Construction

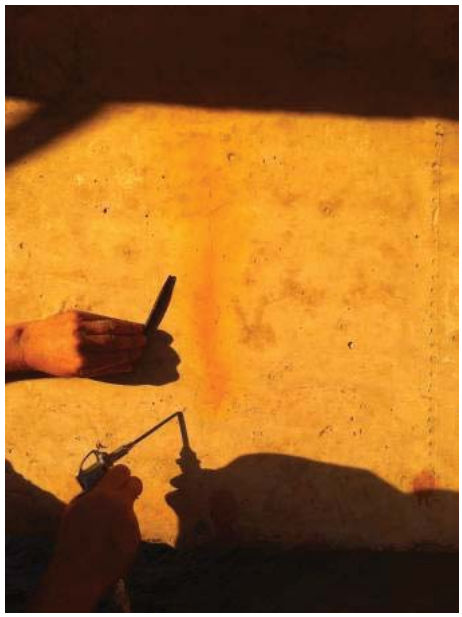
Bridge Maintenance

Sika (Thailand) Limited

Construction

Concrete Repair and Protection System

Honey Combs



Structural Crack > 0.3 mm

Non Structural Crack < 0.3 mm

Sika (Thailand) Limited

Construction

Concrete Repair and Protection System

Sika® Repair Principles

- Remove damage concrete to exposed steel
- Protect exposed steel
- Replace damage concrete
- Seal and prevent ingress of aggressive

Sika (Thailand) Limited

Construction

Concrete Repair: Working Steps

Removal of damaged concrete

Rust removal of rebars

Corrosion protection layer **SikaTop Armatec -110EC**

Bonding bridge

Application of repair mortar

Sika MonoTop -412TH

SikaGrout -214-11

Rendering mortar

Concrete protection (1st layer)

Concrete protection (2st layer)

Sikagard -700S

Sika Services AG

Construction

Concrete Repair and Protection System

Overview of Sika products range for:

Cementitious applied materials

Corrosion protection	Sika® Armatec -110EC
Bonding bridge	Sika® Armatec -110EC
Structural repair materials	Sika® MonoTop® -412TH or SikaGrout® -214-11
Concrete Protection	Sikagard® 700 S

Sika (Thailand) Limited

Construction

Concrete Repair and Protection System

SikaTop® Armatec -110 EpoCem®

A cement-based epoxy-modified three-component anti-corrosion coating and bonding agent.

Use : Bonding Agent and Anti-Corrosive Coating (with Extended Working Time and Open Time)

As an anti-corrosion coating for reinforcement steel;

- For repairs to reinforced concrete where there is corrosion of the underlying reinforcement steel
- For the preventive protection of reinforcement steel in thin reinforced concrete sections

Sika (Thailand) Limited

Construction

Concrete Repair and Protection System

Product	**SikaTop® Armatec -110EC**
Description	A cement-based epoxy-modified three-component anti-corrosion coating and bonding agent.
Consumption	Reinforcement protection: 2 x 2 kg/m^2 Bonding agent: 1 x 1.5 kg/m^2
Application	Hard brush or spay gun
Packing	20 kg/bag

Sika (Thailand) Limited

Construction

Concrete Repair and Protection System

Advantages: SikaTop® Armatec -110

- Contains EpoCem® technology - improved bonding agent
- Extended open times for repair mortars
- Compatible with most Sika® MonoTop® repair mortars
- Excellent adhesion to concrete and steel
- Contains corrosion inhibitor
- Certified for application under dynamic load conditions
- Good resistance to water and chloride penetration
- High shear strength
- Long pot life
- Easy to mix
- Can be brushed on or applied using spray gun

Sika (Thailand) Limited

Construction

Concrete Repair and Protection System

Levelling the profile and filling surface pores

Sika® MonoTop® -412 TH

Application trowels

Smoothing trowels

Sika (Thailand) Limited

Construction

Concrete Repair and Protection System

Product	**Sika® MonoTop® 412TH**
Description	Sika® MonoTop®-412 TH is a 1-component, fibre reinforced, low shrinkage structural repair mortar meeting the requirement of class-R4 of EN 1504-3.
Consumption	Yield: 1 bag = 18.7 liters of mortar
Application	By hand, trowel & spray machine
Packing	20 kg/bag

