No.

THE BASIC DESIGN STUDY
ON
THE PROJECT
FOR
THE REHABILITATION OF NATIONAL ROAD NO. 7
KOMPONG CHAM
IN
KINGDOM OF CAMBODIA

FINAL REPORT

JANUARY 2001

JAPAN INTERNATIONAL COOPERATION AGENCY

NIPPON KOEI CO., LTD.

PACIFIC CONSULTANTS INTERNATIONAL

PREFACE

In response to a request from the Government of the Kingdom of Cambodia,the Government of Japan decided to conduct a basic design study on the Project for Rehabilitation of National Road No.7 Kompong Cham and entrusted the Study to the Japan International Cooperation Agency (JICA).

JICA sent to Cambodia a Study Team from July 17 to August 27, 2000.

The Study Team held discussions with the officials concerned of the Government of Cambodia, and conducted a field study at the study area. After the Study Team returned to Japan, further studies were made. Then, a mission was sent to Cambodia 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 Kingdom of Cambodia for their close cooperation extended to the teams.

January 2001

Kunihiko Saito
President
Japan International Cooperation Agency

January 2001

LETTER OF TRANSMITTAL

We are pleased to submit to you the basic design study report on the Project for the Rehabilitation of National Road No.7 Kompong Cham in the Kingdom of Cambodia.

This Study was conducted by Nippon Koei Co., Ltd., in association with Pacific Consultants International under a contract to JICA, during the period from July 12, 2000 to February 26, 2001. In conducting the Study, we have examined the feasibility and rationale of the Project with due consideration to the present situation of Cambodia 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,

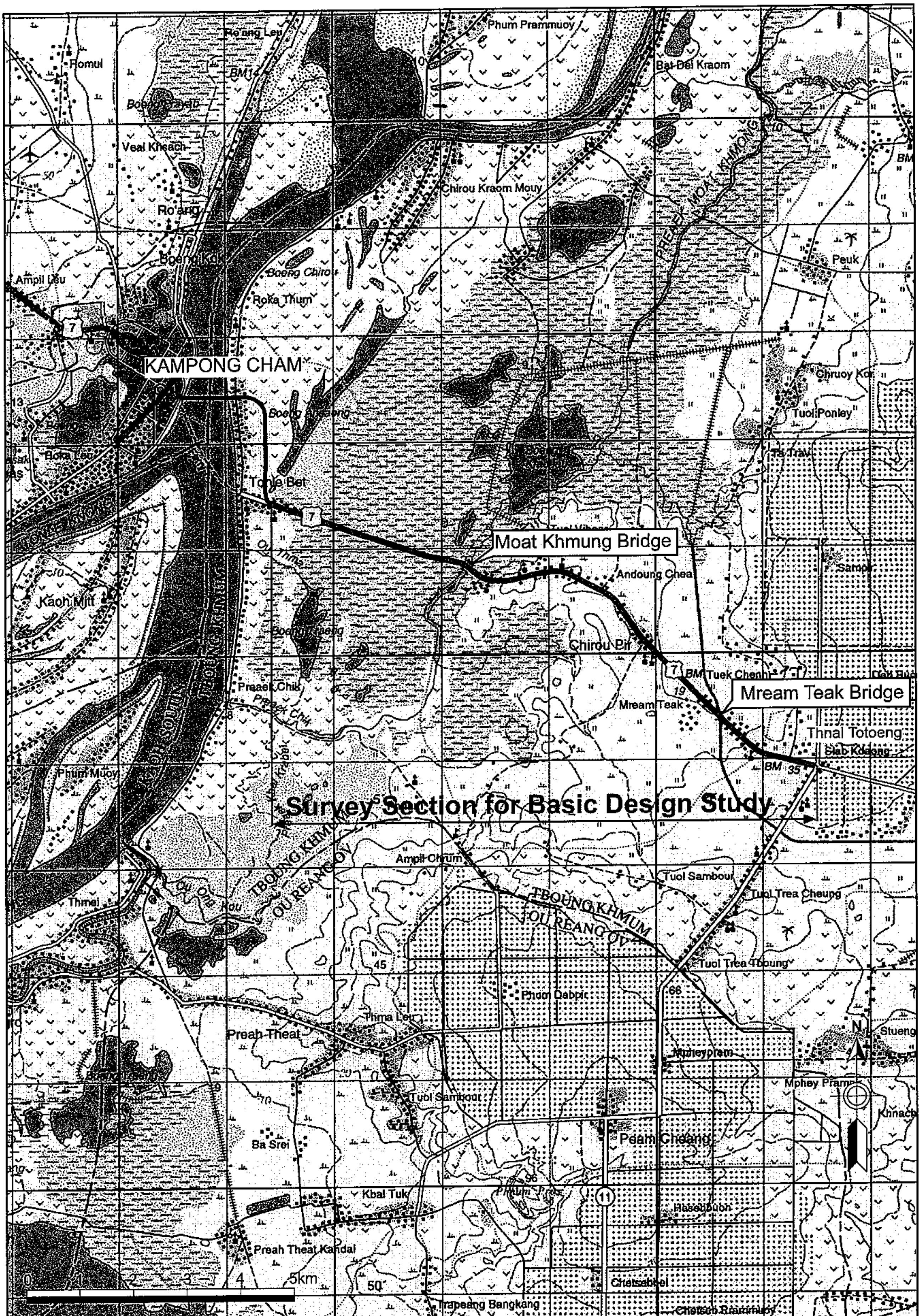
多田一正

Kazumasa TADA

Project Manager

Basic Design Study Team on
The Project for Rehabilitation of National Road No.7 Kompong Cham
In Kingdom of Cambodia

Nippon Koei Co., Ltd.
In association with
Pacific Consultants International



BASIC DESING STUDY ON THE REHABILITATION OF NATIONAL ROAD NO. 7, KAMPONG CHAM IN KINGDOM OF CAMBODIA	LOCATION MAP

PERSPECTIVE VIEW OF MOAT KHMUNG BRIDGE

Pic. 1 Moat Khmung Bridge in rainy season

Pic.2 Existing Road

Pic.3 Moat Khmung Bridge in dry season

ABBREVIATIONS

ADB	Asian Development Bank
C. box-girder bridge	Continuous box-girder bridge
CBR test	California Bearing Ratio test
C. composite girder bridge	Continuous composite girder bridge
C. girder bridge	Continuous girder bridge
EIA	Environmental Impact Assessment
EL	Elevation Level
E/N	Exchange of Notes
HWL	High Water Level
i	Gradient
JICA	Japan International Cooperation Agency
M-Bridge	Moat Khmung Bridge
MPWT	Ministry of Public Works and Transport
MT-Bridge	Mream Teak Bridge
O-D survey	Origin-Destination Survey
PC	Prestressed Concrete
R	Radius
RC	Reinforced Concrete
WL	Water Level

BASIC DESIGN STUDY REPORT
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Figures and Tables

CHAPTER 1 BACKGROUND OF THE PROJECT

The Kingdom of Cambodia is located in almost the center of the Indochina Peninsula with an area of 181,000 km^2 and population of 10.70 million , with approximately 1 million people living in Phnom Penh, the capital city. Most parts of the country are situated in the Mekong river basin

Although this country has been devastated due to the civil war in the 1970s, restoration works has been implemented through effort of many countries and assistant organizations in the wake of the ,outbreak of political friction in 1997 following general election in 1998.

As the first bridge in Cambodia crossing over the Mekong River, is scheduled to be completed by the March of 2002, economic development in the eastern side of the Mekong River is expected to increase traffic volume on Route 7 extending to Vietnam and Laos.

Route 7 covering the east side of the Mekong River, which transverses amid the flooding area of the River, is in danger of devastation due to flooding in the rainy season, which starts from July up to October. As the Moat Khmung bridge is the only passage channel to this flooding water around the eastern area of the Mekong River, this bridge is prone to collapse with violent current. In fact, in 1998, the some parts of the substructure of this bridge collapsed suddenly due to superannulation of concrete together with superstructure. The Government of Cambodia took quick countermeasures to repair this collapsed portion with temporally structures but it is still in a very dangerous situation to the extent that overloaded vehicles may collapse this bridge because of absolute insufficient of duability of loading/

With this background, the Government of Cambodia requested Japanese Grant Aid to the Government of Japan in November, 1998 to fund the following work:

- rehabilitation of road on Route 7 totaling 11.5 km
- rehabilitation of the Moat Khmung bridge
- rehabilitation of the Mream Teak bridge

CHAPTER 2 CONTENTS OF THE PROJECT

2-1 OBJECTIVES OF THE PROJECT

The Mekong Bridge in Cambodia is to be completed by March 2002 at Kompong Cham city 120km from the capital city, Phnom Penh, thanks to Japan Grant Aid. This bridge will connect east side and west one of Cambodia divided by the Mekong River. A two lane highway paved by asphalt concrete has also been constructed with Japan Grant Aid from Phnom Penh to Kompong Cham through Route 6 and 7.

This Project is to study the rehabilitation of the Route 7 totaling 11.5km between the ferry station on the east side of the Mekong River and the junction with Route 11. Some parts of this road section towards the Mekong River are situated in flooding area in which existing Route 7 was built about 60 years ago. Flooded water from the Mekong River flows down at Moat Khmung Bridge located almost at the middle point of the objective study area and conflows again with the Mekong River approximately 5km downstream.

Route 7 on the east side of the Mekong River is to reach Vietnam and Lao, where rehabilitation works are developed with ADB fund from 2000 year.

In the light of road network system in Cambodia, this Project is understood as follows; this road composed with major trunk road connecting this country from the parts of southern area to that of northern area, namely, from Krong Preah Sihanouk, import and export oriented port in Cambodia, through Phnom Penh and Kompong Cham to the border of Vietnam and Lao. At the same time, this road will surely contribute to international network penetrating amid the Indochina Peninsula as listed for Asian Highway A-11.

The characteristics of this Project can be summarized as follows:

- this road has geographical property crossing over flooding area
- from the point of views in road networks, it is a major network internationally and domestically.

The Moat Khmung Bridge collapsed from an explosion driving the civil war in the1970s and one of the concrete piers was washed away due to recorded flood in 1996, and further more it collapsed again in August 1998 because of a decrepit concrete substructure.

The Moat Khmung Bridge of which durability is judged to be low including study section can expect to see increase traffic volume with the completion of the Mekong Bridge to be opened in March 2002. Taking into consideration future traffic increase and present structural safety of Moat Khmung Bridge, the object of this Project is to plan proper facilities with situation of natural conditions such as flooding area.

2-2 BASIC CONCEPT OF THE PROJECT

2-2-1 Outline of the Government of Cambodia's Request

The Government of Cambodia requested the Japanese Grant Aid to the Government of Japan November 1998 for rehabilitation of Route 7 between the ferry station at the east side of the Mekong River and junction with Route 11, totaling 11.5 km for the purpose of meeting with future increasing traffic demand. Major contents in this request are as follows:

- rehabilitation on road section
- rehabilitation of Moat Khmung Bridge
- rehabilitation of Mream Teak Bridge

2-2-2 Basic Conditions To Formulate the Scheme

In accordance with the request solicited by the Government of Cambodia, the Basic Design Study Team, dispatched to the Cambodia from 17th June up to 27th August 2000, has surveyed the flooding area from the4 fixed survey point and observed this flooding area along the Mekong River over a chartered helicopter on August 19. After the Study Team returned to Japan, staffs of adjoining Mekong Bridge construction supervision office managed Nippon Koei Consultant succeeded fix observation survey to catch datum on the severest situation at the highest water level marked at 19th September 2000 in which water level in Mekong River at the gauge station on Kompong Cham reached to 15.90m height, compared with 16.11m height reached in 1996.

The Study Team have also conducted geotechnical investigation, topological survey, traffic volume survey, and so on.

After site survey in Cambodia, the Study Team has judged the following items in consideration with the request by the Government of Cambodia.

- Moat Khmung Bridge and Mream Teak Bridge needed to be reconstructed
- Section between ferry station at east side of Mekong River and end point with approach road of Mekong Bridge road totaling approximately 800m long will be excluded from study, because the major traffic stream will change to the newly constructed Mekong Bridge approach road, which is expected to be completed by March 2002, from existing road to ferry station.

It is judged to be proper that this excluded section is incorporated in the port rehabilitation project.

2-2-3 Basic Design Concept in Planning Facilities within Flooding Area

The existing Route 7 from east side of Mekong River to the direction of Vietnam and Lao was constructed more than 60 years ago without drastic damage such that road in the flooding area had washed away.

It is considered that the Moat Khmung Bridge fulfil such a function that this bridge is the only flux zone in the vast flooding area in which the Route 7 is crossing over amid the flooding area as if it would be same kind of dyke.

The Moat Khmung river which flows through the flooding area, enters it approximately 7 km upstream as a branch of the Mekong River. In addition, water of Mekong River inundate to flooding area over the bank of Mekong River depending upon water level、then the Moat Khmung river has again returned to the Mater Mekong at approximately 5km downstream.

Based on the variety of datum obtained during site survey, no alternation of the current situation should be adopted to the principal of design on facilities such as road and bridge in the flooding area.

2-2-4 Selection of Optimum Project Scheme

(1) Applied Design Criteria

It has been agreed upon with the Cambodian Government that the criteria for the design to be applied to the renovation of the segment of National Route 7 in Kompong Cham is to follow Japanese design specifications in consideration of the efficacy of other projects implemented by Japanese aid. The specifications to be applied will be according to the following references:

- Road Structure Ordinance（Japan Road Association）
- Specification for Highway Bridges（Japan Road Association）
- Government Ordinance for Structural Standards for River Administration Facilities（Japan River Association）
- Design Manual for Asphalt Pavement（Japan Road Association）

(2) Cross Section

The composition of the cross section is fixed in accordance with projects administered in Cambodia meeting with the standards of Cambodian road design and with regards to future traffic activity and volume.

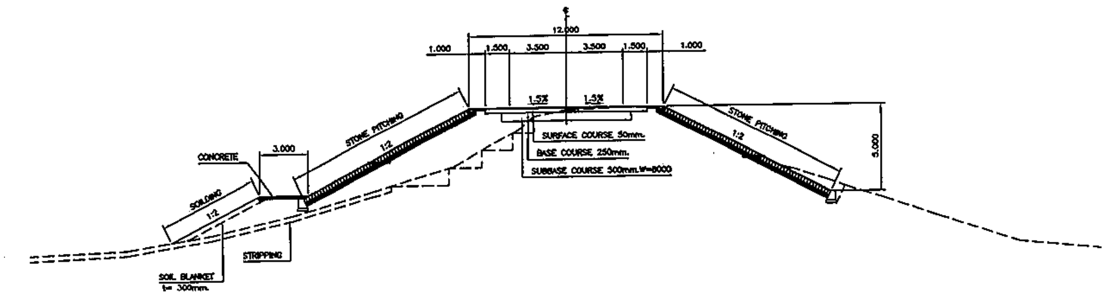


Fig. 2.2.4.1 Typical Cross Section for Road

(3) Road Plan

1) Traffic Volume Survey

a) The Survey

The traffic volume survey was carried out over the second Tuesday, Wednesday, and Saturday in August; in other words two normal working days and one holiday. The origin-destination analysis from this survey provided the following results.

Type of survey	OD survey at west bank ferry terminal	OD survey at east bank ferry terminal	Traffic volume at Moat Khmung Bridge	Traffic volume at intersection of Routes 7 and 11
Time of survey	AM6:00～PM6:00	AM6:00～PM6:00	AM6:00～PM6:00	AM6:00～PM6:00
Method of survey	Interview of drivers boarding ferry	Interview of drivers boarding ferry	Traffic volume count	Traffic volume count by direction

According to the original origin-destination survey plan, the survey was to take place at only one location, but in order to procure more precise information, the survey was carried out on both banks. Furthermore, the origin-destination and traffic volume surveys were conducted by the staff of the local Kompong Cham Public Works as on-the-job training and data was put together by this staff with local counterparts. The results of the survey are as follows. The locations of traffic survey are shown below.

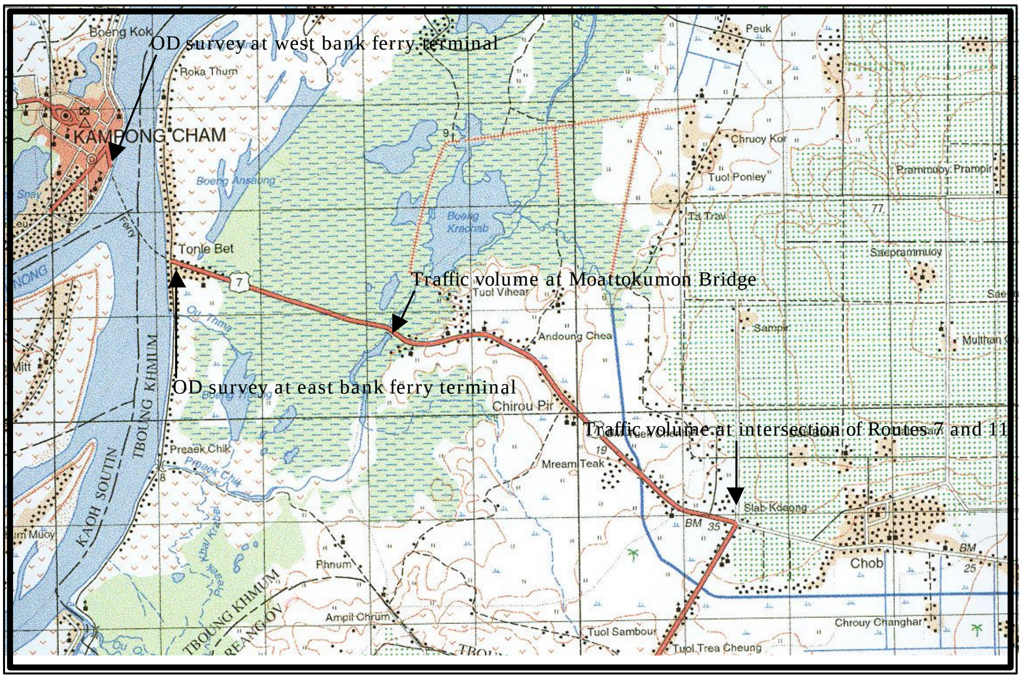


Fig.2.2.4.2. Location of Traffic Survey

b) Results of Traffic Volume Survey

The results of survey conducted at Moat Khmung Bridge are shown below.

Table2.2.4.1 Traffic Survey Results

TYPE \ DATE	2000/8/01		2000/8/03		2000/8/05	
	To: KC	To:JCT	To: KC	To:JCT	To:KC	To:JCT
Bike/Motorbike	1185	1183	1258	1203	1233	1262
Car/Minibus	238	251	203	222	252	216
Truck（2Axle）/Bus	78	95	89	74	104	97
Truck（3Axle）/Bus	29	37	42	44	74	56
Total of 4 wheel	**345**	**383**	**604**	**340**	**430**	**369**
Total	**1530**	**1566**	**1862**	**1543**	**1663**	**1631**

Note To: KC（Kompong Cham direction） To:JCT（No.11 Junction direction）

The characteristics seen as the result of the survey at this location are considered in the following manner:

- There is very little difference in the traffic volume of either direction.
- The survey was only conducted during the daytime as it is said that traffic virtually ceases as the ferry service does not operate at night and it is not safe to go out after dark. Therefore, daily traffic volume is considered to be about 1.2 times the 12-hour traffic volume.
- The traffic peak of two-wheeled vehicles is morning and evening, but four-wheeled vehicles ply the roads at a more constant rate. This is related to the fact that the ferry is the only means of crossing the river. Therefore, traffic characteristics could change drastically after the opening of the Mekong Bridge.
- In terms of vehicle type, two-wheeled vehicles are by far the greatest in number, and the number of passengers in one four-wheeled vehicle tends to be large. Mini-buses as well as trucks tend to carry excess weight and cargo or people fill vehicles to the roof.

c) Traffic Volume Survey at Junction According to Direction

A traffic volume survey according to travel direction was carried out at the intersection of Routes 7 and 11. This was to confirm the chief direction of travel and to predict possible future changes of traffic flow. The results of the survey are shown in the following diagram.

