MINISTRY OF COMMUNICATION,
TRANSPORT, POST AND CONSTRUCTION
LAO PEOPLE'S DEMOCRATIC REPUBLIC

NO.

BASIC DESIGN STUDY REPORT ON THE PROJECT FOR IMPROVEMENT OF NATIONAL ROAD ROUTE 9 (PHASE 2) IN LAO PEOPLE'S DEMOCRATIC REPUBLIC

DECEMBER 2000

JAPAN INTERNATIONAL COOPERATION AGENCY
KATAHIRA & ENGINEERS INTERNATIONAL

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PREFACE

In response to a request from the Government of Lao People's Democratic Republic (Lao PDR), the Government of Japan decided to conduct a basic design study on the Project for Improvement of National Road Route 9 (Phase 2) and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Lao PDR a study team from June 24 to August 1, 2000.

The team held discussions with the officials concerned of the Government of Lao PDR, and conducted field studies at the study area. After the team returned to Japan, further studies were made. Then, a mission was sent to Lao PDR from October 17 to 26, 2000 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 Lao People's Democratic Republic for their close cooperation extended to the team.

December, 2000

Kunihiko Saito
President
Japan International Cooperation Agency

December, 2000

Letter of Transmittal

We are pleased to submit to you the basic design study report on the Project for Improvement of National Road Route 9 (Phase 2) in Lao People's Democratic Republic.

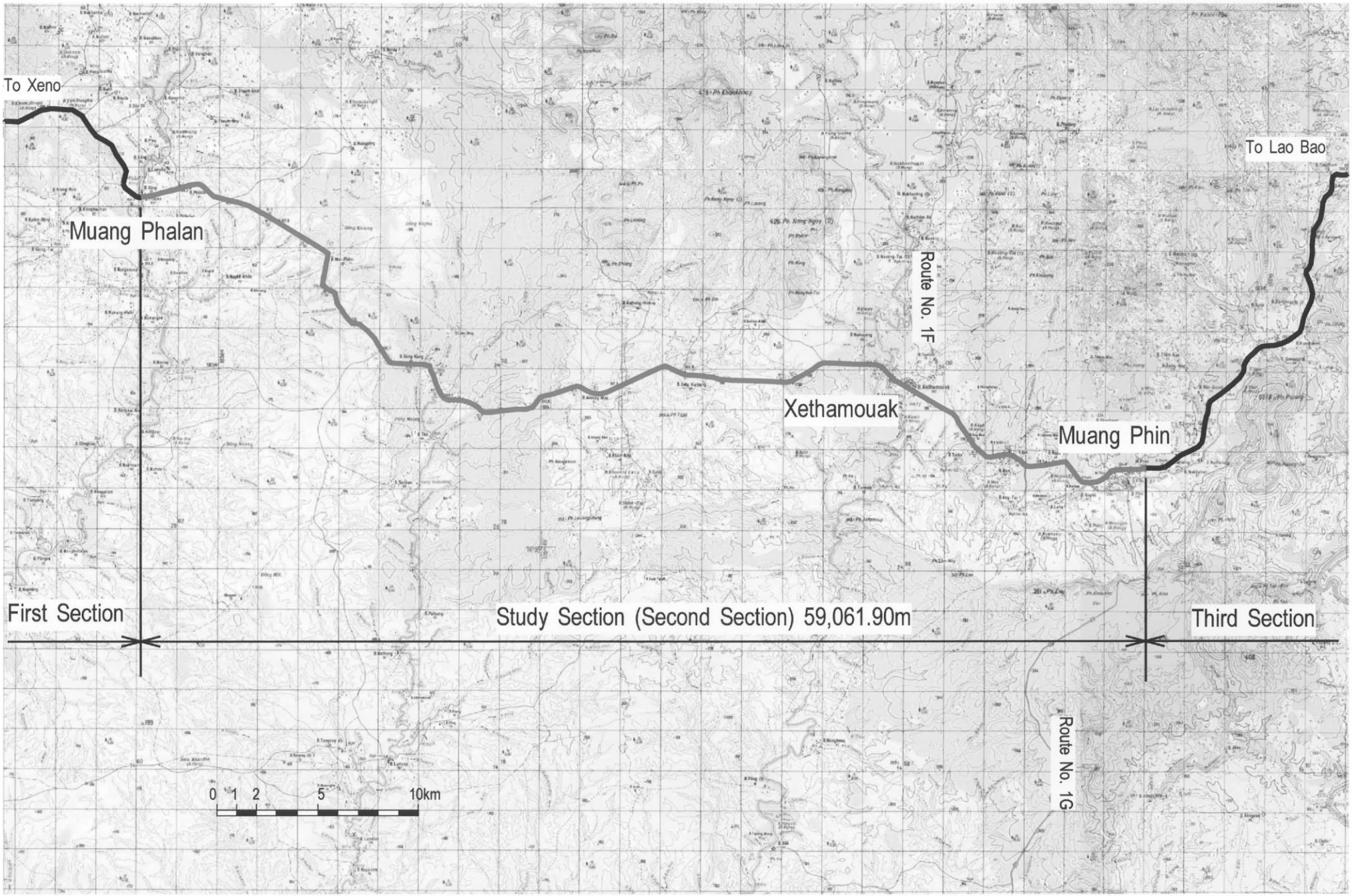
This study was conducted by Katahira & Engineers International, under a contract to JICA, during the period from June 21, 2000 to December 15, 2000. In conducting the study, we have examined the feasibility and rationale of the project with due consideration to the present situation of Lao PDR and formulated 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,

Minoru Miura
Project Manager,
Basic Design Study Team on the Project for
Improvement of National Road Route 9
(Phase 2)
Katahira & Engineers International

Location Map of Project Area



Location Map of Study Section

PERSPECTIVE

Abbreviation

AASHTO	:	American Association of State Highway and Transportation Officials
A C	:	Asphalt Concrete
A D B	:	Asian Development Bank
A D T	:	Average Daily Traffic
A F T A	:	ASEAN Free Trade Area
ASEAN	:	Association of Southeast Asian Nations
B T B	:	Bituminous Treated Base
C B R	:	California Bearing Ratio
CH	:	Chainage
D B S T	:	Double Bituminous Surface Treatment
D C T P C	:	Department of Communication, Transport, Post, and Construction
D / D	:	Detailed Design
DOR	:	Department of Roads
E S A L	:	Equivalent Single Axle Load
F / S	:	Feasibility Study
GNP	:	Gross National Product
I D A	:	International Development Association
k i p	:	Kilo pounds
k p h	:	kilometer per hour
lb	:	Libra
L D C	:	Less Developed Countries
M C T P C	:	Ministry of Communication, Transport, Post and Construction
P C U	:	Passenger Car Unit
P D R	:	People's Democratic Republic
p s i	:	Pounds per square inch
RAD	:	Road Administration Division
R C	:	Reinforced Concrete
R O W	:	Right of Way
S B S T	:	Single Bituminous Surface Treatment
S N	:	Structural Number
U X O	:	Unexploded Ordnance
V P D	:	Vehicle Per Day

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CHAPTER 1

BACKGROUND OF THE PROJECT

CHAPTER 1 BACKGROUND OF THE PROJECT

The role of the road network on the transportation system in Loa PDR is quite important as it caters to 75% of cargo transport and 85% of passenger transport. The Government of Lao PDR has intensified the development of its road network, where total road length in the country increased to approximately 23, 000 km as of 1999, about twice of the length 15 years ago. However, the length of paved road is approximately 3,700 km, which is just about 16% of the whole road, and the ratio of its national roads is not more than 45%.

National Road No.9, the project road of this Study, is a national major trunk road of 240 km in length, connecting Savannakhet, beside the Mekong River which borders with Thailand, and Lao Bao, a town close by the border with Vietnam. It is an important route being an access to the South-China Sea. Improvement for its 211 km section was implemented between 1982 and 1988. But majority of the existing road, except for the section of 29 km in length between Savannakhet and Xeno which was improved in 1996 by IDA loan, show serious damage such as presence of cracks, potholes and peeled surface at every turn. It has caused un-passable situations for some types of vehicles during rainy season.

The project road has not functioned properly as a trunk road. Therefore it becomes urgently necessary to carry out improvement work to include the widening of the road and improvement of the bridges.

ADB has propelled "East-West Transport Corridor Project", a general infrastructure program to develop the middle of the Indo-China Peninsula (the north-east of Thailand, the middle-south of Lao PDR and the middle of Vietnam) by the completion of the feasibility study in December 1996. As a result of the study, top priority was given to the central corridor from Mukdahan of Thailand to Da Nang of Vietnam via Savannakhet, Xeno, Daensavan in Lao PDR and Lao Bao in Vietnam.

With these situation, the Government of Lao PDR requested for a Japan's grant aid assistance in 1997 for the improvement of National Road No.9 particularly the section of approximately 211 km in length (Xeno~Lao Bao).

In response to the request of the Government of Lao PDR, the Government of Japan decided to conduct a basic design study on the Project for Improvement of National Road No.9. As an initial step, Japan International Cooperation Agency (JICA) dispatched a Preparatory Study Team in February 1998, and it was agreed by both parties that the 211 km road section be divided into three sections which will be treated respectively in stages. Then, JICA dispatched the Basic Design Study Team for the project on the First Section of

73 km in length (Xeno~Muang Phalan). Based on the result of the basic design study, "The Project for Improvement of the National Road Route 9" was decided to be implemented under Japan's Grant Aid assistance and was started on July 1998 and still on going at the present time.

The Third Section of 78 km in length (Muang Phin~Lao Bao) is being implemented under an ADB loan at present. For the Second Mekong International Bridge, the detailed design was conducted by JICA and implementation of which will be under the loan from Japan Bank for International Cooperation (JBIC).

Later, the Government of Japan decided to conduct a basic design study on the Project for Improvement of National Road Route 9 (Phase 2) for the Second Section of 60 km in length, the implementation of which was still undecided for inclusion among the requested 211 km Section. JICA dispatched the Basic Design Study Team from June 24 to August 1, 2000 for field survey and discussions with the officials of the implementing agency in Lao PDR.

The study team, during its stay in Lao PDR, confirmed the background, objectives and contents of the Project, collected relevant data and surveyed the project site. After returning to Japan, the Study Team evaluated the Project based on the necessity, socio-economic effects, appropriateness and other relevant factors, and the basic design and implementation plan were drawn up.

As a result, the draft basic design for the improvement of the road section of about 60 km in length between Muang Phalan and Muang Phin was proposed. After explanations and consultations on the draft basic design with the officials of Lao side, the basic design of the Project was developed.

CHAPTER 2

CONTENTS OF THE PROJECT

CHAPTER 2 CONTENTS OF THE PROJECT

2.1 Objectives of the Project

National Road No.9 crossing the middle of Lao PDR is a national major trunk road as an access to the South-China Sea and has borne the important role of an international road network as a trans-peninsula road in the Indo-China Peninsula. However, it is urgently necessary that the road improvement work on the existing pavement, which caused the un-passable situation for some vehicles during rainy season, be implemented. "Strategic Direction for the Development of the Road Sector 2000~2015" prepared by Ministry of Communication, Transport, Post and Construction (MCTPC) shows that the improvement project of National Road No.9 scheduled to be completed in 2003 is one of its top priority projects.

The section of this study is approximately 60km in length connecting the end of the First Section and the beginning of the Third Section, the only section whose implementation remains undecided among the improvement projects of National Road No.9.

This project in particular aims to improve the road transport condition in Savannakhet province and to ensure smooth traffic conditions by the improvement of National Road No.9.

By the implementation of this study section, the improvement project of the entire National Road No.9 will be completed.

2.2 Basic Concept of the Project

2.2.1 Existing Condition of the Project Road

The major national roads in Lao PDR are No.1, 2, 4, 6, 7, 8, 9 and 13. National Road No.13, with a total length of 1,370 km, is the main trunk road in the country, which links Luang Prabang in the north and Khong in the south passing through the major urbanized areas of Vientiane, Savannakhet and Pakse. National Roads No.7, 8 and 9 lead to the Vietnamese border, and No.1 to China.

National Road No.9 was constructed at two sections separately. The first section between Xeno and Sepon, Km 0 – Km 163, was designed with a 7 m carriageway and 1 m shoulders by the Russian Design Institute and constructed by the MCTPC during 1984 to 1988. The second section from Sepon to Lao Bao close by the Vietnamese border, Km 163 – Km 211,

was designed with a 6 m carriageway and 1 m shoulders and constructed by Vietnamese engineers and contractors between 1982 and 1986.

The existing pavement conditions of the study section of 60km in length from Muang Phalan to Muang Phin are described in Appendix 6. Pavement Condition Survey.

2.2.1.1 Existing Condition of the Road

(1) Traffic

National Road No.9, as the central corridor of the country, is one of the most heavily traffic routes on the national road network in Lao PDR with daily traffic of 700 vehicles per day. The typical composition of existing traffic flow is as follows:

- High proportion of motor cycles
- Lower proportion of private vehicles
- Higher proportion of commercial vehicles
- Relatively low level of daily traffic (low level of the vehicle ownership & economic activity and generally poor state of the roads)

(2) Alignment

The horizontal and vertical alignments of the road are proper except at few sections.

