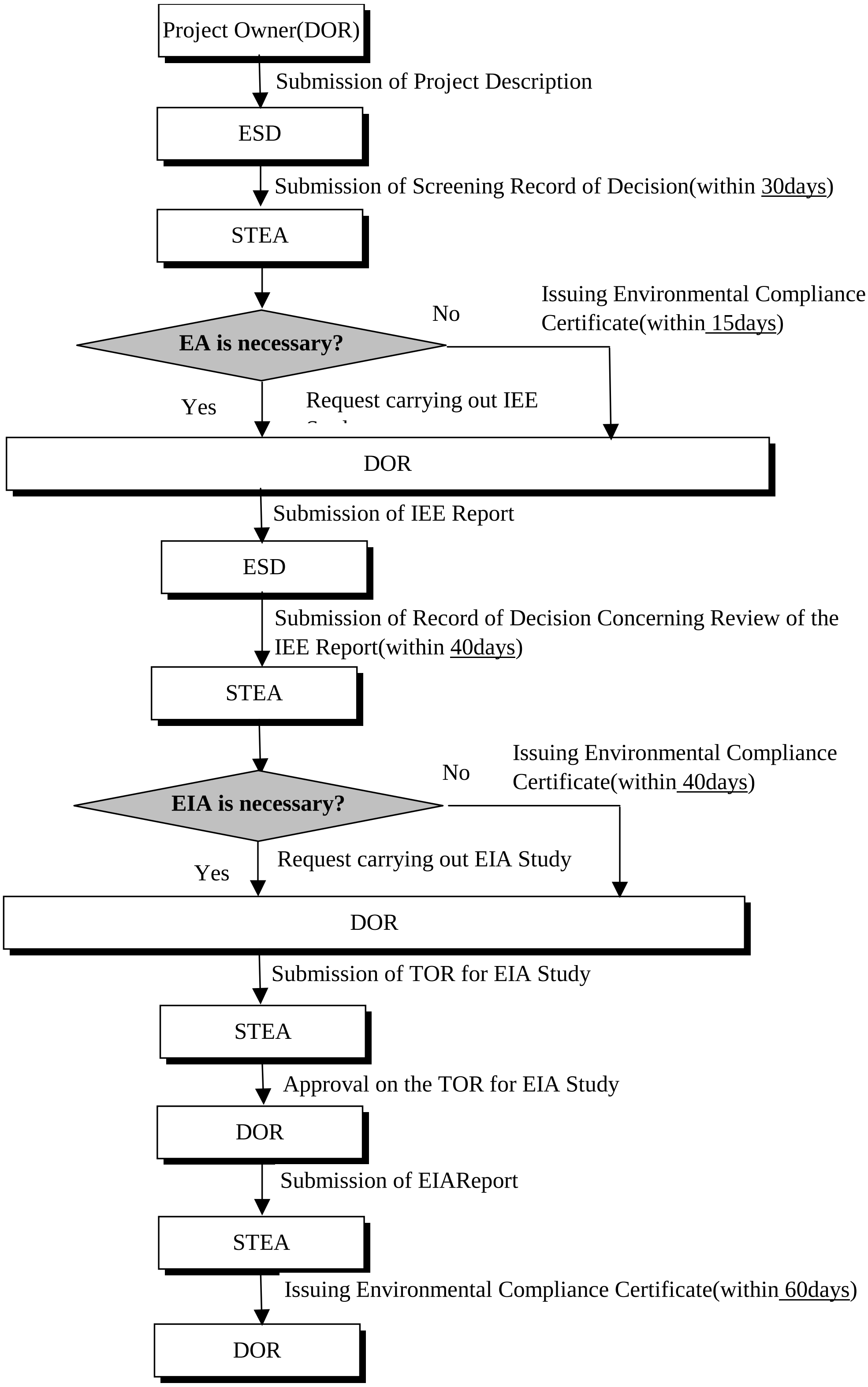


Figure 1.3.1 Flowchart for EIA Procedures

(3) IEE/EIA Experiences of the Road Sector

The main experiences of the road sector in recent years regarding IEE/EIA are as indicated in Table 1.3.1.

Table1.3.1 IEE/EIA Experiences of the Road Sector

No.	Project	Location	Type of EA	Project Funding	Date of Approval
1	Northern Economic Corridor Project	Provinces of Luang Namtha & Bokeo	EIA	ADB, Thai & PRC	13 Oct. 2004
2	Access Road Development Project (NEC-R3)	Provinces of Luang Namtha & Bokeo	IEE	ADB Loan	25 Mar. 2005
3	Route 1 Improvement Project	Vientiane	IEE	Japanese Grant	17 Mar. 2005
4	Kwangsi Waterfalls Road Rehabilitation Project	Luang Prabang Province	IEE	ADB Loan	17 Nov. 2006
5	ADB 10 Project	Provinces of Xaiyabouly etc.	IEE	ADB Loan	15 Mar. 2004
6	Konglor Cave Road Rehabilitation Project	Khammouane Province	IEE	ADB Loan	16 Jan. 2005

Source: STEA, 2006 (compiled by the Study Team)

2.1.3.3 Resettlement Issues in Lao PDR

(1) Land Tenure in Lao PDR

In Lao PDR, all land officially belongs to the GOL under the Land Law (2003). Therefore, in the case where land acquisition is necessary, compensation by the GOL is for the loss of land use and not land ownership. In this regard, people possess a Land Registration document that identifies who has the legal right to use a particular plot of land together with who is responsible for paying the Land Tax. The user's name is indicated in the Land Registration together with a simple location map. Note that people can not use a Land Registration as collateral to borrow money from a bank, as the buying and selling of Land Registrations is prohibited and therefore illegal. In reality, however, the purchasing and selling of Land Registrations does take place. It can be said that the prohibition to buy and sell land freely is one of the main constraints on the development of the local economy.

In response to the preceding, the Lao Land Titling Project, which is being funded by the World Bank and other donors, is registering and issuing land titles so that people can buy and sell land in accordance with the Land Law. This will encourage the development of the local economy as people will be able to borrow money from bank using land as collateral.

(2) Resettlement & Land Acquisition Procedures

Resettlement and land acquisition procedures are described in the “Decree on Compensation and Resettlement for Development Projects (2005)” and the “Regulation for Implementing Decree 192/PM on Compensation and Resettlement of People Affected by Development Projects (2005)”. The compensation principles contained in these documents are as follows:

- A project owner shall compensate affected persons (APs) for their lost rights to use of land and lost assets (structures, crops, trees, and other fixed assets) affected in full or in part at replacement cost.
- Where a significantly large or entire land holding is affected by a project; namely, agriculture, residential or commercial land, compensation shall be via the provision of “land-for-land” arrangements equivalent in size and productivity and shall be acceptable to APs and project owners.
- Replacement cost for houses or structures shall be estimated without depreciation or deduction for salvaged materials.
- Before provision of compensation, project owners shall establish a Resettlement Committee with representatives from all stakeholders to assess the loss to APs.
- Prior to the commencement of project construction, APs shall be fully compensated, resettled, and rehabilitation measures in place though not necessarily completed.

The general procedures for land acquisition and resettlement are as follows:

- <u>Land Acquisition and Compensation Report</u>
  In the case of project impacts being minimal, such that less than 200 persons (about 40-50 families) are affected by a project either marginally or with limited displacement, the project owner will prepare a Land Acquisition and Compensation Report (LACR) and submit it to the appropriate line ministry and STEA for review and approval. In case of project impacts being significant, such that more than 200 persons (about 40-50 families) are displaced or severely affected due to the loss of productive assets, incomes, employment or business by the project, the project owner will prepare a Detailed Resettlement Plan (DRP). Although the DRP and LACR have a similar reporting structure, the DRP requires more detailed information.

- <u>Census</u>
  The census will include information on the household structure and general age & gender characteristics of APs affected by the direct adverse physical and economic impacts of a project. The project owner will take the necessary steps to inform all APs about the commencement of the census and the “cut-off date” for entitlements to compensation and other assistance in accordance with Decree 192/PM.

- Inventory of Affected Assets
  A detailed inventory of affected assets will include information disaggregated by the type and class of asset; the loss of structures and fixed assets; loss of income; employment and businesses; tenure status of the APs; loss of affected community facilities and utilities; and loss of cultural and community assets.

- Estimation of Replacement Cost
  Replacement cost will be estimated by the Resettlement Committee (RC) with representatives from all stakeholders. As for the type of compensation, “cash” compensation and “land-for-land” compensation will be prepared for APs.

- Resettlement Site Development
  Resettlement areas should be fully developed prior to the displacement of the APs from their existing locations and must be located on sites free from any environmental risk or prone to natural disaster, and laid out in accordance with local prevailing planning standards with convenient access to community facilities and services.

- Socio-economic Baseline Survey
  The project owner will collect appropriate socio-economic baseline data for all severely affected households in order to use this information for a post-evaluation study after the completion of resettlement. The socio-economic baseline data for a selected sample of severely affected households will focus on existing household incomes, types of primary and secondary occupations, existing skills and educational levels of household members, incomes and expenditure, savings, assets and debts.

2.1.3.4 Negative Impacts by Selected Alternative

(1) Affected Houses to be Relocated

The scale of resettlement for the selected route of this Project is listed in Table 1.3.2.

Table 1.3.2. Scale of Resettlement of the Final Route

Type of Structure		No.			Remarks
		Right Bank	Left Bank	Sub-total	
House	1-story wood	0	4	4	
	1-story brick	1	0	1	
	2-story wood + brick	0	0	0	
	2-story wood	0	1	1	Shop
	2-story brick	0	0	0	
Warehouse		1	4	5	
Total				11	

(2) Other Negative Impacts

The negative impacts anticipated with the implementation of the Project for the selected route are as summarized in Table 1.3.3. Note that mitigation measures against these negative impacts have to be prepared during the basic design process.

Table 1.3.3 Negative Impacts by Project Implementation

Location	Negative Impacts
Around No2+20 (Right bank)	An existing road connecting with a lodge will be split by the new approach road.
Around No.4+00 (Right bank)	Existing access for vehicles to the Nam Lik River will be split by the new approach road.
Around No.4+70 (Right bank)	The footpath along the Nam Lik River shall be split by the new approach road.
No.7～No8+60 (Left bank)	Existing access to the Nam Lik River on the left bank will disappear due to the new approach road.
Around No8+60 (Left bank)	Access to houses will be disturbed by the new approach road.

(3) Response from Villagers on Negative Impacts of Project Implementation

An interview of APs and a stakeholder meeting on April 5, 2006 were conducted in order to assess the attitudes of APs. In general, although APs support the Project to construct a new Hinheup Bridge, they have some concerns about its implementation and they are as follows:

- Appropriate compensation should be paid if resettlement occurs. Particularly, in the case of buildings, it is desirable that compensation rates reflect market prices exclusive of the depreciation of building materials.
- Cash compensation is the preferred method for APs, and replacement land should have the same value as existing land if resettlement occurs.

In response to the concerns of the APs, the MCTPC explained that compensation would conform to STEA's laws and regulations of "Resettlement and Compensation (2005)". This means that buildings, agricultural land, and fruit trees are considered compensation items, with electricity, water supply, and access roads provided for new relocation sites. In addition, STEA added that the GOL's policy in the case of resettlement is to ensure that the living standard of APs after resettlement is as good as prior to their moving.

2.1.3.5 Effect of UXO on Project Implementation

The Study Team obtained information about the possibility of Unexploded Ordnance (UXO) around the Project site when it visited UXO Lao, which is a NGO that searches and removes

UXO in Lao PDR. In addition, villagers attending a stakeholder meeting for the Project mentioned that there had been no aerial bombing around the villages of the Project site during the war and that there had been no explosion near the site since 1975.

In order to clearly resolve the UXO issue, the Japanese side requested the GOL at an official meeting to confirm that no UXO exists near the Project site, which is contained in the official minutes of meeting. In response to the request, the GOL's Ministry of Defense conducted a search on site between June 21 and 22, and issued a certificate to the Japanese side verifying the non-existence of UXO.

2.1.3.6 Remarks Concerning Future Action

The BD of the Project will be followed by detailed design. Remarks regarding future action, including the detailed design stage, are given below.

(1) Environmental Certificate

Based on the *"JICA Guidelines for Environmental and Social Considerations"*, the Project is classified as a Category B project, and therefore the GOL is required to conduct an IEE. Although environmental studies were conducted (an IEE was executed by the GOL with JICA support), it is necessary to obtain fresh approval from STEA due to the modifications to the bridge location. Given the time required for the procedures for grant aid, it is essential to obtain STEA's approval by November 2006 (see Figure1.3.2).

(2) Resettlement

According to the results of the BD, the number of affected households (including a warehouse) is 11. In compliance with STEA's regulations, projects having fewer than 200 APs are to prepare a Land Acquisition and Compensation Report. The mechanism for compensating for the loss of residential and other structures will be cash and will cover the full replacement cost of structures (exclusive of depreciation and salvage value).

Considering the Project's overall time schedule, a basic agreement between the GOL and the APs should be completed by April 2007. Necessary institutional arrangements for resettlement, such as the establishment of resettlement committees and the securing of a budget, are the responsibility of the GOL. These and other procedures should be monitored hereon.

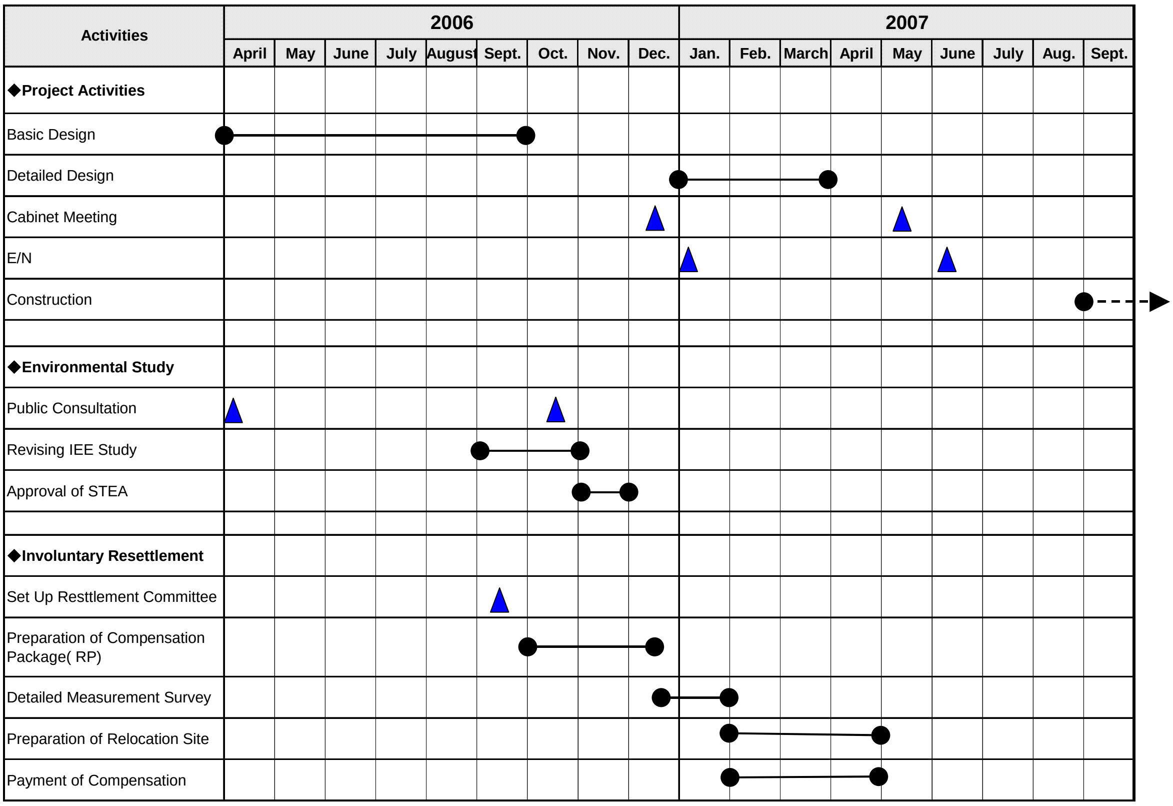


Figure 1.3.2 IEE Study & Approval Schedule for Project Implementation

(3) Stakeholder Meeting

A stakeholder meeting, which was attended by 31 people, was held on 5th April 2006 to explain to local people the change in the bridge route. The Project owner, MCTPC, explained the modifications regarding the crossing point for the bridge and there was a question-and-answer period afterwards. Note that there were no objections from the local people.