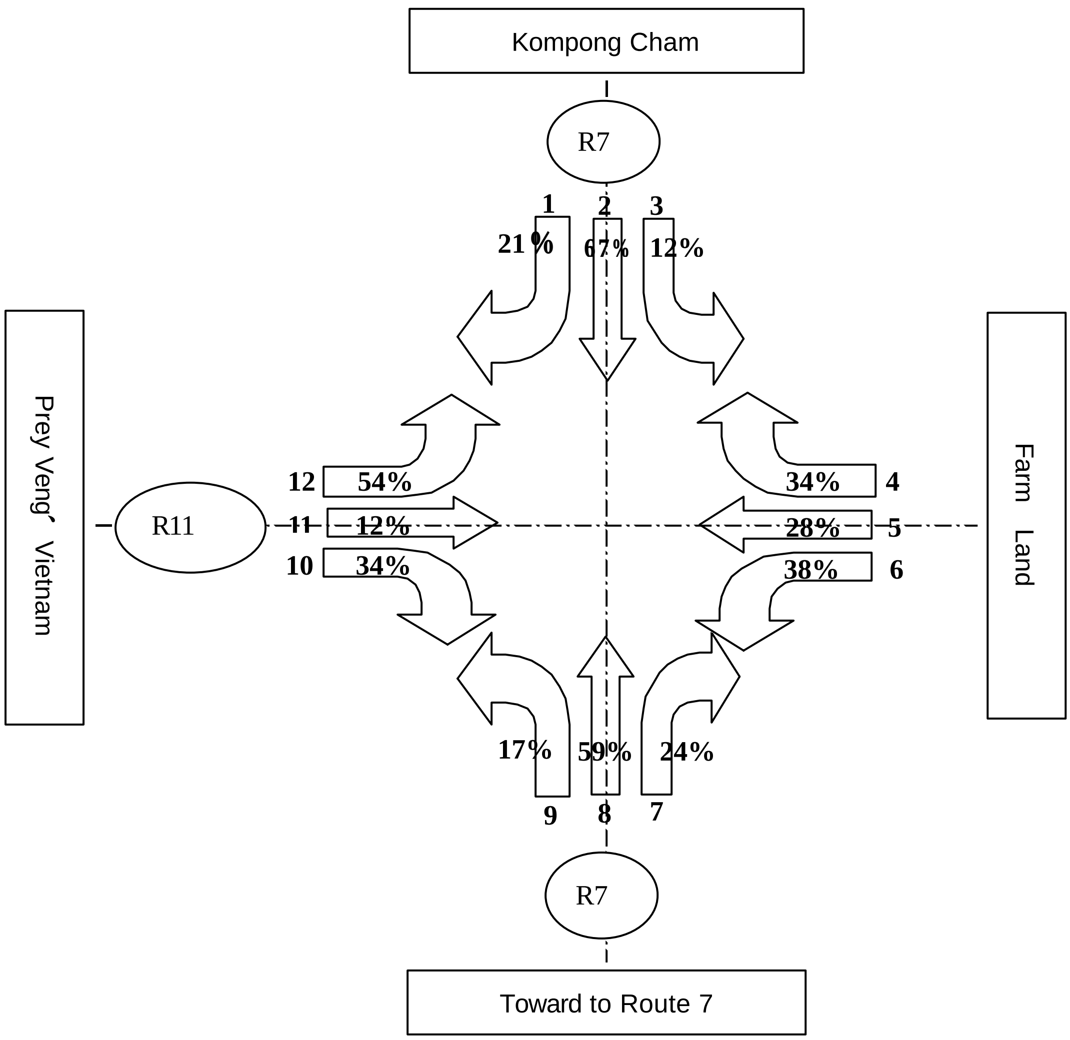


Fig.2.2.4.3 Traffic Volume Survey at Junction According to Direction

Nos. 4, 8, and 12, which lead to Kompong Cham are the main traffic directions from each route. However, as Route 11, which travels in the direction of Vietnam is not actually functioning as a complete route as the Mekong Bridge is not yet open to traffic; therefore traffic volume is still small. Route 7 does lead to Vietnam, but it is in poor condition and far from Ho Chi Minh City; therefore there is little shipment of cargo to Vietnam, or to Laos along the two ways in that direction.

d) Results of Origin-Destination Survey

The following facts were gleaned as a result of the O-D survey.

- International cargo shipment is insignificant.
- For trips originating in rural areas, almost all the destinations are Phnom Penh or Kompong Cham.
- For trips originating in Phnom Penh or Kompong Cham, large numbers are destined for rural villages or Vietnam border towns.
- Shipments from the provinces are mostly agricultural products, while shipments from the cities are consist mostly of conveniences.
- The volume of passengers and cargo in vehicles are in most cases in excess.
- Trailers are few, due to constraints of ferry travel.

The above was confirmed as the basic mode of travel along Route 7. These trends do not depart significantly from survey results of Routes 6, 7, and the Mekong Bridge conducted in the past.

The results of these surveys are presented in the appendix of this report as reference materials.

2) Existing Road Conditions

The section of road involved in this Project is a 11.5 km stretch from the ferry terminal at Kompong Cham to the intersection of Routes 7 and 11, in both directions. The area of the ferry terminal is occupied by shops, eating establishments, and residences, and is somewhat higher in elevation than the surrounding area. The area above this is where the runoff water flows into the Mekong River. East of the ferry terminal, Route 7 runs along the runoff streams as a sort of levee. Up to Moat Khmung-Bridge, landfill along both sides of the road supports rows of houses. However, a large number of these are illegal occupants, concentrated at what should be the crown of the levee as a measure for flood protection. The road surface is extremely poor and in total disrepair, getting worse every day of the rainy season. The climate is hot and humid, encouraging rich vegetation growth which grows quickly. This ecological environment merits some protection. Passing Moat Khmung Bridge, the surroundings become a more undulating plain over which are scattered vegetable patches and military camps. Residences and shops are seen at places along the road, but buildings which effect the road itself are few. The road is slightly higher in elevation than the plots of land adjacent to it and is paved; therefore precipitation runoff from the road very likely flows into the adjacent plots, and there could be a need to consider efficient drainage measures. Mream Treak Bridge is a culvert structure in form, using a drainage-pipe structure for irrigation purposes. This is an irrigation facility used in the dry season to draw water into irrigated areas, so its function needs to be retained. From Mream Treak-Bridge to the Route 11 intersection the road follows a gentle upgrade. There are houses along the road, but few pose any problems. The area of the intersection forms a small settlement, and residences and shops are concentrated along a 200 m stretch. As the period of construction is yet unclear, there is no discussion regarding the improvement of the intersection in this report.

3) Road Plan

Proposals for the road plan will be carried out according to the following criteria.

- A road alignment designed in consideration of the surrounding environment
- A road alignment which would not cause worse flooding than experienced in 1996

As seen in the present condition of the road, it can be divided into a embankment segment and an earthworks segment. As a result of confirming the strength of the embankment itself along the embankment segment, the longitudinal alignment is to be kept at its present elevation as much as the situation permits. In light of the fact that this road has maintained itself over a period of 50 years, its structure should be maintained and structurally reinforced where necessary. Road widening is planned to minimize impact upon ecological conditions and residences, and bridges and other non-relocatable facilities, etc.,will serve as control points and land to be newly acquired for construction is kept to a minimum.

(4) Bridge Plan

1) The Moat Khmung Bridge

a) Situation Regarding the Existing Bridge

A part of the existing Moat Khmung Bridge has fallen in the past. Furthermore, piers on the Vietnam side of the bridge were destroyed by scouring at the time of record floods at the end of September 1996, but the bridge was kept from falling by the fact that it is a continuous bridge. Then in August 1998, concrete piers on the Cambodian side collapsed, bringing down the concrete superstructure with it. Three months later, however, the bridge was restored as a temporary truss bridge. As for the substructure, the pier was restored with shaped steel. That is how the bridge now stands.

When the water level rises in the rainy season, they have to restrict passage of large vehicles because of oscillation of the substructure caused by the flowing water.

b) Evaluation of the Existing Bridge

As mentioned above, except for a part of the substructure, both the superstructure and the substructure of the present Moat Khmung Bridge are temporary structures. That being the case, it needs to be replaced by a permanent bridge as soon as possible.

c) River Cross Section

i) General

A river cross section is needed to make a plan of the bridge. Principles to determine the river cross section are as follows.

- Not to change the present topography at the Moat Khmung Bridge and around it as much as possible.
- The capability of traffic flow that flows through the new Moat Khmung Bridge should be near that of the present bridge.

ii) River Cross-Section

The actual methods to determine the river cross-section of the

Moat Khmung Bridge are as follows.

- Not to change the width of the riverbed at Moat Khmung Bridge.
- Keep the cross-sectional area under the high water level (EL.16.50m) of present bridge.

The result is shown in the next figure.

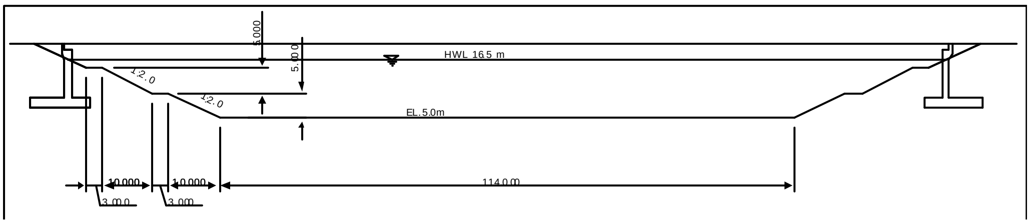


Fig. 2.2.4.4 River Cross Section at the Moat Khmung Bridge

The comparison of characteristics between old bridge and the future one is shown in the next table.

Table 2.2.4.2 Comparison between the existing bridge and the planning

Items	Present	Plan	Remarks
The are of Cross-section	1,616 m^2	1,847 m^2	14%up
The width of river bed	114 m	114 m	Not to change
Slope Gradient of embankment	1:0.8	1:2.0	Should be considered the slope stability
The length of the bridge	154. m	175.0 m	

d) High-Water Discharge

There are no high-water discharge in the Moat Khmung River, so it is estimated from field survey accomplished from 18th July to 18th Aug.

The high water discharge (50-year probability) is 3,800 m^3/s.

e) Selection of Bridge Location

The following are possible alternatives regarding the location for construction of the Moat Khmung Bridge:

i) Construction at the present location of the bridge

ii) Construction at another location:

- Construction at a point 20 m upstream (the minimum distance for making execution of the construction work possible)
- Construction at a point 30 m upstream (the minimum distance for making execution of the construction work easy)
- Construction at a point 20 m downstream (the minimum distance for making execution of the construction work possible)
- Construction at a point 30 m downstream (the minimum distance for making execution of the construction work easy)

A comparative study has been carried out concerning those five alternatives in terms of economic feasibility, ease of execution of the work, and other viewpoints.

Since particularly important elements in such route selection are ease of execution of the work, economy (low cost) and structural safety and stability, those are the points that have been given most attention in the comparative study as shown in the following table 2.2.4.3.

As a result of comparison of those alternatives it has been found that the second alternative is on the whole the best considering such things as cost and stability of the completed structure although it is not the best in terms of ease of accomplishment of the work. That being the case, the location for construction of the planned bridge that has been selected is a point 20 m upstream of the existing bridge.

f) Selection of Type of Bridge

i) Type of Superstructure

In view of the typical river cross section, the bridge length will be L = 175 m, and since the design flood discharge is Q = 3800 t/s, the minimum span length will be l = 34 m. As a result, the possible numbers of spans range from five spans (span length of 35 m) to one span (span length of 175 m).

The optimum bridge type will be decided by comparative study taking into account the following conditions:

- Bridge type that makes for easy maintenance after construction
- Bridge type that is outstanding in terms of low cost
- Bridge type that is outstanding in terms of ease of execution of the work so that the main part of the substructure work can be completed in the first dry season
- Span length that has minimal effect on the river
- Bridge type for which one can expect local procurement and technology transfer effects

The bridge types for inclusion in the comparative study have been selected taking into account the standard applicable effective span table 2.2.4.4:

Table 2.2.4.3 COMPREHENSIVE EVALUATION ON ALTERNATIVES

Item of Evaluation	1 st Alternative (Present location)	2 nd Alternative (20m Upstream)	3 rd Alternative (30m Upstream)	4 th Alternative (20m Downstream)	5 th Alternative (30m Downstream)	Remarks
Executing Condition to Construction	As increasing traffic volume is estimated in the wake of the Mekong Bridge, this alternative combines with detour and ferry system. It is required to study waiting time and capacity of ferry boat. This plan has disadvantageous against required rapid construction of substructure in dry season. ①	When existing bridge is dismantled, this work requires more operational space, but relatively least influence to the new bridge. In case existing bridge is washed away by flood, this plan could avert damage caused by collision of members of old bridge to new bridge. Space obtained between shifted bridge line and existing one will be available to temporally yard. ③	It is obtainable to dismantling space of existing bridge and also available for fabrication yard of concrete girder. ②	It has not only disadvantage of possibility regarding collation of members of old bridge but insufficient working place. ⑤	It has disadvantage of possibility regarding collation of members of old bridge but is obtainable for fabrication yard of concrete girder. bb④	
Construction Cost	②	①	④	③	⑤	
Structural Aspect	③	②	①	⑤	④	
Traficability	③	②	②	②	①	
Comprehensive Evaluation	△	◎	○	△	×	
Present Location (Same as location of existing bridge)	Least information to evaluate durability of existing bridge in order to reinforce bridge makes it difficult to put good reliability on this bridge during using detour. It was reported that existing bridge is about to get damaged while it undertook high water in rainy season 1999. * Substructure had to be completed within the first dry season. * Ferry boat could enter this place when the water level of Mekong River shows the height of 14m. * In case capacity of ferry boat is estimated, considerable big capacity of ferry boat result in costly amount for construction works.					
Alternative(Bridge location is shifted to upstream)	As structural reliability on existing bridge to be used as detour while constructing bridge, it is necessary to avoid some influence to newly constructing bridge at the time of collapse of existing bridge. * It is necessary to examine the validity of shifted length between existing bridge and new one. * It is also required to check the proper minimum length free from score After alternatives shifted to upstream regarding centerline of new bridge from 20m and 30m were examined in terms of construction cost, construction condition and method of reinforcement to existing bridge, alternative shifted 20m was selected.					
Alternative(Bridge location is shifted to downstream)	This alternative has disadvantage in construction cost and problem at collapse of existing bridge being used as detour. From the point of linear alignment, it is superior to others as this plan smoothly connects with new planned road section.					
Considerationsb	The 2 nd Alternative is superior to other one on the whole in terms of structural aspects and economical point although this alternative is medium rank regarding executing condition to construction.					

Table 2.2.4.4 COMPARATIVE STUDY TABLE REGARDING PLACE OF CROSSING OF RIVER (PLACE OF CONSTRUCTION OF BRIDGE)<1/3>

<table>
<tr><td>Comparative routes
Items studied</td><td colspan="3">Alternative 1 : Location at place of existing bridge (construction of detour road)</td><td colspan="3">Alternative 2 : A Parallel Bridge 20 m Upstream</td></tr>
<tr><td>Linear plans</td><td>Planar linearity R = 200m</td><td>Vertical linearity i = 1.0%</td><td>Sight distance L = 75m</td><td>Planar linearity R = 200m</td><td>Vertical linearity i = 1.0%</td><td>Sight distance L = 75m</td></tr>
<tr><td>Topographical and geological situation</td><td colspan="3">· The soil in the vicinity of the place of construction of the bridge consists of layers of sedimentary clay, and the strata have been just about homogenized. Therefore there is little variation in layer formation, and there is hardly any difference between the different routes in terms of this factor of selection of place.</td><td colspan="3">Same as in the case of Alternative 1.</td></tr>
<tr><td>Economic feasibility (construction of detour road, construction of temporary yard, road earth filling work, slope protective work)</td><td colspan="3">②
(1.10)</td><td colspan="3">①
(1.00)</td></tr>
<tr><td>Ease of execution of the work</td><td colspan="3">· This alternative involves a detour road and use of a ferry, and since increase in traffic is expected when the Mekong Bridge is opened for use, it is necessary to study waiting time and ferry transportation capacity.
· Through removal of the existing bridge there is elimination of such problems as the timing of implementation of reinforcement work, which means that there will be less risk involved in making sure of the work execution process.</td><td colspan="3">· There is not exactly sufficient space for removal of the existing bridge, but there would be little influence on the pier of the new bridge.
· Since the existing bridge has low reliability, by building the new bridge upstream of it it will be possible to avoid damage to the new bridge from collision with materials carried downstream in the eventuality of occurrence of damage or even collapse of the existing bridge during the construction period.
· This alternative is superior to alternative 1 in terms of securing construction time in that it will be possible to carry out the reinforcement work on the existing bridge (during the dry season) at the same time as execution of the substructure work on the new bridge.
· This alternative is the most advantageous in terms of construction cost.
· The space obtained by shifting the road can be used as a temporary storage yard for construction materials and equipment.</td></tr>
<tr><td>Difficulty</td><td colspan="3">· There is little space for temporary storage of materials and equipment at the place of construction of the bridge.
· The time during which the ferry can come in (WL = 14.00 m or more) is limited, and that poses a problem concerning sure securing of a substitute road on the basis of a ferry at the time of starting of construction.
· The construction cost will be higher than in the case of the other alternatives in view of the cost of construction of a detour road and securing of space for parking of vehicles waiting for passage by ferry.
· Another alternative that might be considered is that of building a temporary bridge (making use of the existing materials for the superstructure and substructure), but it would entail even greater construction cost than this ferry alternative.</td><td colspan="3">· In order to install of the slope work on the front surface of the abutments under present conditions it is necessary to clear the new bridge for traffic in the work execution stage.</td></tr>
<tr><td>Overall evaluation</td><td colspan="3">△</td><td colspan="3">◎</td></tr>
</table>

Table 2.2.4.5 COMPARATIVE STUDY TABLE REGARDING PLACE OF CROSSING OF RIVER (PLACE OF CONSTRUCTION OF BRIDGE)<2/3>

Comparative routes / Items studied	Alternative 3 : A Parallel Bridge 30 m Upstream			Alternative 4 : A Parallel Bridge 20 m Downstream		
Linear plans	Planar linearity R =200m	Vertical linearity i = 1.0%	Sight distance L =75m	Planar linearity R =300m	Vertical linearity i = 1.0%	Sight distance L =75m
Topographical and geological situation	Same as in the case of Alternative 1.			Same as in the case of Alternative 1.		
Economic feasibility (construction of detour road, construction of temporary yard, road earth filling work, slope protective work)	④ (1.23)			③ (1.13)		
Ease of execution of the work	· More space can be secured for removal of the existing bridge than in alternative 2. · The space obtained by shifting the road is about 150 m x 40 m on the left bank side, and it can be used as a girder making yard. · Required construction period is the same as in the case of alternative 2 and more advantageous than in alternative 1.			· Although dry execution of work is needed for the substructure work as regards rain in the dry season, the scope of dry work is limited by the existence of the substructure of the existing bridge. · There is risk of collision with materials that flow downstream in the eventuality of damage to or collapse of the existing bridge. · As in the case of alternative 2, there is an advantage in comparison with alternative 1 in terms of length of construction period since it will be possible to do the reinforcement work on the existing bridge simultaneously with the substructure work on the new bridge.		
Dificulity	· Because of the 30 m shift there will be more abutment protective work (slope work), and that will make construction cost higher.			· Since there will be dry execution of work on the new bridge, there will not be much space for the upstream coffering. · The construction cost will be higher than in the case of alternative 2.		
Overall evaluation	○			△		

Table 2.2.4.6 COMPARATIVE STUDY TABLE REGARDING PLACE OF CROSSING OF RIVER (PLACE OF CONSTRUCTION OF BRIDGE)<3/3>

Comparative routes / Items studied	Alternative 5 : A Parallel Bridge 20 m Downstream					
Linear plans	Planar linearity R =300m	Vertical linearity i = 1.0%	Sight distance L =75m			
Topographical and geological situation	Same as in the case of Alternative 1.					
Economic feasibility (construction of detour road, construction of temporary yard, road earth filling work, slope protective work)	⑤ (1.27)					
Ease of execution of the work	· In comparison with alternative 4 it will be possible to secure a wider scope of dry execution of work. · The new bridge will be exposed to risk of collision with materials flowing downstream in the eventuality of damage to or collapse of the existing bridge. · The space obtained by shifting the road is about 100 m x 30 m on the left bank side, and it can be used as a girder making yard.					
Dificulity	· Construction cost is the highest in this alternative (but on the other hand it is best as regards running qualities and ease of execution of the abutment protection work).S					
Overall evaluation	×					

Table 2.2.4.7 Standard Applicable Span

Type of superstructure		Recommended Span length and Bridge (50m / 100m / 150m)	Curve: Structure	Curve: Deck	Ratio of (Height /(span length)
Metal Bridge	S.composite girder bridge		○	○	1/18
	S.girder bridge		○	○	1/17
	C.girder bridge		○	○	1/18
	S.box-girder bridge		○	○	1/22
	C.box-girder bridge		○	○	1/23
	S. truss bridge		×	○	1/ 9
	C. truss bridge		×	○	1/10
	Reversed langer bridge		×	○	1/6.5
	Reversed lohse bridge		×	○	1/6.5
	Arch		×	○	1/6.5
PC Bridge	Pretensioned girder		×	○	1/15
	Hollow slab girder		○	○	1/22
	S.T-section girder		×	○	1/17.5
	S.composite girder		×	○	1/15
	Connected composite girder		×	○	1/15
	C.composite girder		×	○	1/16
	S. box girder		○	○	1/20
	C.box-girder (cantilever erection method)		○	○	1/18
	C.box-girder (incremental launching method or falsework Method)		○	○	1/18
	π-shaped rigid frame bridge		×	○	1/32
RC Bridge	Hollow slab girder		○	○	1/20
	C•solid rib arch bridge		○	○	1/ 2

The possible bridge types for the different cases of number of spans to be considered in the comparative study are as follows:

5 spans: . Steel continuous girder bridge
. Prestressed-concrete continuous hollow slab girder bridge
. Prestressed-concrete continuous T-section girder bridge
4 spans: . Steel continuous box girder bridge
. Prestressed-concrete continuous box girder bridge
3 spans: . Prestressed-concrete rigid-frame bridge
2 spans: . Prestressed-concrete T-shaped rigid-frame bridge
1 span: . Prestressed-concrete arch bridge
. Rigid-frame bridge with central hinge

The optimum bridge type for this bridge has been selected by first determining the best three of the above nine compared bridge types (primary selection) and then considering them in greater detail (secondary selection).