According to the Russian design documents, the road was designed with the following geometric criteria:

- Minimum horizontal curve radius 250 m
- Minimum vertical crest curve radius 5,000 m
- Minimum vertical sag curve radius 2,000 m
- Maximum gradient 5 %

(3) Road Width

The existing road width varies from 7.5 m to 10.0 m composed of the following carriageway and shoulders.

- Carriageway width ; 6.5 m ~ 8.0 m
- Shoulder width ; 1.0 m ~ 2.0 m

(4) Pavement

The existing pavement consists of DBST surface, macadam base and subbase with a total thickness of about 400 mm, as shown in Figure 2.2.1-1.

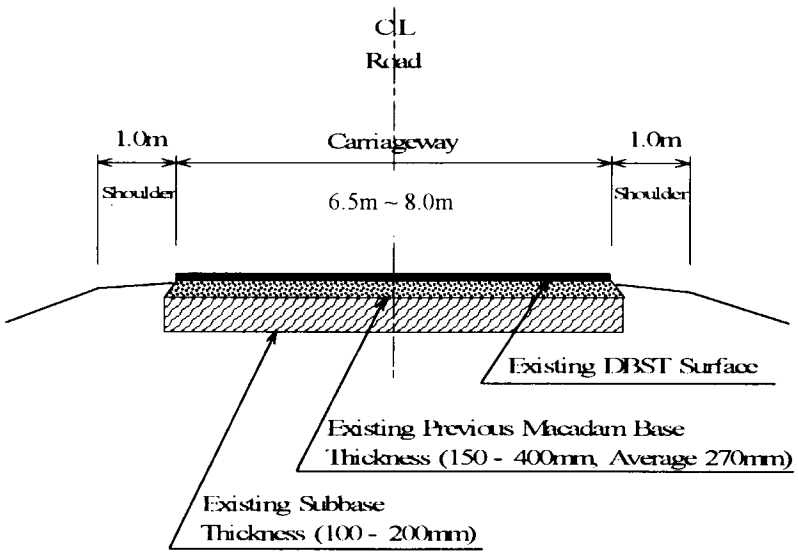


Figure 2.2.1-1 Existing Pavement

The existing pavement, in general, shows several types of deficiencies and deteriorations including transverse/longitudinal alligator cracks, localized failure sections, removal of surface materials, potholes, depression, etc. The existing conditions of pavement are briefly presented in Table 2.2.1-1.

Table 2.2.1-1 Existing Condition of Pavement

Chainage KM	Functional Condition	Structural Condition	Remarks
KM 0 ~ KM 2	Very bad/bad	Medium severity	Many failure sections
KM 2 ~ KM 8	Fair/bad	Low/medium severity	Many failure sections
KM 8 ~ KM11	Bad/very bad	Medium severity	
KM11 ~ KM18	Fair	Low/medium severity	
KM18 ~ KM19	Bad	Medium severity	
KM19 ~ KM20	Good	Low severity	
KM20 ~ KM42	Very bad/bad	Medium severity	Mostly failure sections
KM42 ~ KM45	Bad	Medium severity	Mostly failure sections
KM45 ~ KM48	Good/fair	Low severity	
KM48 ~ KM50	Very bad	Medium severity	Mostly failure sections
KM50 ~ KM52	Fair	Low/medium severity	
KM52 ~ KM61	Very bad/bad	High severity	Mostly failure sections

Note: Structural conditions were evaluated based on severity of alligator cracks.

(5) Culverts and Drainage

On the study section, a total of 61 culverts are installed. Generally, existing culverts provide adequate cross drainage capacity with inlets/outlets at both sides, except at a few locations. The roadside drainages are mostly earth ditches. Erosion and/or sedimentation are observed on them in rolling terrain.

(6) Road Facilities

Traffic signs are installed at some point of junction, bus stops and bridge approaches. Guide posts are installed at culvert locations and bridge approaches.

2.2.1.2 Existing Condition of Bridges

There are 13 bridges along the study section with the types and dimensions, as summarized in Table 2.2.1-2.

Table 2.2.1-2 Summary of Bridges

Bridge Number	Bridge Name	Chainage (KM)	Bridge Type	Bridge Length (m)	Carriageway Width (m)	Side walk (m)
1	Houay Koa	0 + 646	RC Simple Girder	17.74	8.0	2 x 1.45
2	Houay Nha Phenk	7 + 173	RC Simple Girder	39.10	8.0	2 x 1.45
3	Houay Ngua	12 + 079	RC Simple Girder	36.10	8.0	2 x 1.45
4	Huay Sa Loung	18 + 243	RC Simple Girder	36.10	8.0	2 x 1.45
5	Houay Sa Leang	19 + 245	RC Simple Girder	54.10	8.0	2 x 1.45
6	Se Koum Kam	20 + 479	Simple Steel Girder	90.48	7.0	2 x 0.80
7	Houay Jon	22 + 542	RC Simple Girder	24.05	8.0	2 x 1.45
8	Houay Toa	28 + 079	RC Simple Girder	36.10	8.0	2 x 1.45
9	Houay Lak Kouay	40 + 880	RC Simple Girder	42.10	8.0	2 x 1.45
10	Se Tha Mouk	46 + 239	Simple Steel Girder	163.00	7.0	2 x 1.45
11	Houay Ta Sap	52 + 567	RC Simple Girder	18.60	8.0	2 x 1.45
12	Houay Ta Youg	54 + 080	RC Simple Girder	30.05	8.0	2 x 1.45
13	Houay Polo	54 + 421	RC Simple Girder	48.10	8.0	2 x 1.45

The existing conditions of RC bridges are structurally fair, while the other two steel bridges are still serviceable although they show much deflection on the center spans. In general, the structures have some minor deficiencies such as spalled concrete of structural members, inadequate

cover of concrete, damaged expansion joint, etc.

Deficiencies of bridges in view of traffic functionality are summarized as follows:

- Deck slab
  Concrete deck slabs on almost all bridges have irregular surface with hairline cracks.
- Deck drainage
  Decks have no drainage path so that surface water can not be discharged.
- Steel hand railing
  Some of the steel hand railing are damaged or corroded.
- Scour protection
  - Pier foundation of bridges are scoured.
  - Abutment slope protection of bridges are damaged.
- Sidewalk at bridge approaches
  No sidewalks are provided at bridge approaches.

2.2.2 Basic Concept of the Road Improvement

Based on the above mentioned findings and examinations, the importance of the study section is evaluated and summarized on the following aspects.

- Role in road network
- Traffic Demand
  - Early Stage
  - Final Stage
- Socio-economic effect
  - Beneficiary
  - Agriculture
  - Stockbreeding

(1) Role in Road Network

National Road No.9 is a trans-province road in Savannakhet, and it has a vital role in the national road network such as connecting with National Road No.13, No.1F and No.1G at Xeno, Xethmouak and Muang Phin respectively. So that, it has the distinction as the most important traffic facility in related area.

National Road No.9 is the most important route to ensure the access to the South China Sea an open sea for Lao PDR, an inland country. It has carried out the role of international road to support the trade with neighboring Vietnam. Moreover, the importance as an international road will be even greater after the opening of Second Mekong International Bridge, which is scheduled for implementation under a Japanese Yen loan, to connect the three countries of Thailand, Lao PDR and Vietnam.

While, National Road No.9 is included in "East-West Transport Corridor Project", a general infrastructure development program by ADB, whose objective is the completion of a trans-peninsula road in the Indo-China with components of construction of Second Mekong International Bridge connecting Mukdahan of Thailand and Savannaket of Lao PDR, upgrading of Da Nang Port the final destination of the corridor traffic and improvement of National Road No.9.

In addition, National Road No.9 shall carry out a role in "Asian Highway Network Project" planned to realize the ASEAN Free Trade Area (AFTA) propelled by ASEAN. International road network related with National Road No.9 is shown in Figure 2.2.2-1.

(2) Traffic Demand

Compared with National Road No.8 located in the north of the project road, National Road No.9 is currently the most heavy traffic route in the trans-nation roads with an ADT of about 700 vehicles.

The present and forecast average daily traffic at Muang Phin along the study section is shown in Table 2.2.2-1.

Table 2.2.2-1 Present and Forecast Traffic

Average Daily Traffic (ADT)

	Motor-cycle	Bus	Car, Pick-up	Commercial Vehicle	Total
Present in 2000	453	60	51	174	738
Forecast in 2010 *	1,128	575	414	922	3,039
Forecast in 2020 *	2,787	934	1,065	2,026	6,812

* Forecast traffic with the construction of Mekong Bridge and upgrading Road No.9 and related roads.

Source: Technical Report No.3, East-West Transport Corridor Study, ADB, 1997
Traffic Count Survey, July 2000

Figure 2.2.2-1 INTERNATIONAL ROAD NETWORK

Beneficiary

Population of Savannakhet province is estimated at 748,000 in 1999, approximately 15% of total population in Lao PDR. This population will alternately be the direct beneficiaries of the Project in view of socio-economic development of the province, the smooth commodity flow and development of external trade.

All populations of the southern provinces, which are the provinces of Attopeu, Sekong, Saravane and Champasack, with about 1.01 million are also expected to benefit indirectly from the Project.

Table 2.2.2-2 Population by Province (1999)

Unit; Thousand

Province	Area (Km^2)		Population	
1. Savannakhet	21,774	(9.2%)	748	(15%)
2. Vientiane Municipality	3,920	(1.6%)	583	(11%)
3. Champasack	15,415	(6.5%)	558	(11%)
4. Luangprabang	16,875	(7.1%)	406	(8%)
5. Xayabury	16,389	(6.9%)	325	(6%)
6. Vientiane	15,927	(6.7%)	319	(6%)
Whole Country	236,800	(100%)	5,091	(100%)

Source: Basic Statistic-(1975-2000), National Statistic Center, Lao PDR

Agriculture

Savannakhet province is economically dominated by agriculture and forestry. Rice is the main crop in the province, contributing 20% of total production in the country.

Table 2.2.2-3 Rice Production (1999)

Unit; Thousand Ton

1. Savannakhet	420.2	(20 %)
2. Champasack	307.5	(15 %)
3. Vientiane Municipality	229.9	(11 %)
4. Saravanh	139.6	(7 %)
Whole Country	2,094.0	(100 %)

Source: Basic Statistic-(1975-2000). National Statistic Center, Lao PDR

Livestock

Livestock is an important production in Savannakhet province, supplying 18% of buffalos, 22% of cattle and 21% of goats and sheep of total produce in the country.

Table 2.2.2-4 Number of Livestock (1999)

Unit: Thousand heads

Item	Whole Country		Savannakhet		Ranking by Provinces
Buffalo	991.8	(100 %)	183.4	(18 %)	1
Cattle	944.1	(100 %)	204.1	(22 %)	1
Pig	1,036.4	(100 %)	94.0	(9 %)	3
Goats and Sheep	94.4	(100 %)	19.5	(21 %)	1
Poultry	11,214.5	(100 %)	1,248.1	(11 %)	1

Source: Basic Statistic-(1975-2000). National Statistics Center, Lao PDR.

(4) Basic Concept of the Road Improvement

The subject of this study is the Second Section connecting the First Section and the Third Section, both of which are under construction at present, hence the basic concept was decided taking into account both sections.

Basic Concept of the necessary road improvement is shown in Table 2.2.2-5.

Table 2.2.2-5 Basic Concept of Road Improvement

Items	First Section (Japan's Grant Aid)	Second Section (This Study)	Third Section (ADB Loan)
1. Design Standards	MCTPC Road Design Manual with modifications.	MCTPC Road Design Manual with modifications.	MCTPC Road Design Manual with modifications
2. Road Design Class	Class II. (3000-8000 PCU)	Class II. (3000-8000 PCU)	-
3. Design Speed	• 100 kph Flat/Level Terrain • 50~70 kph (Populated area)	- 100 kph Flat Terrain - 70 kph Rolling Terrain - 50 kph (Populated area)	- 100 kph (West of Zepon) Flat - 80 kph (East and Zepon) Rolling - 50~70 kph (Populated area)
4. Road Cross Section	- No of lane : 2 - Lane width : 3.5m - Shoulder : 1.5m 2.5m (populated area) - Paved shoulder : 1.0m (t=5cm) : 2.5m (t=5cm)	- No of lane : 2 - Lane width : 3.5m - Shoulder : 1.5m 2.5m (populated area) - Paved shoulder : 1.0m (t=5cm) : 2.5m (t=5cm)	- No of lane : 2 - Lane width : 3.5m - Shoulder : 1.5m 2.5m (populated area) - Paved shoulder : 1.0m (SBST)
5. Alignment	- Follow Existing Alignment	- Follow Existing Alignment	- Follow Existing Alignment
6. Pavement	- Pavement Life 8 years - 1.8 million ESAL application - Overlay on Existing Pavement -Min 5cm AC -Min 5cm Bituminous Treated Base -Min 12 or 15cm Base -Preparation of Pre-Overlay repair - New Construction -Min 5cm AC -Min.5cm Bituminous Treated Base -10.0cm Base -28cm Cement Treated Subbase -CBR=5 Subgrade	- Pavement Life 8 years - 1.72 million ESAL application - Overlay on Existing Pavement -Min 5cm AC -Min 5cm Bituminous Treated Base -Min 12 or 15cm Base -Preparation of Pre-Overlay repair - New Construction -Min 5cm AC -Min.5cm Bituminous Treated Base -10.0cm Base -28cm Cement Treated Subbase -CBR=5 Subgrade	- 8 million equivalent standard axle - Overlay on Existing Pavement -Min 5cm AC -Min 1cm SBST -17.5cm Base -17.5cm Subbase -Trimming of existing surface (50~100mm) - New Construction -Min 5cm AC -Min 1cm SBST -Min 17.5cm Base -Min 17.5cm Subbase -15cm Lower Subbase(CBR=15) -CBR=5 Subgrade

Basic concept of the improvement for drainage facilities and traffic facilities are shown in Table 2.2.2-6 and Table 2.2.2-7 respectively.