On 24th August 2006, MCTPC, supported by the Study Team, again held the stakeholder meeting with local residents in order to explain the BD results including the affected houses and mitigation measures against adverse social impacts. It is expected that Resettlement Committee would be formulated soon.

2.2 Basic Design of the Requested Japanese Assistance

2.2.1 Design Policy

(1) Basic Concept

The basic concept, which is based on site reconnaissance results, as well as discussions with the GOL, is as follows:

- Survey results on the existing Hinheup Bridge indicate all piers are damaged, foundation scouring, a deficiency of or loose bricks on the piers, and the inability to re-strengthen the piers with any method reliably. Accordingly, it is appropriate to construct a new bridge instead of trying to re-strengthen the existing one.
- Both the Japanese and Lao sides agreed that the new Hinheup Bridge be built approximately 200m downstream from the existing bridge (Alternative-D), after a comparison of 6 alternatives that were formulated based on site reconnaissance.
- The scope of work undertaken by the Japanese side will include approach roads to the new bridge from the existing NR 13N as well as the bridge itself, together with all the necessary facilities for main structures. However, road signs should be provided by the GOL.

(2) Natural Condition Policy

There are two major seasons at the Project site: a rainy season from May to October and a dry season from November to April. More than 90% of the yearly rainfall is concentrated in the rainy season. The water level of the Nam Lik River, which the Project bridge crosses, corresponds with this rainfall pattern. Accordingly, the construction plan should consider large changes in both rainfall patterns and river water levels.

The design high water level (HWL) shall be analyzed using water level data for the period of 1965 to 2005 from an observatory located approximately 300m upstream from the existing bridge. Note, however, data for 7 years of this period is missing. Furthermore, site reconnaissance found that the assumed maximum water level as defined by the flooding of 1981 may be unreliable based on information from villagers. Therefore, the 1981 date should be re-confirmed based on interviews with villagers.

There is the possibility of the banks in front of the bridge abutments eroding, as flow velocity is estimated to be around 3 m/sec. In fact, erosion in front of an existing bridge abutment was detected. Accordingly, protection work should be considered for the front of the new abutments and piers.

As for the geological conditions around the Project site, bearing strata of sandstone 5-10m in depth is located on both banks and is found on the surface of the riverbed within the river. Consequently, a spread foundation shall be adopted for piers. However, for abutments, a comparison of the pile and spread type foundations should be carried out.

An approach slab will be installed at the end of approach roads where embankment height is more than 5m. Also, there will be appropriate borrow materials and sufficient compaction to prevent settlement or a gap occurring between an abutment and approach road.
As for earthquakes, as no severe earthquake has ever been recorded in the Project area, only minimum effects will be considered in the design of the bridge structures.

(3) Social Policy

Although minimizing the number of houses affected was a major determinant in choosing the agreed alternative for the new bridge location, it is impossible for the new route to affect no houses. Note that the design of the approach road will minimize to the extent possible resettlement and land acquisition. It is also necessary to monitor the resettlement activities of the GOL during the implementation of the Project and to confirm whether appropriate compensation, including provision of new land, is in accordance with the relevant laws and regulations. If a complaint from an AP arises, the Japanese side will advise the Lao side to deal with it in a timely and appropriate manner.

The new approach roads may cut off or affect existing paths used by local people in their daily lives. If this occurs, mitigation measures should be prepared to ensure present levels of service and be included in the scope of the Project.

The number of construction vehicles passing over the existing Hinheup Bridge should be minimized not only because frequent passage would further damage it, but also because the safety of pedestrians (particularly students) would be put at risk. For these reasons, a temporary road for construction going through the river should be provided. However, the temporary road should consider that fishing is one of the major economic activities for nearby villagers. Furthermore, all construction activities should take care not to pollute the river.

(4) Policy for Construction in Lao PDR

It is essential for the GOL to undertake an IEE on the final route for the Project after completion of the BD study and to get approval from STEA. As for UXO, the GOL has already searched the Project site and confirmed that none exist.

Equipment and materials, excluding PC cables and bridge accessories, are currently available on the domestic market because of the various ongoing road and bridge projects. In addition, although it has just started, leasing is now possible in Lao PDR. Accordingly, construction equipment and materials for the Project should be basically procured from the domestic market as much as possible.

(5) Local Contractor Policy

The capacity of local contractors has improved regarding bridge and road construction due to their experience with donor-funded projects or projects funded by the Lao Government. As a result, it has been determined that they are capable of constructing simple small- to medium-sized bridges and DBST roads with little problem.

However, in regards to bridge construction for this Project, since it is planned to adopt the incremental launching method for PC box girders, which will be the first time this method is applied in Lao PDR, the role of local contractors will be limited to supplying labor, equipment and materials, and some partial sub-contracting. On the other hand, in the case of the road works, local contractors can play a responsible role as they have much experience in this field. Accordingly, it is necessary to encourage the Japanese contractor to transfer bridge technology to local contractors regarding methodology, quality, scheduling, and safety management.

(6) Operation & Maintenance Policy

After the DOR of MCTPC implements the Project, which includes both tendering and construction, the completed facilities will be transferred to the DCTPC of Vientiane Province, which will be responsible for the operation and maintenance of these facilities. Since provincial DCTPCs have been maintaining NR 13 N relatively well in recent years, it has been decided that they have the minimum capability to operate and maintain the new bridge and approach roads. However, an evaluation survey for “the Project for Bridge Reconstruction on NR13S” implemented under Japanese Grant Aid indicates there are still issues remaining regarding inspection and repair of damage to the surface of approach roads and bridges. Accordingly, it is necessary to transfer road and bridge maintenance techniques during Project implementation.

As for the maintenance budget, approximately US$970 per km is annually allocated to each provincial DCTPC for the routine maintenance of national roads, which seems sufficient. It is, therefore, necessary to occasionally encourage the GOL to allocate the required maintenance budget every year.

(7) Facility Grade Setting Policy

Project scope includes the new Hinheup Bridge, its approach roads to the existing NR 13N, and the necessary accompanying facilities. As mentioned in Item (3), mitigation measures will be prepared when the new approach roads cut off existing paths or inconvenience local villagers, and these measures are to be incorporated in the Project scope.

The 1996 Road Design Manual (hereafter referrer to as the Design Manual) will be basically applied for the road and bridge design of the Project. However, since the Design Manual does not elaborate on bridge specifications in detail except for live load, the Japanese standard and specifications will be applied for other design items. The major specifications for the Project are as follows:

- Design Standard: Road Design Manual
- Road Class: Class III
- Live Load: HS20-44 x1.25
- Bridge Width Formation: 10.0m
- Approach Road Width Formation: 11.0m
- Pavement: Asphalt concrete for bridge surface, DBST for surface of approach roads

(8) Construction Methodology & Scheduling Policy

The erection method for the bridge superstructure will adopt the incremental launching method. This has the advantage of being able to work in the rainy season, as it is unnecessary to utilize space under the girders where the river rises to in the rainy season.

Regarding the foundation type, the spread foundation will be applied for piers as there is exposed bedrock in the Nam Lik River. For abutments, the application of a pile foundation shall be examined taking into consideration the availability of piling machines.

The construction period will be determined in consideration of the rainy season, which is from May to October. Followed by substructure construction in the dry season, superstructure work will continue in the rainy season. Works for the approach roads, including earth works and paving, will be undertaken in the dry season.

2.2.2 Basic Plan

2.2.2.1 Determination Process of the Project Scope

The scope of the Project was determined in accordance with the process shown in Figure 2.2.1.

Contents of Request of GOL — May 2002

- Construction of new Hinheup Bridge with a 2-lane carriageway.
- The new location shall be 30m upstream from the existing bridge.

↓

IEE by GOL & JICA Technical Support — March 2005; Dec. 2005

- The GOL conducted an IEE as the original route plan would cause much resettlement, which is categorized as B under JICA's environmental guidelines and is a precondition to proceed with the BD study.
- JICA requested an IEE for other bridge location alternatives. In response to the request, the GOL asked for the support of the IEE implementation.

↓

Contents of BD Study Policy — March 2006

- New construction of Hinheup Bridge with 2-lane carriageway.
- Necessity of obtaining consensus with the GOL on selecting the most appropriate alternative for new bridge location from among 6 alternatives.
- Discussion on responsibility for construction of the approach roads.
- Examination of most appropriate bridge type.
- Examination of most appropriate bridge and approach road width formation & pavement structure.

↓

Site Reconnaissance Results — March 2006

- Six alternatives are formulated and Alternative-D, which has the new bridge located 200m downstream, was accepted by the GOL.
- Since approach road construction can have a large affect on the timing of the operation of the new bridge, it will be included as one of the components the Japanese side is responsible.

↓

Results of Basic Design Policy Meeting in Japan — April 2006

The following Basic Design components were approved at the meeting:

- Continuous 5-span PC box-girder bridge to be erected with incremental launching method.
- Bridge width formation to be 10m.
- Road width formation with DBST pavement to be 11m.

Figure 2.2.1 Process for Determining Project Scope

2.2.2.2 Selection of New Bridge Location

The Study Team prepared six alternatives for the location of the new bridge on the basis of results from site reconnaissance (see Figure 2.2.2). The outline of each alternative is summarized in Table 2.2.1.

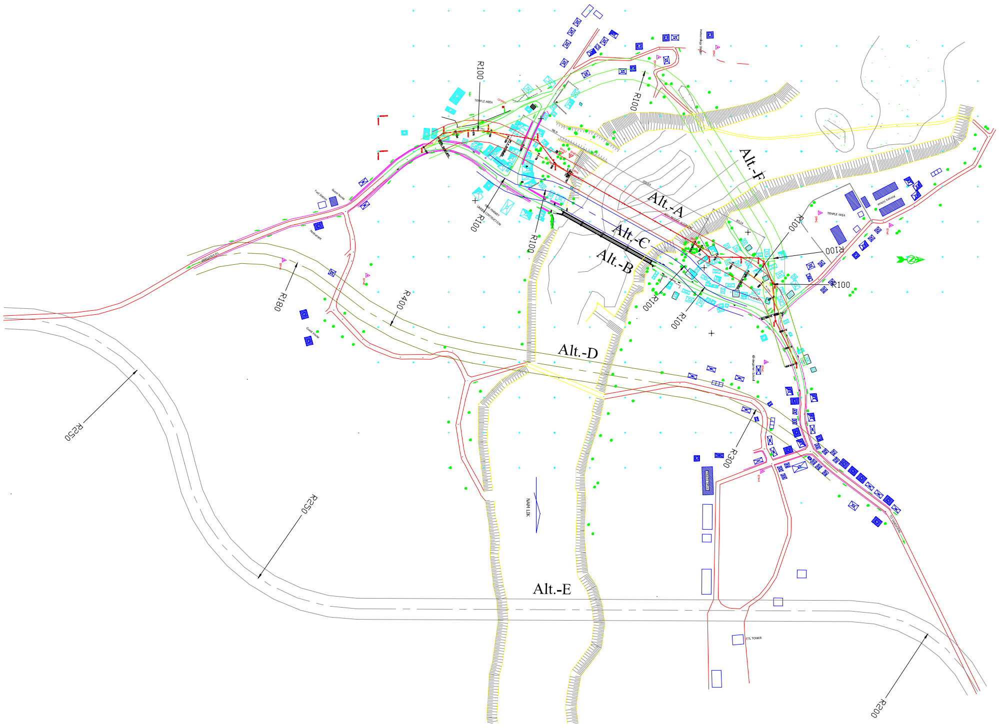


Figure 2.2.2 Alternative Route for New Bridge Location

Table 2.2.1 Outline of Each Alternative

Alternative	Outline
A	- Original plan of GOL - Longer than existing bridge - Geometric alignment of approach roads favorable on both sides with comparably shorter length. - Many houses affected by road construction.
F	- Shorter than Alt- A. - Design speed lower than Alt-A due to sharp curve and intersects with a provincial road. - No. of houses affected larger than Alt-A.
C	- Shorter than Alt-A. - Design speed lower than Alt-A due to sharp curve. - No. of houses affected larger than Alt-A. -Difficult to secure construction yard near the site.
B	- No. of houses affected the same as Alt-A. - A detour route with a temporary bridge required during construction. - Difficult to secure construction yard near the site.
D	- Bridge length approx. the same as Alt-A. - Favorable geometric alignment for approach roads on both banks. - Fewer houses affected than upstream alternatives. - Possible to secure construction yard near the site.
E	- Longest bridge & approach road lengths. - Favorable for promoting downstream town development plan of district offices - Fewest houses affected.

Table 2.2.2 summarizes the characteristics of each alternative, the total bridge and approach road length, construction cost, and the number of affected houses. Of these, construction cost, number of affected houses and town development plan compatibility are selected as the major determinant factors for choosing the most suitable alternative. As the result of the comparison, Alternative-D was selected and accepted by the GOL because: (1) its construction cost is appropriate (far more economical than Alternative-E); (2) few houses are affected; (3) it is a good location for promoting the town development plan; and (4) access for local residents is more convenient than that of Alternative-E, incase that the existing bridge become out of service by deterioration.

In addition, the outline of comparison evaluation is summarized below.