On the following pages are given the primary selection table and the secondary selection table.

The conclusion of the comparative study of bridge type is that the best alternative is a 5-span prestressed-concrete continuous T-section girder bridge (5@35m).

ii) Type of Substructure

- Selection of Abutment and Pier Type

In the vicinity of the bridge the load-bearing layer is about 30 m from the riverbed, and it will therefore be necessary to do foundation work. Excavation to designated level for the abutments needs to be only to about the level of the natural ground.

The structural height will be approximately 13 m, and they will be reversed-T abutments, which are outstanding in terms of low cost and ease of execution of the work (construction time, rolling compaction of background, etc.) as can be seen in the abutment selection table below.

Table 2.2.4.8 Substructure Selection Table

Item	Type	Applicable height (m)				Condition of applicability
		10	20	30		
Abutment	1. Gravity Type	■				Suitable for cases in which the load-bearing layer is shallow, with a direct foundation.
	2. Reversed T	■	■			This is a type with many cases of application. It is suitable for direct foundation and pile foundations.
	3.counterforted type		■			Suitable for cases in which the abutments are high. The quantity of materials used is small, but construction time is long.
	4. Box type		■			This type was developed for high abutments. Construction time is rather long.
Pier	1. Column type		■			Suitable for cases in which the piers are low and the conditions of intersection are difficult as well as for placement in the river, etc.
	2. Rigid Frame		■	■		Suitable for bridges with wide cross section and comparatively high piers.
	3. Pile vent		■	■		This is the most economical type, but it is not suitable for bridges with large horizontal force and also obstructs flow in the river during floods.
	4. Elliptical Pier (Wall type)		■	■	■	Type suitable for bridges with high piers and large external force.

iii) Selection of Pier Type

If the thickness of overburden is 2.0 m, the designated level to which excavation is done for the piers will be about 4 m from the riverbed.

As a result the pier height will be about 18 m. Furthermore, since it will be a bridge placed in the flowing water part of the river, the piers will be of the wall type as indicated in the substructure selection table.

It is a river in which the direction of flow of the water during flooding is practically in a straight line, and occurrence of whirlpools and the effects of the pressure of the water flow and drifting wood will be minimized by having a small river obstruction ratio of High Water Level.

iv) Type of Foundation

The load-bearing layer of the ground where the substructure will be installed will be about 30 m from the riverbed. That being the case, the optimum type of foundation is the pile foundation, which is outstanding in terms of bridge size, foundation depth, ease of execution of the work and economy.

Considering the depth of the load-bearing layer, the soil conditions, ease of execution and bridge size, the possible types of foundation piles are steel pipe piles and cast-in-place piles. Also taking into account economy, ease of execution and other factors, it is judged that cast-in-place piles are most suitable for the foundation of the bridge.

Since it is clear from the soil investigation that there is continuation of layers with relatively large skin friction, the reverse circulation drilling method is most suitable as the method of execution of the work.

v) About Pier Types

In designing the new Moat Khmung Bridge, it is necessary to give due consideration to possible scouring around the piers, as the river under the bridge flows quite rapidly during flooding.

In view of the above, we have decided to use the wall-type of foundation for the Moat Khmung Bridge, in which foundation piles would be buried on top of footings underneath the river bed.

The cross section of this wall-type pier has an elongated elliptic shape. Only the rounded parts of the pier walls will be protruding from the riverbed and thus less likely to disturb water currents during flooding.

Pile-bent piers, as indicated in the Japanese specifications and other documents, would be placed in single-file parallel to the direction of the river. This type of piers has a lot of freedom lengthwise and much less rigidity than the wall-type structure. Pile-bent piers are more susceptible to horizontal warpage and would require large-diameter foundation piles in order to secure the same level of rigidity as that of the wall-type piers.

Generally, large-diameter pile-bent piers (multi-pile foundation) in deep water are easier to install and less costly because they do not require cofferdam and need less boring work. Also, piers that are driven deeper into the ground have better resistance to scouring.

Foundation piles and substructure of the Moat Khmung Bridge will be installed in the dry season. Water level of the construction site will be low, and dry work will be easily installed with simple dewatering. Entire concreting and curing of foundation and substructure work can be done under air. Therefore, the wall-type piers with footings beneath the riverbed and cast-in-place pile foundation are more suitable than the pile-bent piers in terms of structural integrity, cost, and ease of installation.

Table 2.2.4.9 Primary Selection of Type of Bridge for the Moat Khmung Bridge(1)

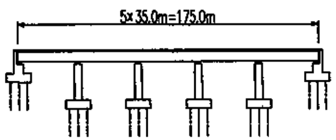
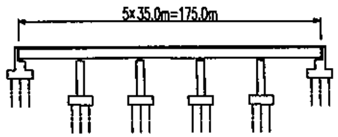
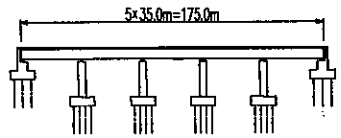
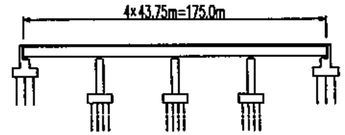
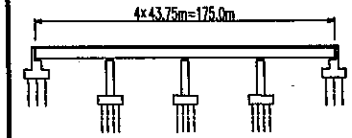
Type / Item	Alternative 1 5-SPAN CONTINUOUS STEEL GIRDER BRIDGE	Alternative 2 5-SPAN CONTINUOUS HOLLOW SLAB GIRDER BRIDGE	Alternative 3 5-SPAN CONTINUOUS PRESTRESSED-CONCRETE T-SECTION GIRDER BRIDGE	Alternative 4 4-SPAN CONTINUOUS STEEL BOX GIRDER BRIDGE	Alternative 5 4-SPAN CONTINUOUS PRESTRESSED-CONCRETE BOX GIRDER BRIDGE
Span division					
Structural characteristics	･In general wide use ･The dead load of the superstructure is smaller than in the case of prestressed concrete girders, making for a smaller load on the substructure. ･Disadvantageous in terms of the rate of area △	･The low height of the (鋼造=?) steel structure of the superstructure is advantageous in terms of tie-in with the approach road. ･There are few cases of applied span. ･Disadvantageous in terms of the rate of area △	･The low height of the structure of the superstructure is advantageous in terms of tie-in with the approach road. ･Widely used and the object of standard design in Japan. ･Disadvantageous in terms of the rate of area △	･Widely used . ･Advantageous for tie-in with the approach road in view of the low steel structure height. ○	･High-rigidity bridge. ･Advantageous for tie-in with the approach road in view of the low steel structure height. ○
Construction method	･Erection using erection girders method. ○	･Stepping formwork method. △	･Erection using erection girders method. ○	･Draw or push out erection method ○	･Launching erection method ○
Ease of execution of the work	･It is necessary to complete 1 abutment and 4 piers in the first dry season. ･The construction time is about the same as for a prestressed-concrete bridge. ○	･It is necessary to complete 1 abutment and 4 piers in the first dry season. ･Execution of the superstructure work is not very easy. ×	･It is necessary to complete 1 abutment and 4 piers in the first dry season. ･High process flexibility in preparation of superstructure. ○	･Erection is easy because of lighter weight than in the case of prestressed-concrete girders. ･The construction time is about the same as for a prestressed-concrete bridge. ○	･Larger scale of erection work than in the case of the other alternatives in view of the heavy dead weight of the girders. △
Local procurement, etc.	･Procurement of girder in a third country. ･Little procurement of materials and employment of labor. ×	･Fairly high rate of employment of labor and procurement of materials in comparison with steel girders. ○	･Fairly high rate of employment of labor and procurement of materials in comparison with steel girders. ○	･Little procurement of materials and employment of labor. ×	･There is a high rate of local procurement, and one can also expect a considerable employment effect. ○
Maintenance and upkeep	･Disadvantageous in terms of maintenance in view of the fact that regular repainting is necessary. ×	･Maintenance is easy, requiring only periodical checks. ○	･Maintenance is easy, requiring only periodical checks. ○	･Disadvantageous in terms of maintenance in view of the fact that regular repainting is necessary. ×	･Maintenance is easy, requiring only periodical checks. ○
Technology transfer	･Little opportunity for technology transfer. ×	･Applicable to and useful for bridges with small span length. ○	･Applicable to and useful for bridges with small span length. ○	･Little opportunity for technology transfer. ×	･One can expect technology transfer effect with future increase in demand for prestressed-concrete ○
Economic feasibility	1.19 △	1.44 ×	1.00 ○	1.44 △	1.07 ○
Overall evaluation			○ selection.		○ selection.

Table 2.2.4.10 Primary Selection of Type of Bridge for the Moat Khmung Bridge (2)

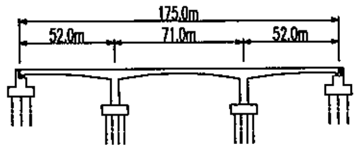
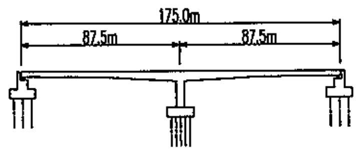
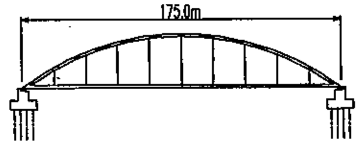
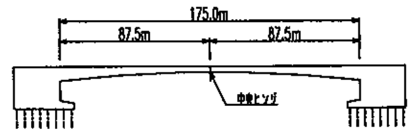
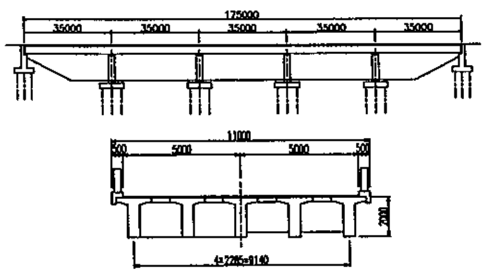
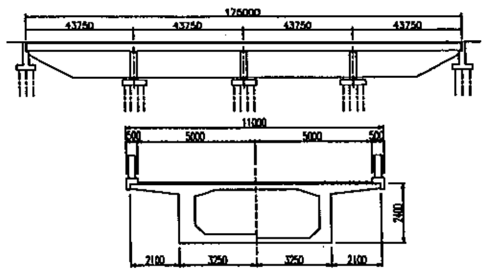
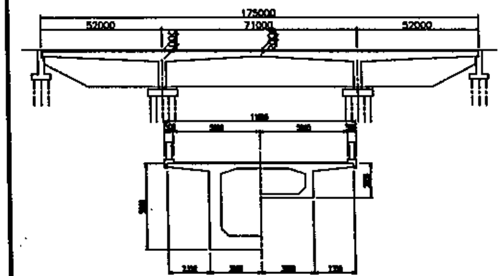
Type / Item	Alternative 6 3-SPAN CONTINUOUS PRESTRESSED-CONCRETE RIGID-FRAME BRIDGE	Alternative 7 PRESTRESSED-CONCRETE T-SHAPE RIGID-FRAME BRIDGE	Alternative 8 ALTERNATIVE 8, PRESTRESSED-CONCRETE THROUGH ARCH BRIDGE	Alternative 9 PRESTRESSED-CONCRETE RIGID-FRAME BRIDGE WITH CENTRAL HINGE
Span division				
Structural characteristics	・Outstanding stability after completion. ・Large burden on foundations because of heavy dead weight. ○	・The applied span length is exceeded, but the actual past figure is 104 m. ・Tie-up with the approach road is poor because of the high structure height at the pier position. ×	・Not very many prestressed-concrete arch bridges of this size have been built. ×	・Very large substructure. ・This type not adopted because of the problem of deformation of the hinge part. ・This type is not suited to places such as those where there have been earth fills because of the considerable dead weight. ×
Construction method	・Cantilever method ○	・Cantilever method + support work ○	・Center erection method. △	・Cantilever erection method. △
Ease of execution of the work	・Temporary gridges to the piers is needed up to completion of the superstructure. ・Easy execution of substructure work since only 2 piers are in the river. ○	・A long temporary bridge to the middle of the ri ver is needed up to completion of the superstructure. ・Easy execution of substructure work since there is only 1 pier in the river. △	・No work in the river as regards either the superstructure or the substructure. ・Very large-scale erection work is necessary. ・The construction time is relatively long. △	・Both the substructure and the superstructure will involve large-scale work execution, and it is disadvantageous in terms of required construction time as well. △
Local procurement, etc.	・One can expect lots of local procurement of materials and employment. ○	・One can expect lots of local procurement of materials and employment. ○	・One can expect lots of local procurement of materials and employment. ○	・One can expect lots of local procurement of materials and employment. ○
Maintenance and upkeep	・Easy maintenance in view of the fact that there ar e shoes only at the end support points. ○	・Easy maintenance in view of the fact that there are shoes only at the end support points. ○	・Easy maintenance in view of the fact that there ar e shoes only at the end support points. ○	・Occurrence on deformation, etc. of the hinge part is possible. △
Technology transfer	・One can expect use in medium～large length bridges as well. △	・One can expect use in medium～large length bridges as well. △	・Not of a general-purpose nature. ×	・a little general-purpose nature. △
Economic feasibility	1.17 △	1.34 △	1.52 ×	1.64 ×
Overall evaluation	○ selection.			

Table 2.2.4.11 TABLE ON SECONDARY SELECTION OF BRIDGE TYPE FOR MOAT KHMUNG BRIDGE

Type / Item	ALTERNATIVE A 5-SPAN PRESTRESSED-CONCRETE CONTINUOUS T-SECTION GIRDER BRIDGE	ALTERNATIVE B 4-SPAN PRESTRESSED-CONCRETE CONTINUOUS BOX GIRDER BRIDGE	ALTERNATIVE C 3-SPAN PRESTRESSED-CONCRETE CONTINUOUS RIGID-FRAME BRIDGE
Span division			
Structural characteristics	•Used a lot and the bridge of standard design in Japan. •Lowest girder height of the three alternatives and best tie-in with the approach road. △	. High-rigidity bridge. since the girder height is the highest among the three alternatives. △	. Smallest river hindrance rate among the three alternatives. . The girder height at the end support points is lower than in Alternative B, which makes for better tie-in with the road. (H=2. 0m) ○
Construction method	•Erection using erection girders. ○	•Launching erection method ○	•Cantilever method ○
Ease of execution of the work	•Although it is necessary to comlete 1 abutment and 4 piers above H.W.L. in the first dry season, that is within what is possible. •In the case of erection using erection girders large-scale use of heavy machinery is not necessary. ○	. Erection of the superstructure involves larger-scale work than in the case of Alternative A, and it will be necessary to import and bring in lots of erection equipment. . It will be necessary to complete 1 abutment and 3 piers in the first dry season. ○	. A temporary bridge for liaison with the piers and a structural platform will be needed for up to completion of the superstructure. . Execution of the substructure work will be easier than in the case of Alternatives A and B since only 2 piers have to be executed in the river. ○
Local procurement, etc.	•A lot of local procurement of materials for both the superstructure and the substructure. •Will provide considerable employment opportunities for local people. ○	•A lot of local procurement of materials for both the superstructure and the substructure. •Will provide considerable employment opportunities for local people. ○	•A lot of local procurement of materials for both the superstructure and the substructure. •Will provide considerable employment opportunities for local people. ○
Maintenance and upkeep	•Easy maintenance. ○	. Easy maintenance. ○	. Easier maintenance because of fewer supports. ○
Technology transfer	•Applicable to bridges with small span lengths and most practical. ○	. One can expect use in medium～large length bridges as well. △	. One can expect use in medium～large length bridges as well. △
Rough quantity estimates	Superstructure:Concrete 1,272 m3 Prestressing stee 145t Substructure:Concrete 1,047 m3 Foundation piles, diameter 1000 1,341 m	Superstructure:Concrete 1,643 m^3 Prestressing steel 93 t Substructure:Concrete 993 m^3 Foundation piles, diameter 1000 1,373 m	Superstructure:Concrete 1,876 m^3 Prestressing steel 96 t Substructure:Concrete 1,103 m^3 Foundation piles, diameter 1000 1,320 m
Economic feasibility	1.00 ◎	1.07 △	1.17 ×
Overall evaluation	◎	△	×

g) Two Dimensional Hydrodynamic Model Simulation

i) General

Hydrodynamic model simulation was put into practiced to provide with information to make plans on the flooding area on the Route 7.

Two cases were simulated to evaluate the difference of water elevation at Kompong Cham and upper stream side of Route 7.

Case 1：Extend the length of the Moat Khmung Bridge to 300m.
Case 2：Make the flood water over flow on Route 7.

The flow in the inundation area including the Mekong River was simulated by the two-dimensional finite element simulation model. The results are shown in the Table 2.2.4.12 .

The flood 1996 that is the biggest flood in these recent years was adopted as the model flood, and the SMS (Surface Water Modeling System) that was developed in U.S.A was used for hydrodynamic model simulation.

ii) Verification of Model Constants

Model constants that are coefficients of river bed roughness, eddy viscosity and another was verified by the data of field survey that was practiced in this study.

iii) Calculation Results

According to the results, the scale of total flow is too big to make apparent difference of water level at Kompong Cham, and the difference is very small.

- The extension of the Moat Khmung Bridge is not effective, and not able to reduce the water level remarkably. The cost to extend the bridge is not valuable for this .
- The difference of over-flow or not along Route 7 with length 4km by water depth of 30cm is very small.

Table 2.2.4.12 Results of Two-dimensional Hydrodynamic Simulation

Items	Influence to Water Level Kompong Cham	Influence to Water Level Upstream Side of Route 7
Case-1 Double length of Moat Khmung Bridge(300m)	-1 cm	-5 cm
Case-2 Influence of Over-Flow at Route 7, L=4km, h=30cm	-1 cm	—

According to the case-2 that is the case of extending the length of the Moat Khmung Bridge, although the range of influence depends on the rank of velocity, the area downstream of Route 7 of more than 20 cm/s, that is thought to be the influence of flow from the Moat Khmung Bridge, is more than twice than now, and that is about a half area of inundation field. This will change the natural flow circumstances of inundation field.

2) Mream Teak bridge

a) Situation Regarding the Existing Bridge

In terms of outer appearance this bridge is a three box culvert. However, the part corresponding to the bulkhead is of pillar column type.

The box culvert is thought to have been built in the days of the Pol Pot regime as a part of an irrigation channel, but at the time of the survey the water level was low, and standing water was to be seen around the culvert, the amount of flow certainly not being sufficient for a channel. The culvert also has a stop-log function. The local survey of the bridge has shown that there has been considerable deterioration of the concrete, and measurement of member dimensions and observation of the state of reinforcing bar displacement shows inability to withstand the loading weight of an improved route.

b) Evaluation of the Existing Bridge

Considering the state of progression of deterioration, the dimensions of the members, the state of reinforcing rod displacement, etc., revealed in the local survey, it is clear that it cannot meet the required standards for the new improved road. Since the live load applied to the bridge will be B-live load, it is considered to be more appropriate to build a replacement bridge from the standpoint of economy, maintenance, structure, etc., than to undertake major reinforcement of the members, repair and widening of the existing bridge.

c) Selection of the Location of the Bridge

The terrain in the area of the Mream Teak Bridge is high and not affected by the water level of the Mekong River, and therefore it is a place where dry work will be easy in execution of the construction work. Furthermore, both sides of the existing bridge represent a straight-line section.

Considering such surrounding conditions, building a replacement bridge at the present bridge location will be easy in terms of execution of the work, and it will be possible to ensure good vehicle running qualities after completion by reproduction of the present straight-line section.