Table 2.2.2-6 Basic Concept of the Improvement for Drainage Facilities

Items	Concept of This Study
Culvert	- New installation, if necessary at flood section, etc. - Extension of insufficient culvert length at widening section, and provide the wing wall, if necessary - Replacement of low capacity culvert
Side ditch	- Provide earth ditch at flat & cut section and populated area
Flood section	- Slope protection with gabion, if necessary at flood section, etc.

Table 2.2.2-7 Basic Concept of the Improvement for Traffic Facilities

Items	Concept of This Study
Traffic sign	- According to Lao Road Design
Lane marking	- Centerline delineation - Edgeline delineation
Guide post / rail	- High embankment - Tight curve - Bridge approach
Bus stop	- Provide at populated areas
Bus Bay	- Provide at Xethamouak and Muang Phin
Access Road	- Provide at 8 places such as stock yard of log, etc.

Any other critical problem was not found in the field investigation.

2.2.3 Basic Concept of the Bridge Improvement

Existing 13 bridges along the study section are determined to be of acceptable conditions without any serious structural deterioration due to traffic loading, and so can still be serviceable up to the time it becomes necessary for reconstruction due to the obsolete structural condition. Reconstruction of existing bridges is not only needless but a waste of the past investment on them. Therefore the improvement of structural capabilities on existing bridges in this study is not planned.

However the roughness on deck slabs of bridges affect the quality of running ability, and it has recommended counter measures. Items to be improved on bridges are as follows:

- To repair and flatten the deck slab
- To provide the sidewalk at bridge approach

Table 2.2.3-1 shows the basic concept of the bridge improvement.

Table 2.2.3-1 Basic Concept of Bridge Improvement

Items	First Section (Japan's Grant Aid)	Second Section (This Study)	Third Section (ADB Loan)
1. Deck slab	- Cover with asphalt concrete (t=5.0cm)	- Cover with asphalt concrete	- Cover with asphalt concrete
2. Expansion joint	- No seriously damaged joint - Butt- joint must be covered with AC - Finger steel joint, no repair	- No seriously damaged joint - Butt- joint must be covered with AC - Finger steel joint, no repair	- install new
3. Inadequate deck drainage	- Drainage paths will be provided through crossfall in AC surfacing	- Drainage paths will be provided through crossfall in AC surfacing	- Provide new drainage paths through kerbs and crossfall in AC surfacing.
4. Steel railing	- Existing steel railing which has a few places of damage and corroding, repair	- Existing steel railing which has a few places of damage and corroding, repair	- Repair, clean and paint
5. Splitted concrete girder	- No repair because of no structural deficiencies	- No repair because of no structural deficiencies	- Cut bars and path repair with non-shrink mortar
6. Cracked concrete	- No repair because of no structural damages.	- No repair because of no structural damages.	- Inject with epoxy
7. Inadequate cover	- No repair because of no progress in corroding of steel reinforcing bars.	- No repair because of no progress in corroding of steel reinforcing bars.	- Chemical surface treatment or path repair
8. Steel bearing	- No repair because of no serious problem.	- No repair because of no serious problem.	- Clean and paint
9. Steel girders	- Fair condition of painting, no repair.	- Fair condition of painting, no repair.	- Clean and paint
10. Scour protection	- Repair with gabion	- Repair with stone masonry	- Repair or provide new gabion or rock protection
11. No sidewalk at bridge approach	- Construct sidewalk with RC guide post.	- Construct sidewalk with RC guide post.	-

2.3 Basic Design

The basic design concept of this study is to improve the section of National Road No.9 from Muang Phalan (CH72.913) to Muang Phin (CH131.075) so as to accommodate the expected traffic demand during the design life and to ensure the safety and reliability of the road transport.

2.3.1 Design Concept

2.3.1.1 Road Improvement

(1) Basic Design Elements

Basic design elements were reviewed in accordance with the Road Design Manual (Provisional Use), Vientiane, 1996, Communication Department, MCTPC, taking into consideration the geometric design standards of the two countries, Vietnam and Thailand, which are presented in Table 2.3.1-2.

Through the study on the considerations applied to the First Section and the Third Section, major design concepts were decided and shown in Table 2.3.1-1.

Table 2.3.1-1 Major Design Concept

Road Design Class		Class II	
Traffic Volume	(ADT)	3000 ~ 8000	
Design Speed	(kph)	100	(Flat Terrain)
		70	(Rolling Terrain)
		50	(Populated Area)
Lane Width	(m)	3.5	
Shoulder Width	(m)	1.5	(General Section)
		2.5	(Populated Area)

Table 2.3.1-2 Comparison of Major Design Elements

Lao PDR																					
Road Design Class	I			II			III			IV			V			VI			VII		
Traffic	> 8000			3000-8000			1000-3000			300-1000			100-300			50-100			< 50		
Administrative Classification	National/Provincial Road												Access/Local/Minor Rural Road								
Terrain	F	R	M	F	R	M	F	R	M	F	R	M	F	R	M	F	R	M	F	R	M
Design Speed (km/hr)	100	80	60	100	80	60	80	60	40	80	60	40	60	40	20	60	40	20	40	30	20
Number of Lanes	4			2			2			2			2			1			1		
Lane Width (m)	3.75	3.75	3.5	3.75	3.75	3.5	3.5	3.5	3.0	3.0	3.0	3.0	2.75	2.75	2.5		3.5			3.5	
Carriageway (m)	15	15	14	7.5	7.5	7	7	7	6	6	6	6	5.5	5.5	5		3.5			3.5	
Vietnam																					
Category of Road	I			II			III			IV			V			VI			VII		
Daily Traffic	> 6000			3000-6000			1000-3000			300-1000			50-300						< 50		
Importance of Highway	International Highway (Special Importance)			International Highway			Secondary Trunk Road						Interregional Provincial Road						Regional Provincial Road		
Terrain	F	R	M	F	R	M	F	R	M	F	R	M	F	R	M	F	R	M	F	R	M
Design Speed (km/hr)	120	-	-	100		80	80	-	60	60	-	40	40	40	25				25	25	15
Number of Lanes	4			2			2			2			1						1		
Lane Width (m)	3.75	-	3.75	3.75	-	3.75	3.5	-	3.5	3.0	-	2.75		3.5						3.5	
Carriageway (m)	15	-	15	7.5	-	7.5	7	-	7	6	-	5.5		3.5						3.5	
Thailand																					
Road Class	0			1			2			3			4			5			Urban Area		
Traffic	above 8000			4000-8000			2000-4000			1000-2000			300-1000			below 300			-		
Road Classification																					
Terrain				F	R	M							F	R	M	F	R	M	F	R	M
Design Speed (km/hr)				90-110	80-110	70-90							7-90	55-70	40-55	6-80	5-60	3-50	60	60	60
Number of Lanes	4			2			2			2			2			1			-		
Lane Width (m)	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5				3.5	3.5	3.5
Carriageway (m)	14	14	14	7	7	7	7	7	7	7	7	7	7	7	7		8		-	-	-

- Road Design Class and Traffic
  Based on the forecast of future traffic volume by "East-West Transport Corridor Project", Road Design Class II, which corresponds to 6,812 ADT in 2020, is adopted.

- Design Speed
  Through the study of topography and existing road alignment, the design speed is decided on 100kph in flat terrain and 70kph in rolling terrain. But taking into consideration existing small curves, design speed of the section between KM45+000 and KM61+381 (End Portion of the study section), where topography is classified as flat terrain, 70kph is applied. Speed control of 50kph is introduced in populated area for reason of traffic safety for inhabitants.

- Lane Width
  The Road Design Manual regulates the lane width of 3.75m for flat and rolling terrain and 3.5m for mountainous terrain. However a lane width of 3.5m is utilized for the design to conform with the First Section and the Third Section.

- Shoulder Width
  Shoulder width of 2.5m with paved surface is introduced in populated areas for safety and convenience of inhabitants and sizable number of local traffic including motorcycles and bicycles. In the other general section, a width of 1.5m with gravel surface is utilized.

(2) Basic Design Planning

- Horizontal Alignment
  In view of the function of the existing road, the horizontal alignment is designed to follow the existing centerline as closely as possible so as to avoid the additional land acquisition and the danger of UXO, the area is delivered to be highly contaminated. But in sections with substandard alignment, a separate study is done.

- Vertical Alignment
  The final elevation of improved road is preferred to follow the existing road in order not to hamper present roadside services. It is

also designed to provide the minimum gradient for the drain of road surface.

- Road Facilities
  Required road facilities and control devices such as bus stop, road marking, guide post, traffic sign, road hump etc. are designed in accordance with the Road Design Manual, Communication Department, MCTPC or international standards.

2.3.1.2 Pavement Improvement

(1) Pavement Structures

- Surface Structures
  Asphalt concrete (AC) surface course is applied to conform with the First Section and the Third Section.

- Base and Subbase Course
  In to facilitate maintenance, the same base/subbase structure as the First Section is applied. Cement treated subbase course and granular base course are utilized. Bituminous-treated base was also utilized as top layer of base course, which reduced total thickness of the pavement structure.

(2) Life of Initial Pavement Structure

- Performance period (life) of initial pavement structure is decided as 8 years, which is the same with the First Section, taking into consideration the maintenance capability of MCTPC and initial investment cost.

(3) Rehabilitation Design Planning

- Full-depth reconstruction method and overlay method with AC pavement are applied depending on the existing condition of pavement, CBR of subgrade, and roadside drainage condition.

2.3.1.3 Bridge Improvement

- Basic Design Planning
  In general, measures to increase the structural durability and strength of existing bridges involve a huge amount of cost, but this is not practical except for measures that have guaranteed effect, such as prolonging a life of structure. The bridges are in a reasonable condition at present, and do not show structural deterioration caused by traffic loading, therefore no counter measures for structural reinforcement is proposed.

- Improvement of Running Ability
  The roughness of the surface of deck slabs of existing 11 RC bridges, running ability, are not of as acceptable level. Therefore, such surfaces are recommended to be improved by applying AC overlay. No improvement of running ability is planned for existing steel bridges No.6 and No.10 because the additional dead load of overlay will increase deflection of steel girder.

2.3.1.4 Others

- The climate conditions at the study area is stable i.e. less variation of the temperature, no freeze, but a rainfall amount is seasonal. The reduced workability period during rainy season is considered on the implementation plan.

- The project road in the populated area is busy with pedestrians and bicycles, a widened paved shoulder with 2.5m in width is used in the design. The introduction of bus stops and bus bays is expected to improve convenience for inhabitants who lives along the project road.

- Running speed control of 50 kph is imposed in populated area to ensure the safety of inhabitants. It introduces the road hump at entrance and exit of controlled sections to force to slow down the through traffic.

- Popular road facilities in Lao PDR are utilized for the economical and easy maintenance work by the implementing agency.

- The construction period is 3~4 years generally for a road improvement project of 60km extension. On this study, construction schedule is planned to follow the most effective and economical means within

Japan's Grant Aid scheme. It also considered the coordination with the other sections on the same route for the timing of opening, i.e. the cooperation with the other component of "East-West Transport Corridor Project".

2.3.2 Design Criteria

2.3.2.1 Road Improvement

(1) Geometric Design Standards

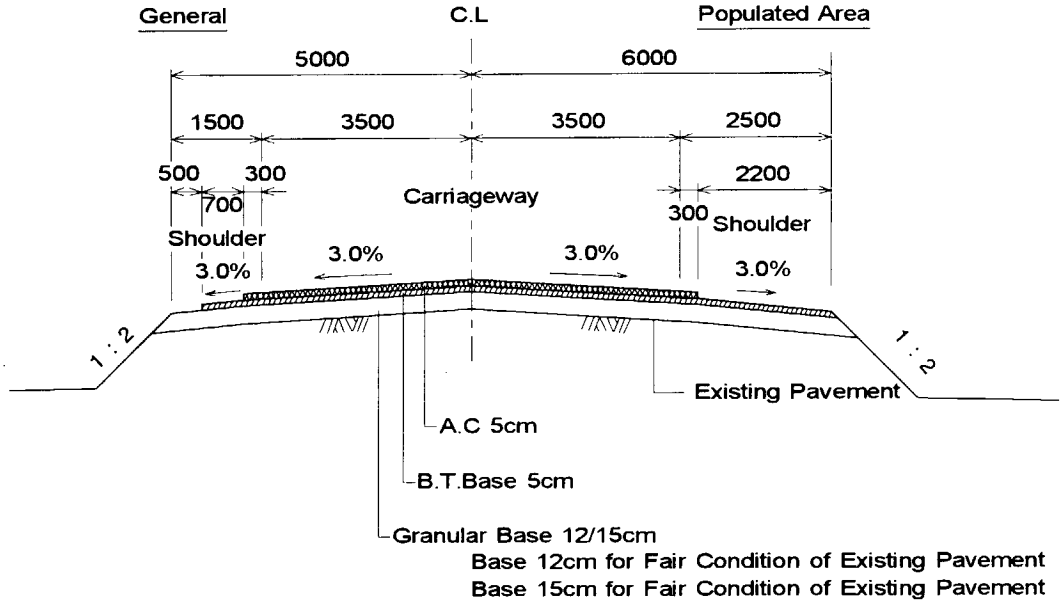
Table 2.3.2-1 summarizes the geometric design standards selected for this study.