- Both the Alternatives A and F are proposed to cross over the river at the upstream side of existing bailey bridge. The bridge length will be longer than the existing bridge therefore the cost should be high comparatively. The large number of houses shall be removed by its construction. In this respect, the social environment impact will be so high that it cannot be recommended.
- Alternative C should have merit in terms of lower construction costs because of similar length of existing bridge. However, the large number of houses shall be removed by its construction that implicates the highest social environment impact among the alternatives. In this concern, this proposal was declined.
- Alternative B is a plan to replace only the existing bailey girder with concrete superstructure. Although the superstructure is improved, the reliability of substructure is probably low due to considerably damages in the past years. Also, necessary ground-up of approach embankment, which keeps the overhead clearance from the flood level shall remove the number of houses. In this respect, the cost is increased so that this alternative cannot be recommended.
- Alternative E will be given a lowest social environment impact among the alternatives. This alternative is proposed in line with the community development plan. This plan was established by local government however the status of plan is not affirmed yet. Also, this bridge will be longest among the alternatives so that the highest construction cost can be estimated. In this respect, the recommendation will be difficult due to the policy of grand aide project given by Japan ODA.

Table 2.2.2 Alternatives Routes for New Hinheup Bridge

			Alternatives at Upstream Side						Existing Bridge Position		Alternatives at Downstream Side			
			A: Original Request from GOL		F: Furthest upstream of Existing Br.		C: Slightly Upstream of Existing Br.		B: Utilization of Existing Bridge Piers		D: Btw Existing Br & District Offices		E：Furthest Downstream	
Outline of Alternative	Bridge Location (from Existing Br)		50m upstream		200m upstream		20m upstream		Same as existing bridge		200m downstream		550m downstream	
	Characteristics		- Longer than existing bridge. - Favorable geometric alignment of approach roads on both sides with comparably short length. - Many houses to be affected by road construction.		- Bridge length shorter than Alt- A. - Design speed lower than Alt-A due to sharp curve and intersects with provincial road. - No. of houses affected more than Alt-A.		- Shorter bridge length than Alt-A. - Design speed lower than Alt-A due to sharp curve. - No. of houses affected more than Alt-A. - Difficult to secure construction yard near site.		- No. of houses affected same as Alt-A. - A detour route with a temporary bridge required during construction. - Difficult to secure construction yard near site.		- Bridge length approx. same as Alt-A. - Favorable geometric alignment for approach roads on both banks. - Fewer houses affected than upstream alternatives. - Possible to secure construction yard near site.		- Bridge & road lengths longest of all alternatives. - Favorable position to promote town development plan at downstream district offices. - Fewest houses affected.	
	Length of Facility (m)	Bridge	205		175		160		145		160		250	
		Approach Rd. (R+L)	220+175		400+170		120+150		100+100		420+300		820+500	
		Total	600		745		430		345		880		1,570	
Major Evaluation	1.Construction cost (Mil JP¥)	Br. + Approach Rd.	1023+16	C	875+23	B	800+11	A	870+8	B	800+35	A	1250+53	C
		Others(Detour route)	-		-		-		90+7		-		-	
		Total	1,039		898		811		975		835		1,303	
	2. No. of Houses Affected		26	C	30	C	37	C	26	C	10	B	2	A
	3. Compatibility with Town Dev. Plan		Low	C	Low	C	Low	C	Low	C	Medium	A	High but not well formulated	A
Other Evaluation Items	1.Bridge Planning	Reliability of New Structure	Reliable because of new construction.		Reliable because of new construction.		Reliable because of new construction.		Concern with durability of strengthened substructure.		Reliable because of new construction.		Reliable because of new construction.	
		Treatment of Existing Bridge	Removal necessary due to swirling caused by new piers that will adversely affect existing piers.		Possible to restore existing bridge because of sufficient distance from new piers.		Removal necessary due to swirling caused by existing piers adversely affecting new piers.		Existing piers should be strengthened and the existing Bailey bridge replaced with new steel girders.		- Possible to restore existing bridge because of sufficient distance from new piers. - Restoration recommended in consideration of usage by nearby communities.		- Possible to restore existing bridge because of sufficient distance from new piers. - Restoration of existing bridge recommended in consideration of its usage by nearby communities.	
		Bridge Foundation	Bearing strata located deeper than downstream alternatives.		Bearing strata located deeper than downstream alternatives.		Bearing strata located deeper than downstream alternatives.		-		Bedrock exposed but stability check necessary		Bedrock exposed to riverbed so shallow foundation possible.	
	2. Approach Road Planning	Geometry (design speed :DS)	Only 40km/h possible due to limited space.		Only 40km/h possible due to limited space		Difficult to secure even 40km/h operation due to sharp curve.		Only 40km/h possible due to limited space.		60km/h possible because of sufficient space.		60km/h possible because of sufficient space.	
		Intersection with Existing Road	Yes, with PR.653.		Yes, with PR.653.		Yes, with PR.653.		Yes, with PR.653.		No.		No.	
		Road Structure	L bank: embankment R bank: cut		L bank: embankment R bank: cut		Both banks: low embankment		Both banks: low embankment		L bank: high embank.+ partially cut R bank: low cut & crossing stream		-Both banks: high embankment depending on bridge setting. - L bank: deep valley at crossing point of NR13.	
	3.Constructability	Temporary Detour during Construction	Not required as use of existing detour possible.		Not required as use of existing detour possible.		Not required as use of existing detour possible.		Temporary bridge needed during construction.		Not required as use of existing detour possible.		Not required as use of existing detour possible.	
		Construction Yard	Difficult to secure and only available for approach road.		Small space can be secured on right bank.		Difficult to secure near site.		Difficult to secure near site.		Sufficient space is available on right bank.		Sufficient space available on both banks.	
	4. Impacts on Social Environment	Impacts on Community	New approach road divides community into two due to embankment or cuts off roads.		- Approach road on right bank encroaches on land of temple. - Approach road affects flat area near right bank which is used as community land for fruit trees and cattle grazing.		- Most structures to be relocated are shops and it is difficult to find an appropriate place to do business - New approach road level higher than existing one and will affect houses and shops.		- Most structures to be relocated are shops and it is difficult to find an appropriate place to do business. - New approach road level higher than existing one and will affect houses and shops.		- Lesser impact on shops than upstream alternatives (only 2 shops affected). - Consideration of utilizing construction yard after construction for community and business purposes needed. - Slightly far from existing community.		- Little resettlement required. - Inconvenient for existing community. - Alternative furthest from existing community.	
		Traffic Safety	NR13 crossing required for students for both banks.		NR13 crossing required for students for both banks.		Few impacts.		Students have to use detour bridge during construction.		Few impacts.		Few impacts.	
		Adverse Impacts during Construction	Noise, vibration and dust to affect houses along road.		Noise, vibration and dust to affect houses along road.		Noise, vibration and dust to affect houses along road.		-Noise, vibration and dust to affect houses along road.		Small impact on left bank only.		Almost no impacts.	
	5.River condition	River Alignment	Br. centerline located at curve of river where erosion easily occurs (R bank).		Br. centerline located at curve of river where erosion easily occurs (R bank).		Br. centerline located on straight section of river and less possibility of erosion.		Br. centerline is located on straight section of river and less possibility of erosion.		Br. centerline is located on straight section of river and less possibility of erosion.		Br. centerline is located on straight section of river and less possibility of erosion.	
		Riverbed Conditions	Fast flows and soil riverbed will result in scouring on left side of river.		Fast flows and soil riverbed will result in scouring on left side of river.		Bedrock exposed on both banks and riverbed is stable.		Bedrock exposed on both banks and riverbed is stable.		Bedrock exposed on both banks and riverbed stable.		Partial exposure of bedrock and slow river flow makes for stable riverbed.	
Comprehensive Evaluation			Unsuitable - Large number of houses needs to be relocated. - Large impact on existing community due to high embankment. - High construction cost due to long bridge length.		Unsuitable - Large number of houses needs to be relocated. - Large impact on existing community due to high embankment. - High construction cost due to long bridge length.		Not Recommendable - Large number of houses needs to be relocated. - Large impact on existing community during construction and afterwards due to high embankment. - Bridge length approx. same as existing one so advantageous in terms of construction cost.		Unsuitable -Less reliable than new bridge as strengthening is for unknown existing structure function. - High construction cost.		Recommendable - Relatively low construction cost. - Few houses need to be relocated. - Can be compatible with town development plan. - Existing community can utilize new bridge with little inconvenience should existing bridge collapse.		Not Recommendable - Alternative with highest construction cost. - Most compatible with town development plan but no detailed plan at present. - Existing community will suffer the access to each bank in case of collapse of the existing bridge.	

2.2.2.3 Outline of Project Facilities

Table 2.2.3 summarizes the Project facilities based on the results of the Basic Design Study.

Table 2.2.3 Outline of Project Facilities

Facility	Contents					
1.Bridge						
(1)Bridge length/ Span	195m=30m+45m+45m+45m+30m					
(2)Width formation	Inner width 10m = 1.0m(footpath)+ 0.5m(shoulder)+3.5m x 2(carriageway) +0.5m(shoulder)+1.0m(footpath) (footpath & carriageway separated with discontinuous curbs）					
(3)Gradient	Longitudinal: I=-1.0%、Cross-fall: 2.5%					
(4)HWL	192.8m (Freeboard: 1.2m) (Dist. to bottom of girder: 194.30m)					
(3)Design Loads						
・Live Load	HS20-44 x 1.25					
・Seismic load	Kh = 0.06					
・Other loads	Braking force, water flow pressure					
・Temp. change	±15°					
(4)Superstructure						
・Structural type	Continuous 5-span PC box girder type					
・Erection method	Incremental launching method					
(5)Substructure	A1	P1	P2	P3	P4	A2
	RC box	RC wall	RC wall	RC wall	RC wall	RC box
(6)Foundation						
・Type	Spread	Spread	Spread	Spread	Spread	Spread
・Bearing Stratum	Sandstone	Sandstone	Sandstone	Sandstone	Sandstone	Sandstone
(7) Ancillary Facility	Lighting（six poles）, Newel post, Drainage facility					
(8) Others	Loads for water supply pipe, electric pipe and telephone pipe are considered as future design loads					
2.Approach Roads						
(1) Length	Right bank: 485m, Left bank: 270m					
(2) Design Conditions	Road class: Class III, Design traffic volume(1000～3000PCU/day), Terrain: Rolling, Design speed: 60km/h					
(3) Cross-section	Total width: 11m＝0.5m (Unpaved shoulder) + 1.5m (Paved shoulder) + 3.5m x 2 (Carriageway）+ 1.5m（Paved shoulder）+ 0.5m (Unpaved shoulder)					
(4) Geometric Standards	Geometric standards according to the design speed of 60km/h Min horizontal curve applied: R=200ｍ, Max. longitudinal gradient applied：4.0%					
(5) Pavement Structure	Carriageway: DBST, Shoulder: SBST Design Spec.: Road Note 31, Design Life: 10 years, Design traffic volume: based on traffic count survey					
(6) Drainage Facility	Type: side ditch, transverse pipe culvert, Design method: Rational formula, Design rainfall intensity: 120mm/h (5-year return period)					

2.2.2.4 Study on Major Design Conditions

(1) Study Items

There are two major design conditions listed below for the Project that must be examined from the viewpoint of appropriateness for grant aid. Since DBST is acceptable to the GOL for the paving of the approach roads, and can be said to be the most cost-effective pavement for current traffic volumes, this chapter does not deal with the pavement type for approach road.

- Bridge Design: Bridge formation and Design High Water Level
- Approach Road Design: Road formation

(2) Bridge Formation

1) Request from GOL

The new bridge formation requested by the GOL is as shown in Figure 2.2.3. Note that this formation is the same as that applied in the “Project for Reconstruction of Bridges on National Road 13”, which was implemented via Japan’s Grant Aid scheme.

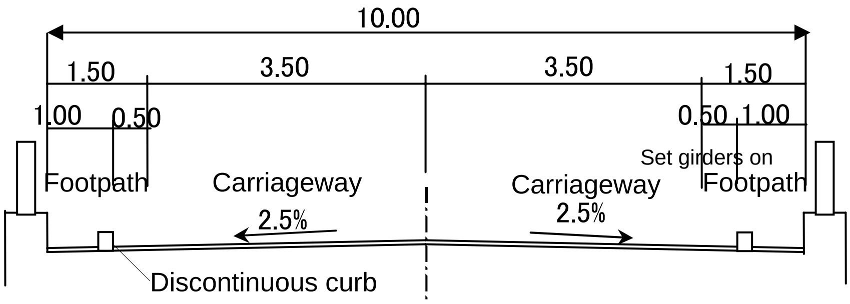


Figure 2.2.3 Bridge Formation Requested by GOL

2) Examination of Appropriateness of Request

① Carriageway Width

The request regarding carriageway and shoulder widths can be judged appropriate for the following reasons:

- The future improvement plan for NR 13N states the necessity for lanes 3.5m in width.
- The traffic count survey revealed a present traffic volume of 2390 PCU/day (see Appendix-1), indicating a traffic level suitable for a Class III road (1000-3000 PCU/day). The heavy vehicle ratio was also a relatively high 14.5%.
- Lane width of 3.5m for a two-lane 7m carriageway has been widely applied in current road and bridge projects (i.e., the Project for Reconstruction of Bridges on National Road 13, and the Northern Economic Corridor Project (ADB funded))

② **Footpath Width**

The footpath width of 1m on both sides can be judged appropriate for the following reasons:

- Five hundred and thirty pedestrians, including approximately 420 students, per day was counted at the existing bridge as part of the above-mentioned traffic count survey. This number is quite high and exceeds the requirement for footpath installation that there be more than 100 people (and 500 vehicles) per day as stated in the Japanese Road Structure Ordinance. Note that the existing bridge has been utilized as a route to school and it is vital to ensure safe passage for these pedestrians, which will also result in smooth vehicle flows on the bridge.
- A 1m wide footpath, with an effective clearance of 0.8m, is the recommended minimum, considering minimum requirement (0.75m) of the Japanese Road Structure Ordinance, it can not be applied the narrower width for foothpath.
- Another reason for including footpaths is that the existing bridge could go out of service in the future and they would be necessary to handle the increase in traffic.
- As can be seen from other bridge projects in Lao PDR, bridges located in populated areas basically have footpaths on both sides.

(3) Study on Design High Water Level

1) Design Return Period for Flooding

The Design Manual indicates that the design return period for flooding ranges from 50 to 150 years, depending on the importance of the structure. In practice, a 50-year return period usually has been applied for bridges on national roads, excluding those crossing the Mekong River. This policy shall also be applied to this new bridge in consideration of past experience and appropriateness for Japanese Grant Aid. Note, however, that the Nam Lik River has a relatively large discharge volume of approximately 4000m^3/sec.

2) Probability Analysis on Design High Water Level

Design HWL and discharge shall be estimated with the simple and Weibull methods, by plotting annual time-series data for HWL and discharge on a log-graphic sheet. Annual HWL is for the 40-year period of 1965 to 2005, which for purposes of analysis is statistically sufficient for determining an HWL for a 50 to100 year return period. However, site reconnaissance found that the observatory data for 1981, which has been assumed to be the highest HWL in recent years, is not reliable when compared with the interview results of villagers living near the observatory. Accordingly, the interview results on HWL for 1981 has been adopted as the yearly HWL for that year.