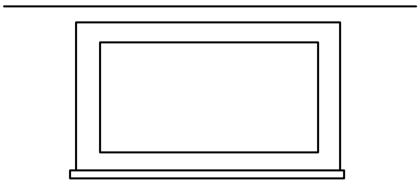
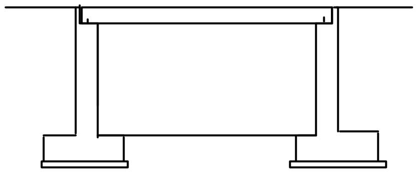
The best method is that of removal of the existing bridge and building its replacement after securing a detour road by laying pipes in the water channel about 30 m upstream and filling.

d) Selection of Type of Bridge

A comparative study has been made of the possible types of structure for fulfilling the present bridge's functions, i.e. the box culvert alternative and the reinforced-concrete bridge alternative.

Such comparison has shown that the box culvert type is outstanding in terms of economy and is structurally suited for the Mream Teak Bridge.

Table 2.2.4.13　Selection of Bridge Type for Mream Teak Bridge

	Box culvert	Bridge
Sketch	B=7000, H=5000 	L=8,500, H=6000 
Structure	- Stability is highest - Easy to install stop-log function since it is concrete on all four sides. - In terms of scale it is a structure that is most often used for agricultural water channels. - The structure is simple, which makes for easy execution of the work. ○	Structure will be separated to superstructure, substructure and stop-long. Need to install stop-log as a separate structure. Small scale for the bridge type. △
Maintenance	Regular inspection ○	Regular inspection Maintenance of Shoes and expansion joint ×
Economy	1.00 ○	2.29 ×
Total evaluation	○	×

(5)　River Structure Plan

1)　National Condition

Study area in the Route 7 including Moat Khmung Bridge can be described to be surrounded in extremely special circumstance as follows:

a)　Though general river width in Mekong River is considered to be spreaded 2~3 km length, river width around Kompong Cham is especially narrow as approximately 1 km length with the gradient of water surface being steep against neighbour gradient. Existing Route 7 at the east side of Mekong River crosses over flooding area of Mekong River coffering the flooding flow. On this point, this road section was regarded to be constructed in a very special situation.

b) Accordingly study section is considered to be located in a hydraulically severe situation. Namely, road section has suffered from overtopping of flooded water. One of the substructures of Moat Khmung Bridge was washed away and this bridge collapsed due to aged concrete pier.

c) Characters of Route 7 will be summarized as below:
   - Road section is to flood in ordinary rainy season to the extent that flooded water overtops depending water level.
   - Principal design concept is not to change present situation as much as possible, so in planning rehabilitation of road section flooded water can overtop when it is exceptional high water.

d) As natural condition regarding Moat Khmung Bridge, the following facts were recognized as the results of site survey during basic design study.
   - Water level in the Study area surrounded in flooding area is so high during a few months in rainy season that difference of water level between upstream and downstream reaches to more than 20 cm.
   - Consequently continuative time of flood shows approximately a few months beyond ordinary concept.
   - As average velocity at Moat Khmung bridge shows approximately 2~3 m/sec, it also estimates water velocity as 4~5m/sec locally.
   - As materials of riverbed is composed of clay with 0.07 diameter, it is judged that moisture clay has tendency to be weak for scoreing.
   - As described in difficulty of hydrologic aspects, scoreing is recognized at the point of downstream 180 away.
   - Height of approach road will be about 15m height for reason of surrounding topographical situation.

For these reasons, it is required that in designing slope protection and river bed protection, special attention had to be taken on the ground that study has sever national condition.

2) Bank Protection

a) General

It is necessary to protect the face of slope of Route 7 because the elevation of it would not be changed, and the Route 7 is to be destined to overflow just in case.

But it is about 4 km from the point where the approach road to the Mekong River Bridge connects to the Route 7 to the Moat Khmung Bridge, so the cost would be very high if all of this section is to be protected.

Therefore, it is necessary to select part of Route 7 for protection, and protect the bank slope selectively.

b) Section of Bank Protection

The selection of sections of bank protection has made according to the following items.

i) Sections with elevation under EL.16.50m which seems to be one of the most lowest section along the Route 7.
ii) Sections in which many residents live and the overflow of Route 7 will have a big impact to their life.
iii) Sections where there was any overflow, or sandbag against the rising water according to information from residents.

Generally in case of overflow at embankment downstream side is weaker than that of upstream side, then all face of embankment of downstream side should be protected. On the other side, upstream side of the embankment should be protected vertical upper side of slope because when it overflows the approach velocity will damage the top of slope and the cost for embankment could be saved.

c) Type of Bank Protection

Typical bank protections are shown in Fig. 2.2.4.13. The natural conditions that should be considered on selection of typical bank protection are as follows.

i) The high and low water level of surrounding field varies widely high and low according to the rainy and dry seasons.

ii) The road is designed to be over-flowed because the elevation of road will not be changed.

The type of bank protection that is the most safe and maintenance free should be selected by considering many other factors.

The comparison of each bank protection type is shown in Table 2.2.4.14. Wet block or stone pitching type was adopted by comparing each type, and the reasons are as follows.

- The dry pitching type of river protection should not be adopted for the following reason. Because of once a piece has disappeared or got out of place vibration of road by vehicles or change of water level or over-flow, the damage will spread out and the protection of slope will be disordered and the maintenance will be necessary continuously in future.
- The connected concrete block type could not be adopted because of the high cost.
- The wire cylinder type is not cheap and it will have the problem on maintenance in future after the wire has worn out or rusted away.

  The riprap work has also the problem that the rubble will spread out and the maintenance will be necessary continuously.

The most desirable type is wet type pitching.

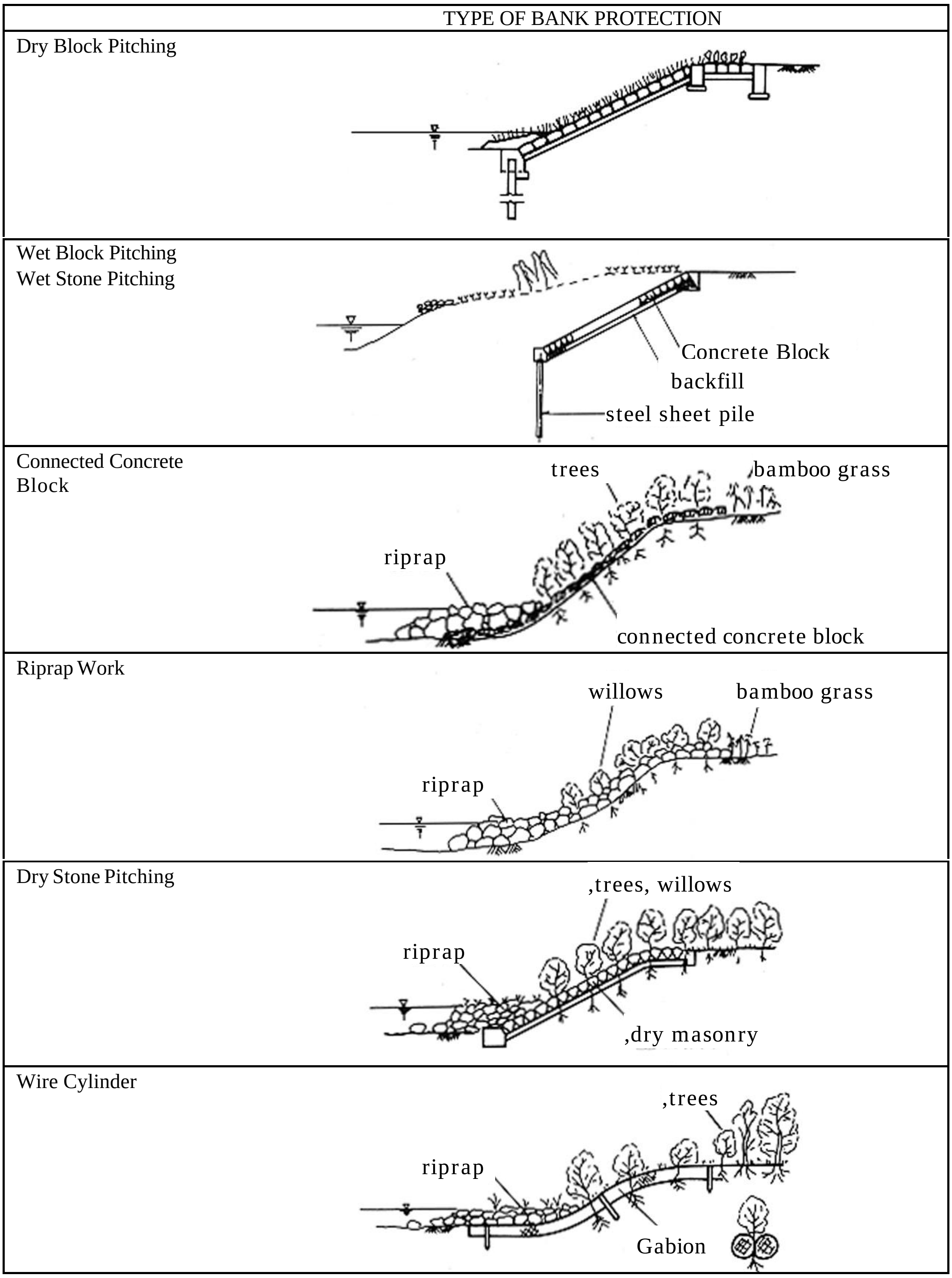


Figure2.2.4.13 Type of Bank Protection

Table 2.2.4.14 Comparison of Bank Protection Type

Type	Dry Concrete Block Pitching	Wet Block Pitching Wet Stone Pitching	Connected Concrete Block	Riprap Work	Dry Stone Pitching	Wire Cylinder
Points	Set concrete blocks on foot protection, back-filling, anti-suction sheet. Good drainage, and release residual water pressure. Planted slope is possible that is good for environment. They'll spread out if once part of them lost.	Set stones or blocks on foot protection, back-filling. There needs anti-suction sheet and drain pipe for release the residual water pressure. Strong structure because they're fixed	Planted slope is possible, but large construction executing and high cost. Strong structure	Bank protection by boulder of diameter 25-30cm. Good for condition that slow velocity flow condition like pond, but not good at fast velocity flow condition.	Set stones instead of concrete blocks of the Dry Concrete Block Pitching. Good drainage, and release residual water pressure. If there is suction, the slope would be broken. If one part of them was lost, they will easily spread out.	Bank protection by wire cylinder. There need anti-suction sheet, but there is a possibility of suction. In case of the wire is worn out, or rust away, the slope protection will break.
Over flow	There is a possibility that when the velocity is fast, piece of them will turn over.	No problem for over-flow.	No problem for over-flow.	Stable slope, but if big traction force there would be possibility of spread down.	There is a possibility of lost when the velocity is fast.	If the wire breaks, the same case as Riprap Work.
Remarks	Possibility of spread out. Good drainage, but there is also a possibility of suction.	A little expensive	Expensive Big construction Machine	Possibility of spread out. Good drainage, but there is also a possibility of suction. Possibility of damage by plant.Necessity of continuous maintenance	Possibility of spread out. Good drainage, but possibility of suction.	Possibility of spread out. Good drainage, but there is also a possibility of suction.
Costs	(1.32)	(1.84)	(6.56)	(1.00)	(1.32)	(1.32)
Evaluation	△	○	×	△	△	△

3) Riverbed Protection

a) General

The flow through the Moat Khmung Bridge concentrates there and the velocity is very fast. Riverbed material is clay (d50=0.07mm) and may be easily eroded by fast flow.

The riverbed of the existing Moat Khmung Bridge may be solid and armored from the long period under the flood flow, and it's diameter may be larger than that of neighborhood. Riverbed may not be eroded so easily. On the other side, the location of new Moat Khmung Bridge will be 20m upstream of existing bridge and the riverbed has not been armored yet. Therefore new river bed under the Moat Khmung Bridge will be exposed under a fast, long time, deep depth flow condition, and eventually the erosion at the new river bed under the bridge will be eroded deeply unless there is riverbed protection. So the riverbed protection is necessary especially under the severe hydraulic condition and high embankment about 15m high to protect the piers of Moat Khmung Bridge.

b) Area of Riverbed Protection

Condidering the area of riverbed scour, the area of riverbed protection should be the area 20m upstream and downstream from the axis of the Moat Khmung Bridge and the width of the river 114m.

c) Type of Rivebed Protection

Typical bank protections are shown in Table 1.2.4.11, the comparison of each riverbed protection type is shown in the same table. Riprap work type was adopted by comparing characters of each type.

i) Wire Cylinder Work

The riverbed will be stable at first, but after wire has rusted through, it will have the problem on maintenance. There will be many difficulty concerned with providing and maintenance. So the wire cylinder type was not adopted.

ii) Crib Work

This work involves first setting a form around the pier, putting concrete into it, then making the reinforced concrete crib to make it stable riprap around the pier.

But these crib work will get out of control when it non-uniform scouring occurs around the pier, and these will need many works of maintenance in the future. Therefore, the crib work type was not adopted.

iii) Connected Concrete Block

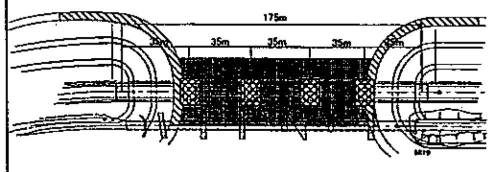
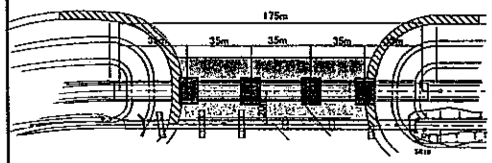
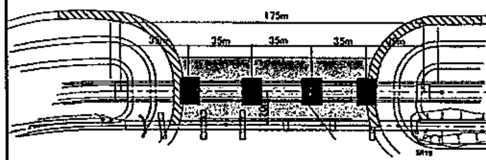
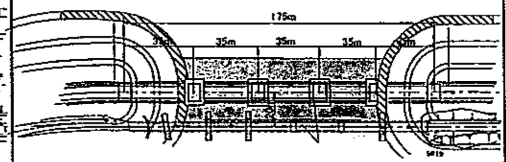
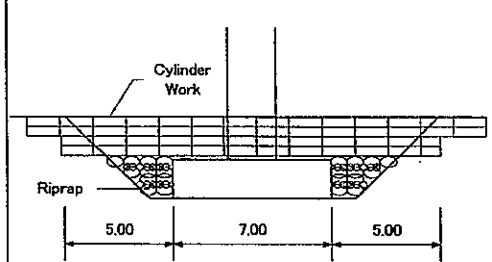
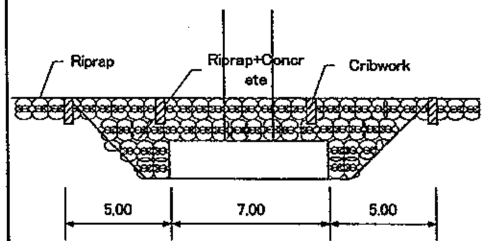
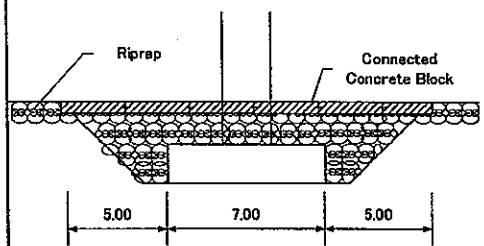
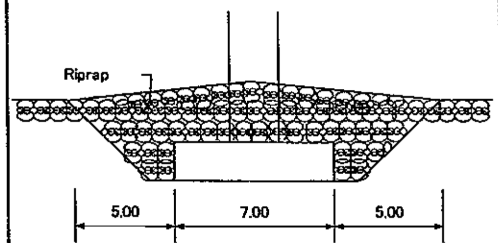
This type will be the most stable for riverbed, but the cost will be high and a plant for making concrete blocks will be needed and transportation to the riverbed. And it will be difficult to maintain them. So the connected concrete block type was not adopted.

iv) Riprap Work

In this case the riprap work will be simple and reasonable expense. However, the flow is so fast and strong that the radius of stones should be greater. If the riprap work will be made by big stanes, the riverbed protection will have the flexibility to the vary of riverbed, and in that case there will be less problem of maintenance in the future.

Therefore, the Riprap Work Type is the best way to adopt to the river bed protection at the Moat Khmung Bridge. And the radius of material is recommended to be more than 30cm.

Table 2.2.4.15 Comparison of River Bed Protection and Foot Protection Type

	① Cylinder Work	② Cribwork	③ Connected Concrete Block	④ Riprap Work
Plan				
Cross Section				
Characters	River Bed protection by cylinder work Prevent local scour near the bridge pier by the cylinder work including the refilling. Generally there is no reliability for durability, but if they are well attached to the river bed , can be expected long time river bed stability.	River bed protection with riprap work. And cribwork that is made at field with reinforced concrete and riprap around the bridge pier . Riprap will be fixed around the pier and protect it for long time. If the local scour grow, repairing of it is very difficult.	River bed protection with riprap work. And connected precast concrete block around the bridge pier . Riprap will be fixed around the pier and protect it for long time.	River bed and Foot protection with riprap work. Riprap will not be fixed around the pier. If large radius of riprap is used this type of protection will protect river bed and foot for long time.
Cost	(1.72)	(1.59)	(1.88)	(1.00)
Construction	There will be no problem because the river will be dry up during the construction.	There will be no problem because it is made at field and need not plant to make it.	There need a plant to make the precast concrete blocks and transportation from the yard to field.	There will be no special problem.
Durability	Usually this type is thought as temporary works and is not expected long time durability, and it is necessary the maintenance. If this is to adopted it is desirable to up the grade of radius of wire or plating.	Observation will be necessary and if the local scour grow, repairing of it is very difficult.	There will be no special problem. Observation will necessary and if the local scour grow, repairing of it is necessary.	There will be no special problem if large radius of riprap is used.
Evaluation	△	○	○	◎

2-3 BASIC DESIGN

2-3-1 Design Concept

(1) Necessary Items to be considered at the stage of Basic Design

1) Floodplain Facility Design

It seems that main town area in Kompong Cham and the Route 7 both have the same degree of safety against inundation. That is when the water level at Kompong Cham rises up to EL.15.9m, it seems to begin overflow at Route 7 and the main town area of Kompong Cham where hotels and market, shopping streets concentrate is already inundated.

But even if the difference of rise of water level would be very small caused by raising embankment of Route 7, serious social impact will occur when no over-flow road has appeared near Kompong Cham City.

Therefore, the embankment of Route 7 shouldn't be raised because it will present a very difficult problem.

On the other hand that is fact Route 7 is very important with the connecting Mekong River Bridge for the promotion of rural economics of the east side of the Mekong River.

It is also obvious that even if the duration were short and probability small, it would be minus for the economy and society if the Route 7 doesn't work for a while in the rainy season, and that should be avoided.

Therefore, the elevation of the embankment of Route 7 should also not be lower than the existing level, which would cause traffic flow to be more inconvenient than it is now.

As to the area of existing ferry station at the east side of the Mekong River and about 1km from it, there are many houses and people liveing there. If the flood control facility like bridge or culvert has to be constructed, there would be difficulty of needing to relocate inhabitants, or fear of dynamic change of nature to the existing resident area by changing flow.

As for the Moat Khmung Bridge, it should have the adequate function by considering that Route 7 has been working about 60 years, and the bridge has been broken sometimes but it cannot be repaired easily once damaged.

According to these matters the basic design of road section of Route 7 and the Moat Khmung Bridge at inundation field should be done by the following principles.

a) Route 7 should keep the same existing level, and is to thought to be destined to be over-flowed.
b) As for the Moat Khmung Bridge, there would be no change of it's function for and sufficient protection to the riverbed and embankment.

2) Road

Route 7 crosses the flood plain of the right bank of the Mekong River at a right angle and can be defined as a dike road. It is said to have been built around 50 years ago and has never had a record of rupturing. However, with the unusual climatic conditions of recent years, it is difficult to rely upon the criteria of the past; therefore, basic design proceeded paying attention to the following points in regards to the situation of the Mekong River flood plain.

- Construction measures for overflowing
- Possibilities of high embankment
- Pavement composition and construction methods

As a design concept for a dike road, the structure should be designed so as to allow overflow while not permitting rupturing of the dike. In specific terms, in times of overflow, the downstream end of the dike where water flow speed increases bank protection implemented, while on the upstream end a water-stopping structure is newly constructed and the main bank protection is vegetation.

The grade of the embankment, applying Japanese earthwork standards of 1:2 for high embankment, is to be a stable grade. Additionally, stability was verified through structure examination (slide calculation). In consideration of overflow, asphalt pavement (flexible-type pavement) and concrete pavement (rigid-type pavement) ought to be studied. When asphalt is submerged in water, damage is incurred to the subbase and the pavement itself is subsequently damaged. By using concrete pavement, prevention of pavement damage from overflow is made possible. However, initial investment is extremely costty and was deemed inadvisable for this project.