Table 2.3.2-1 Geometric Design Standards

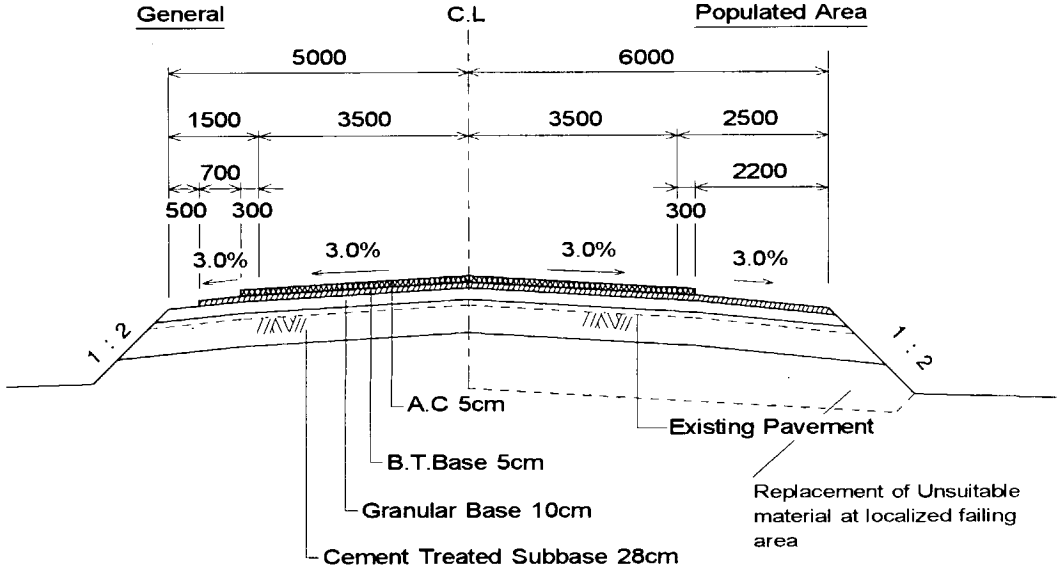
Items	Description
Road Design Class	Class II, ADT 3000 ~ 8000
Design Speed	70kph (Rolling Terrain) 100kph (Flat Terrain)
Lane Width	3.5m
Shoulder	1.5m (General Section), 2.5m (Populated Area)
Max. Gradient	5% (Flat Terrain), 6% (Rolling Terrain)
Min. Horizontal Curve Radii	435m (Flat Terrain), 195m (Rolling Terrain)
Min. Vertical Curve Radii	2.2km (Crest), 2.0km (Sag)
Cross Fall (Carriage)	3%
Cross Fall (Shoulder)	3% (Paved), 3% (Unpaved)
Right of Way	70m

(2) Standard Cross Section

In accordance with the geometric design standards, the standard cross sections were developed as graphically illustrated in Figure 2.3.2-1.



Overlay Section (TYPE-1, TYPE-2)



Note; Unsuitable materials at some sections of localized failing area shall be replaced with selected materials about 1m in depth.

ReconstructionSection (TYPE-3, TYPE-4)

Figure 2.3.2-1 Standard Cross Section

2.3.2.2 Pavement Improvement

(1) Design Criteria

The criteria for the structural design of pavement were established as presented in Table 2.3.2-2.

Table 2.3.2-2 Criteria for Structural Design of Pavement

Category	Value	Description
1. Design Variable		
1.1 Time Constraints		
• Performance Period	8 years	Life of Initial Pavement Structure
• Analysis Period	20 years	Planned Stage Improvement
1.2 Traffic	$3.43x10^6x0.5$	W18, Predicted Number of ESAL
1.3 Reliability		
• Standard Normal Deviate	$Z_R=0$	Not Considered, Reliability 50%
• Combined Standard Error	$S_0=0.45$	Error of Traffic and Performance Prediction
2. Performance Criteria		
2.1 Serviceability	$P_O=4.2$	Initial Design Serviceability Index
	$P_t=2.5$	Design Terminal Serviceability Index
2.2 Serviceability Difference	$P_O-P_t=1.7$	Difference between Initial and Terminal Serviceability Index
3. Material Property		
3.1 Effective Roadbed Soil Resident Modules	$M_R=7500$ psi	$M_R=1500xCBR$ (5)
3.2 Pavement Layer Material Characteristic		Modules (psi) / Layer Coefficient
• AC Surface Course		$E_{AC}=350,000$ / 0.39
• Bituminous Treated Base	1620 lb	$E_{BT}=340,000$ / 0.30
• Granular Base	CBR=80	$E_{BS}=28,000$ / 0.135
• Cement Treated Subbase	CBR=30	$E_{CT}=15,000$ / 0.115
• Granular Subbase	CBR=30	$E_{SB}=15,000$ / 0.115
• Granular Subbase	CBR=15	$E_{SB}=12,000$ / 0.09
4. Pavement Structural Characteristic		
4.1 Drainage		
• Granular Base	m=1.0	
• Granular Subbase	m=0.95	

2.3.3 Basic Design

2.3.3.1 Road Design

The road was designed in accordance with the established design criteria.

(1) Road Shoulder

There are several houses and villages located along the study section. For the convenience of inhabitants in populated area, road shoulder with 2.5m in width was utilized, and road shoulder with 1.5m in width was utilized in the other general section. Location of widened shoulder is presented in Table 2.3.3-1.

Table 2.3.3-1 Section of Widened Road Shoulder

No.	CHAINAGE (km) B. Point	End Point	Length (m)	Village Name	Remarks
1	2+400 ~	2+700	300	Phoxay	
2	10+250 ~	11+280	1,030	Phoxy	
3	15+975 ~	16+500	525	Nonsavang	
4	18+600 ~	18+865	265	Donebans	
5	20+110 ~	20+220	110	Donebans	
6	21+750 ~	22+100	350	Naomsarat	
7	28+450 ~	28+925	475	A. Louy	
8	30+050 ~	30+325	275	Salakay	
9	31+950 ~	32+075	125	Nathong	
10	33+575 ~	34+000	425	Bankonghin	
11	40+150 ~	40+600	450	Anouxanya	
12	41+125 ~	41+525	400	Anouxanya	
13	45+200 ~	45+900	700	Oudomxay	
14	46+800 ~	48+350	1,550	Xethamouak	Bus Bay
15	52+000 ~	52+300	300	Domphougneum	
16	54+160 ~	54+700	540	Nomsaad	
17	59+100 ~	57+300	200	Oudomdy	
18	59+835 ~	61+300	1,465	Muang Phin	Bus Bay
	Total		9,485		

The following criteria was developed to classify areas, places, and locations where widening shoulder is necessary.

- Villages, towns, and thickly inhabited areas are regarded as "populated area" but the areas where they located at a far distance from the road are excluded.

- Fairly big villages are selected, which fronts the road for more than 100 m long.

- In cases where villages, towns, and thickly inhabited areas are located on one side of the road, the area is deemed to be the populated area, and the widening and paving of shoulders are carried out on both sides of the road.

(2) Horizontal Alignment

In view of the function of the existing road, the horizontal alignment was designed to follow the existing center line as closely as possible. Design speed was decided on 100kph in flat terrain, 70kph in rolling terrain and 50kph in populated area.

However, for the section that was extended about 16km between KM45+000 and KM61+381 (End Portion of the study section) which was classified as flat terrain has substandard curves at 10 locations, i.e. smaller curve less than required minimum curve radius R=435m for design speed 100kph, and several populated areas where controlled running speed within 50kph are located. It enforces frequent speed change and/or adjustment to the drivers on these sections.

Therefore, design speed for this 16km stretch was made to conform with 70kph of rolling terrain taking into consideration the safe driving and riding comfort. As a result of this modification, all curves in the study section satisfied the required minimum curve radii for each design speed.

The substandard curves at 5 locations with small central angle, which as not satisfy the required minimum curve length for the design speed, were decided to be improved.

Table 2.3.3-2 shows the elements of curve where improvement of the horizontal alignment was introduced.

The horizontal alignment and design speed of each section are drawn in Figure 2.3.3-1. For the section with speed control of 50kph, road humps are placed at entrance and exit to slow down traffic.

Table 2.3.3-2 Element of Improved Curve

IP No.	Chainage (km)	Design Speed (kph)	Curve Radii (m)		Improved Matters
			Existing	Improved	
5	KM 5+199	100	800	1,000	Improvement of insufficient curve length
24 25	KM22+916 KM23+138	70	390 550	380 550	Adjustment of compound curve
34 35	KM32+575 KM32+714	70	270 450	250 340	Adjustment of compound curve
43	KM42+180	70	360	1,100	Improvement of insufficient curve length
47	KM48+750	70	1,250	2,800	Improvement of insufficient curve length
49	KM51+689	70	1,290	1,290	Adjustment of centerline
50	KM52+727	70	240	400	Improvement of insufficient curve length
51	KM53+210	70	300	300	Adjustment of centerline
52	KM53+964	50	300	300	Adjustment of centerline
58	KM60+332	50	270	270	Adjustment of centerline
60	KM61+124	50	610	800	Improvement of insufficient curve length

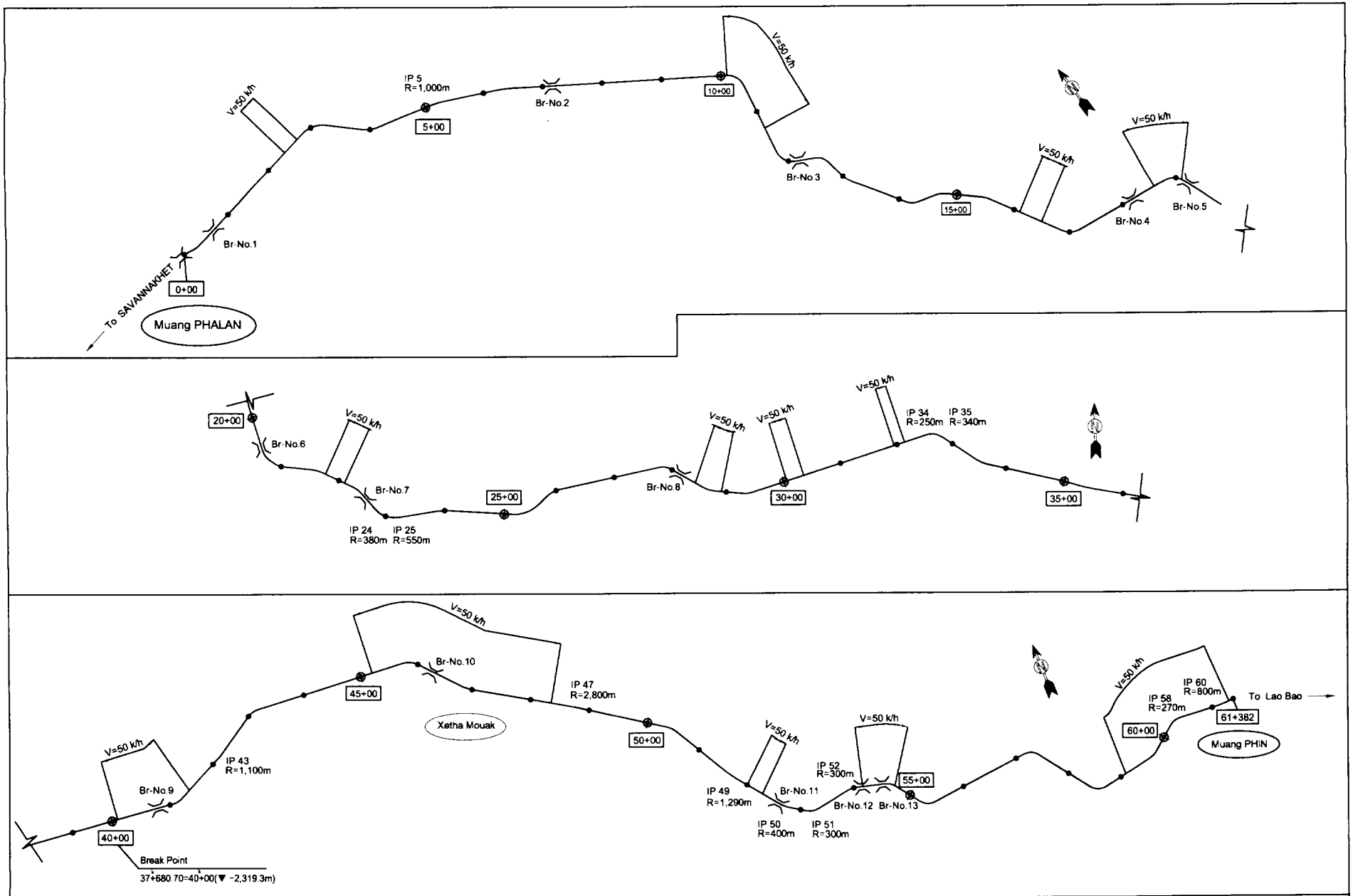


Figure 2.3.3-1 Horizontal Alignment (Improved Curves) and Design Speed

(3) Vertical Alignment

Since beginning and end portions of the study section are located in flat terrain, the maximum grade 3.00% was utilized and which satisfied the requirement (5.0%) of the Design Manual. While, the middle portion is located in rolling terrain, the maximum grade 5.15% was utilized and which satisfied the requirement (6.0%) of the Design Manual.