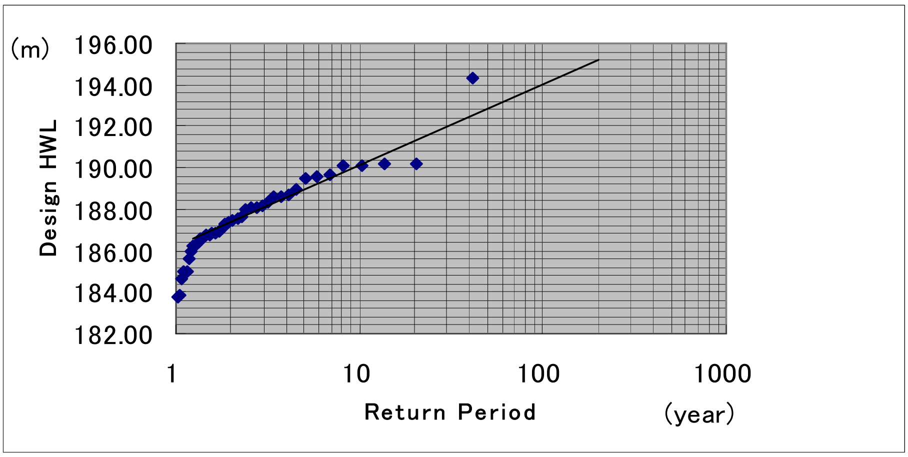


Figure 2.2.4 Probability Analysis on Design HWL

Table 2.2.4 Design HWL & Discharge by Return Period

	Unit	1/100	1/50	1/25	1/10	1/2
HWL	m	194.30	192.80	192.00	190.40	187.60
Discharge	m^3/s	4,200	3,900	3,500	3,150	2,500

3) Design High Water Level

The Japanese standard recommends that freeboard be 1.2m for a river with a discharge of 2000-5000m^3/sec. Accordingly, the distance to the bottom of a girder should be set at least at 194.0m (192.80+1.20) for a 50-year return period. On the other hand, reliable interviews indicate that the highest HWL in the past (which was in 1981) was approximately 194.30m, which is almost equivalent to a HWL for a 100-year return period. Accordingly, this Study will apply this flooding height of 194.30m in the planning of the bridge without any freeboard.

(4) Road Formation for Approach Road

1) Request from GOL

The road formation requested by the GOL for approach roads is as shown in Figure 2.2.5.

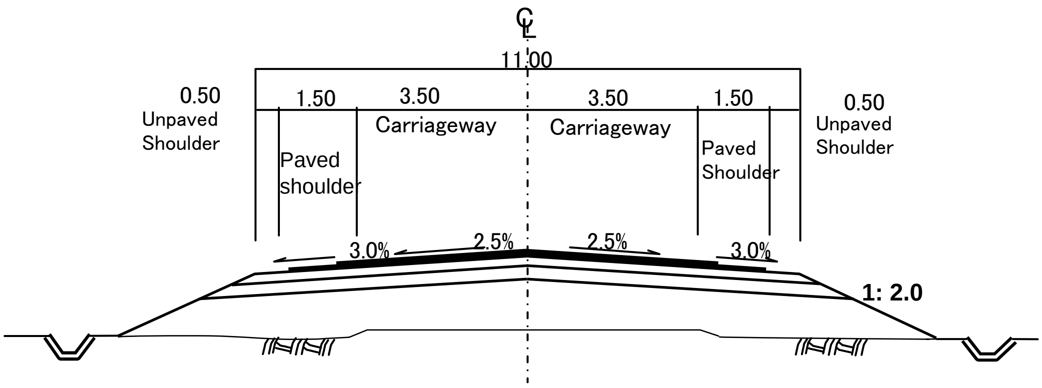


Figure 2.2.5 Road Formation Requested by GOL

2) Examination of GOL Request

① Carriageway Width

The validity of the carriageway width requested by the GOL has already been taken up in the previous chapter, therefore, the only examination of shoulder is described hereunder.

② Shoulder Width

Although the Design Manual recommends a 2m paved shoulder for a road with a design speed of 60km/h, this is relatively wide compared to roads elsewhere in the country. Also, there is no case of this being applied to other road improvement projects in Lao PDR. Taking into consideration that villages are located along the approach roads to the existing Hinheup Bridge and the continuity of the bridge's formation, it is deemed that a 1.5m shoulder is appropriate for this Japanese Grant Aid scheme. Note that there will be a 0.5m unpaved shoulder bordering the paved shoulder in order to protect the whole road structure as well as secure space for traffic sign installation.

2.2.2.5 Design Conditions for New Bridge

(1) Design Standards & Specifications

The Design Manual is the only standard for road and bridge design in Lao PDR. However, it only contains design live load and return period for design HWL regarding bridge design. Accordingly, Japanese standards and specifications will be applied for the other specifications of the new bridge design.

(2) Design Method

The allowable stress method shall be applied for the bridge design.

(3) Major Design Conditions for Bridge

Table 2.2.5 summarizes the major design conditions for the new Hinheup Bridge.

Table 2.2.5 Major Design Specifications for Bridge

Items	Specifications
(1) Width Formation	See Figure 2.2.6
(2) Cross-fall	2.5%
(3) Pavement	Asphalt Pavement t=50mm
(4) Facilities to be installed in future	Water pipe: ϕ 200, Electric line pipe: ϕ 30, Telephone line pipe: ϕ 30
(5) Ancillary Facilities	Railing, Expansion Joint, Lighting
(6) Design Return Period for Flooding	50 years
(7) Freeboard	1.2m

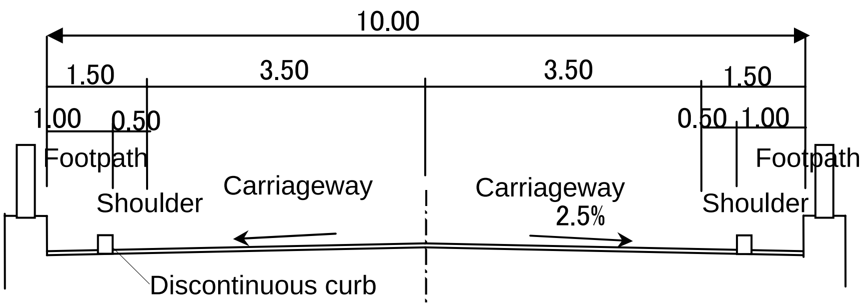


Figure 2.2.6 Typical Cross-section for Bridge

(4) Design Loads

1) Live Load

HS20-44x1.25 will be applied for the new bridge because it is located on NR 13, which is one of the major trunk roads in Lao PDR.

2) Seismic Load

Figure 2.2.7 shows few large-scale earthquakes in northern Lao PDR in the last 40 years. Accordingly, the minimum level for seismic force (Kh=0.06) shall be considered in the bridge design.

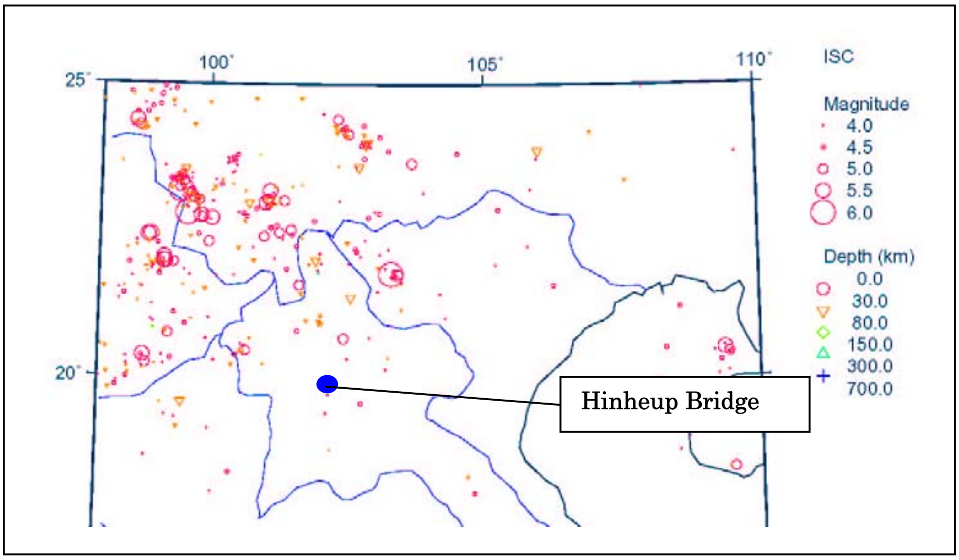


Figure 2.2.7 Earthquake Record for Northern Lao PDR

3) Other Loads

The following types of loads shall be considered as required:

- Dead load
- Impact load

- Wind load
- Influence of creep for concrete
- Influence of dry shrinkage for concrete
- Earth pressure
- Static water pressure
- Water pressure during flood
- Buoyancy
- Settlement

(5) Material Strength

1) Unit Weights of Materials

Table 2.2.6 Unit Weights of Materials

Designation	Self-weight kN/m^3	Designation	Self-weight kN/m^3
Steel	77.0	Cement, mortar	21.0
Concrete reinforced	24.5	Asphalt concrete	22.5
Pre-stressed concrete	24.5	Concrete pavement	23.0
Non-reinforced concrete	23.0	Timber	8.0

2) Strength of Materials

Specifications in terms of strength for concrete, reinforcement and steel plates will be in accordance with Japanese Standards and Specifications.

Table 2.2.7 Minimum Strength of Concrete

Designation	Minimum Strength (N/mm^2)
PC Girder (post tension)	30
Slab	30
Abutment & Pier	21
Concrete Pile	30
Lean Concrete	18

Table 2.2.8 Strength of Reinforcement

Designation	Yield Strength (N/mm^2)
Round Bar	σ py> 235
Deformed Bar(SD295)	295< σ py<390
Deformed (SD345)	345< σ py<440

Table 2.2.9 Tensile Strength of Steel

Designation	Min. Tensile Strength (N/mm^2)	Remarks
SS400,SM400	410	Normal Steel
SM490,SM490Y	500	Ditto
SM520	530	Ditto

2.2.2.6 Bridge Planning

(1) Determination of Bridge Length

Bridge length shall be set so as to enable the design flood discharge to flow without any disturbance. However, river width during flooding for both upstream and downstream should be considered in order to determine proper bridge length.

River width during flooding ranges from 150m to 300m for the downstream and upstream sides of the new bridge, as the river edge line turns back upon itself repeatedly. At the crossing point of the new bridge, although river width would be approximately 240m for the design HWL, a bridge length of about 195m is appropriate considering the lower topography of the left bank.

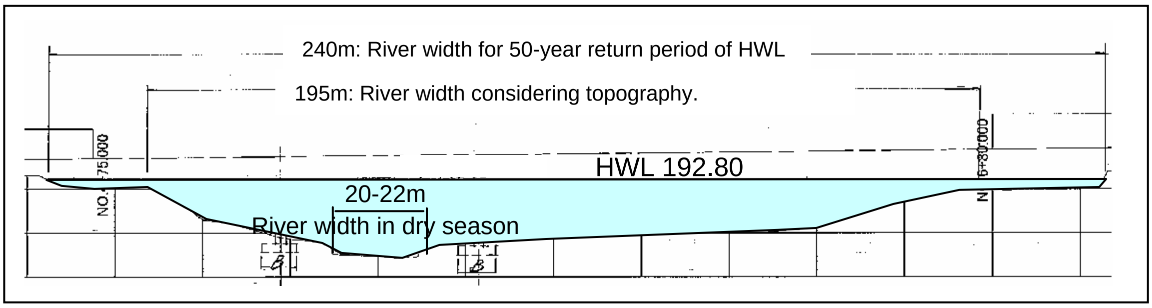


Figure 2.2.8 Bridge Length at Crossing Point

(2) Span Arrangement

1) Span Length

The span arrangement shall be determined based on the following factors in accordance with the Japanese River Structure Ordinance. Note that the impacts from disturbed flows caused by the existing piers will be negligible, as the new bridge is 200m downstream from the existing bridge.

① Disturbance ratio of new piers for river width during flooding should be less than 5%.
② Span length should exceed standard span length as calculated by the discharge volume in accordance with Japanese standards.
③ Span length between P1 and P2 should be more than 45m considering the uncertainty of bedrock when footings are set at the edge of both banks.

The results of an examination of the factors for determining span arrangement are as summarized in Table 2.2.10.

Table 2.2.10 Results of Span Arrangement Examination

Factor	Examination	Results
Disturbance ratio for cross-section of river due to new piers	In the case of pier width being 2m, the following spans are required: 190m x 0.05/2.0 ＝ 4.75→5 spans	Less than 6 spans is appropriate (max. span length ≧39m)
Base span length	BSL = 20＋0.005Q＝20+0.005 x 3900 =39.5m	Max. span length ≧ 39.5m
Necessary span length when considered ③ factor	River width ranges from 20 to 22m and footing on both sides shall be set 8m from the edge of the banks due to the uncertainty of the bedrock. Accordingly, maximum span shall be: 21m＋（8mx2＋4mx2）＝45m	Max. span length ≧ 45m

2) Conclusions

Considering the results in Table 2.2.10, the Study Team concluded that bridge length and span arrangement should be 195m＝30m + 45mx3 +30m for the following reasons:

- In consideration of the river's topographic features, bridge length is almost the same as the average river width for 50-year return period flooding.
- Recommended span arrangement (span ratio: 0.67) is superior in terms of bending moment.
- Recommended span arrangement is aesthetically pleasing.

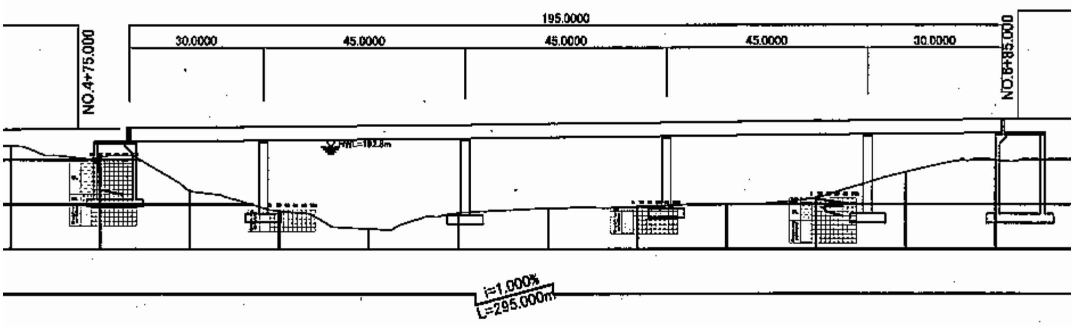


Figure 2.2.9 Bridge Length & Span Arrangement Plan

(3) Superstructure Type

1) Selection Concept

Considering that maximum span length is 45m, four types of superstructure from past experience are possible in practical terms: (1) PC I-shaped girder, (2) PC continuous box girder with equal depth, (3) PC continuous box girder with variable depth, and (4) steel I-shaped girder (see Table 2.2.11). The four types are then compared in terms of cost effectiveness; constructability and construction time, and the most appropriate superstructure type selected.