3) Bridge

Problems will remain if the Moat Khmung Bridge is considered only as a floodplain bridge. Highway No. 7, which divides the floodplain into upstream and downstream parts, has a role as a sort of levee. That being the case, the Moat Khmung Bridge represents the only opening connecting the upstream and downstream parts of the floodplain. Since that opening will have to be used to adjust the entire difference in water level between upstream and downstream, there will be cases of very fast flow when the difference in water level is considerable. In order to maintain a bridge placed under such conditions it is necessary to take adequate measures for prevention of scouring of the substructure. It will also be necessary to provide river bed protection to ensure stability of the riverbed and bank protection in the vicinity of abutments.

Furthermore, in order to prevent stopping up of the river cross section by drifting wood and other objects at the time of flooding, the clearance under the girders will have to be at least as much as in the case of the existing bridge.

(2) Design Standards

1) Geometric Structure Design Standards

Road

The decisions on scale and scope of road and bridge reconstruction are The decisions on scale and scope of road and bridge reconstruction are based upon surveys of geology and terrain, hydraulics, traffic volume, etc; especially in this case appropriate road and bridge design is to be conducted in awareness of the characteristics of the situation, that is, flood plain and basin. Route 7 is an important national arterial connecting the

Mekong Bridge in Kompong Cham to Vietnam and Laos and, as shown below, is to be of the same grade and level (in terms of criteria design and construction) as the recently-constructed Routes 6 and 7 and as the Mekong Bridge.

Geometrical structure standards which have been adopted until now are shown below.

a) Geometric Structure

Table2.3.1.1 Geometric Design Standards

Item	Unit	Standard
Design Speed	Km /h	60
Horizontal Curve		
Minimum Radius	M	120
Maximum Superelevation	%	6
Minimum Curve Length	M	100
Vertical Curve		
Minimum Radius of Sag	M	1,000
Minimum Radius of Crest	M	1,400
Maximum Gradient	%	5.0
Cross Slope of Carriage Way	%	2.0
Lane Width	M	3.5

Table 2.3.1.2 Dimension of Cross Section

Items	Dimensions
Carriage Way	2×3.5=7.0m
Bike-lane	2×1.50=3.0m
Shoulder	2×0.50（1.0）=1.0（2.0m）m
Total Width	11.00m（Embankment 12.0m）
Cross Fall	2.0%
Pavement	Asphalt Pavement

b) Horizontal and Vertical Alignments

i) Horizontal Alignment

Horizontal alignment is designed based upon the following criteria.

- Existing alignment will be widened along the upstream embankment segment
- In the vicinity of a bridge, the existing bridge will be used as the detour route, at an appropriate curve radius to the existing condition.

ii) Vertical Alignment

Vertical alignment is designed based upon the following criteria.

- The elevation of the road within the bridge segment is to be as is indicated as the bridge segment planned road surface elevation in the bridge plan.
- Within the bridge segment a 1 % vertical grade is to be secured for drainage.

  The elevation of the planned road in short segments is to be based upon the existing road elevation.

Bridge

a) Design Live Load

As the live load, the B-live load of the Japan Road Association's Highway Bridge Specification will be applied.

Loading method and other aspects will also be as stipulated in that specification.

b) Seismic Load

Since Cambodia has not experienced any earthquakes in the past, the horizontal seismic coefficient will be taken as 0.05 as indicated in Cambodia's design guidelines.

c) Other Loads

All of the other loads will be taken as specified in the above-mentioned Highway Bridge Specification of Japan.

d) Strength of Materials

i) Specified concrete strength

<Superstructure>:

Prestressed-concrete continuous T-section girder bridge

$\sigma ck = 400 kgf/cm^2$

<Substructure>:

Abutments and piers

$\sigma ck = 240 kgf/cm^2$

Foundation piles

$\sigma ck = 240kgf/cm^2$

Unreinforced concrete:

$\sigma ck = 180kgf/cm^2$

ii) Reinforcing bars

Product equivalent to SD 345 or SD295.

iii) Prestressing steel

Prestressing steel strand 12T12.7

River

The section of Route 7 in the flood plain should be treated as the embankment of river, and the design criteria is adopted from next criteria.

“GOVERNMENT ORDINANCE FOR STRUCTURAL STANDARDS FOR RIVER ADMINISTRATION FACILITIES (STRUCTURAL ORDINANCE)”

River Bureau, Ministry of Construction, Japan

a) Slope of Embankment

The gradient of slope of embankment should be 1:2, especially it’s the same at the bridge because of the high embankment.

b) Width of Berm

The width of berm should be 3 meters or more, and the berm should be established every 3 – 5 meter when the difference from the levee crown to the riverbed or ground is more than 6 meters.

c) Area of River Bed Protection

If necessary, the range of riverbed protection around the new pier of the bridge should be more than 5 meters around the pier. Especially considering the difference of natural condition from that of general case in Japan, in this case the range of bed protection should be more wide.

2-3-2 Basic Plan

(1) Road Plan

1) Road Alignment

The following serve as control points for the road which is the subject of this plan.

- Factories and residences in the vicinity of the starting point
- Residences in the vicinity of Moat Khmung Bridge
- Bridges
- Method of widening

Regarding the factory in the vicinity of the starting point, possibilities of including a single curve in order to avoid it were considered but dropped as it is not a favorable alignment. As it was found that there were few problems with relocation of the facility, as the object in question itself is only a retaining wall, and that it is located within the right-of-way, it was decided to move the facility rather than adjust the road alignment.

Regarding residences around Moat Khmong Bridge, these also are found to be illegal structures built within the right-of-way. The structures themselves are simple wooden structures and it was deemed therefore that the road alignment should be designed without undue consideration to these existing structures.

Regarding the location of the existing bridge (discussed in detail in a later section), it is considered appropriate to locate 20 m from the present location. In the bridge alignment, drainage is considered by applying a 1 % upgrade at both portals.

Regarding road widening, as examined in the outline of the reconnaissance survey results, it is proposed that areas of embankment will be widening toward the upstream direction, and other areas will be widened on both sides.

The road alignment (plan and profile drawings) fixed for Cambodia National Route 7 is shown below.

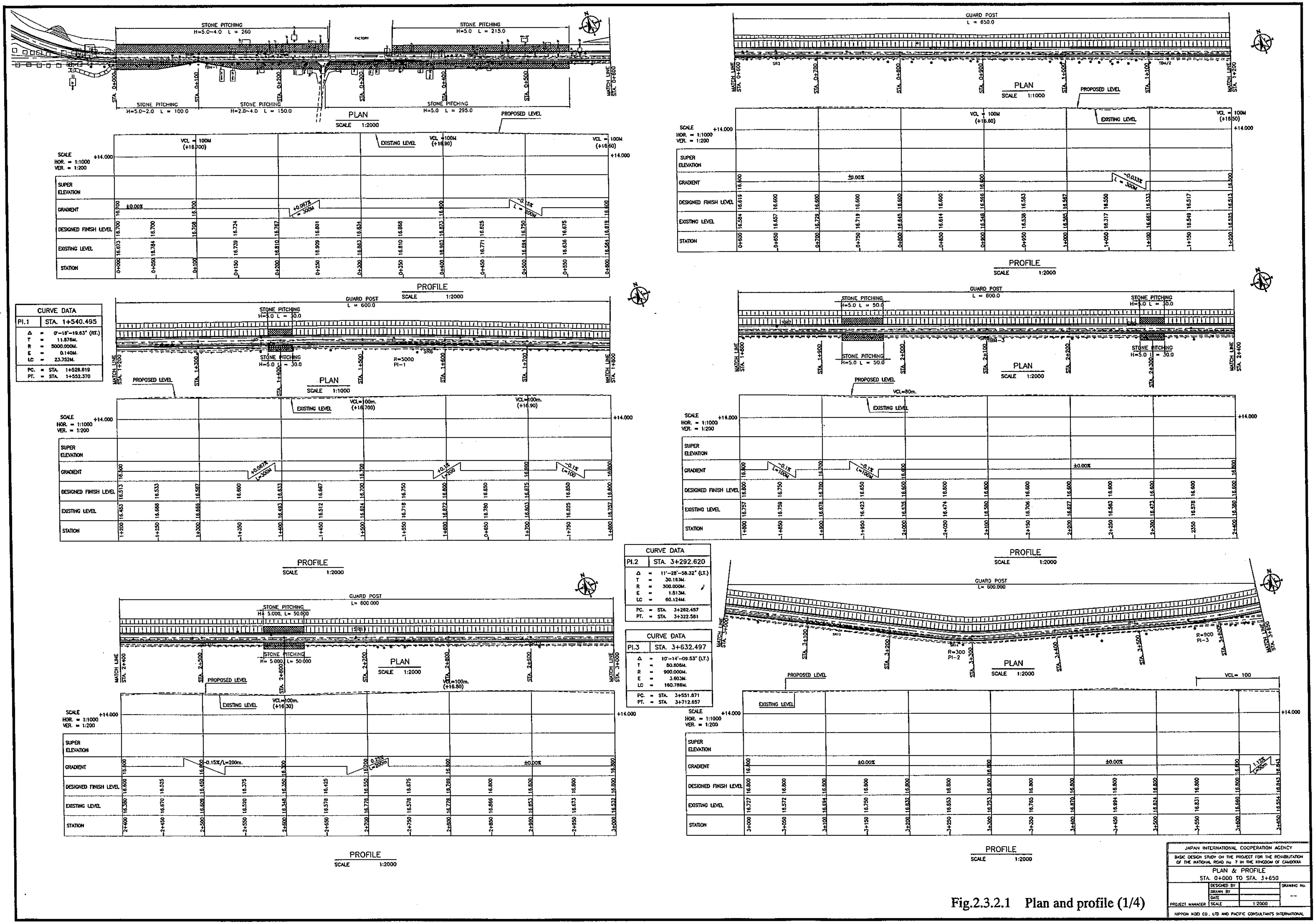
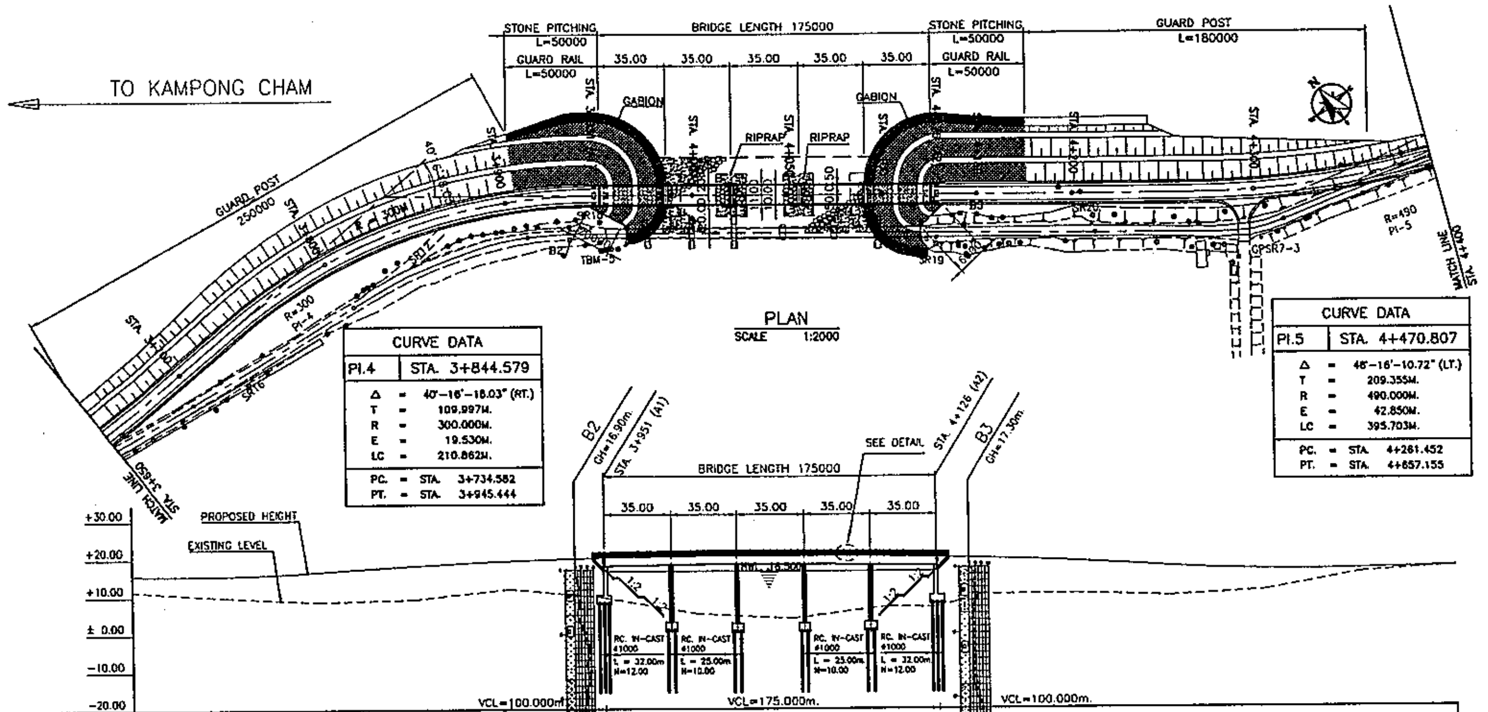


Fig.2.3.2.1 Plan and profile (1/4)

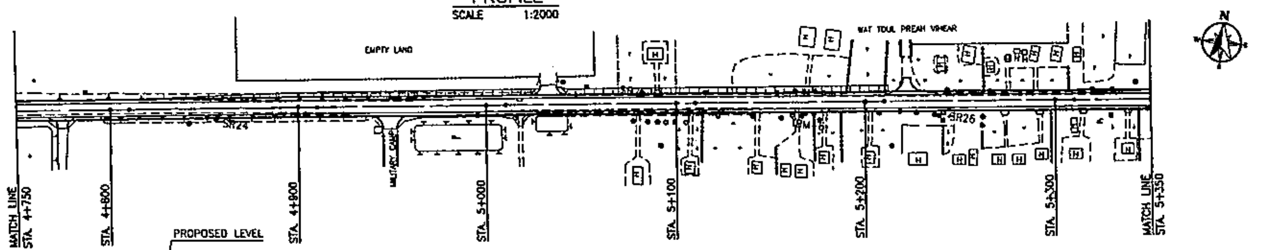


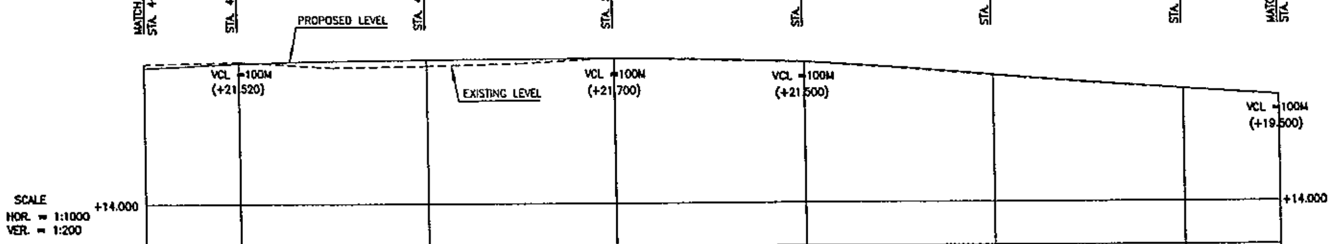
CURVE DATA	
PI.4	STA. 3+844.579
Δ =	40°-16'-18.03" (RT.)
T =	109.997M.
R =	300.000M.
E =	19.530M.
LC =	210.862M.
PC. =	STA. 3+734.582
PT. =	STA. 3+945.444

CURVE DATA	
PI.5	STA. 4+470.807
Δ =	46°-16'-10.72" (LT.)
T =	209.355M.
R =	490.000M.
E =	42.850M.
LC =	395.703M.
PC. =	STA. 4+261.452
PT. =	STA. 4+657.155

STATION	3+700	3+750	3+800	3+850	3+900	3+950 3+951 (A1)	4+000	4+385 4+500	4+100	4+126 (A2)	4+150	4+176	4+200	4+250	4+300	4+350	4+400
GRADIENT			3.00%		19.650	1.00%		21.025		1.00%		19.650		3.00%	15.930		
PROPOSED HEIGHT	15.680	15.635	16.624	18.120	19.380	20.140 20.150	20.503	20.580	20.371	20.150	19.852		18.862	17.430	16.464	16.565	17.066
GROUND LEVEL	11.500	9.850	8.650	9.220	11.950	9.620 9.620	5.200	4.000	6.850	6.850	10.250		10.300	9.600	11.000	15.600	17.189
ACCUMULATED DISTANCE	370.000	375.000	380.000	385.000	390.000	395.000 395.100	400.000	450.000	410.000	412.600	415.000		420.000	425.000	430.000	435.000	440.000
DISTANCE	50.000	50.000	50.000	50.000	50.000	50.000 1.000	50.000	50.000	50.000	26.000	24.000		50.000	50.000	50.000	50.000	50.000
HORIZONTAL ALIGNMENT	R=∞																
SUPER ELEVATION	1.5%																

PROFILE
SCALE 1:2000

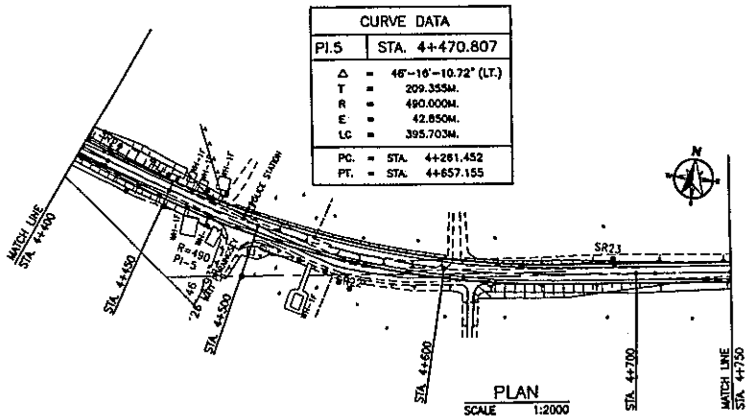


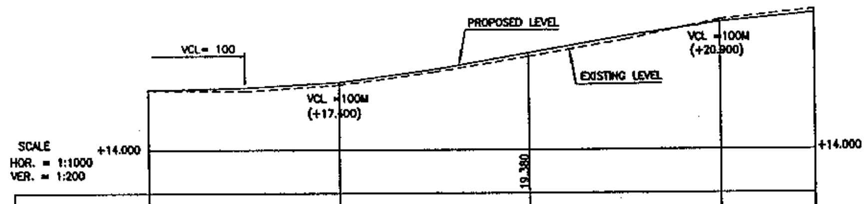


SCALE
HOR. = 1:1000
VER. = 1:200

STATION	4+750	4+800	4+850	4+900	4+950	5+000	5+050	5+100	5+150	5+200	5+250	5+300	5+350
SUPER ELEVATION													
GRADIENT	+0.62% L = 50m.	21.520		+0.09% L = 200m.		21.700	−0.20% L = 100m.	21.500		−0.80% L = 250m.			19.500
DESIGNED FINISH LEVEL	21.210	21.454	21.565	21.610	21.655	21.664	21.600	21.425	21.100	20.700	20.300	19.900	19.600
EXISTING LEVEL	21.414	21.521	21.214	21.291	21.418	21.680	21.547	21.415	21.058	20.666	20.236	19.930	19.552

PROFILE
SCALE 1:2000



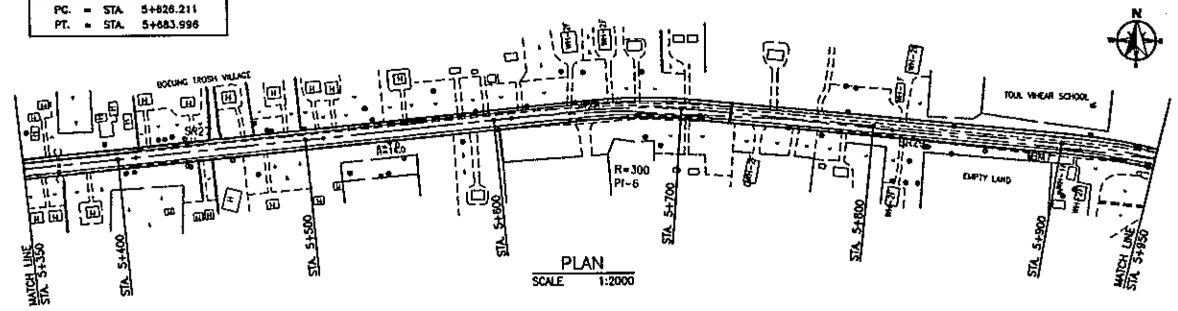


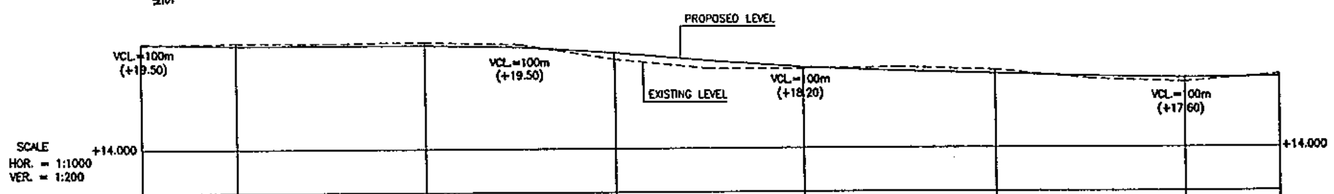
SCALE
HOR. = 1:1000
VER. = 1:200

STATION	4+400	4+450	4+500	4+550	4+600	4+650	4+700	4+750
SUPER ELEVATION								
GRADIENT	17.200	+0.20% L = 100M	17.400		+1.75% L = 200M		20.900	+0.62% L = 50M
DESIGNED FINISH LEVEL	17.200	17.300	17.594	18.275	19.150	20.025	20.759	21.210
EXISTING LEVEL	17.189	17.126	17.452	18.136	18.965	19.841	20.880	21.414