On the other hand, more than 0.3% of grade is desirable for to care surface drainage, but there are several sections with grades ranging from 0.01%~0.1% on the existing road.

Therefore, normal cross fall was decided to be 3% for smooth drain of surface water, and any other structure that obstruct the drain such as curb, etc. were not provided. Moreover, provision of the drainage system be to permeate the drain in the ground was planned.

2.3.3.2 Pavement Design

The new pavement and overlay structures were designed based on AASHTO Guide for Design of Pavement Structures, 1993.

(1) Design Requirements

Design requirement for flexible pavement involves various factors as shown in Table 2.3.2-2 Criteria for Structural Design of Pavement.

(2) 18-kip ESAL Prediction

Based on the traffic demand analysis and axle load surveys conducted by "East-West Transport Corridor Project", the number of 18-kip equivalent single axle load applications (18-kip ESAL Application) was calculated with damaging factors analyzed in the Corridor Project.

The forecast numbers of 18-kip ESAL applications are summarized in Table 2.3.3-3 and graphically shown in Figure 2.3.3-2.

Table 2.3.3-3 Number of EASL (Xeno-Muang Phin Section)

Type of Vehicle		Bus/ Pickup	Light Truck	Medium Truck	Heavy Truck	Articulated Truck	Total (per year)
Damage Factor		0.383	0.383	1.276	2.598	4.008	
2000	VPD	115	33	209	92	86	535
	ESAL	44.0	12.6	266.7	239.0	344.7	907.0 (331,000)
2010	VPD	241	71	461	201	189	1,163
	ESAL	92.3	27.2	588.2	522.2	757.5	1,987.4 (725,000)
2020	VPD	506	153	1,017	439	417	2,532
	ESAL	193.8	58.6	1,297.7	1,140.5	1,671.3	4,361.9 (1,592,000)

Note: VPD; Vehicle per day per 2-way.
ESAL; Number of ESAL per year per 2-way.

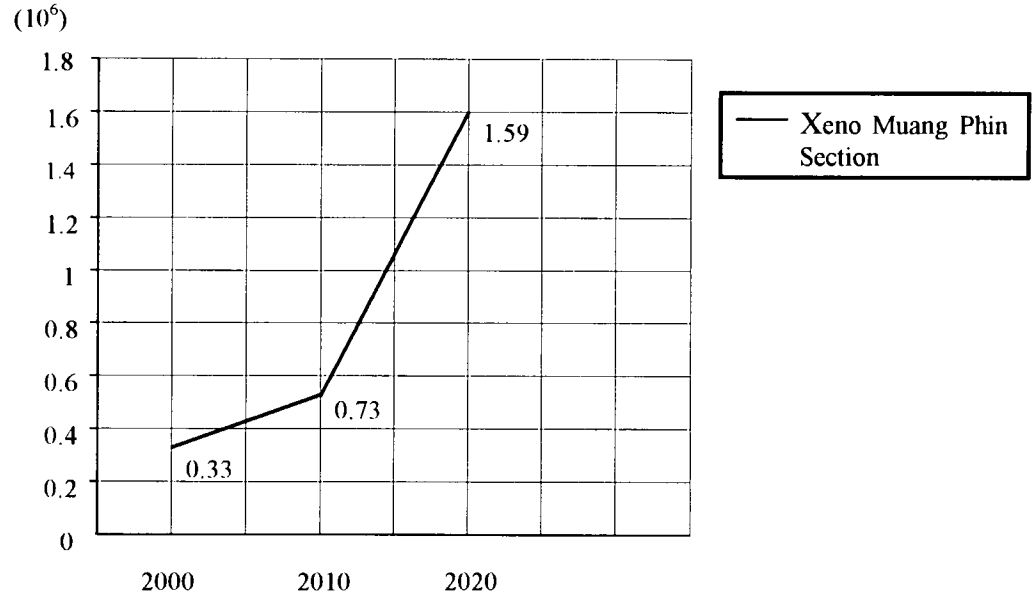


Figure 2.3.3-2 Forecasted Number of ESAL
(Two-way)

Cumulative ESAL application (two-ways) is presented in Table 2.3.3-4.

Table 2.3.3-4 Cumulative ESAL Application (Two-ways)

	Cumulative ESAL
From 2001 to 2008 (8 years)	3.43×10^6
From 2001 to 2010 (10 years)	4.95×10^6
From 2001 to 2012 (12 years)	6.58×10^6
From 2001 to 2020 (20 years)	16.55×10^6

(3) Structural Design for Reconstruction

The structural design of pavement is based on the identification of the flexible pavement structural number (SN) to withstand the predicted number of axle load traffic (W18). Equation for flexible pavement is as follow.

$$Log_{10}(W_{18}) = Z_R \times S_0 + 9.36 \times Log_{10}(SN + 1)$$

$$-0.2 + \frac{Log_{10}\left(\frac{\Delta PSI}{4.2 - 1.5}\right)}{0.40 + \frac{1094}{(SN + 1)^{5.19}}}$$

$$+ 2.32 \times Log_{10}(M_R) - 8.07$$

The structural numbers required for the specified period are presented in Table 2.3.3-5.

Table 2.3.3-5 Pavement Structural Number (SN)

Xeno – Muang Phin Section (one lane)

	W_{18}	SN
From 2001 to 2008 (8 years)	1.72×10^6	3.05
From 2001 to 2010 (10 years)	2.48×10^6	3.24
From 2001 to 2012 (12 years)	3.29×10^6	3.40

Selection of Layer Thickness

SN is converted into actual thickness of surface, base and subbase layers with the following equation.

$$SN = a_1D_1 + a_2D_2m_2 + a_3D_3m_3$$

where;

a_1, a_2, a_3 = Layer coefficients representative of surface, base, and subbase layers, respectively.

D_1, D_2, D_3 = actual thicknesses (in inches) of surface, base, and subbase layers, respectively, and

m_2, m_3 = drainage coefficients for base and subbase layers, respectively

Proposed Pavement Structure (TYPE - 3)

Asphalt Concrete	=	5 cm (1.97 inches)
Bituminous Treated Base	=	5 cm (1.97 inches)
Granular Base (CBR = 80)	=	10 cm (3.94 inches)
Cement Stabilized Subbase (CBR = 30)	=	28 cm (11.02 inches)
Subgrade (CBR = 5)		

$SN = 0.39 \times 1.97 + 0.30 \times 1.97 + 0.135 \times 3.94 \times 1.0 + 0.115 \times 11.02 \times 0.95$
$= 0.77 + 0.59 + 0.53 + 1.20$
$= 3.09 \geqq 3.05$

(4) Structural Design for Overlay

The required thickness of overlay to handle future traffic demand is determined by the following equation:

$$SN_{OL} = a_{OL} \times D_{OL} = SN_f - SN_{eff}$$

where;

SN_{OL} = Required structural number for overlay.
a_{OL} = Structural coefficient for the AC overlay.
D_{OL} = Required overlay thickness (inches).
SN_f = Structural number required to handle future traffic demand.
SN_{eff} = Effective structural number of the existing pavement.

SN_{eff} (From Condition Survey)

$$SN_{eff} = a_1D_1 + a_2D_2m_2 + a_3D_3m_3$$

where;

D_1, D_2, D_3 = Thickness of existing pavement surface, base and subbase layers.
a_1, a_2, a_3 = Corresponding structural layer coefficient.
m_2, m_3 = Drainage coefficient for granular base and subbase.

Layer Coefficients for Existing AC Pavement Layer

- AC Surface (Fair Condition) = 0.25
  - Low–severity alligator cracking more than 10%.
  - Medium–severity alligator cracking less than 10%.
  - Medium and high–severity transverse cracking more 5～10%.

- AC Surface (Bad Condition) = 0.17
  - Medium–severity alligator cracking more than 10%.
  - High–severity alligator cracking less than 10%.
  - Medium and high–severity transverse cracking more 10%.

- Granular Base = 0.12
  - No evidence of pumping, degradation, or contaminating by fines.

- Granular Subbase = 0.05
  - No evidence of pumping, degradation, or contaminating by fines.

Proposed Overlay Structure

Proposed Overlay TYPE-1; (For Existing Pavement with Low–severity alligator cracking)

$SN_{eff} = a_1D_1 + a_2D_2m_2 + a_3D_3m_3$
$= 0.25 \times 1.18$ (3 cm) $+ 0.12 \times 7.87$ (20 cm) + neglect
$= 0.30 + 0.94$
$= 1.24$

$SN_{OL} = SN_f - SN_{eff}$
$= 3.05 - 1.24$
$= 1.81$

Proposed Structure; (TYPE – 1)

Asphalt Concrete = 5 cm (1.97 inches)
Bituminous Treated Base = 5 cm (1.97 inches) Minimum.
Granular Base(CBR 80) = 12 cm (4.0 inches) Minimum.

$SN_{OL} = 0.39 \times 1.97 + 0.30 \times 1.97 + 0.135 \times 4.0$
$= 0.77 + 0.59 + 0.54$
$= 1.90 > 1.81$

Proposed Overlay TYPE-2; (For Existing Pavement with Medium–severity alligator cracking)

$SN_{eff} = 0.17 \times 1.18$ (3 cm) $+ 0.12 \times 7.87$ (20 cm) + neglect
$= 0.20 + 0.94$
$= 1.14$

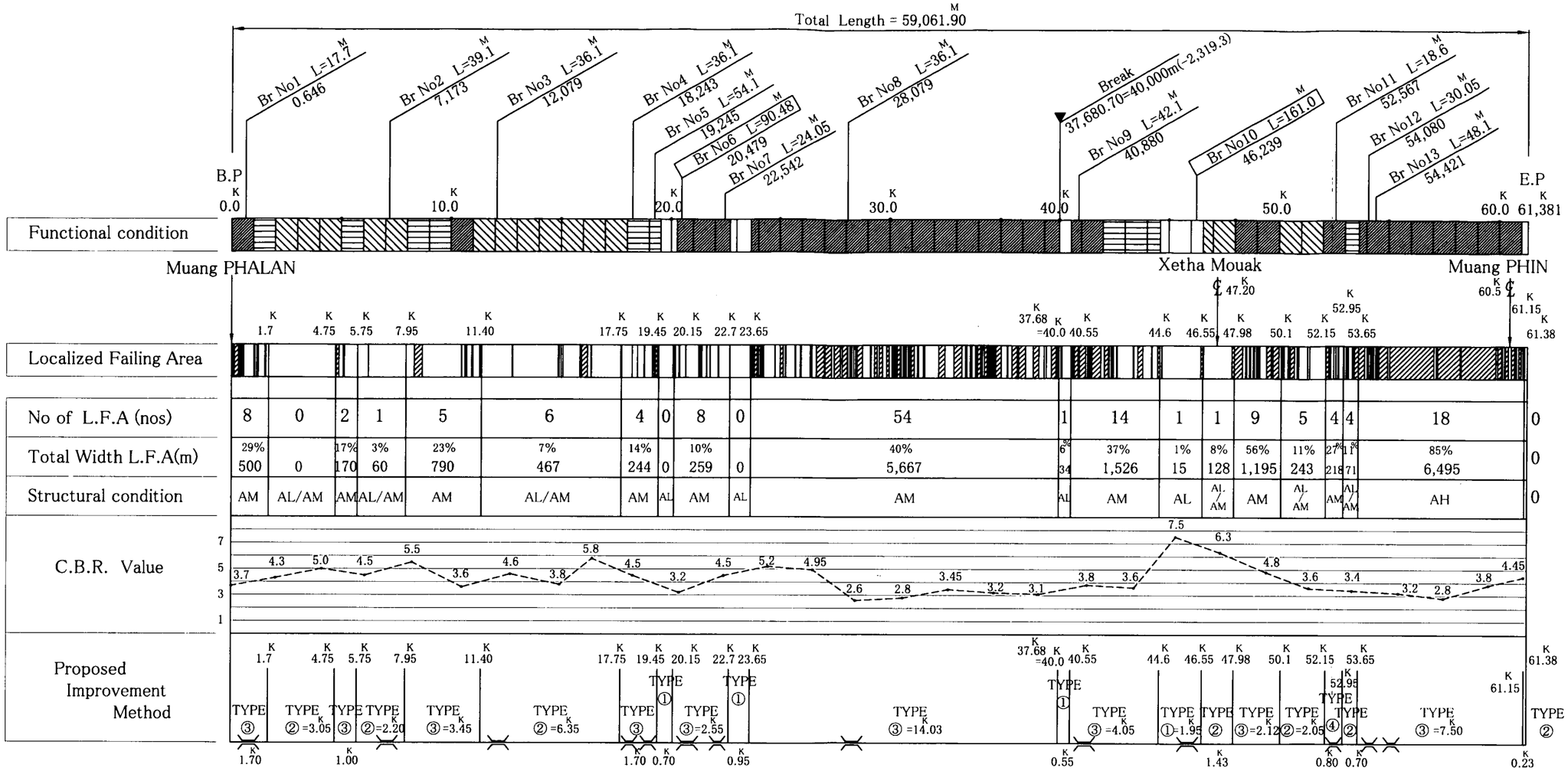
$SN_{OL} = 3.05 - 1.14$
$= 1.91$

Proposed Structure; (TYPE – 2)

Asphalt Concrete = 5 cm (1.97 inches)
Bituminous Treated Base = 5 cm (1.97 inches) Minimum
Granular Base (CBR 80) = 15 cm (5.91 inches) Minimum

SN_{OL} = 0.39 x 1.97 + 0.30 x 1.97 + 0.135 x 5.91
= 0.77 + 0.59 + 0.80
= 2.16 > 1.91

Figure 2.3.3-3 shows the structural and functional condition of existing pavement, localized failure section, CBR value of existing pavement and proposed improvement measures.