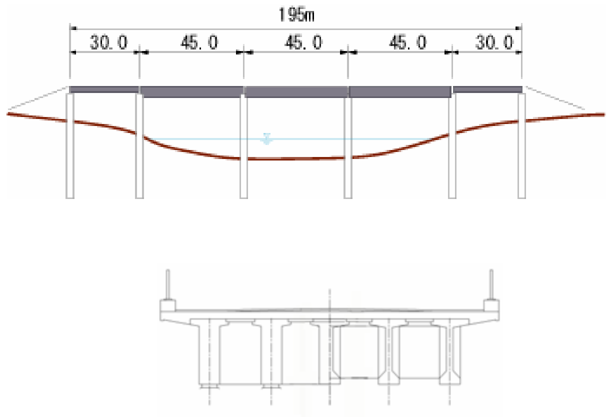
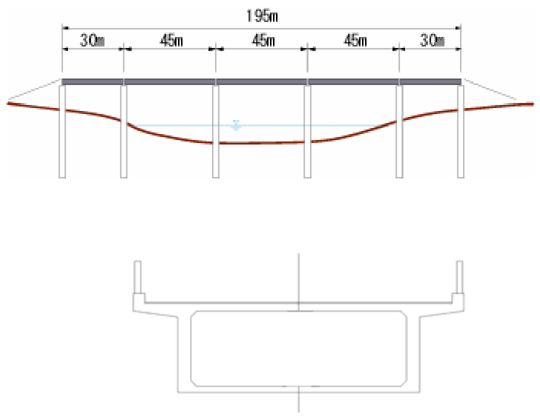
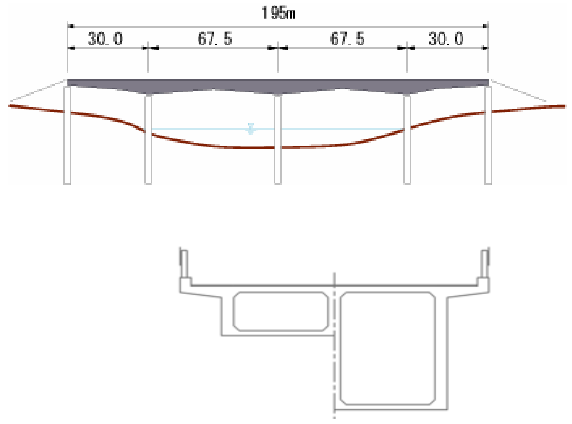
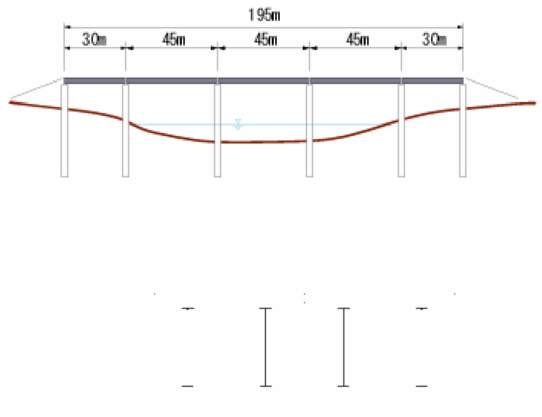
Table 2.2.11 Applicable Superstructure Type

Superstructure Type		Span Length										Girder depth/Span
			20m		30m		40m		50m		60m	
PC type	Continuous T-shaped		━	━	━	━	━					1/15
	Continuous Box Girder with equal depth (Inremental launching method)				━	━	━	━	━	━		1/16
	Continuous Box Girder with Variable Depth (Cantilever method)								━	━	━	1/18-1/35
Steel	Continuous I-shaped				━	━	━	━				1/20

2) Comparison of Four Superstructure Types

Table 2.2.12 shows the comparison results for the four above-mentioned alternatives. As the table indicates, the PC-continuous box girder with equal depth executed via the incremental launching method is the most appropriate superstructure and implementation method.

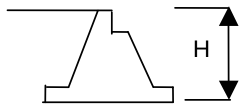
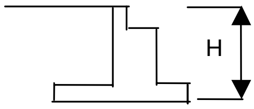
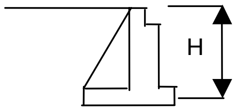
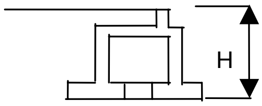
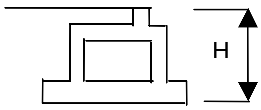
Table 2.2.12 Comparison of Superstructure Type

		Alt.-I:PC T-shaped Girder Type	Alt.-II: PC Box Girder Type with Equal Girder Depth	Alt.-III PC Box Girder with Variable Girder Depth	Alt.-IV: Steel I-Shaped Girder Type
Sketch					
Features of Alternatives	Br. L/Span	195m ＝ 30+45+45+45+30	195m ＝ 30+45+45+45+30	195m = 37.5+60+60+37.5	195m ＝ 30+45+45+45+30
	Br. Type	Continuous 5-span PC T-shaped Girder Type	Continuous 5-span PC Box Girder with Equal Depth	Continuous 4-span PC Box Girder with Variable Depth	Continuous 5-span Steel I-shaped Girder
	Erection	Erection Girder Method	Incremental Launching Method	Canti-lever Method	Crane Erection Method
	Structural Features	- Applicable for 25-45m span length (max.45m). - Girder depth to be 3.0m for girder depth/span ratio of 1/15. - After setting simple girders at final position, each girder to be connected with RC structure. - Weight of bridge heavier than steel girder type. - Girder depth differs between center and edge span due to span length difference. - Bridge surface level to be raised against design HWL due to girder depth.	- Applicable for 30-60m span length. - Girder depth to be 2.8m for girder depth/span ratio of 1/16. - Lighter in weight than PC T-shaped type. - Appropriate span arrangement provides good structural balance in terms of bending moment. - Bridge surface lower than PC T-shaped girder type. - Most suitable bridge type for incremental launching method.	- Applicable to 15-120m span length. - Maximum girder depth to be 3.3m at edge of 60m span for girder depth/span ratio of 1/35 at span center and 1/18 at end of span. - Weight of girders lighter than other PC types because of variable girder depth. - Higher bridge surface needed due to higher girder depth.	- Applicable to 25-60m span length. - Girder depth to be 2.5m for girder depth/span ratio of 1/18. - 20% lighter in weight than PC types. - Two options: continuous 5-span type and continuous 3-span type with simple span at both ends are possible. -Lowest bridge surface possible due to lower girder depth.
Structure		Structurally not rational due to span length being maximum value.	- Most rational structure in terms of span length.	- P1 position limited due to topography, resulting in inferior moment balance due to short end span length.	- No structural problems regarding span length.
Constructability		- Large-scale erection girder with portal frame crane used for erection due to heavy girders. - Little experience with 45m girder length. - 150t girder requires careful handling at erection. - Erection work possible during rainy season as there is no need to use space under girder. - Fabrication space needed at backside of abutment.	- Erection nose shall be attached with girders in order to incrementally launch the girders. This span length is most suitable for this method. - Construction yard for this method available on right bank. - Erection work possible in rainy season as there is no need to use space under girders. - Few problems with this erection method because of straight alignment and small longitudinal gradient (1%).	- Girders launched from a pier little by little (2-4m) from both sides using a traveler. - Much past experience and relatively safe erection method. - Procurement of materials to piers when erection starts can be an issue during the rainy season and cost for temporary platforms is high.	- Erection using crane with 80-ton lifting capacity from riverbed or temporary platform; compared to other alternatives erection time is shortest. - Erection possible in rainy season. - Girders transported to site after fabrication in third country.
Construction time for superstructure)		Approximately 14 months	Approximately 14 months	Approximately 18 months	Approximately 14 months （including order processing, fabrication & transportation）
Cost for superstructure		1.00 (Higher cost due to application limit)	1.00	1.17	1.67 Procurement from foreign country requiring high cost
Maintenance		- Maintenance cost less than steel type. - Expansion joint required at 4 places.	- Maintenance cost less than Alt-I &IV. - Expansion joint only required for 2 places.	- Maintenance cost less than Alt-I & IV - Expansion joint only required for 2 places.	- Periodic painting requires the highest cost of maintenance. - Expansion joint is only required at 2 places.
Impact on Environment		Not expected	Not expected	Not expected	Not expected
Aesthetics		- Difference in girder depth is aesthetically inferior.	- Equal girder depth and good balance between center and end spans is aesthetically superior.	- Variable girder depth gives rhythmical impression and good balance between center and edge spans is aesthetically superior.	- Equal girder depth and good balance between center and end spans is aesthetically superior.
Comprehensive Evaluation		○	◎ Recommendable because most rational in structure, economical, and superior in terms of aesthetics. Few problems with constructability, construction time and maintenance.	△	×

(4) Abutment Type

Abutment type shall be selected based on its height range as shown in Table 2.2.13.

Table 2.2.13 Applicable Abutment Type

Abutment Type		Applicable H (m)	Characteristics
Gravity Type		H≦5	- Simple structure - Easy to construct - Relatively heavy
Inverted-T Type		5< H ≦12	- Cost effective within applicable height range -No difficulty in building
Buttressed Type		10 ≦ H	- Complicated to build - Careful compaction of backfills needed
Rigid-Frame Type		10≦ H ≦ 15	- Complicated structure -High cost -Good for expanding discharge capacity
Box Type		12≦ H	-Complicated structure & construction -High cost -Only applicable when height exceeds 15m

Abutment height is determined based on both the road profile considering the design HWL with freeboard and the position of the bearing strata according to the results of the geological investigation. Table 2.2.14 shows the selection results for abutment type.

Table 2.2.14 Selection Results for Abutment Type

Position	Height (m)	Type
A1（Right bank）	17.5	Box type
A2（Left bank）	23.5	Box type

(5) Pier Type

A wall-type pier shall be adopted to prevent swirling flows that cause scouring and thereby realizing smooth river flows. Since the angle of the bridge transverse line to the river flow is small, piers shall be set at 83 degrees to the bridge axle line in order to be parallel to the river flow. However, since it is possible to set bearings for the superstructure slightly away opposite the bridge axle from the pier center, the superstructure can be designed as a straight bridge with no skew angle.

(6) Foundation Type

1) Appropriate Bearing Strata for Substructure

Four boreholes were dug during site reconnaissance: two for abutments and the remaining two for piers. Table 2.2.15 shows the analysis results of the bearing strata for each substructure from the boring logs. The detailed boring logs are contained in Appendix-2.

Table 2.2.15 Bearing Strata by Substructure

Name	Borehole No.	Depth to Bearing Strata (Elevation)	Name of Bearing Strata	Remarks
A1	BH-01	10.0 (180.107)	Sand stone	- Silt sand layer located 8m down with high STP numbers is not reliable as it is a thin layer and is likely to loose strength after excavation.
P1	BH-02	Ground surface (178.64)	Ditto	
P2	BH-03	0.8 (178.49)	Ditto	
P3	BH-04	4.8 (177.128)	Ditto	- The lower sandstone layer can be a bearing strata as the upper one is unreliable due to its lesser strength and thinness.
A2	BH-04	13.0 (177.128)	Ditto	- The lower sandstone layer can be a bearing strata as the upper one is unreliable due to the possibility settlement and its thinness.

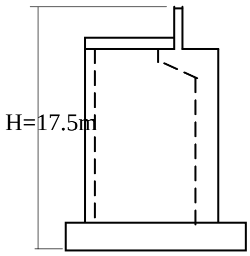
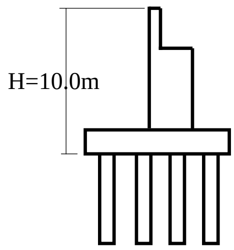
2) Foundation Type for Abutment

The spread foundation and pile types were compared in order to determine the appropriate foundation type for abutments based on the analysis of the bearing strata shown in Table 2.2.15. Based on the results of this analysis the spread foundation type was selected for both the A1 and A2 abutments because:

- In terms of construction cost both types are similar.
- It is difficult to procure a piling machine in the domestic market and there is a risk that construction could be delayed if the pile foundation type is applied.

Table 2.2.16 shows the comparison results for the A1 abutment as an example.

Talbe 2.2.16 Comparison of Foundation Type for A1 Abutment

		Alternative A: Spread Foundation	Alternative-B: Pile Foundation
Outline	Sketch		
	Height/ Pile type	17.5m	10.0m ϕ 1.0、L=7m, n=16 本
	Structure Type	RC box type	RC inverted-T Type
	Features	Cost effective when height exceeds 12m.	Cost effective when height less than 12m.
Structure		Structurally stable even if scouring occurs in front of abutment.	Could become structurally unstable if scouring occurs in front of abutment as piles would be exposed.
Cost		1.0	1.0
Constructability		- Open excavation or one with temporary sheet-pile using bearing strata. - Complicated structure due to high vertical walls and partitions. - Construction period shall be shorter even with complicated structure than Alt.-B due to no piling work.	- Simple structure and good constructability. - Requires procurement of piling machine for bored piles from third country. - Construction time shall be longer than Alt-A due to piling work.
Comprehensive Evaluation		○ - Although construction volume is larger than Alt-B, shorter construction time is possible as there is less risk since procurement from a third country is unnecessary. However, safety measures should be carefully taken during the works due to the high wall.	△

3) Foundation Type & Covering Depth on Footing for Piers

A spread foundation supported by sandstone layers shall be adopted for piers, as shallow bearing strata were found in the boring survey mentioned in Table 2.2.15. Fifty cm of covering on the footing shall is sufficient because it is also supported by the sandstone layer.

(7) Bridge Surface Works

A finger type expansion joint made of aluminum alloy shall be selected because of its durability and ease of maintenance. Note that it is difficult at present for the GOL to frequently replace damaged expansion joints.

Lighting shall be provided on one side of the new bridge in order to prevent vehicle collisions at the entrance of the bridge as well as for the existing bridge.

A curb shall be installed in order to secure the safety of pedestrians crossing the bridge. However, it shall be a discontinuous curb in order to allow bicycles on the carriageway to enter the footpath when a rider feels that it is dangerous.

(8) Installation of Approach Slab

An approach slab of 5m will be installed at the backside of abutments, which are more than 6m in height, in order to avoid sharp differences between the bridge surface and approach road (based on *Guideline for Earth Works in Japan*).

(9) Protection Works for River Bank & Abutment

The abutments of the proposed bridge are set back from the river waterline. However, in the rainy season, it is anticipated that some scouring and erosion will occur around the bridge and approach road embankments due to high velocity flows. To protect embankments around abutments, revetment with stone masonry is to be adopted up to the design HWL, and up to 10m from abutments along approach roads.

On riverbanks in front of abutments, gabion will be placed for protection approximately 20m from the bridge both upstream and downstream in accordance with the Japanese River Structure Ordinance, since it is flexible, durable and economic. Gabion will also be placed around piers in order to protect filled materials from scouring.

2.2.2.7 Design Conditions for Approach Road

(1) Design Standards & Specifications

The Design Manual shall be applied for the geometric design of approach roads. Note, however, *Overseas Road Note 31* developed by the UK's Transport Research Laboratory shall be adopted for the pavement design of approach roads as it provides a reliable DBST pavement design method.