PROFILE
SCALE 1:2000

CURVE DATA	
PI.6	STA. 5+655.193
Δ =	11°-2'-10.05" (RT.)
T =	28.982M.
R =	300.000M.
E =	1.397M.
LC =	57.785M.
PC. =	STA. 5+626.211
PT. =	STA. 5+683.996





SCALE
HOR. = 1:1000
VER. = 1:200

STATION	5+350	5+400	5+450	5+500	5+550	5+600	5+650	5+700	5+750	5+800	5+850	5+900	5+950
SUPER ELEVATION													
GRADIENT	19.500	19.580	±0.00%	19.580	19.500	19.530	−0.87% L=150m	18.200		18.330	−0.3% L=200m	17.600	0.2% L=50m 18.350
DESIGNED FINISH LEVEL	19.600	19.500	19.500	19.500	19.391	19.065	18.630	18.271	18.050	17.900	17.750	17.663	17.700
EXISTING LEVEL	19.552	19.638	19.608	19.687	19.527	19.100	18.718	18.214	18.196	18.263	18.100	17.611	17.450

PROFILE
SCALE 1:2000

JAPAN INTERNATIONAL COOPERATION AGENCY		
BASIC DESIGN STUDY ON THE PROJECT FOR THE REHABILITATION OF THE NATIONAL ROAD No. 7 IN THE KINGDOM OF CAMBODIA		
PLAN & PROFILE STA. 3+650 TO STA. 5+950		
	DESIGNED BY	DRAWING No.
	DRAWN BY	--
	DATE	
PROJECT MANAGER	SCALE 1:2000	
NIPPON KOEI CO., LTD AND PACIFIC CONSULTANTS INTERNATIONAL		

Fig.2.3.2.2 Plan and profile (2/4)

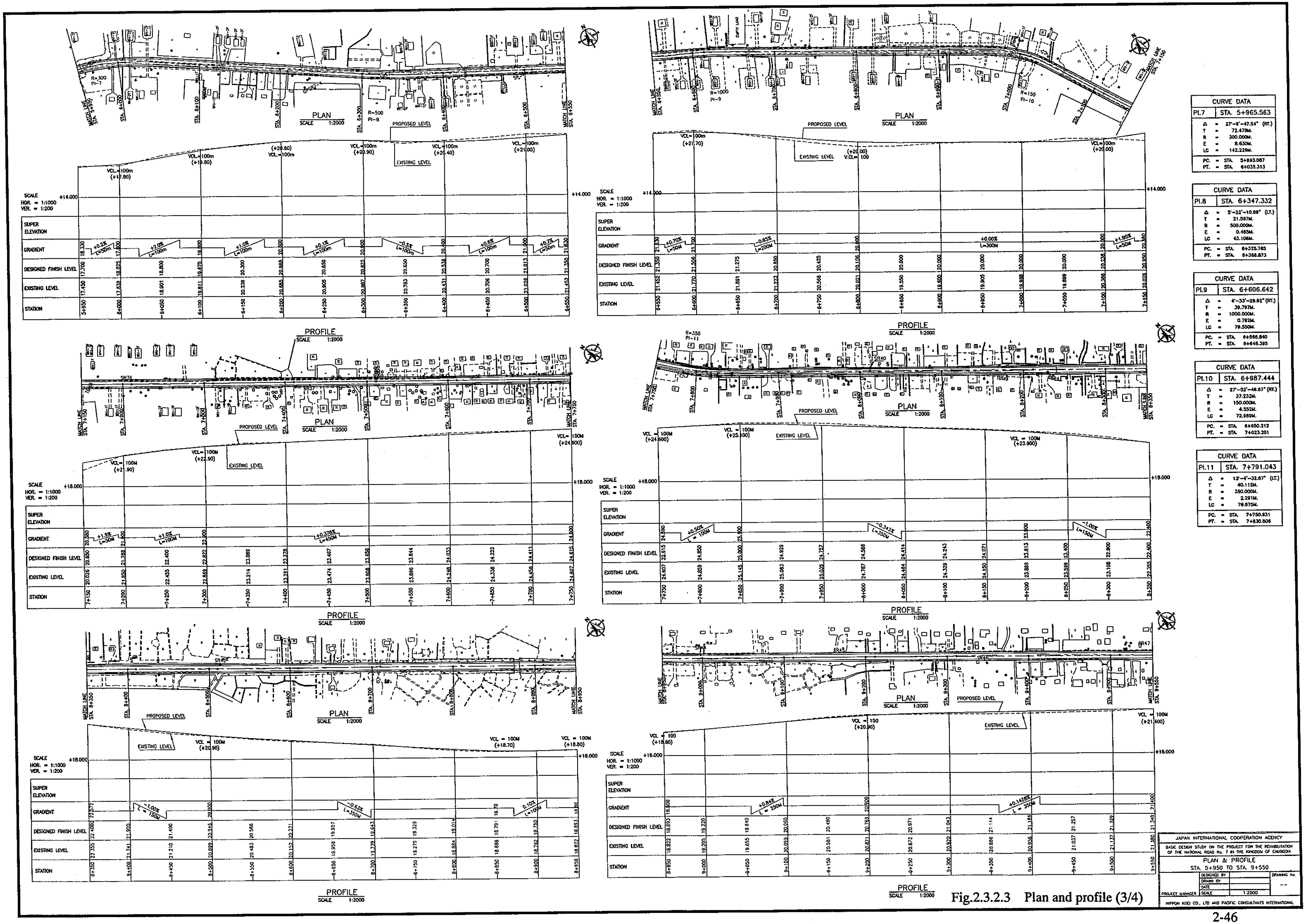


Fig.2.3.2.3 Plan and profile (3/4)

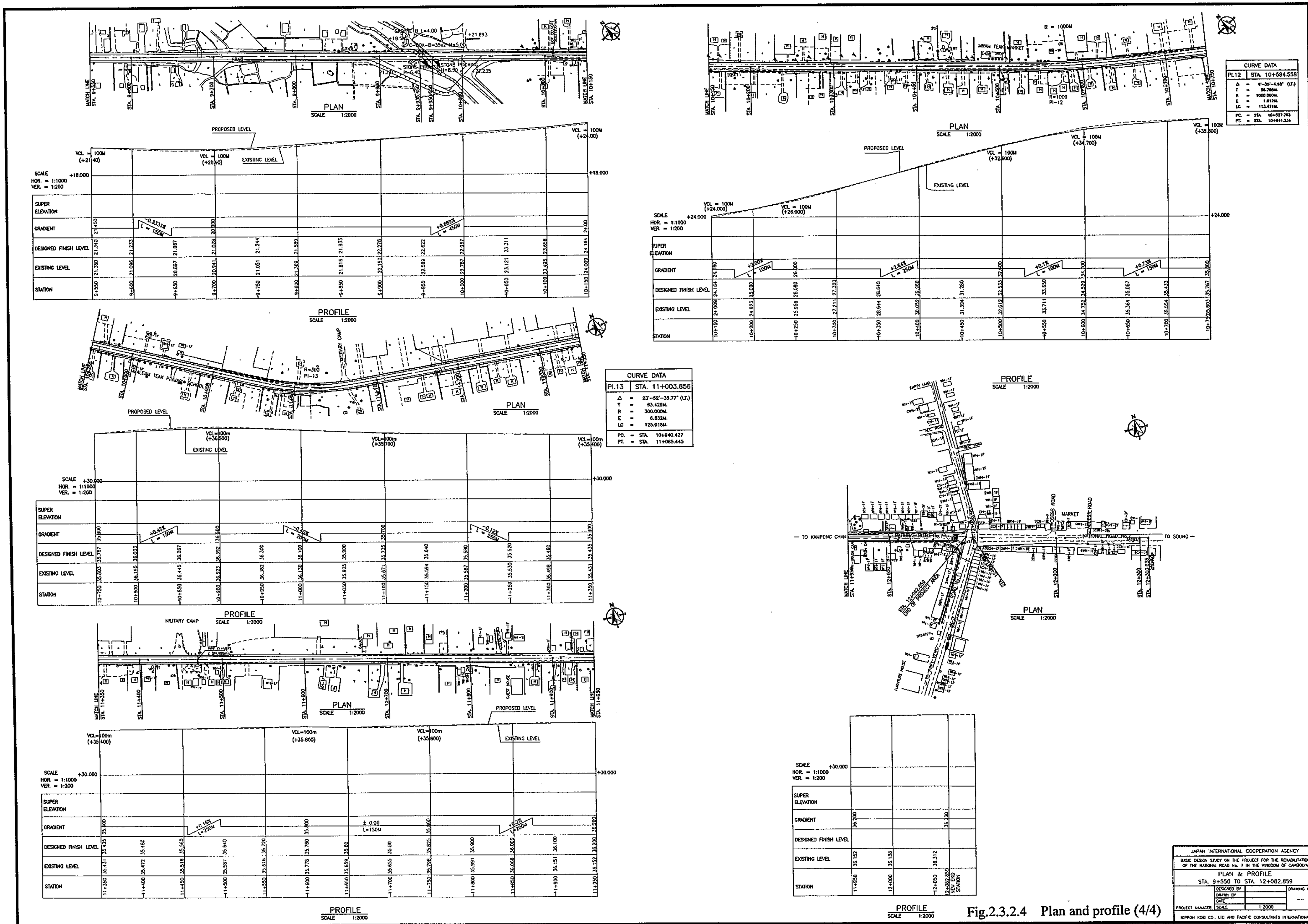


Fig.2.3.2.4 Plan and profile (4/4)

2) Intersection Plan

The Study Team considered three alternative designs for the intersection at the east limit of the Project (Tonal Toten Intersection). Intersections had selected deferent service levels to meet with the Japanese Grant Project requirements. Selected intersections are as follows;

Plan1： right turn lane with side walk（service level :High）
Plan2： right turn lane only（service level :Medium）
Plan3： minimum improvement（service level :Low）

The Study Team also considered suitable demarcation points between this Project and possible future ADB-funded Highway No. 7 and Highway No.11 projects. As a result of this Study, it was concluded that Tonal Toten intersection should not be included in the Project for following reasons:

1. Even if no improvement are made to the intersection, benefit is low due to the low traffic level.
2. Need for intersection improvement is not clear as ADB funded Highway No. 7 and Highway 11 project have not yet been confirmed.
3. It may be necessary to relocate houses.

The intersection is shown on plan and profile drawings (without improvement).

3) Pavement Design

a) Applied Design Standards
The applied standards for pavement design are to be the same as those in "Asphalt Design Outline" (Japan Road Association) adopted for the restoration of National Route 6A and improvement of National Routes 6 and 7.

b) Design Criteria
i) Design CBR
As the planned road elevation and existing road elevation are nearly the same, it is possible to divide the construction into embankment structure segment and road widening segment.

Material for embankment will come from by-products of earthworks or purchased from neighboring farmlands or soil quarries. Soil quality tests, including CBR tests have been conducted, and a design CBR of 3% has been verified.

ii) Design Life

The design life of the planned asphalt is normally five (5) years.

iii) Design Traffic Volume

The design traffic volume is based upon the traffic volume surveyed at No. 39+700 , Mt-Bridge. The daily traffic volume (vehicles/day/direction) by vehicle type needed for pavement design is calculated by multiplying the average surveyed traffic volume over three days by 1.2 to compensate for night volumes.

iv) Growth Rate of Traffic Volume

The growth rate of traffic volume is 3%(before opening the bridge)and12%(after opening the bridge), as the result of the "Mekong Bridge Project".

v) Method of Determining Design Traffic Volume

The method of applying wheel load of traveling vehicle as seen in the book of standards is to be adopted as the method of determining design traffic volume.

Table 2.3.2.1 Design Traffic Volume

Vehicle Type	Surveyed traffic volume (vehicles/16 hrs)		Daily traffic volume (vehicles/day/direction)
	West Bound	East Bound	
Car／Pickup	277	276	553
2-axle truck/bus	108	106	214
3-axle truck/bus	58	55	113
Percentage of large vehicles	37%	37%	37%

c) Asphalt Pavement Structure Design (Embankment segment)

i) Calculation

The necessary conversion pavement thickness of asphalt pavement is shown below.

$$T = \sum_{i=1}^{n} Ti/10 = \sum_{i=1}^{n} (Tixai)/10$$

TA : Necessary thickness of each layer when designed by surface layer and base layer heated asphalt mixture.

N : Accumulated 5-ton conversion number of wheels (wheel/single direction) in design longevity (n = 10 years)

CBR : Design CBR of subbase.

Furthermore, N (accumulated 5-ton conversion number of wheels) in a design longevity of 5 years is shown below.

$$\alpha_i = (P_i/5)^4$$

$$N_5 = \Sigma n_i \times \alpha_i$$

$$N = N_5 \times a \times 365 \times 5$$

Here,

alpha l : asphalt damage coefficient by wheel load Pi (in the case of a five-ton wheel load, α_i =1.0)

Pi : Measured wheel load (in tons; for the purposes of this design, standard load according to vehicle type has been adopted.

N5 : Accumulated 5-ton conversion number of wheels per day (no. of wheels/day/single direction)

a : 3%

ni : Number of wheels per day of wheel load Pi. (wheel/day/single direction)

ii) Results of Calculation

The calculation of accumulated 5-ton conversion number of wheels per day is shown in Table .

Table2.3.2.2 Accumulated 5-Ton Conversion Number of Wheels

Vehicle Type	Weight (tons)	Wheel placement	P_i (ton)	Ni (wheels/day/single direction)	α_i	$n_i \times \alpha_i$ (wheels/day/single direction)	
Car／Minibus	2	F	1.0	553	0.0016	0.9	1.8
		R	1.0	553	0.0016	0.9	
2-axle truck	14	F	1.4	214	0.0062	1.3	338.0
		R	5.6	214	1.5735	336.7	
3-axle truck	25	F	2.5	113	0.0625	7.1	233.1
		RF	5.0	113	1.0000	113.0	
		RR	5.0	113	1.0000	113.0	
Total						N_5 = 572.9	

Therefore, $N = 572.9 \times (1.02)^{5.0} \times 365 \times 5 = 1{,}212{,}070$

$T_A = 3.84 \times (1{,}212{,}070)^{0.16} / 3^{0.3} = 26.0\text{cm}$

d) Determination of Asphalt Composition

i) Fixed equal-conversion thickness and equal-conversion coefficient of the cross-section

The cross-section's equal-conversion thickness TA, fixed for the surface layer, base layer, base course, and lower subbase, is obtained through the following equation:

$$T_A' = a_1 \times T_1 + a_2 \times T_2 + a_3 \times T_3$$

Here, :a_1, a_2, a_3: Equal-conversion coefficient (Table2.3.2.3)

T_1, T_2, T_3: Thickness of each layer (cm)

Table2.3.2.3 Equal-Conversion Coefficients of Road Materials

Layer	Material and specification	Equal-conversion coefficient
Surface layer, base layer	Hot mix asphalt for surface and binder course	1.00
Base course	Crushed stone for Mechanical stabilization (Modified CBR value: 80 or more)	0.35
Subbase	Crusher-Run (Modified CBR value: 30 or more)	0.25

ii) Minimum necessary thickness for surface layer, base layer and subbase layers

The minimum necessary thickness for surface layer, base layer and subbase layers are determined as follows:

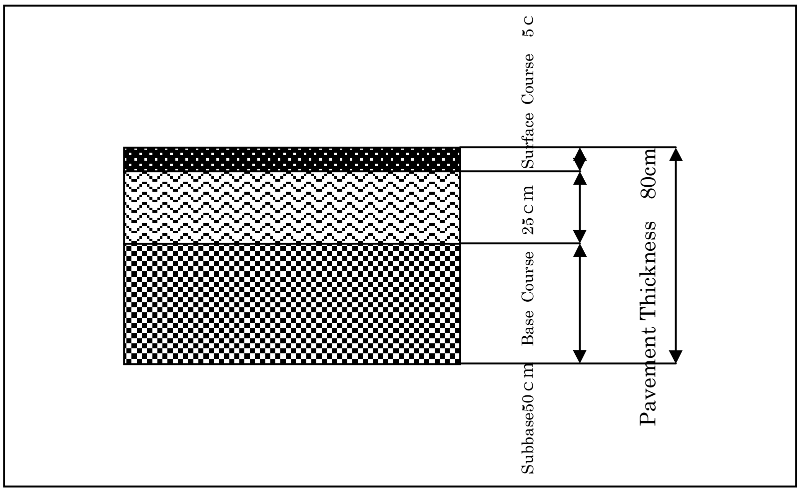
Surface layer + base layer = 5 cm

Subbase layers = 3 times size of maximum grain diameter and/or 10 cm

iii) Most Appropriate Pavement Composition

In reference to the availability of paving materials and cross-sections applied in the past, The most appropriate pavement composition was decided upon, as shown below.

The equal-conversion thickness of the above cross-section TA' = 26.25 cm satisfies the necessary asphalt thickness TA = 26.00.



Pavement Structure up to Moat Khmung Bridge

e) Pavement structure within segment to be widened

i) The present CBR of existing ground foundation

The road alignment past the Moat Khmung Bridge calls for reconstruction in the form of widening. For this project on-site CBR tests were carried out and design CBR of 2% had been applied.

ii) Calculation of Pavement Thickness

With regards to traffic volume, the calculation is the same as the above, and only the CBR value changes. Therefore, N and TA become as follows:

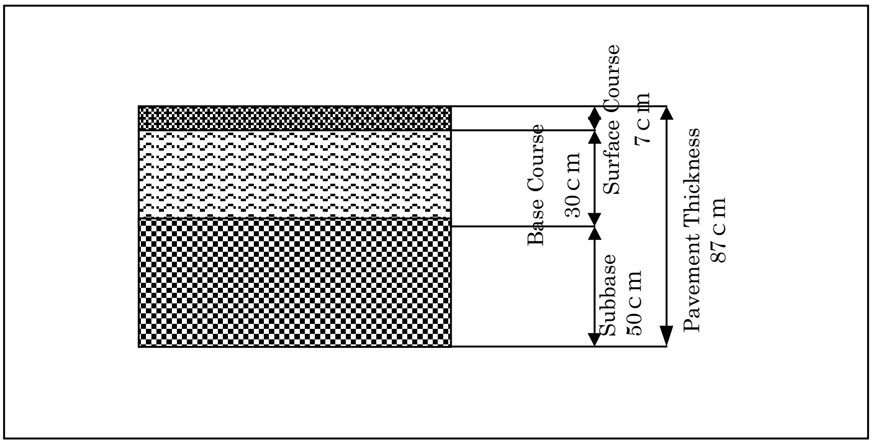
N＝572.9 x (1.02)^5.0 x 365 x 5=1,212,070

T_A=3.84 x (1,212,070)^0.16 / 2^0.3=29.34

Calculations were made below so as to satisfy the TA above.

Surface layer	:	7 cm
Base course	:	30 cm
Subbase	:	50 cm

TA comes out to below 30 and therefore satisfies the above figure.