Functional condition

Legend (Riding Quality)

- : Very Good
- : Good
- : Fair
- : Bad
- : Very Bad

Structural condition

(Severity of Alligator Cracking)

AL : Low Severity (class 1 cracking)

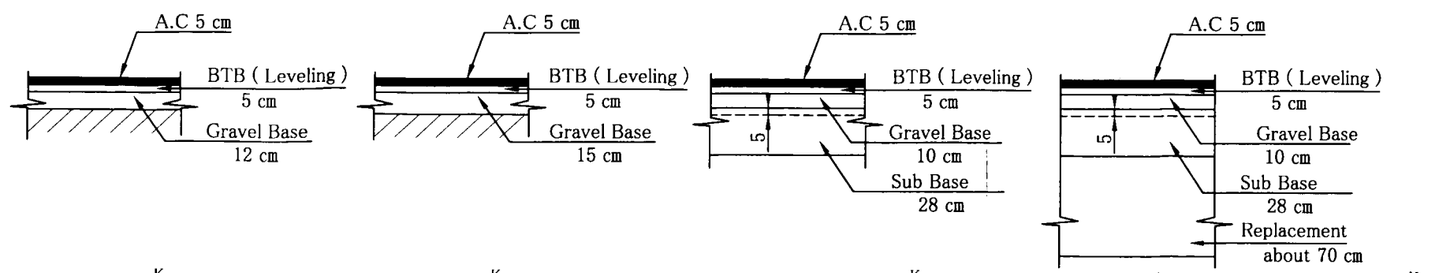
AM : Medium Severity (class 2 cracking)

AH : High (class 3 cracking)

Localized Failing Area (L.F.A)

- : 10 m ~ 100 m
- : 100 m ~ 2,000 m

Proposed Improvement Method



Overley 1 = 4.10 K

(On fair existing pavement)

TYPE - 1

Overley 2 = 15.78 K

(On bad existing pavement)

TYPE - 2

Reconstraction (R.C) = 36.13 K

TYPE - 3

Reconstraction with Replacement(R.R)=3.05 K

(For badly saturated Weak Sub Grade of Localized Failing Area)

TYPE - 4

Figure 2.3.3-3 EXISTING PAVEMENT CONDITIONS AND PROPOSED IMPROVEMENT METHODS

(5) Replacement of Sub-grade (Type-4)

There are 145 locations of localized failure pavement with a total length of 18.0km in the study section. For the various sections totaling 2.8km in length which are of particularly bad conditions, the replacement of sub-grade was recommended. This measure was utilized for the areas of paddy field & irrigation pond, sag portion of vertical alignment, the point of rutting & hollow and the section of swelled embankment.

The sections scheduled for replacement of sub-grade are listed in Table 2.3.3-6.

Table 2.3.3-6 Section of Replacement of Sub-grade (Type-4)

No.	CHAINAGE (Km)	Length (m)	No.	CHAINAGE (Km)	Length (m)
1	10+450 ~ 10+600	150	14	43+000 ~ 43+125	125
2	10+930 ~ 10+990	60	15	43+500 ~ 43+625	125
3	15+750 ~ 15+900	150	16	44+550 ~ 44+620	70
4	24+750 ~ 24+800	50	17	48+010 ~ 48+120	110
5	25+010 ~ 25+150	140	18	48+600 ~ 48+650	50
6	25+650 ~ 25+720	70	19	48+970 ~ 49+000	30
7	26+650 ~ 26+800	150	20	51+450 ~ 51+500	50
8	27+375 ~ 27+525	150	21	51+600 ~ 51+630	30
9	32+300 ~ 32+425	125	22	52+150 ~ 52+567	417
10	34+750 ~ 34+900	150	23	52+586 ~ 52+950	364
11	35+650 ~ 35+700	50	24	55+480 ~ 55+520	40
12	36+950 ~ 36+980	30	25	59+400 ~ 59+450	50
13	40+100 ~ 40+150	50	26	59+750 ~ 59+810	60
				Total	2,846

The remaining section 15.2km which is damaged only on the surface course was evaluated that the reconstruction method (Type-3) is suitable.

(6) Unsuitable Material under Road Shoulder

It was informed that unsuitable material was utilized under road shoulder during the construction of existing road. These material shall be removed and replaced with selected material.

Unsuitable material may not be present or defects were not observed at sections of overlay (Type–1 / Type–2), the removal is not required. It is not required at sections of replacement of sub-grade (Type-4)

because the material under the shoulder will be removed together with sub-grade. Therefore only at section of reconstruction (Type–3) where it is required to specify the replacement as shown in Figure 2.3.3-4.

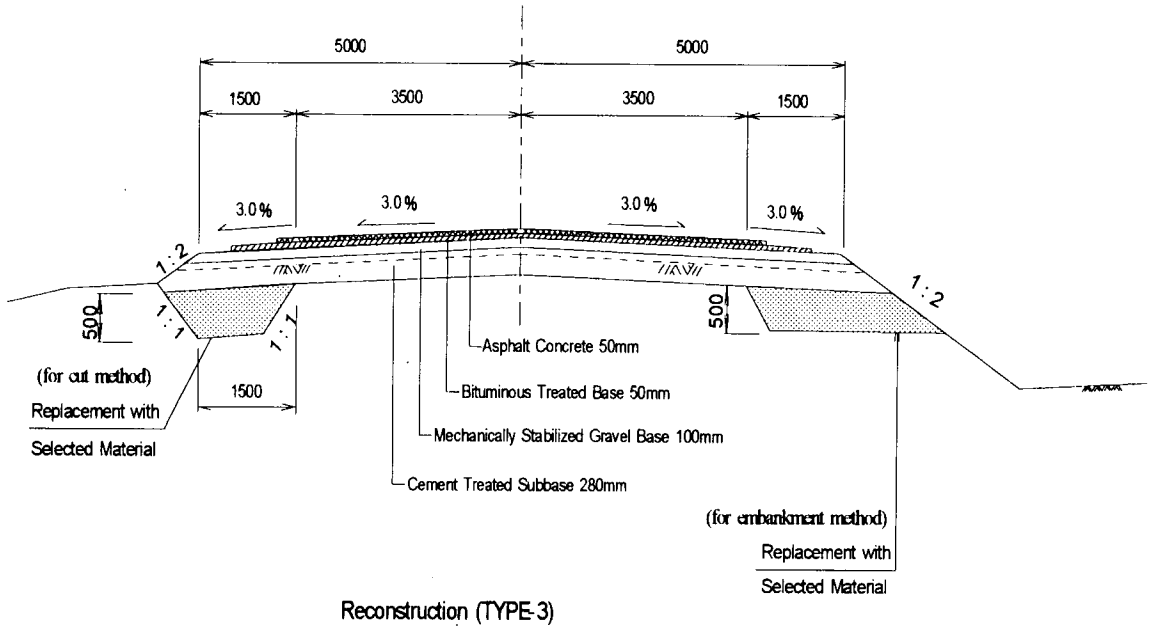


Figure 2.3.3 – 4 Replacement with Selected Material

Table 2.3.3-7 shows the section of replacement of unsuitable material.

Table 2.3.3-7 Section of Replacement of Unsuitable Material

No.	CHAINAGE (Km)	Length (m)	No.	CHAINAGE (Km)	Length (m)
1	0+050 ~ 0+596	546	19	28+165 ~ 32+300	4,135
2	0+714 ~ 1+700	986	20	32+425 ~ 34+750	2,325
3	4+750 ~ 5+750	1,000	21	34+900 ~ 35+650	750
4	7+950 ~ 10+450	2,500	22	35+700 ~ 36+950	1,250
5	10+600 ~ 10+930	330	23	36+980 ~ 37+681	701
6	10+990 ~ 11+400	410	24	40+550 ~ 40+830	280
7	17+750 ~ 18+193	443	25	40+972 ~ 43+000	2,028
8	18+329 ~ 19+195	866	26	43+125 ~ 43+500	375
9	19+349 ~ 19+450	101	27	43+625 ~ 44+550	925
10	20+150 ~ 20+429	279	28	48+120 ~ 48+600	480
11	20+620 ~ 22+402	1,782	29	48+650 ~ 48+970	320
12	22+526 ~ 22+700	174	30	49+000 ~ 50+100	1,100
13	23+650 ~ 24+750	1,100	31	53+560 ~ 54+030	470
14	24+800 ~ 25+010	210	32	54+160 ~ 54+371	211
15	25+150 ~ 25+650	500	33	54+519 ~ 55+480	961
16	25+720 ~ 26+650	930	34	55+520 ~ 59+400	3,880
17	26+800 ~ 27+375	575	35	59+450 ~ 59+750	300
18	27+525 ~ 28+029	504	36	59+810 ~ 61+150	1,340
				Total	35,067

2.3.3.3 Bridge Design

In accordance with the basic design concept and criteria, improvement measures of bridges were carefully examined with emphasis on the improvement of running ability rather than structural reinforcement or reconstruction. The major repair works designed for this study are as follow:

- Abrasion of Deck slab shall be covered with asphalt concrete (t = 5cm) for improvement of running ability.
- Expansion joint shall be covered by overlay.
- Inadequate deck drainage shall be reformed to provide suitable cross fall by means of overlay for drainage of surface water.
- Damaged and corroding steel railing shall be repaired.
- Damaged scour protection and scoured sub-structure shall be repaired with gabion.
- Sidewalk with RC guide posts at bridge approaches shall be provided.

However, overlay is not suitable for bridge No.6 and No.10 as mentioned in previous paragraph 1.3.1.3, so improving its running abilities were not planned. In stead of overlay, running speed is controlled by newly installed road humps at approach of these bridges to minimize the effect caused by the roughness of deck slab.

The existing condition of each bridge and corresponding improvement measures are summarized in Appendix 7. Existing Condition of Bridges and Improvement Method.

2.3.3.4 Muang Phin Intersection Design

There is an intersection on the study section with National Road No.1G at Muang Phin (KM61+006) near end point of study section, which is a T-type un-channelized junction.

Improvement of the intersection was planned by widening of corner cut and road marking for channeling. The drawing of the intersection is shown in Figure 2.3.3-5.