(2) Road Class & Design Speed

Roads in Lao PDR are classified into seven categories depending on their role in the road network and traffic volume in accordance with the Design Manual. Although NR 13N was upgraded to a Class IV road in the early 1990s, MCTPC has a future plan to improve NR 13N to a Class III road by 2020.

Considering this background, it has been deemed that approach roads to the new bridge should be designed as a Class III road. The design speed for the approach roads is to be 60km/h because of the hilly terrain.

Table 2.2.17 Road Class and Design Speed

Road Class		I	II	III	IV	V	VI	VII
Design Traffic Volume (PCU/day)		>8000	3000 -8000	1000 3000-	300 -1000	100 -300	50 -100	<50
Design Speed (km/h)	Flat	100	100	80	80	60	60	40
	Rolling	80	80	60	60	40	40	30
	Mountainous	60	60	40	40	20	20	20

(3) Road Formation

Based on the results in 2.2.4, the road formation in Figure 2.2.10 shall be adopted for the approach roads.

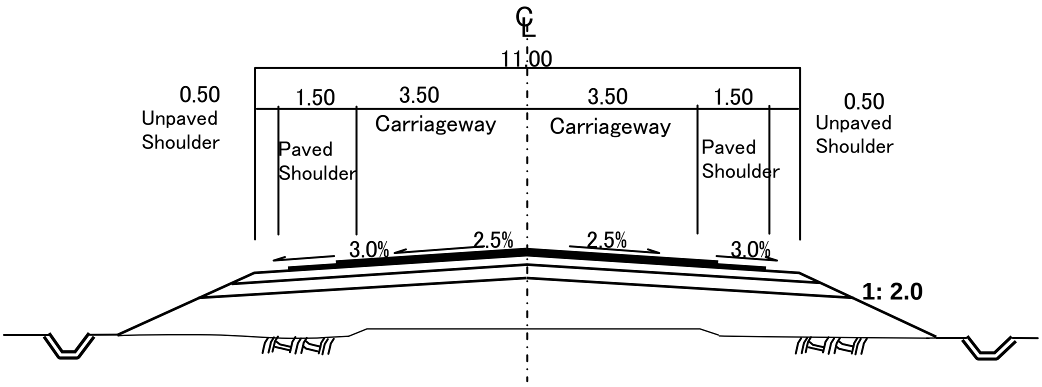


Figure 2.2.10 Typical Cross-section for Approach Road

(4) Geometric Design Conditions

As mentioned in 2.2.2.7 (1), geometric design will be accordance with the Design Manual. Table 2.2.18 shows the values for major geometric design items. Regarding longitudinal gradient, a gradient of less than 5% shall be applied in order to avoid the deceleration of heavy vehicles, which according to the traffic count survey are numerous.

Table 2.2.18 Geometric Standards

Item	Unit	Design Standard
Design Speed	Km/hr	60
Horizontal alignment		
Minimum curve radius	m	130
Transition curve run off		1/400
Minimum sight distance	m	225
Vertical alignment		
Maximum gradient	%	7
Minimum radius of crest	m	2500
Minimum radius of sag	m	1500
Minimum vertical curve length	m	40
Cross section		
Cross fall	%	2.5
Maximum super-elevation	%	3-10

(5) Pavement Structure

1) Design Method

The design method for DBST pavement shall be undertaken based on Overseas Road Note 31 as mentioned above.

2) Design Conditions

Table 2.2.19 shows the major design conditions for pavement.

Table 2.2.19 Design Conditions for DBST Pavment Design

Items	Contents/ Values	Remarks
1. Design Life	10 years	In the near future asphalt pavement will be applied
2. Future Traffic Volume	- Traffic count survey results are assumed to be representative of present traffic volume. - Average annual increase in traffic is assumed to be 7%.	Same value used in the Study on Road Network Development in Southern Laos.
3. Design Axle Load	Standard axle load for Laos shall be applied. - Sedan, Pick-up, Mini-bus: 0 - Medium-Large size bus: 1.0 - 2-axle track: 1.57 - 3-axle track: 6.01 - 4-axle track: 9.32 Accumulated Equivalent Standard Axle Load: 5.5×10^6 ESA	
4. Sub-grade Strength	CBR: 8 to15	Based on soil test results

3) Pavement Structure

As a result of the pavement design conditions described in Table 2.2.19, the pavement structure is as shown in Figure 2.2.11 (refer to Appendix-3 for details).

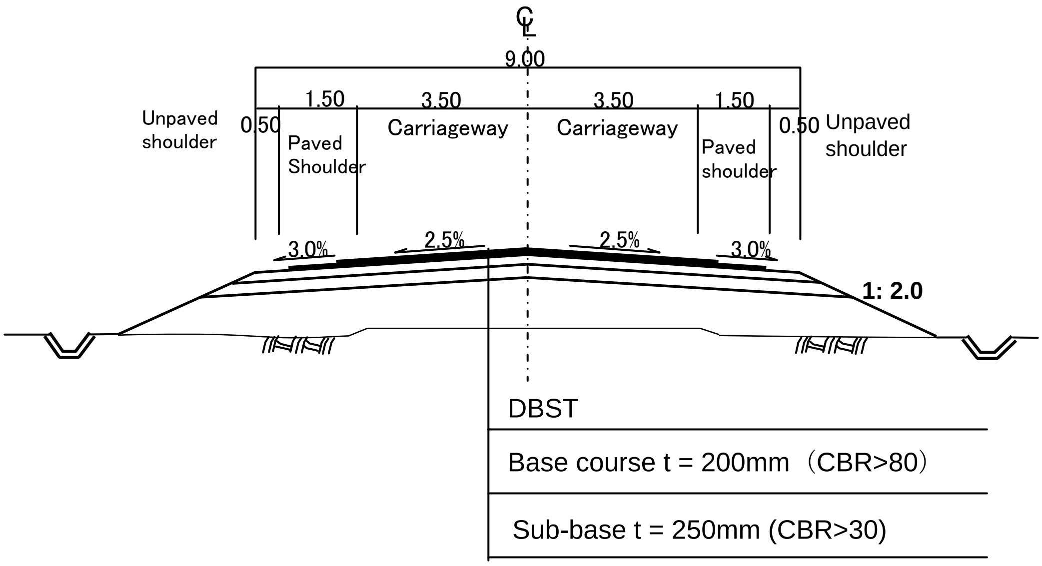


Figure 2.2.11 Pavement Structure

(6) Earth Structure

The applicable slope gradients are dependent on the height of both cut and embankment sections as summarized in Table 2.2.20.

Talbe 2.2.20 Slope Gradient for Cut & Embankment Sections

	Soil type	Gradient		Remarks
		（H＜6m）	（6m＜H＜10m）	
Embank -ment	Normal	1:1.5	1:2.0 Height of berm shall be set every 5m	Refer to Road Design Manual
Cut	Normal	1:1.0	1:1.0 Height of berm shall be set every 5m	Ditto
	Rock :weathered :fresh	 1:0.5 1:0.3	Height of berm shall be set every 5m	Ditto

(7) Drainage Facility

1) Drainage Planning

Drainage facilities shall be installed at the locations described in Table 2.2.21. The type of drainage shall be concrete U-shaped side ditches and RC pipe culverts for transverse drainage.

Table 2.2.21 Necessary Places for Drainage Facility

Type	Place
Side ditch	- Both ends of approach road - On berm and top toe of cut section
Transverse drainage	- Places where approach roads cut off existing drainage

2) Design Conditions

The design conditions for drainage facilities are described in Table 2.2.22.

Table 2.2.22 Design Conditons for Drainage Facilities

Items	Contents	Remarks
Formula for discharge volume	Rational Formula Q = 0.278CIA C: Run off coefficient, I: Rainfall intensity, A: Area	Applicable less than $5km^2$
Formula for time of flow	$Tc = (0.87L^3/H)^{0.385}$ H: Height difference, L: Distance	
Return period	5 years	
Rainfall intensity at designated return period	I = 120mm/hr	A value applied in the Northern Economic Corridor Project

(8) Other Facilities to be Incorporated into Project

Table 2.2.23 summarizes the necessary facilities to be incorporated into the Project. Whereas some facilities are provided in order to improve safety, others are provided as mitigation measures to alleviate inconvenience to villagers.

Table 2.2.23 Other Facilities to be Incorporated into Project

Facility	Contents	Effect	Remarks
1.Guardrail	Before bridge section	To prevent vehicles from running off of road	Embankment sections 3m or more in height
2. Intersection plan	Intersections between new & existing approach roads	Provision of safe access to existing road	
3. Bus bay	Bus bays on both sides	Provision of new bus bays to replace existing ones	Left bank
4. Path for daily life	Access to new approach road from existing road	Mitigation measure to remedy segmentation of existing road by new approach road	Around No2+20 (Right bank)
	Access to new approach road from existing road	Ditto	Around No.4+00 (Right bank)
	Replacement of existing road	Ditto	Around No.4+7 (Right bank)
	Replacement of existing road	Ditto	No.7 - No8+60 (Left bank)
	Access to new approach road from existing road		Around No8+60 (Left bank)

2.2.3 Basic Design Drawings

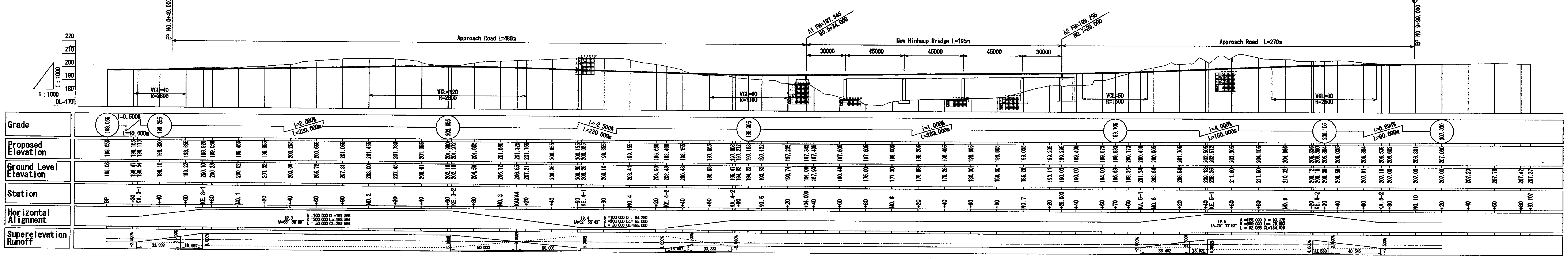
Table 2.2.24 shows the drawing list for the basic design of both the bridge and approach roads.

Table 2.2.24 Drawing List

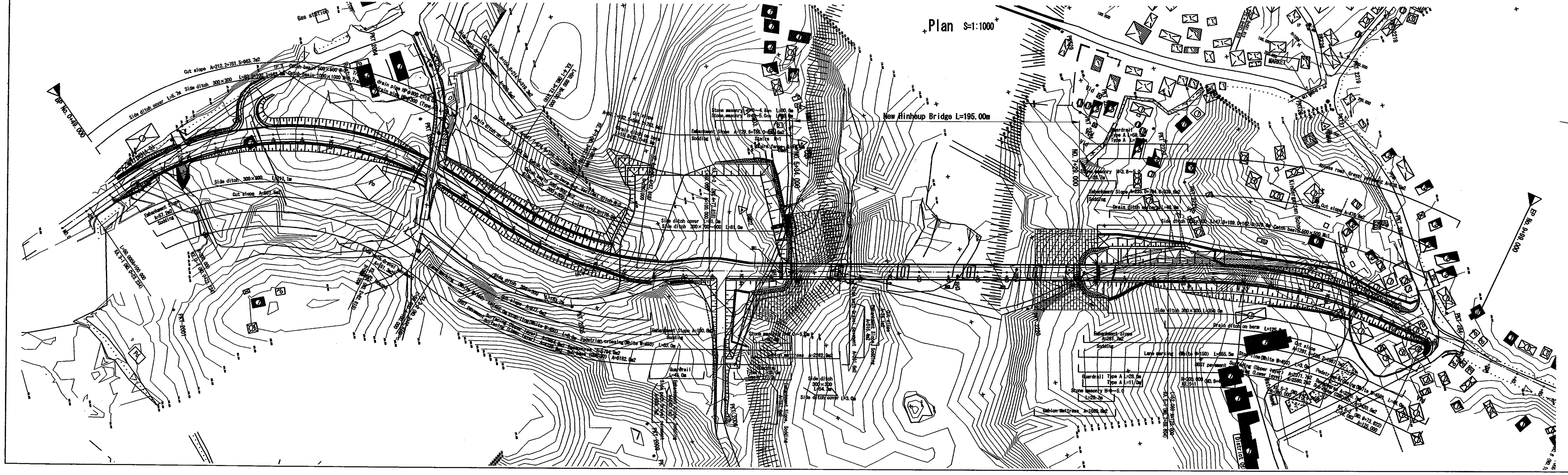
Drawing No.	Name of Drawing
1	General View of Bridge and Approach Roads
2	General View of Bridge
3	General View of Superstructure
4-6	PC Bar Arrangement Plan (necessary for erection stage) for Main Girder (1)-(3)
7-12	PC Cable Arrangement Plan(necessary for design loads) for Main Girder(1)-(6)
13	PC Cable Arrangement Plan for Transverse Beam
14	PC Cable Arrangement Plan for Upper Slab
15-16	General View for A1 Abutment(1)-(2)
17	General View for P1 Pier
18	General View for P2Pier
19	General View for P3 Pier
20	General View for P4 Pier
21-22	General View for A2 Abutment (1)～(2)