Pavement Structure beyond Moat Khmung Brudge

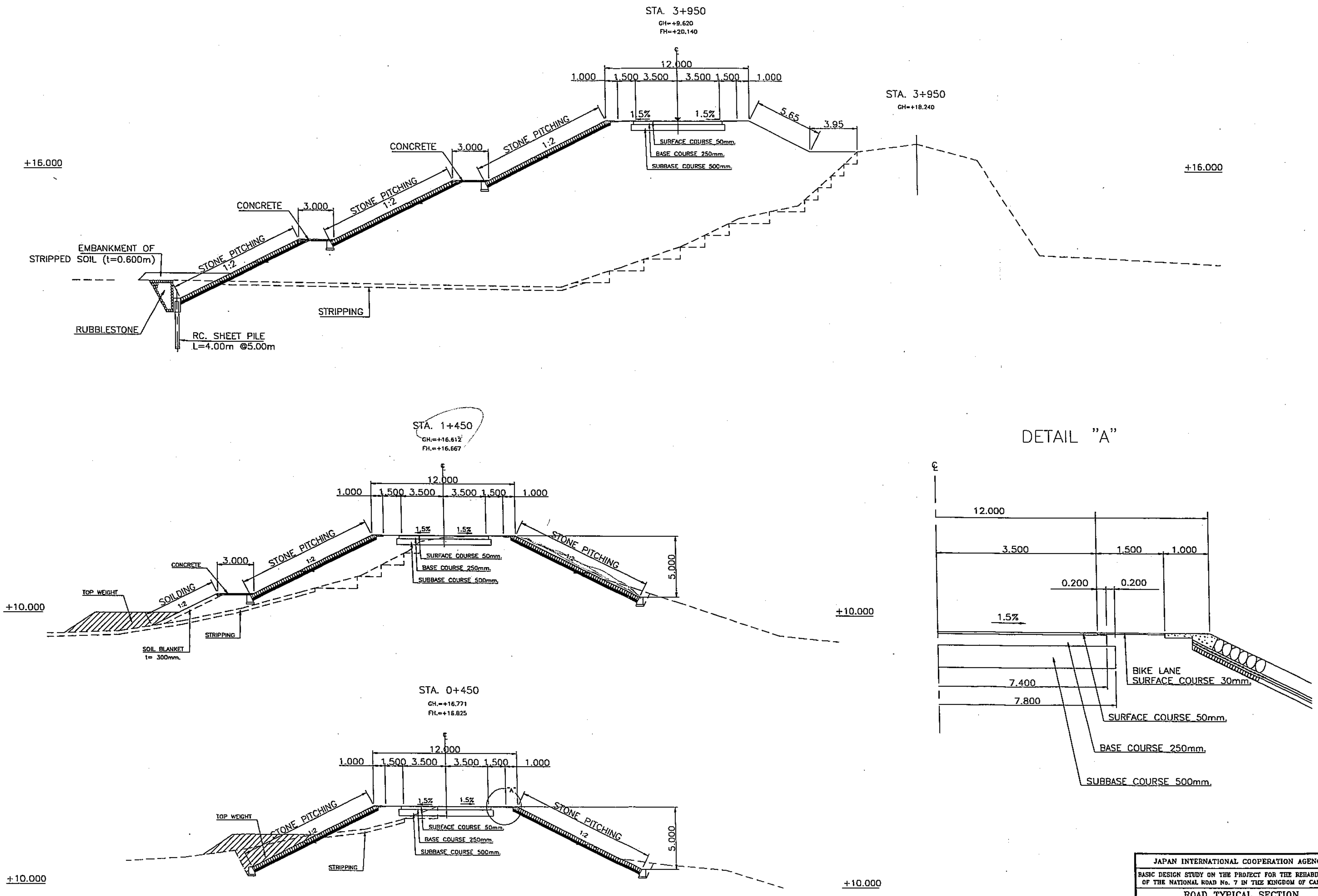


Fig. 2.3.2.5 Road Typical Section (1)

JAPAN INTERNATIONAL COOPERATION AGENCY			
BASIC DESIGN STUDY ON THE PROJECT FOR THE REHABILITATION OF THE NATIONAL ROAD No. 7 IN THE KINGDOM OF CAMBODIA			
ROAD TYPICAL SECTION STA. 0+450, STA. 1+450, STA. 3+950			
	DESIGNED BY		DRAWING No.
	DRAWN BY		--
	DATE		
PROJECT MANAGER	SCALE	1:150	
NIPPON KOEI CO., LTD AND PACIFIC CONSULTANTS INTERNATIONAL			

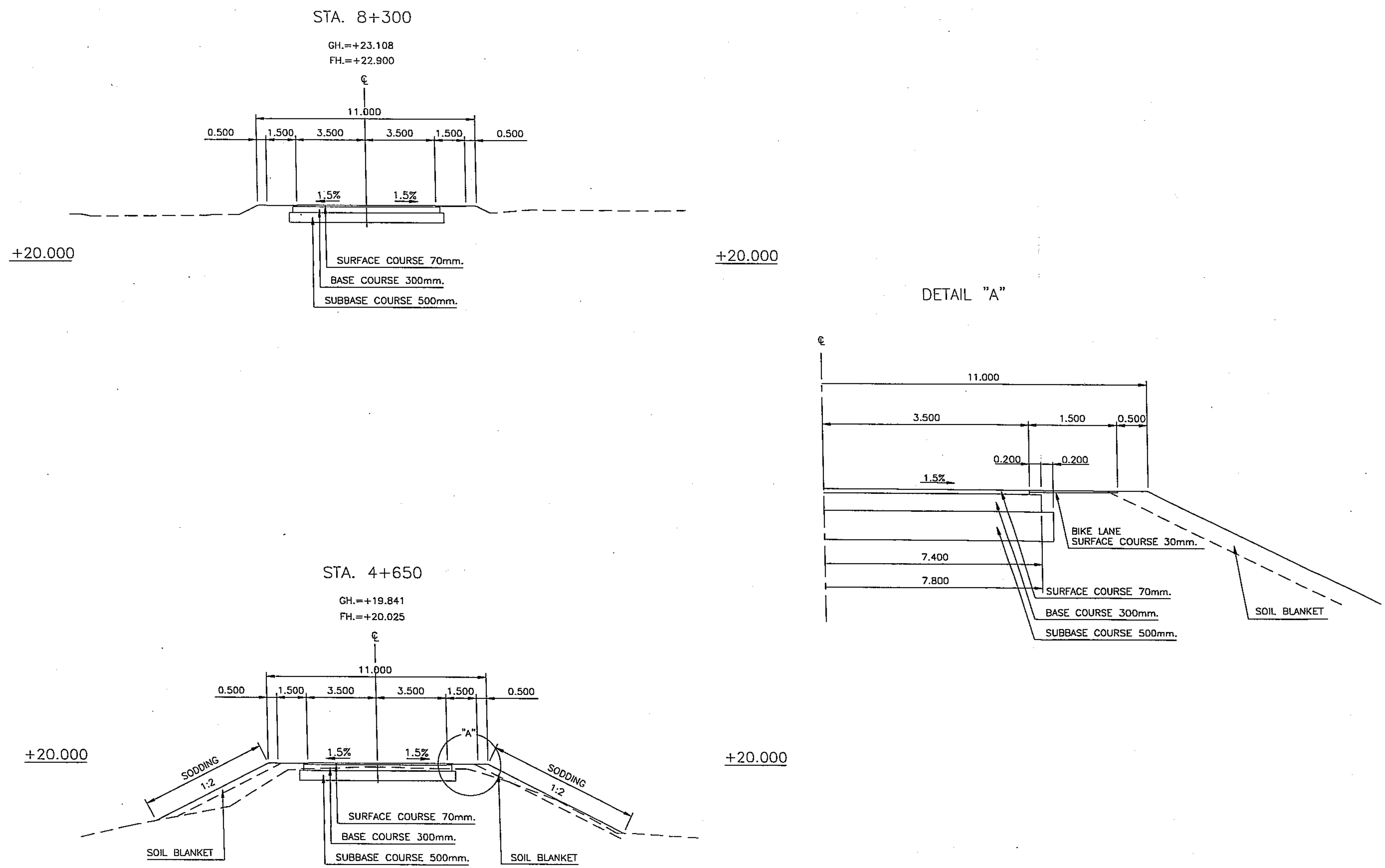


Fig. 2.3.2.6 Road Typical Section (2)

JAPAN INTERNATIONAL COOPERATION AGENCY		
BASIC DESIGN STUDY ON THE PROJECT FOR THE REHABILITATION OF THE NATIONAL ROAD No. 7 IN THE KINGDOM OF CAMBODIA		
ROAD TYPICAL SECTION STA. 4+650, STA. 8+300		
DESIGNED BY		DRAWING No.
DRAWN BY		--
DATE		
PROJECT MANAGER SCALE	1:100	
NIPPON KOEI CO., LTD AND PACIFIC CONSULTANTS INTERNATIONAL		

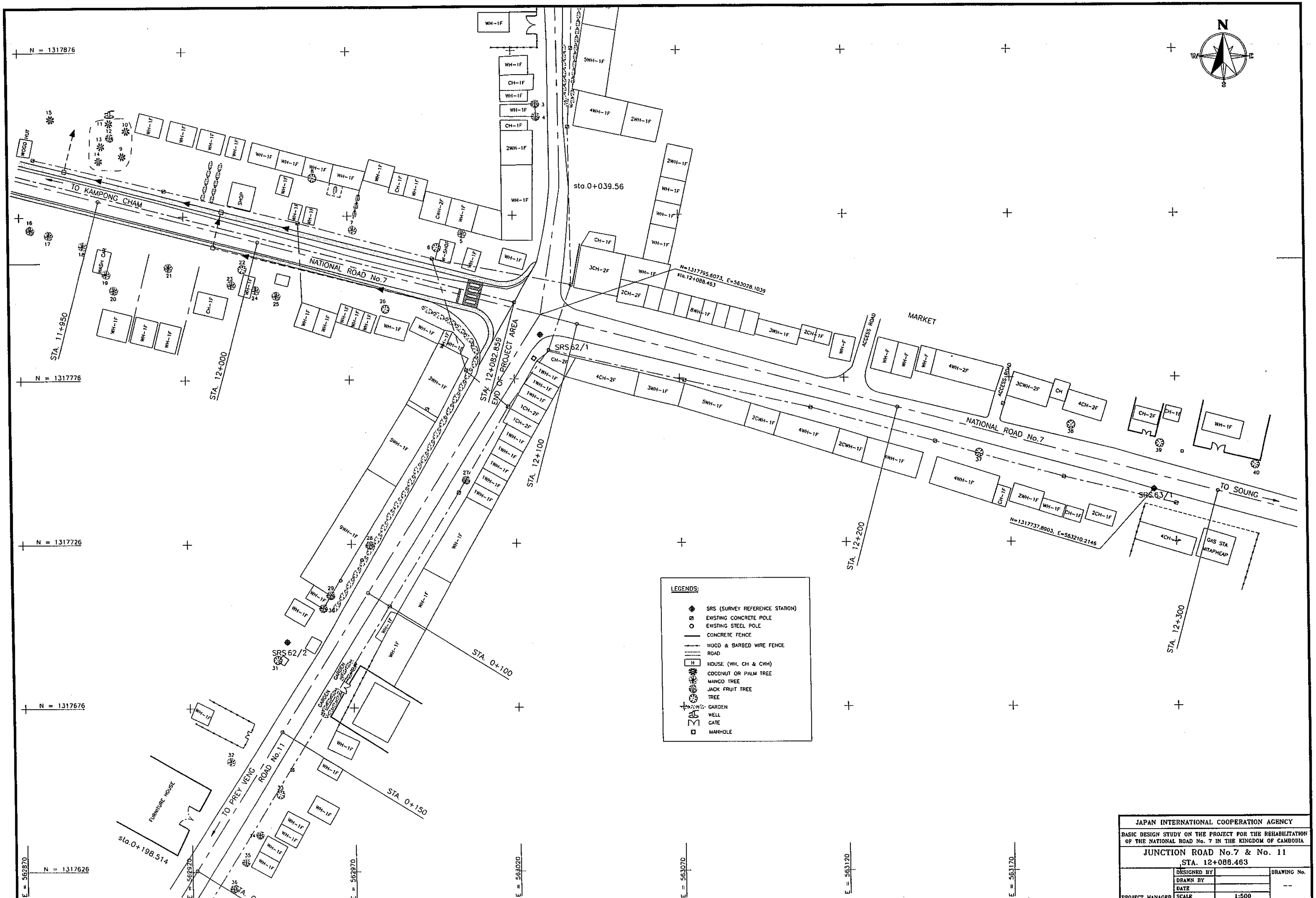


Fig. 2.3.2.7 Junction Road No. 7 & N. 11

(2) Bridge Design

1) The Moat Khmung Bridge

a) Design Flood Discharge

High-water discharge of 50-year probability flood was estimated from the field survey data of water level at Kompong Cham and the velocity at the Moat Khmung that was obtained during July – August in 2000.

As the result, the discharge of 50-year probability flood was estimated 3,800 m3/s.

As mentioned before, the principles to determine the cross-section are that, not to change the present topography, and keep the flood capacity same as present, therefore the high-water discharge should be the same 3,800 m3/s.

b) Estimation of High Water Level at Moat Khmung bridge

i) Principal Concept for Estimation of High Water Level

Even though the existing Moat Khmung Bridge has been several time suffered from damage or collapse caused by flooding or civil war since approximately 60 years ago when it was constructed, road section of Route 7 within flooding area at the east side of Mekong River has been operated without collapse of road section. Taking into account above fact, return period of high water level is established as 50 years.

ii) High Water Level

Return period of high water level at Moat Khmung Bridge is estimated as follow: after fixing water level relation with datum at gauge station in Kompong Cham and surveyed one at Moat Khmung Bridge, high water level at Moat Khmung Bridge is estimated from that one at gauge station in Kompong Cham.

As high water level at Kompong Cham is estimated to be 16.16m in 50 year’s return period and 16.30m in 100 year’s one respectively with method of Log Pearson III, that one at Moat

Khmung Bridge is determined to be 16.50m in 50 year's return period.

c) Bridge longitudinal section plan

The policies for the bridge longitudinal section planning are given below:

i) Height below girders of at least that of the existing bridge.
ii) Securing extra clearance under girders for design floodwater flow volume.
iii) Gentle longitudinal section gradient for adequate securing of sight distance. (i=1.00%)

The longitudinal section planning is based on the above policies.

The table below gives the difference in height below the girders between the new and the existing bridges assuming longitudinal section planning as per the following

Design height of position in front of abutment parapets =20.150

Longitudinal section gradient i = ±1.00%
Vertical curve R =17,500m

The least difference is 0.03 m, which occurs at existing pier P3.

Difference in Height Under Girders between New and Existing Bridges

Difference in height under girders (m)	0.63	0.40	0.23	0.03	0.09	0.21	0.24	0.37

The results of the above longitudinal section planning show that an extra clearance under girders of 1.80 m is secured at the lowest abutment position. Furthermore, the longitudinal section gradient has been made as gentle as possible to avoid increase in accidents due to difference in speed between new and old vehicles in view of the large number of dilapidated, poorly maintained vehicles on the road in Cambodia.

d) Alignment

For a design speed of 60 km/h the minimum horizontal curve radius is

R = 150 m, but it is possible to make an improvement over the existing bridge's curve radius of about R = 150 m by planning R = 200 m so as to secure sight distance.

e) Substructure planning

The river water flow speed at the Maot Khmung Bridge is 2-3 m/s and can be expected to attain 4-5 m/s locally. What one has to be most careful about in planning piers in a river like that is scouring of the foundation part. That being the case, the bridge foundation footing has to be given sufficient depth of embedment and river bed protection has to be provided around the footing as measures against scouring.

There will also be prevention of slope collapse around the abutments by providing slope protection in front of them, and stability of the new and old abutments will be ensured.

As regards the type of piers, considering the fast flow speed and the deep water depth of 11.5 m and the consequent pressure of the flowing water on the piers, the wall type of piers, which has low resistance, will be adopted, and the pier shape will be elliptical for some reduction of such water flow pressure.

f) Bank protection and river bed protection

Wet masonry revetment will be provided for protection of the bank around the abutments for preservation of the Moat Khmung Bridge considering the severe conditions under which it is placed. Furthermore, there will be implementation of protective work based on rubble around the pier foundation footing where there is risk of scouring, and protection of the river bed with rubble will be carried out in a 20 m section on both the upstream and downstream sides of the bridge in the way of preventing lowering of the river bed as a result of scouring.

2) Mream Teak Bridge

General view of Mream Teak Bridge is shown as follows, designing as culvert box.

Fig. 2.3.2.8 General View of Moat Khmung Bridge

RIVER SUBSIDIARY

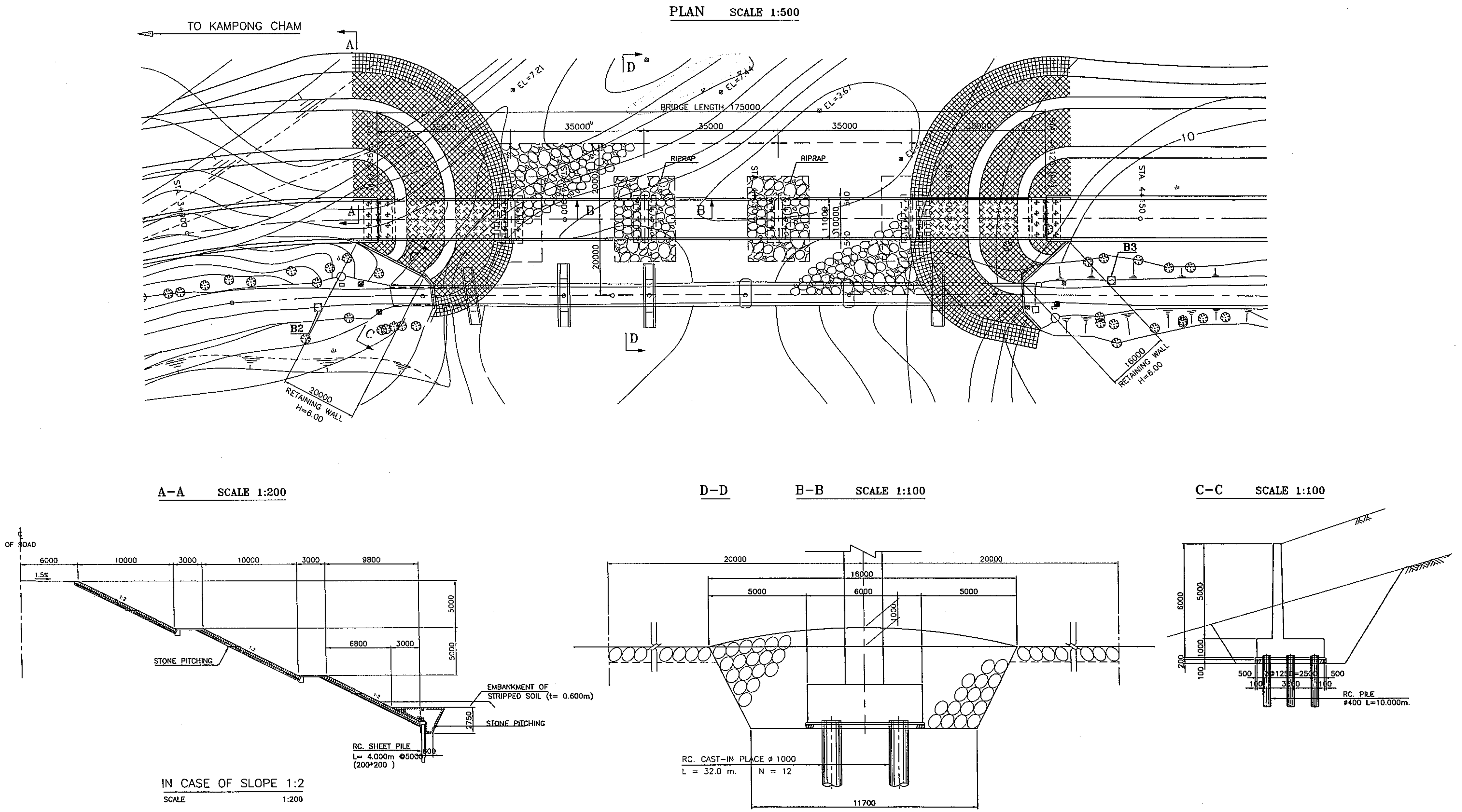


Fig. 2.3.2.9 River Subsidiary

JAPAN INTERNATIONAL COOPERATION AGENCY			
BASIC DESIGN STUDY ON THE PROJECT FOR THE REHABILITATION OF THE NATIONAL ROAD No. 7 IN THE KINGDOM OF CAMBODIA			
RIVER SUBSIDIARY			
	DESIGNED BY		DRAWING No.
	DRAWN BY		--
	DATE		
PROJECT MANAGER	SCALE		
NIPPON KOEI CO., LTD AND PACIFIC CONSULTANTS INTERNATIONAL			