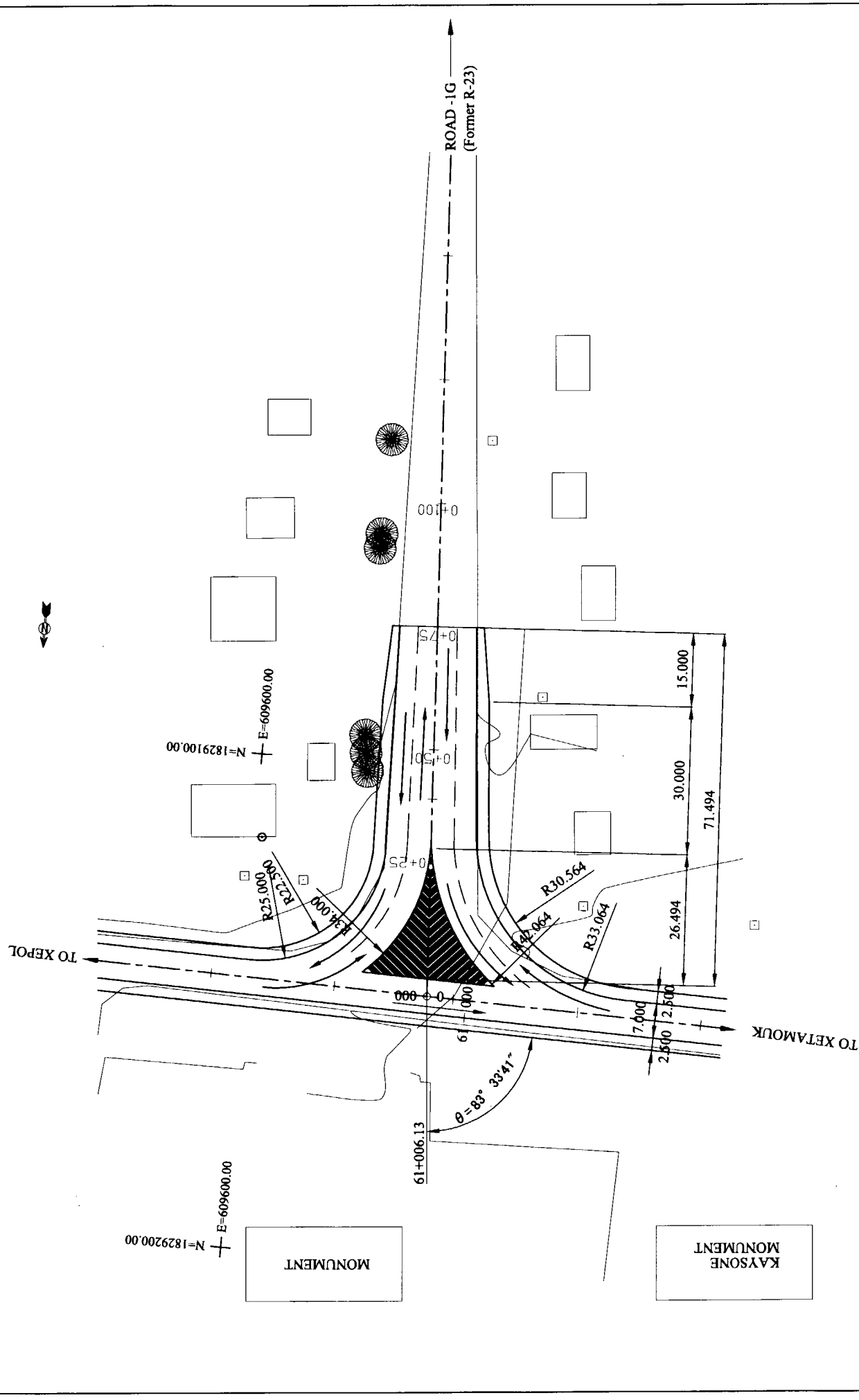


Figure 2.3.3-5 T-Type Intersection for Muang Phin

CHAPTER 3

IMPLEMENTATION PLAN

CHAPTER 3 IMPLEMENTATION PLAN

3.1 Implementation Plan

3.1.1 Implementation Concept

The following are the basic conditions for implementing this project.

- This project, if approved, will be implemented in accordance with the provisions of Japan's Grant Aid Program after the signing of the Exchange of Notes between the Governments of Japan and Lao PDR.
- For this project, MCTPC is the responsible agency and DOR is the implementing agency.
- The detailed design, tenders and construction supervision of this project will be undertaken by a Japanese consulting firm in accordance with a contract between the MCTPC and the consultant.
- The construction of this project will be undertaken by the successful Japanese tender to be awarded the contract by the MCTPC.

The following are the main concepts in the implementation plan:

- The road will be constructed by a Japanese contractor under its direct management, employing labors and leasing available equipment from local sub contractors.
- Materials and equipment necessary for the Project will be procured in Lao PDR as far as available. Items unavailable locally will be procured from Japan or third countries. Third countries will be selected based on conditions, i.e. cost, quality, required delivery time, etc...
- The construction method and progress schedule of the Project will be planned reflecting local conditions of climate, rainy season, topography, geology, transportation and others.
- Easy and low cost method of construction will be utilized for the Project as much as possible.
- Organizations for the construction and the supervision of the Project will be standardized and clearly regulated.

- Traffic and safety controls during construction will be planned to maintain passage for existing traffic;
  - Both traffic lanes will be opened during the improvement work as much as possible.
  - Flagmen and facilities for traffic control shall be arranged.
  - The existing road and bridges shall be opened for traffic during construction. Traffic control and safety control shall be considered carefully.
- Quarry, borrow pit and disposal area shall be selected based on the rationality.
- The measures to cope with UXO contamination shall be taken adequately.

3.1.2 Implementation Conditions

The following are the basic conditions for implementing the project:

(1) UXO (Unexploded Ordnance) Contamination

In Lao PDR, many shells had been shot and many land mines had been laid during the war, and some of these still remain as UXO above or below the ground. In fact several UXO were found during the investigation work for this study.

During the implementation of the project, it is necessary that the UXO search at each stage of the work which is the responsibility of the contractor in preventing accidents, contractor should build a close coordination with DOR and Lao army for the proper execution in the removal and disposal work which is the responsibility of Lao side. Moreover, it's also necessary to educate the labor force regarding the existence of UXO, its danger and how react when found.

(2) Crushed Stone (Aggregate)

Material investigation was carried out for the proposed quarries at 6 locations including the quarry which is utilized in the construct of the First Section. As a result of the investigations and laboratory tests on collected samples, materials at 3 locations out of 6 do not satisfy the required value for the Los Angeles Abrasion Test, and the material at

1 location, which is gneiss, has the tendency of flat cracking. Hence, materials at above 4 locations were deemed not suitable as aggregate of the asphalt concrete. Thus the only possible sites of quarries at the remaining 2 locations, i.e. Ban Nakapong where is utilized in the project for the First Section and Ban Saloy which is located about 4km away from end point of the Second Section to the Third Section side. (Refer Appendix 10. Geotechnical Survey)

There will be difficulty to excavate Ban Nakapong by both projects, because of overlapping of the duration of construction. Therefore it was recommended that crushed stone for this project would be purchased from the company who is currently operating a crushing plant at Ban Nakapong.

Ban Saloy located beside the Third Section is proposed quarry for the project of the Third Section. Possible areas for the excavation is spread over both banks of the H. Alang River, and the operation by both projects is possible. This location was studied to produce crushed stone with own plant of this project.

Result of the general comparative study, Ban Nakapong has the advantage in respect of hauling distance and the cost of crushed stone. Therefore, the production of crushed stone at Ban Saloy for use by this project was not recommended and it was planned to be purchased.

However, the permit to excavate, issued for Ban Nakapong, is not enough for the required volume for the construction of the Second Section, so it is necessary to apply for the additional expansion of quarry. Regarding this matter, it was agreed that Lao side shall get the permission for additional 9 ha at Ban Nakapong before the signing of the Exchange of Notes of this project.

3.1.3 Scope of Works

The undertakings of both Governments, Japan and Lao PDR are listed in Table 3.1.3-1.

Table 3.1.3-1 Undertaking of Both Governments

	Item	Contents	Undertaken by		Remarks
			Japan	Lao PDR	
Road Improvement	Procurement of materials and equipment	Procurement	○		
		Customs clearance		○	
	UXO (Unexploded Ordnance) contamination	UXO Search	○		
		Removal of the UXO, if required		○	
	Temporary work	Acquisition of lots		○	Lots for field office, stock yard and work shop
		Other works than the above	○		
	Acquisition of right-of-way, quarry site, etc.	Acquisition of ROW, etc.		○	
		Removal of existing properties		○	Fences, houses, etc.
		Permission of quarry		○	Additional 9 ha
		Clearing and grubbing	○		Trees, etc.
	Restoration of closed quarry	Landscaping	○		
		Replanting tree		○	
	Main work	Land for disposal of waste materials arising from existing facilities		○	
		Other works than the above	○		

The lots for field office, storage yard and workshop to be prepared by the Government of Lao PDR are estimated at 3.0 ha. These shall be located near the Project area.

3.1.4 Consultant Supervision

A Japanese consultant will supervise the implementation of the Project on behalf of the Government of Lao PDR. The consultant will carry out the detailed design, assist in tendering and execute the construction supervision, in accordance with the contract concluded between the Government of Lao PDR and consultant.

Detailed Design

Major works in the detailed design to be carried out by the consultant are as follows:

- Site Survey for detailed design
- Detailed Design of the Road and related facilities
- Preparation of Drawing and Specifications
- Preparation of Construction Schedule and Cost Estimation
- Preparation of Tender Documents

The necessary time for the detailed design is about 5.5 months.

Assistance in Tendering

The consultant will render the following services during the period from tender publication up to construction contract

- Tender publication
- Pre-qualification
- Tendering
- Tender evaluation
- Contract facilitation

The necessary time for assistance in tendering is about 3.0 months.

Construction Supervision

The consultant will carry out supervision of the construction work, which will be executed by the contractor. The main work items are as follows:

- Inspection and approval of site survey
- Inspection and approval of construction planning
- Quality control
- Progress control
- Measurement of work
- Inspection of safety aspects
- Final inspection and turnover

The construction period is about 30 months. To successfully carry out supervision, the consultant personnel are required to be stationed on the site during the entire construction period.

3.1.5 Procurement Plan

In principle, materials, equipment and labors necessary for the Project are planned to be procured locally as far as available. Items which are not available from local sources which require quality, quantity or cost are planned to be procured from Japan or third countries.

(1) Materials

Popular construction materials in Lao PDR are imported from Thailand and Vietnam. Materials for this project are planned to be procured locally, because imported materials are also available from local stores.

Table 3.1.5-1 shows the procurement plan for major materials.

Table 3.1.5-1 Material Procurement Plan

	Procured from			Remarks
	Lao P.D.R.	Japan	Third Country	
Material for Structure				
Crushed stone	○			
Base course material	○			
Cement	○			Imported
Sand for concrete	○			
Aggregate for concrete	○			
Aggregate for asphalt	○			
Sand for asphalt pavement	○			
Straight asphalt	○			Imported
Asphalt emulsion	○			Imported
Road marking paint	○			Imported
Reinforcing steel	○			Imported
Wire mesh	○			Imported
Precast concrete products	○			Local, Imported
Log pile	○			
Gabion	○			Imported
Rubble	○			
Traffic sign boards	○			Imported
Material for Temporary Structure				
Timber for forms	○			
Plywood for forms	○			Imported
Nails	○			Imported
Annealed wire	○			Imported
Timber for staging	○			Imported
Sand bags	○			Imported
Electric welding bars	○			Imported
Oxygen and acetylene	○			Imported
Safety facilities	○			Local, Imported
H-beams, sheet piles	○			Imported
Oil, fuel and fat	○			Imported

(2) Equipment

There is no leasing company for construction equipment in Lao PDR,

and locally available equipment that could be procured from local contractors is limited. Furthermore, local contractors have less experience on large scale construction and do not own large equipment. So local procurement is only for small equipment available in limited numbers. The unavailable number of small equipment and large equipment will be procured from Japan or the third countries. A base of procurement for construction equipment for Lao PDR is mostly from Thailand by inland transportation, and it is planned to be procured from Thailand in this study, which is not available locally. The procurement of Asphalt Plant and Soil Plant, which is difficult to procure in the third countries, are planned to be procured from Japan.

Procurement plan of the major equipment is shown in Table 3.1.5-2.

Table 3.1.5-2 Equipment Procurement Plan

	Procured from			Remarks
	Lao P.D.R.	Japan	Third Country	
Bulldozer			○	Thailand
Backhoe excavator	○		○	Thailand
Tractor shovel			○	Thailand
Dump truck	○		○	Thailand
Cargo truck	○		○	Thailand
Truck crane			○	Thailand
Wheel crane			○	Thailand
Soil plant		○		
Motor grader			○	Thailand
Macadam roller			○	Thailand
Tire roller			○	Thailand
Vibration roller			○	Thailand
Tamper	○		○	Thailand
Asphalt plant		○		
Asphalt finisher			○	Thailand
Line marker			○	Thailand
Water tank truck			○	Thailand
Submerged pump	○		○	Thailand
Generator			○	Thailand
Concrete mixer	○		○	Thailand
Welding machine			○	Thailand
Belt conveyer			○	Thailand
Pick-up truck(s)			○	Thailand

3.1.6 Soft Component

Due to the existing conditions of National Road No.9 it took 6 hours 20

minutes to travel between Savannakhet and Daensavan (Lao Bao) 240km in length, using a 4 wheel driving wagon during field investigation (average speed: 38kph). Running speed after completion of the project will be quite higher than present (design speed: 50kph~100kph), and MCTPC has to consider some counter measures for the prevention of traffic accidents by the enlightenment activities to inhabitants along the project road.

On the other hand, it is also important for Japanese Government to secure the appearance and continuation of positive effects by this project to develop the operation and maintenance system on the project road.

Therefore the introduction of "Soft Component" is proposed to secure the early appearance and continuation of effects by this project under Japan's Grant Aid. Soft Component provides the technical assistance to MCTPC, the implementing agency, on the traffic safety measures.

Major activities under the Soft Component are as follows:

- Operation of seminars : It is held twice at the timing of completion of neighbor section around 2002 and 2003.
- Distribution of pamphlets : Pamphlets for the enlightenment of traffic safety are prepared in Lao language for 4 kinds of users deiver, rider, pedestrian and children .
  Prepared pamphlets, total 10,000 sheets, are distributed at seminars.

Seminars will be planned to pass on to attendees the importance of consciousness and knowledge of traffic safety with visual presentation of examples of traffic accidents.