General View of Bridge & Approach Road

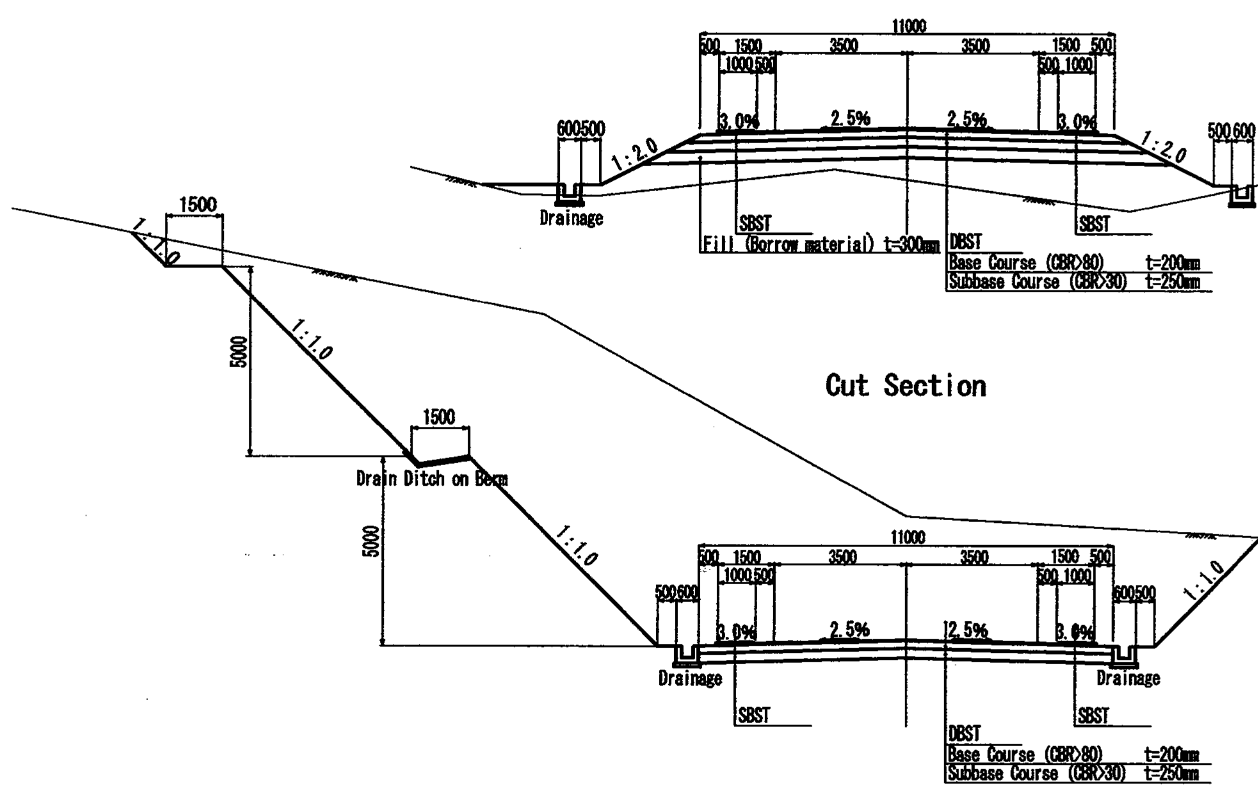
Profile V=1:1000 H=1:1000



Plan S=1:1000



Typical Cross Section S=1:100



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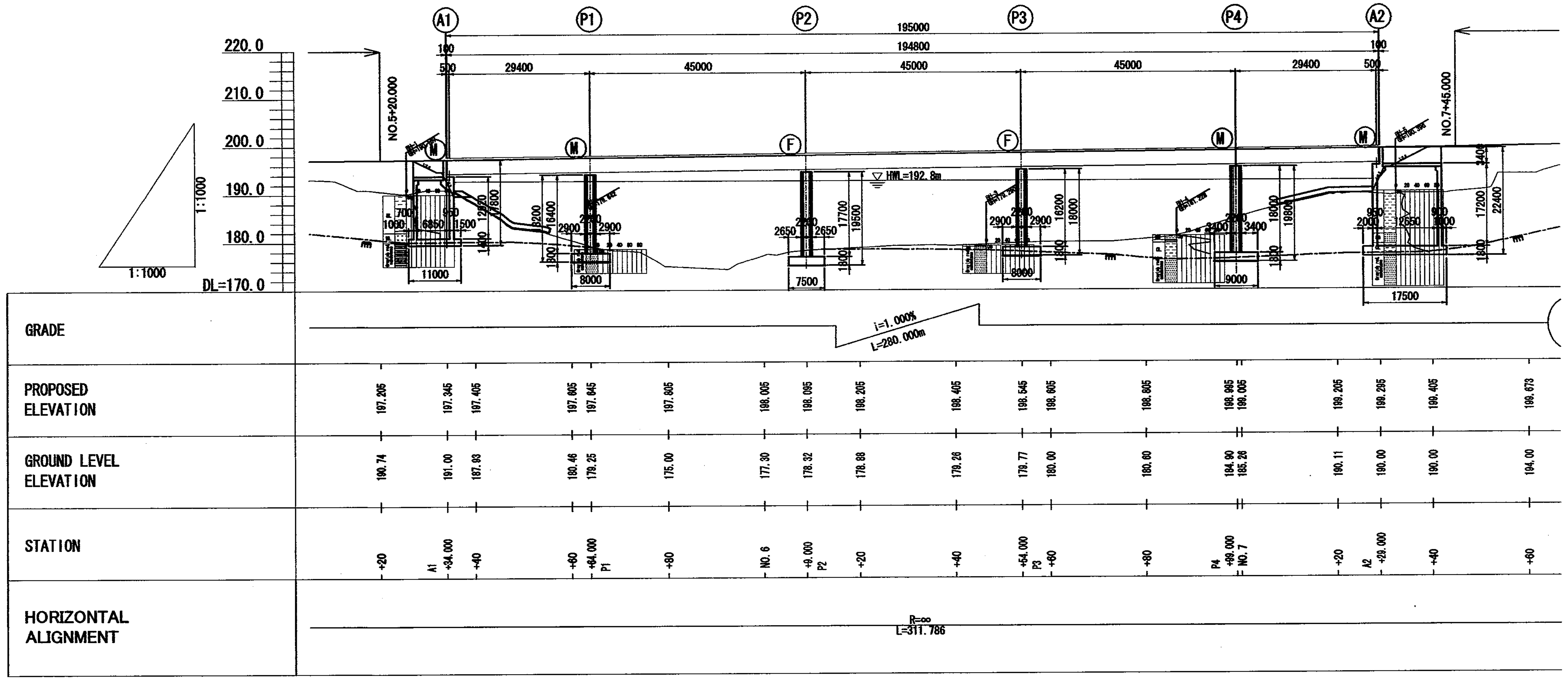
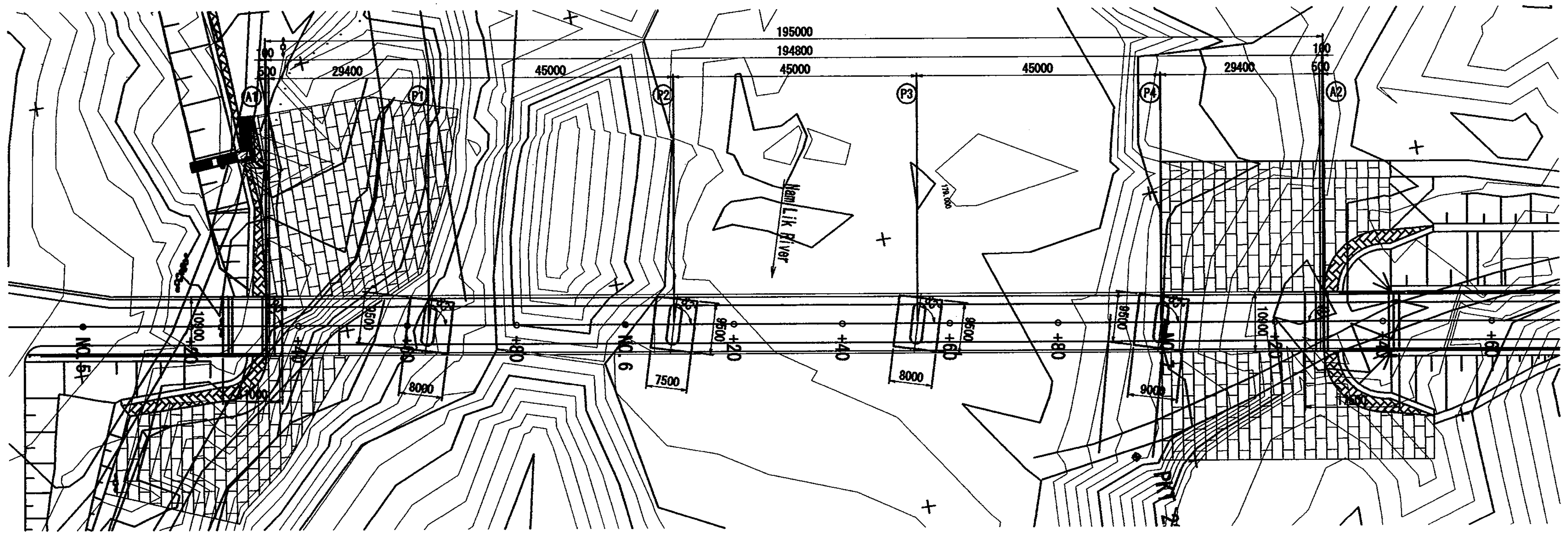
MINISTRY OF COMMUNICATION, TRANSPORT, POST & CONSTRUCTION		
The Project for Construction of the Hinheup Bridge on National Road 13		
GENERAL VIEW OF BRIDGE & APPROACH	Scale	
	Drawing No.	
Oriental Consultants Co., Ltd In association with Nippon Koei Co., Ltd		
Drawn by	Checked by	Approved by

GENERAL VIEW OF THE BRIDGE

PROFILE S=1/500

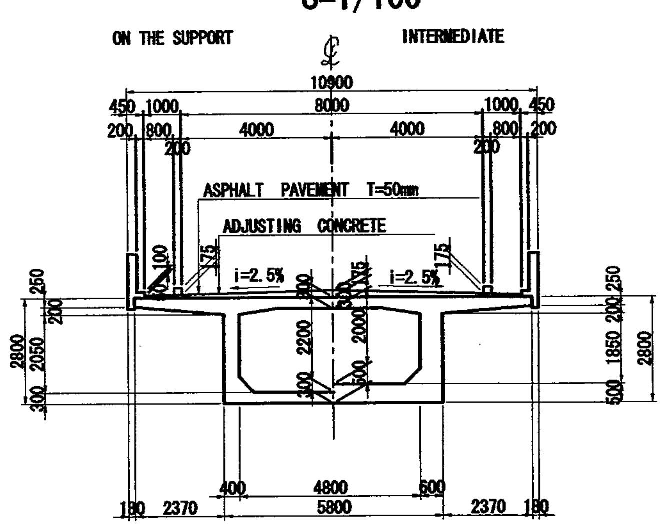


PLAN S=1/500



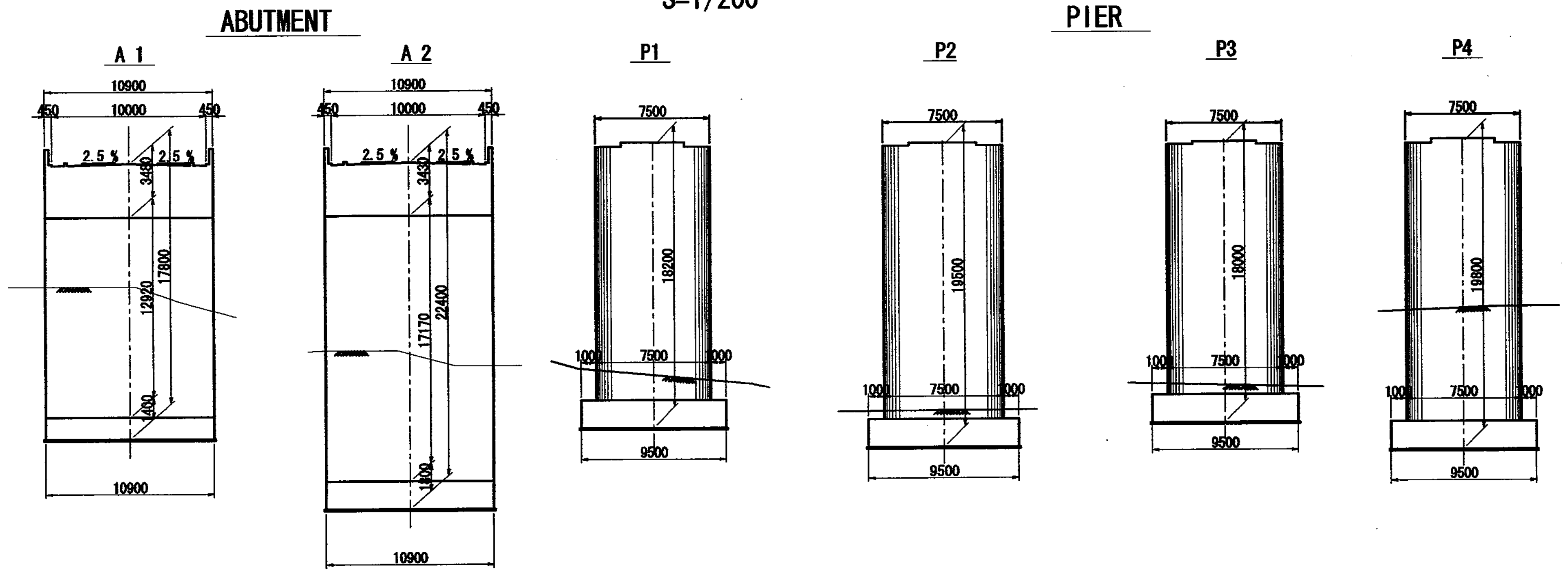
CROSS SECTION

S=1/100



FRONT VIEW

S=1/200



DESIGN CRITERIA

Road Class & Design Speed	Class III(Rolling), V=60km/h		
Bridge Length (Span Length)	195.00m(29.40m+3@45.00m+29.40m)		
Bridge Width	Carriageway:8.00m, Footpath:2@1.00m		
Pavement	Asphalt Concrete t=50mm		
Longitudinal Gradient	+1.0 %		
Cross-fall of Carriageway	2.50 %		
Superstructure Type	5 span Continuous PC Box Girder		
Substructure Type	Abutment	Box Type	
	Pier	Wall Type	
Foundation Type (Bearing Stratum)	Abutment	A1 , A2 : Spread Foundation (Sand Stone)	
	Pier	P1 , P2 , P3 , P4: Spread foundation (Sand Stone)	
Material Strength			
Superstructure	Girder		σ28=40N/mm²
	Cross Beam		σ28=40N/mm²
	Slab		σ28=40N/mm²
Surface Facility	Curb , Handrail , Adjusting Concrete		σ28=21N/mm²
Substructure			σ28=21N/mm²
Reinforcing Steel			SD295 (py=295N/mm²)
Pre-stressing Steel	Girder	Φ32(SBPR930/1180) 12S15.2mm(SWPR7BL)	
	Cross Beam	1S28.6(SWPR19L)	
	Slab	1S28.6(SWPR19L)	

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MINISTRY OF COMMUNICATION, TRANSPORT, POST & CONSTRUCTION
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GENERAL VIEW OF THE BRIDGE	Scale
	Drawing NO.