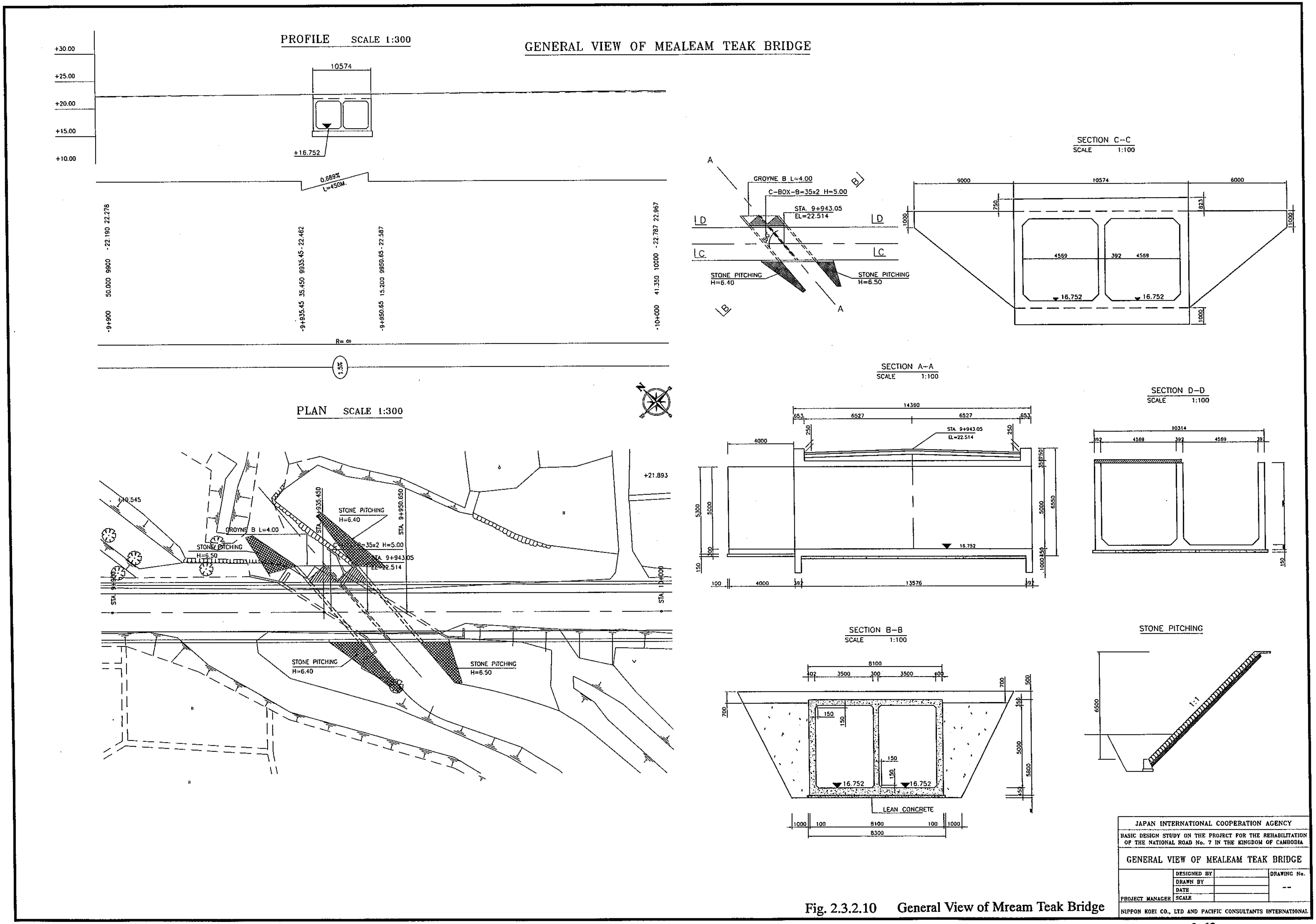


Fig. 2.3.2.10 General View of Mream Teak Bridge

CHAPTER 3 IMPLEMENTATION PLAN

3-1 IMPLEMENTATION PLAN

3-1-1 Implementation Concept

Taking into account that the Project will be implemented under the Japan's Grant Aid Scheme, the implementation concepts are established as follows:

- Maximize the procurement of local labors, materials, and equipment in Cambodia so as to increase employment opportunities, to facilitate technology transfer and to provide positive impact to the local economy.
- Establish good communication between the Government of Cambodia, the consultant and the contractor for the Project to be implemented as smoothly as possible.
- Prepare a practical construction plan taking into account the local rainfall pattern, actual situation of flooding area, period required for materials and equipment procurement, and application of appropriate construction methods.
- Establish camp and plant yard, and field operations, secured and meeting the present environmental requirements in Cambodia.
- Formulate field work programs preventing any inconvenience to the present vehicular traffic and pedestrians.
- Based on the decree on maximum load for transportation or national roads, construction plan will not violate this stipulation.
- While construction works is developing, MPWT should also supervise violating vehicles with overloaded goods crossing over the existing Moat Khmung bridge for the purpose of preserving this bridge in proper condition in order to use a detour

3-1-2 Implementation Condition

Special considerations for the project implementation are as follows:

(1) To obey labour standard

The contractor shall respect and obey relevant labour standard and related work condition and shall take a special attention to prevent from disputes with worker, based on required construction law established in Cambodia.

(2) Clearance of customs

Imported construction materials from Japan or third countries will come by one of two main routes; one is sea transport through Krong Preah Sihanouk and the other is land transport through Thai border. To ensure this Project the Government of Cambodia should cooperate with custom clearance in unloading and custom procedure.

(3) Conditions of Procurement

The construction materials available in Cambodia are concrete aggregates and sand, material for banking, gasoline and timber.

As the Mekong Bridge is expected to be completed by March 2002, an operating concrete plant located on Kompong Cham City for Mekong Bridge project will not be available at the time of commencement of this Project. Because no concrete plant exists on the east side of the Mekong river, it is necessary to construct a new concrete plant on this east side.

(4) Capability of Local Contractors

Among many contractors available in Cambodia, a few contractors are undertaking civil construction projects and the remaining are for building construction. However, the civil contractors' business scale is small in general. In the civil construction projects, Thai workers are involved at many positions from superintendents to common labors.

Due to late modernization caused by the civil war, capability of construction in Cambodia is not high compared with surrounding countries. However, technical transfer is being advanced because many construction works, especially those in public works, are developed with foreign aids.

(5) To secure construction yard

The Government of Cambodia should provide necessary land such as detour and construction yard. According to construction plan, following temporary facilities such as construction office for the Consultant and the Contractor, concrete plant, asphalt plant and stockyards are required.

On the whole, those facilities will be provided by the Government Cambodia so as to be prepared in proper time.

(6) Relevant Laws of Procurement from the Third Countries

General Information on Tax Laws and Business Licenses is applicable law in Cambodia for procurement from the third countries and Japan. It has been confirmed that Gross Revenue Tax, Import Tax and other Taxes imposed in Cambodia are exempted in the Project.

(7) Security

To ensure that engineers related to this Project can work safely and there is no stealing of construction materials, the Government of Cambodia should provide special security to the Japanese side.

(8) Supervision on traffic control to the existing Moat Khmung Bridge.

As existing Moat Khmung Bridge has not enough durability, this bridge will be reinforced aiming at strengthening capacity of load for passing this bridge during construction works prior to commencement of reconstruction of this bridge. Consequently, the Government of Cambodia should supervise overloaded vehicles on this bridge and those passing Route 7 based on the decree to be controlled on violated vehicles.

3-1-3 Scope of Works

The scope of works for which the Japanese Government and the Government of Cambodia are responsible respectively are as follows:

(1) Works and facilities to be provided by Japanese Side

- Installation of construction yard, warehouse, material stock yard and construction office.
- Transportation of construction materials from Japan and third countries
- Maintenance of existing facilities such as existing Moat Khmung Bridge and others during construction period

(2) Works and facilities to be provided by Cambodia Side

- Acquisition of required land.
- Relocation and compensation of houses and obstacle facilities to this project.
- Provision of the construction camp/office yards and plant/storage yards including compensation, if necessary, for the execution of the project.
- Removal of mine and unexploded shells
- Relocation / removal and installation of the utilities.
- Supervision on overloaded vehicles
- Removal of existing Moat Khmung bridge after completion of this project.

3-1-4 Consultant Supervision

(1) Consulting Services Schedules

The Project will commence after signing an Exchange of Notes (E/N) pertaining to the engineering services for detailed design between the Governments of Japan and Cambodia. The contract for the detailed design will be concluded between the MPWT and the Japanese Consultant who will provide the following engineering services within the limits of the Grant Aid.

1) Detailed Design Phase

The consultant is to carry out the detailed engineering design of the bridge and approach roads in compliance with specifications and concepts in the basic design.

- Design criteria and standard
- Design report
- Drawings
- Quantity and cost estimate
- Construction planning
- Tender and relevant documents

2) Pre-Construction Phase

After signing an Exchange of Notes (E/N) pertaining to the engineering service for constructions supervision and the construction, the MPWT is to initiate to select a Japanese contractor to implement the project through an open tender. The consultant is to assist the MPWT on the following tasks:

- Bid announcement
- Pre-qualification of contractors
- Pre-bid conference and site inspection
- Tender and the tender evaluation
- Contract negotiation

3) Construction Supervision Phase

The engineering services for construction supervision will begin, after issuance of the Notice of Proceed to the contractor by the MPWT.

The consultant is to perform his duties in accordance with criteria and standards applicable to the construction works and is to exercise the powers vested in him as the Engineer under the contract to supervise the filed works by the contractor.

The consultant within his capacity as the Engineer is to directly report to the MPWT about the field activities and is to issue field memo or letters to the contractor regarding various matters in terms of progress, quality, safety and payment.

(2) Organization of Project Implementation

1) Staffing for Detailed Design

In the preparation of the detailed design including the tender documents, Japanese staff of the following expertise are needed:

- Team Leader
- Bridge Engineer
- PC Girder Design Engineer
- Substructure Engineer
- Highway Engineer
- Geologist
- River Engineer

- Hydrologist
- Construction Planner/Cost Estimator
- Specification Writer

2) Staffing for Construction Supervision

With reference to the major field works required for close supervision during the construction period, following consulting staff are considered during the construction supervision stage:

- Team Leader
- Resident Engineer
- Material Engineer
- Bridge Engineer for Superstructure
- Bridge Engineer for Substructure
- Foundation Specialist
- River Engineer
- Highway Engineer

3-1-5 Procurement Plan

Construction materials obtainable in Cambodia are aggregates, banking materials, timber and gasoline. As operating concrete plant at Kompong Cham city is being provided with Mekong River Bridge Project, which is expected to complete by March 2002, this plant could not be used for this Project on the ground that this Project is expected to commence after completion of the Mekong Project. Besides this reason, no concrete plant exists along the Route 7 on the east side of Mekong River, so a new concrete plant is needed to be constructed.

Major construction materials required for this Project are listed as below.

Table3.1.5.1 Procurement of Major Construction Materials

Item	Procured in Cambodia	Procured in Japan	Procured in third Country
Banking Soil	O		
Asphalt Mixture	O		
Asphalt Emulsion	O		
Cement	O		
Admixture	O		
Aggregate	O		
Reinforcing bar	O		
PC strand		O	
PC Sheath		O	
PC Anchorage		O	
Bearing Shoe		O	
Expansion		O	
Timber	O		
Materials of scaffold			O
Material frame		O	
Steel Sheet		O	
Traffic board	O		
Fuel	O		

There are minor and commonly used construction equipment owned by local contractors available in Cambodia. The equipment will be lent to the Japanese contractor. Hence, these equipment are scheduled to be used in the Project but major construction equipment with long term period required will be procured in Japan from the cost wise aspect.

The procurement of the construction equipment is shown below.

Table3.1.5.2 Procurement for Major Construction Equipment

Item	Capacity	Procured in Cambodia	Procured in Japan	Procured in third Country
Bulldozer	15 t	O		
Excavator	0.6m^3	O		
Giant Breaker			O	
Motor Grader	3.8 m	O		
Tandem Roller	12t	O		
Tyre Roller	8-20t	O		
Asphalt Finisher	2.4-3.6m	O		
Asphalt Distributor		O		
Dump Truck	10 t	O		
Concrete Plant			O	
Ajitator Truck	4.4m^3		O	
Concrete Pump Car				
Wheel Loader	2.5m3		O	
Folk Lift			O	
Grouting mixer			O	
Tension Jack			O	
Crawler Crane	60 t		O	
Truck Crane	25 t		O	
Vibrator	60kW		O	
Water Distributor		O		
Truck with Crane		O		
Pile Diver			O	

3-1-6 Implementation Schedule

Implementation schedule is shown in Table 3.1.6.1.

3-1-7 Obligation of Recipient Country

The following necessary measures should be undertaken by the Government of Cambodia on condition that the Grant Aid by the Government of Japan is extended to the Project:

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

2) To secure the land for the execution of the Project, such as land for approach road, bridge construction, working areas, storage yard, etc.

3) To clear the sites prior to the commencement of the construction.

4) To bear commissions to a Japanese foreign exchange bank for its banking services based upon the Banking Arrangement, namely the advising

commission of the "Authorization to Pay" and payment commission.

5) To ensure prompt unloading, tax exemption, customs clearance at the port of disembarkation in Cambodia and prompt international transportation therein of the materials and equipment for the Project purchased under the Grant Aid.

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

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

8) To provide necessary permissions, licenses and other authorizations for implementing the Project, if necessary.

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

10) To bear all the expenses other than those to be borne by the Japan's Grant Aid within the scope of the Project.

11) To coordinate and solve any issues related to the Project which may be raised from third parties or inhabitants in the Project area during implementation of the Project.

12) To secure the safety of Japanese nationals including the other personnel engaged in the Project and to provide tight security against riot, insurrection, civil commotion, rebellion, and usurped power.

Construction Schedule **The Project for the Rehabilitation of National Road No. 7 Kampong Cham in K**

□ : Working in Japan
▬ : Working in Cambodia
▭ : Rainy season

Item	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42
Year	2000						2001												2002												2003											
Month	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
Contractor Resident Subtotal												2.0	4.0	4.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0										
Contractor Specialis Subtotal														2.0	3.5	3.0	3.0	4.0	1.0	1.0	2.5	4.5	5.0	4.0	4.0	1.5																
Consultant Detail Design Subtotal					4.0																																					
Consultant Supervising Subtotal												4.0	2.5	3.0	2.0	2.0	1.0	1.0	1.0	2.0	1.0	2.0	2.0	2.0	1.0	1.5	1.5	1.0	1.0	1.0	1.0	1.0										
Amount(M/M)	0.0	0.0	0.0	0.0	4.0	0.0	0.0	0.0	0.0	0.0	0.0	4.0	2.5	3.0	2.0	2.0	1.0	1.0	1.0	2.0	1.0	2.0	2.0	2.0	1.0	1.5	1.5	1.0	1.0	1.0	1.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Item
Exchange of note
Contract with consultant
Survey at Site
Detail Design
Preparation for Tender
Approval of Tender
Qualification of Tender
Appraisal
Site Explanation
Tender
Preparation for Contract
Verfication of Contract
Construction
Notice to proceed
Moat Khmung Bridge
Preparation work
Rainforcement work for existing bridge
Abatment and Pire
Cast in place Girder
Election Work
Slab work ,Handrail work etc.
Earthwork
Bank works
Road Works
Mileamteck bridge
Pavement Works
Demobilization Works

		Item	Grade	Japan M/M	Cambodia M/M	Cambodia N	Japan M/M	Cambodia M/M	Cambodia N	Total
Contractor	Resident	Project Manager	3					21.0	1.0	21.0
		Civil Engineer	4					20.0	1.0	20.0
		Civil Engineer	4					20.0	1.0	20.0
		Civil Engineer	5					18.0	1.0	18.0
		Concrete Engineer	5					21.0	1.0	21.0
										0.0
		Subtotal						100.0	5.0	100.0
	Specialis	Pilimg Staff	5					10.5	3.0	10.5
			(3)							
		Pilimg Specialist	5					8.0	1.0	8.0
		Election Specialist	5					15.0	3.0	15.0
			(3)							
		CrashingPlant Specia	5					2.5	1.0	2.5
		Batcher Prant Specia	5					1.5	1.0	1.5
		Subtotal						37.5	10.0	37.5
							0.0	137.5	15.0	137.5
Consultant	Detail Design	Project Manager	2		1.0	1.0				1.0
		Superstructure Des	3							0.0
		Substructure	3							0.0
		Road Design	4							0.0
		Culvert Design	4							0.0
		GeologicalSurvey	4		1.0	1.0				1.0
		Topographic	4		1.0	1.0				1.0
		Construction Plan	4		1.0	1.0				1.0
		Tender Works	4							0.0
		Subtotal			4.0	4.0				4.0
	Supervising	Project Manager	2					1.5	1.0	1.5
		Resident Engineer	3					21.0	2.0	21.0
		Superstructure Eng	3					3.0	1.0	3.0
		Substructure Engine	3					3.0	1.0	3.0
		Road Engineer	3					4.0	1.0	4.0
		Material Specialist	3					1.0	1.0	1.0
		Pavement Specialist	3					1.0	1.0	1.0
		River Specialist	3					1.0	1.0	1.0
		Subtotal					0.0	35.5	9.0	35.5
Amount(M/M)				0.0	4.0	4.0	0.0	35.5	9.0	39.5

3-2 OPERATION AND MAINTENANCE PLAN

3-2-1 Operation Scheme for Maintenance Works

After the completion of this Project, the following operation and maintenance with proper frequency are required to keep the facilities in sound conditions.

Category	Frequency	Item to be inspected	Scope of Works
Inspection/Maintenance to bridge	Once a year	Expansion Joint	Cleaning and Inspection on expansion joint
		Drainage	Cleaning and Inspection on drainage
		Handrail	Check of damage/reform
Maintenance to road	Once a year	Pavement	patching works if there are potholes
		Shoulder	Grass cutting and leveling
		Embankment Slope	Check any surface erosion and repair
Maintenance to riverbed protection	Once a year	River bed protection	Inspection and repair if any damaged.

3-2-2 Maintenance Cost

Total maintenance cost in a year requires amounts to $5000. This amount is equivalent to 0.11% of total budget for MPWT in the year 2000.

Estimated maintenance costs to each operational works are as below.

Work item	Frequency	Approximate maintenance cost in a year
Inspection and maintenance to bridge including river bed protection	once a year	$2,000
Inspection and maintenance to roads	once a year	$3,000
Total		$5,000

CHAPTER 4 PROJECT EVALUATION AND RECOMMENDATION

4.1 PROJECT EFFECT

Judging from the results and observations under this Basic Design study,the project will have the following effects.

1) Direct Effects

- While annual rate traffic increasing ratio on relevant study section is estimated as approximately 3 % at present, this ratio after completion of the Mekong Bridge in Cambodia , which is scheduled to open by March2002, is expected to stand for about 12 %. As it is difficult to comply with traffic volume without rehabilitated facility five years after completion of the Mekong Bridge, completion of this plan will contribute to dissolve overcharged traffic demand on Route 7 from the east side of the Mekong River in conformance with Mekong Bridge Project in terms of traffic planning.

- Trip time from junction of Mekong Bridge approach road to that of Route 11 totaling approximately 12km will be shorten to less than 15 minutes compared with about 40 minutes at present.

- Once existing the Moat Khmung Bridge functioning only passage of flood water, is replaced to permanent bridge structure, disconnection of relevant section caused by collapse of this bridge will be cleared.

2) Indirect Effect

- Because development of rural area will be encouraged in line with development towards the east side of the Mekong River triggered with completion of Mekong Bridge, implementation of this Project will help the Cambodian economy to thrive.

- International road will be expanded as a result of securing part of the Asian Highway connecting those areas from the northern part to southern part of the Indochina Peninsula as well as strengthening the domestic road.

- As access from the east side of Mekong River to the capital city, Phnom

Penh, becomes easier, it is expected that agricultural sector in Cambodia will be activated.

4.2 RECOMMENDATION

Since this road and bridge project is planned at a flooding area around the Mekong River, constructed facility will be subject to extremely severe natural conditions. Further more, as basic concept on this Project is not to change present situation as much as possible in considering hydrological stand points so as to have the least impact on social and environmental conditions, the following problems will have to be addressed when this Project is implemented.

Maintenance Works on rehabilitated facility: Careful inspections are required on both road and bridge facilities especially after rainy season. Among various kinds of inspections, those of river bed protection should be periodically carried out with observation records in order to monitor scale of scouring around Moat Khmung Bridge.

Relation between ADB project and this Project: As eastern side of Road on Route 7 from junction of Route 11 is to be implemented with ADB fund, treatment of construction demarcation point at the junction between Route 7 and 11 will needed to be discussed with each executing consultant.

In carrying out7 detailed design and construction works on this Project, investigation and quick removal works, if necessary, regarding mines and UXO will needed to be ensured as committed with Minutes of Discussion on 26 October 2000 between the Government of Cambodia and Japan.

Execution of traffic control on overloaded vehicles by the Government of Cambodia : Because considerable vehicles are operating throughout the country, proper traffic control should be imposed on these vehicles in order to maintain rehabilitated facility in good condition for a long period.