Major items of seminars are as follow:

Traffic Safety: Prohibition of overloading, observance of regulated number of passengers, prohibition of irregular parking, manner of drivers, manner of pedestrians, presentation of examples of accidents, information of traffic regulations, prohibition of unlicensed driving, etc.

Traffic Moral: Crossing at Zebra Zone, observance of traffic signal, observance of traffic sign, observance of traffic lane, retention of safe interval, prohibition of road vending, etc.

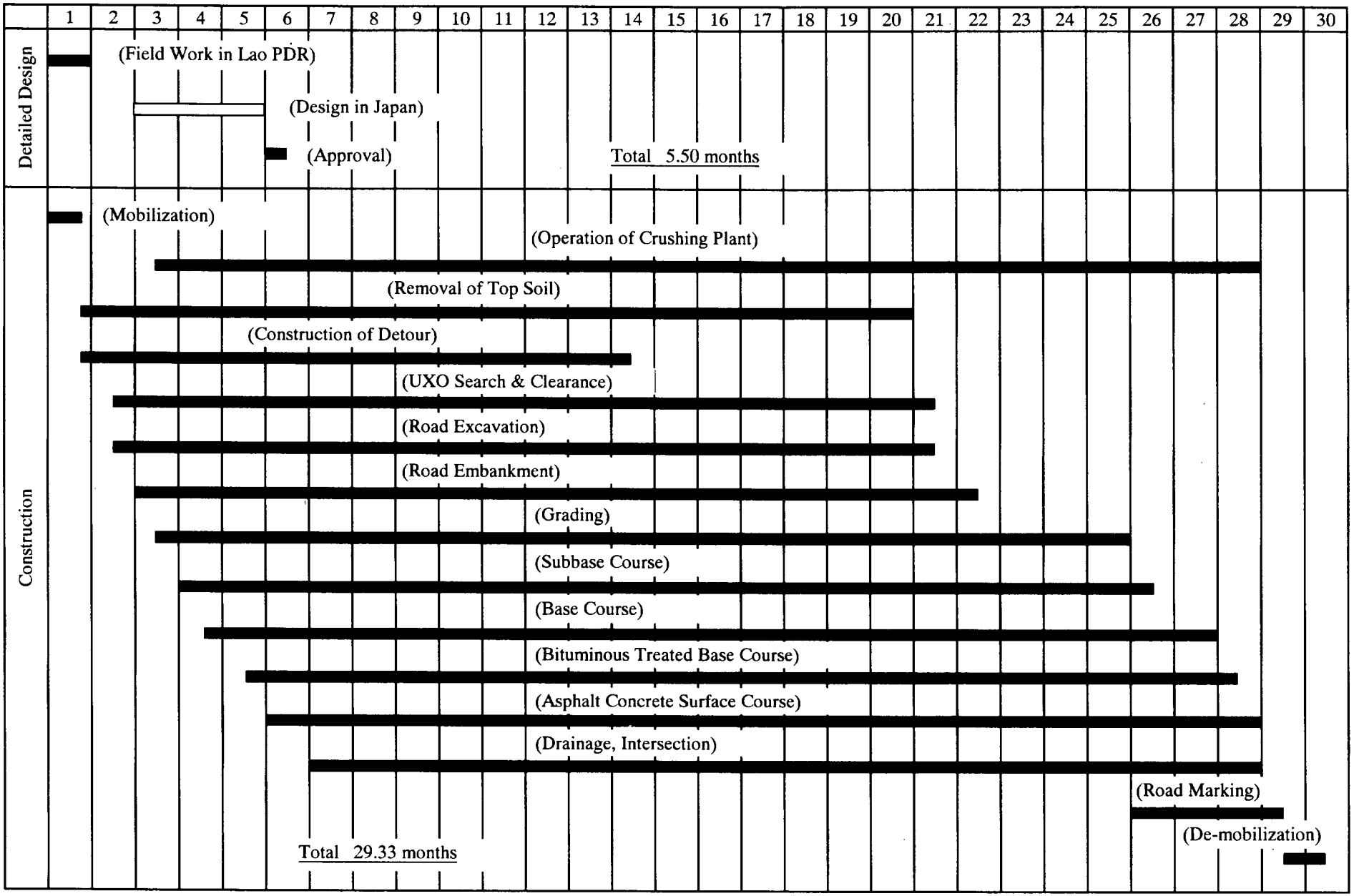
3.1.7 Implementation Schedule

For the planning of implementation schedule it is necessary to coordinate with the other component of "East-West Transport Corridor Project", in particular with the First Section "The Project for Improvement of the National Road Route 9".

Duration for the construction is estimated to be about 30 months taking into consideration UXO removal, quarry permission, right of way, quantities of construction, rainy season, procurement of material, detour control and economic cost.

Table 3.1.7-1 shows the proposed implementation schedule of this project.

Table 3.1.7-1 Implementation Schedule



3.1.8 Obligations of Lao PDR

The following necessary measures shall be taken by the Government of Lao PDR 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 necessary for the execution for the Project, such as the Right of Way, land for Bridges, temporary offices, working areas, storage yards and others.

(3) To acquire the permission of quarry for required additional area.

(4) To clear the sites prior to the commencement of the construction including removal of the UXO (Unexploded Ordnance), if required.

(5) To remove and clear discovered UXOs during construction.

(6) To re-plant tree at closed quarry.

(7) To make passable all roads and bridges leading to the Project sites before the commencement of inland transportation of materials and equipment.

(8) To bear commissions to the 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.

(9) To ensure prompt unloading, tax exemption, customs clearance at the port of disembarkation in Lao PDR and prompt internal transportation of the materials and equipment for the Project purchased under the Grant Aid.

(10) To exempt Japanese national from customs duties, internal taxes and other fiscal levies which will be imposed in the recipient country with respect to the supply of the products and services under the verified contracts.

(11) 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 Lao PDR and stay therein for the performance of their work.

(12) To provide necessary permissions, licences and other authorizations for implementing the Project, if necessary.

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

(14) 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.

(15) To bear all the expenses, other than those covered by the Japanese Grant Aid, necessary for the Project.

3.2 Project Cost Borne by the Government of Lao PDR

Project cost borne by Lao PDR is estimated at 578.82 million kip. (Refer to Appendix 5).

3.3 Operation and Maintenance Costs

Maintenance of the improved road will be managed by DOR. The pavement will become more durable in the project, and can reduce the time and cost for the maintenance. It means the budget of the maintenance work operated by state enterprises can be saved.

Routine maintenance of roads and related facilities shall be executed. Routine maintenance crews shall be set up and operated under the supervision of DOR. As significant defects are found on roads during routine maintenance, the Government should formulate special maintenance procedure, based upon detailed inspections.

The routine maintenance activities required for the project road are shown in Table 3.3-1.

Table 3.3-1 Routine Maintenance Activities

Inspection	Remarks
Pavement	- settlement, crack, depression, scale, fracture
Shoulder	- scouring, settlement, deformation
Cut slope, Embankment	- slope failure, erosion, etc.
Side ditch (gutter, lid)	- settlement, deformation, etc.
Drainage pipe	- choked, etc.
Drain pit	- sediment, etc.
Outlet	- deformation, etc.
Others	

The annual cost necessary for maintenance of the project section is estimated and presented in Table 3.3-2.

Table 3.3-2 MAINTENANCE PLAN FOR THE PROJECT ROAD

1. Routine Inspection (Total road length :60 Km)

Facility	Inspection Item	Interval	Number of Staff	Equipment/Material	Days	budget (Kip)
.Ditches	Existing of mud, sand, obstacles, etc.	12 times/year	2 persons	Measuring tape, scoop, hammer, bar	96 persons	11,000,000
.Culvert crossing road	Existing of mud, sand, obstacles, etc.	(4 days/round)				
.Pavement	Crack, deformation, potholes, etc.					
.Cut slope	Collapse, erosion, etc.					
.Embankment slope	Collapse, erosion, etc.			Pick-up truck	48 units	18,500,000
.Bridges	Surface of deck, abutment, pier, river condition					
.Road marking	Stain, discolor					
.Sign boards	Damage, deformation, stain, discolor					
					Sub-total	29,500,000

2. Clearing

Facility	Inspection Item	Interval	Number of Staff	Equipment/Material	Days	budget (Kip)
.Ditches	Removal of deposit of mud, sand, obstacle	4 times/year	5 persons	Scoop, bar	80 persons	9,200,000
.Culvert crossing road		(4 days/round)		brooms		
.Pavement				hand tool		
.Cut slope						
.Embankment slope				Pick-up truck	16 units	6,200,000
.Bridges						
.Road marking						
.Sign boards						
					Sub-total	15,400,000

3. Repair

Facility	Inspection Item	Interval	Number of Staff	Equipment/Material	Days	budget (Kip)
.Ditches	Repair of pothole	4 times/year	4 persons		336 persons	38,600,000
.Culvert crossing road	Removal of deposit of mud, sand, obstacle	(21 days/round)		Plate tamper	84 units	11,600,000
.Pavement				Pick-up truck	84 units	32,300,000
.Cut slope						
.Embankment slope				Base course	80 m3/year	18,500,000
.Bridges				Reseal	410 l/year	3,700,000
.Road marking						
.Sign boards						
					Sub-total	104,700,000
					Grand total :	149,600,000

CHAPTER 4

PROJECT EVALUATION AND RECOMMENDATION

CHAPTER 4 PROJECT EVALUATION AND RECOMMENDATION

4.1 Project Effect

Existing Condition of National Road No.9 has not carried out its function properly as a national road due to significant damages. The Government of Lao PDR regards Improvement Project of National Road No.9 as one of the top priority projects, as its First Section and Third Section are already being implemented. Improvement Project of Lao PDR for National Road No.9 will not be concluded without the completion of the Second Section, which is the study section of about 60 km in length connecting Muang Phalan and Muang Phin.

Savannakhet City leading the administration and economy of Savannakhet province is located at the edge of the middle-west of the province. For residents of the province, only National Road No.9, of the trans-province road, provides an access to Savannakhet City. The population of Savannakhet Province is estimated at 748,000 people as of 1999, and all of them will be the direct beneficiary of this project.

In addition, National Road No.9 functions as major trunk road in national road network and as an international road to Vietnam, so the ratio of in flow traffic from outer provinces and neighbor countries is quite high. In view of this situation, it regards the beneficial range of this project as spreading over the middle-south of Lao PDR.

Direct effects by the implementation of this project are as follows:

- Increase of transport volume

  Passenger and cargo transport will increase by the upgrading of capacity and stability of the project road.

	Passenger / day	Cargo / day
2000 (present)	539 vehicles	199 vehicles
2010 (forecast)*	1,908 vehicles	1,131 vehicles

*) Based on F/S report of East-West Transport Corridor Project

- Shortening of necessary travel time

  Necessary travel time between Muang Phalan and Muang Phin will be much shortened as the result of increase of running speed and upgrading of running ability.

	Necessary Travel Time	Ave. Speed
Present	136 minutes (4-WD wagon)	25 kph
After project	57 minutes (All type)	62 kph

- Saving of the budget for road maintenance

  The budget for road maintenance will be minimized due to its having a more durable pavement structure.

	Routine Maintenance	Periodic Maintenance
DBST (Existing)	$694 / km	$1,600 / km・year
AC (After project)*	50% down	25% down

*) Based on the past experience

- Removal of unpassable period

  At present, it is limited to some vehicle types during rainy season due to the occurrence of deep rutting and muddy surface. After the project, it will become in all weather road and be passable to any type of vehicles through the year.

	Unpassable Period	Unpassable Vehicle Type
Present	about 5 months	Passenger Car, Tuktuk
After project	None	None

Indirect effects by the implementation of this project are as follows:

- Saving of vehicle operating cost

  Vehicle operating cost will decrease by the upgrading of running ability (advance of fuel mileage, decrease of maintenance cost, extension of vehicle life and so on).

- Decrease of damage of loads and saving of packing cost

  Damage of loads will decrease by the upgrading of running ability, so packing cost will be saved due to the utilization of simple packing.

- Improvement of living convenience

  Convenience of local residents will be improved by upgrading of access to public facilities, expansion of public transportation and so on.

- Increase of investment

  Value of landuse will rise by upgrading of access, then domestic and foreign investment will increase, which also promotes development of the province.

- Activation of local economic

  It will contribute to the activation of local economic of the provinces by the increase of traffic, saving of transportation cost, regional development and so on.

In this way, this project will contribute to an advanced living standards for local residents and promote socio-economic activity in Savannakhet province and Lao PDR. Moreover it contribute to complete East-West Transport Corridor connecting the north-east of Thailand and Da Nang Port in Vietnam, so it is regarded as important in the development of the Indo-China Peninsula. Thus, it is concluded that the implementation of this project under Japan's Grant Aid is appropriate.

4.2 Recommendation

In additional to the above great effects, that will be expected, this project will widely contribute to advance Basic Human Needs. Thus it is judged that the importance for implementation of this project is large. The Government of Lao PDR shall perform following subjects to secure effects and its sustenance of this project.

- Operation of proper maintenance and its budgetary arrangement
- Acquirement of knowledge and technical skill for AC pavement
- Proper counter measures on traffic safety and its sustainable operation

Among also, it introduces Soft Component which provide technical assistance in this project for the traffic safety measures.