Oriental Consultants Co., Ltd
In association with Nippon Koei Co., Ltd

Drawn by	Checked by	Approved by

STRUCTUAL VIEW OF BOX GIRDER (1) S=1/100

PLAN

SIDE VIEW

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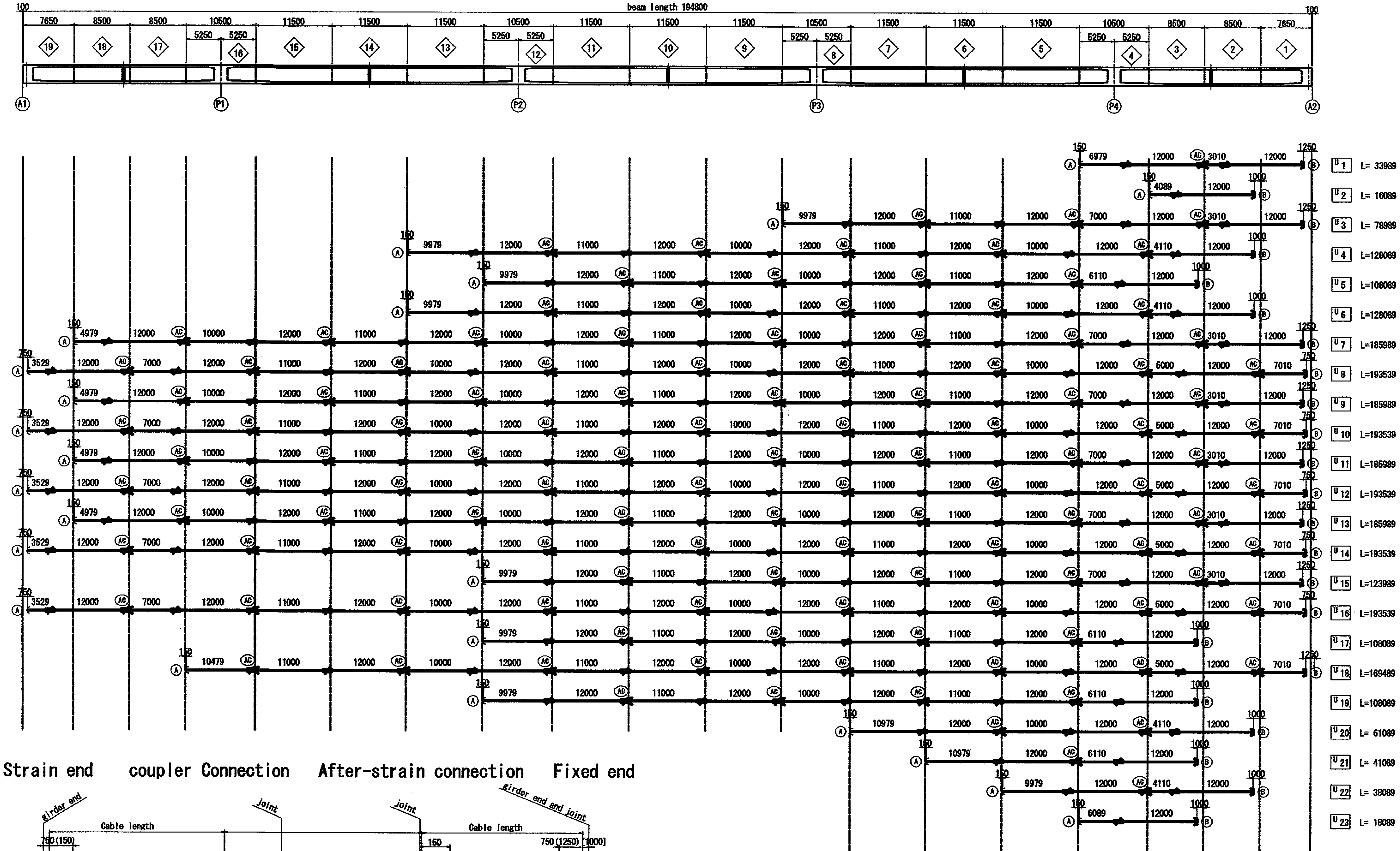
BASIC DESIGN STUDY ON THE PROJECT FOR CONSTRUCTION OF NEW HINHEUP BRIDGE ON NATIONAL ROAD 13			
STRUCTUAL VIEW OF BOX GIRDER (1)		SCALE AS SHOWN	DRAWING NO.
ORIENTAL CONSULTANTS COMPANY LIMITED NIPPON KOEI CO., LTD.			
DRAWN BY	DESIGNED BY	PROJECT MANAGER	APPROVED BY

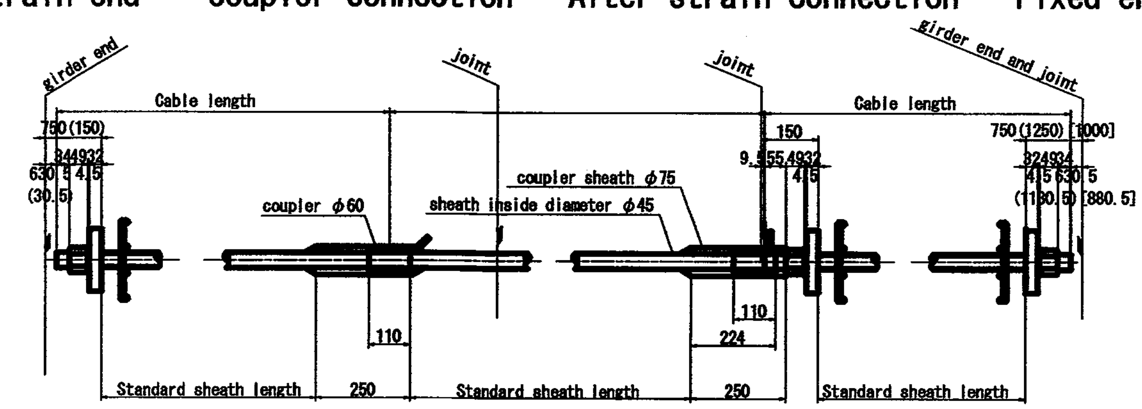
PC BAR ARRANGEMENT OF GIRDER (1) S=1/300

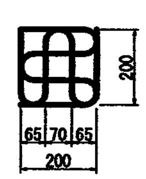
(32 mm SBPR 930/1 180)

upper slab



Strain end　　coupler Connection　　After-strain connection　　Fixed end





2-φ10x914

Ⓐ	Strain end	[
Ⓑ	Fixed end	]
Ⓐⓒ	After-strain connection	
	Grout pipecoupler sheath	L=250mm
	〃	〃

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BASIC DESIGN STUDY ON THE PROJECT FOR CONSTRUCTION OF NEW HINHEUP BRIDGE ON NATIONAL ROAD 13

PC BAR ARRANGEMENT OF GIRDER (1) — SCALE 1/300 — DRAWING NO.

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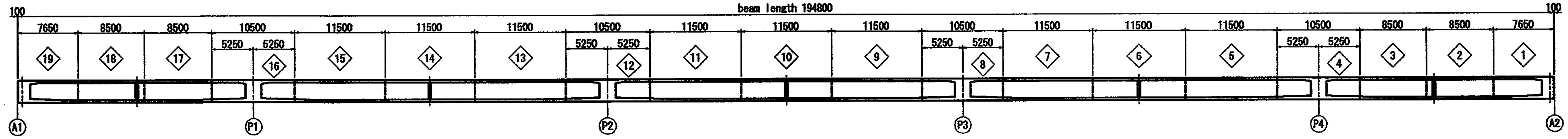
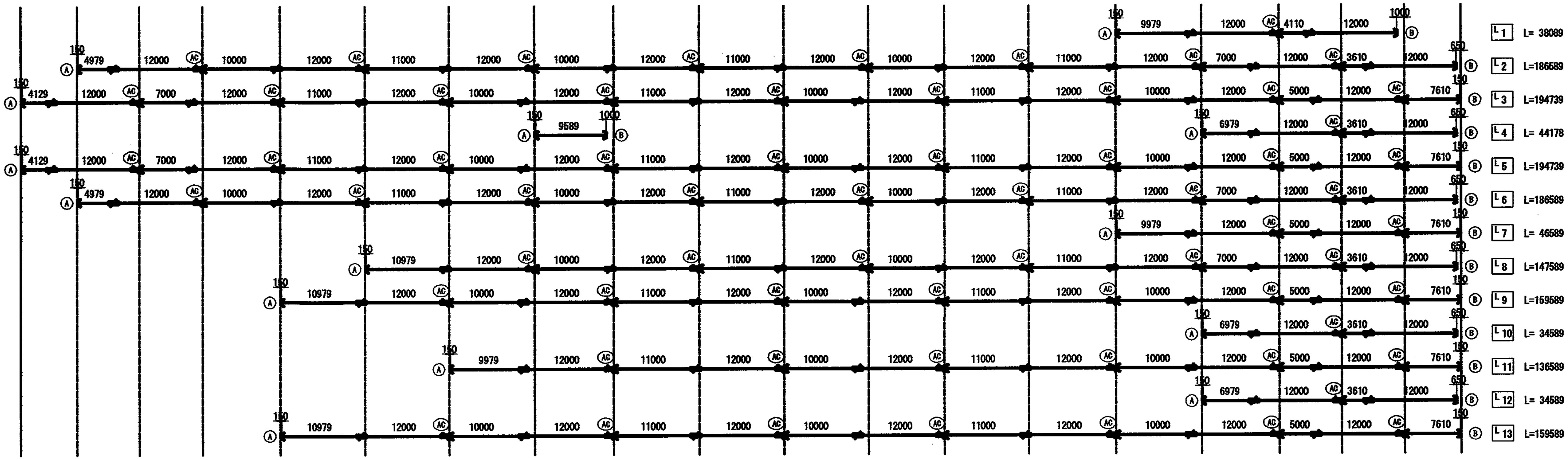
PC BAR ARRANGEMENT OF GIRDER (2) S=1/300

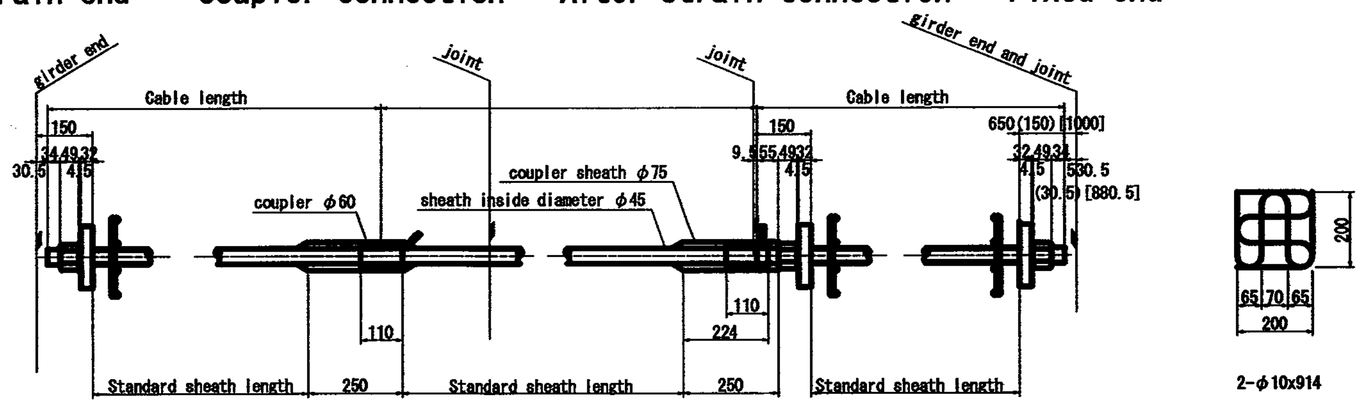
(32 mm SBPR 930/1 180)

bottom slab





Strain end　coupler Connection　After-strain connection　Fixed end



Ⓐ Strain end
Ⓑ Fixed end
Ⓐⓒ After-strain connection
Grout pipecoupler sheath L=250mm
〃 〃

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THE LAO PEOPLE'S DEMOCRATIC REPUBLIC

BASIC DESIGN STUDY ON THE PROJECT FOR CONSTRUCTION OF NEW HINHEUP BRIDGE ON NATIONAL ROAD 13

PC BAR ARRANGEMENT OF GIRDER (2)　SCALE 1/300　DRAWING NO.

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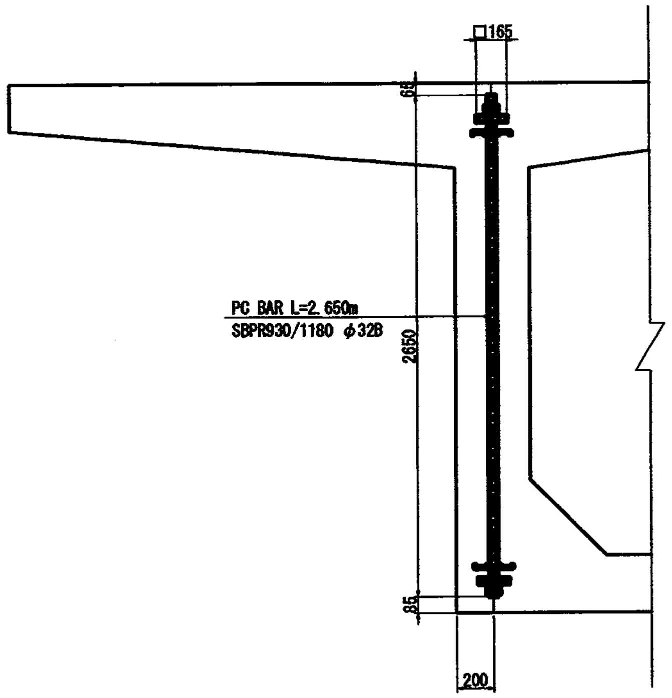
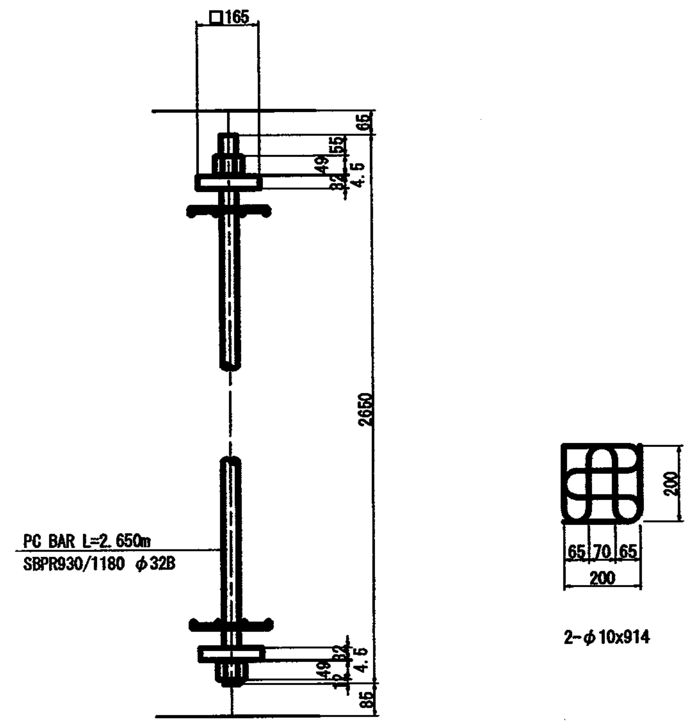
PC BAR ARRANGEMENT OF GIRDER (3)

SECTIONAL VIEW S=1/20



DETAIL OF ANCHORAGE S=1/10



PC BAR SBPR930/1180 φ32 B

Length (m)	Number	Weight (kg/m)	Weight (kg/one)	Weight (kg)
2.650	48	6.31	16.722	803
		All Weight	Σn=48	ΣW=803

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PC CABLE ARRANGEMENT OF GIRDER (2) S=1/50

SIDE VIEW

PLAN

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