Sika (Thailand) Limited

Construction

Concrete Repair and Protection System

Advantages: Sika® MonoTop®-412TH

- Superior workability
- Suitable for hand and machine application
- Can be applied up to 50 mm thick per application layer
- Class R4 of EN 1504-3
- Structural repair
- Sulphate resistant
- Does not require bonding agent when manually applied
- Low chloride permeability
- A1 fire rating

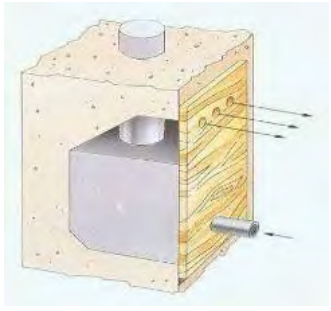
Sika (Thailand) Limited

Construction

Concrete Repair and Protection System

Levelling the profile and filling surface pores

SikaGrout® -214-11



Sika (Thailand) Limited

Construction

Concrete Repair and Protection System

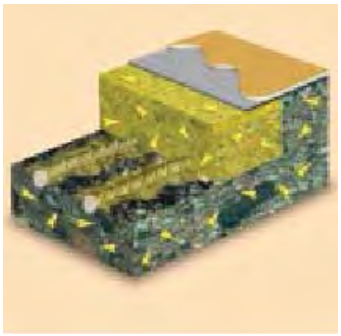
Product	**SikaGrout® -214-11**
Description	SikaGrout® -214 -11 is a non-shrink, self levelling, cementitious grouting mortar with extended working time to suit local ambient temperatures.
Consumption	Approx. 1.9 kg/m^3
Application	By pouring and pumping machine
Packing	25 kg/bag

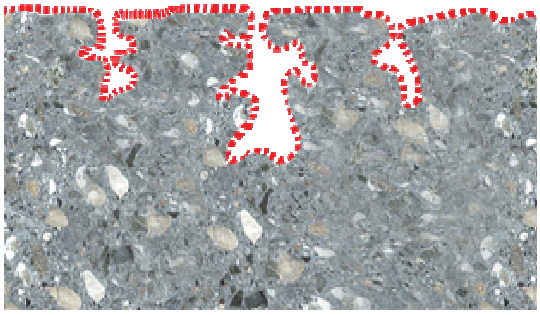
Sika (Thailand) Limited

Construction

Concrete Repair and Protection System

Sealing and coating preventing the ingress of aggressive infuences





Sikagard® -700 S

Sika (Thailand) Limited

Construction

Concrete Repair and Protection System

Hydrophobic Impregnation

EN 1504-2 definition:
It is a treatment of concrete to produce a water-repellent surface. The pores and capillaries are internally coated, but they are not filled. There is no film on the surface of the concrete and there is little or no change in its appearance

Sika (Thailand) Limited

Construction

Concrete Repair and Protection System

Product	**Sikagard® 700 S**
Description	One part water repellent impregnation for absorbent cementitious substrates. It penetrates well into the open pores of the substrate, providing durable water repellency, while still allowing water vapor diffusion in both directions.
Consumption	2 x ~ 0.300 - 0.500 kg/m2 (0.375 - 0.625 l/m2)
Application	By brush or spray
Packing	3 or 15 lt/pail

Sika (Thailand) Limited

Construction

Concrete Repair and Protection System

Advantages:

Sikagard® 700 S

- Reduction of capillary water absorption.
- Reduces efflorescence.
- Reduces dirt penetration into the pores.
- Improves thermal insulation.
- Can be overcoated with solvent based and dispersion coating ➔ . Sikagard® -680S Betoncolor
- Higher durability and resistance than conventional silicone based treatments.
- Does usually not change the appearance of the substrate.
- Reduces chloride ion ingress and movement.
- Does not act as a vapour barrier.

Sika®

Sika (Thailand) Limited

Construction

Concrete Repair and Protection System

Sika®

Sika (Thailand) Limited

Construction

Concrete Repair and Protection System

Surface Preparation :

Concrete :

- Must be sound, clean and free of loose or weak particles, dust and dirt.
- In particular, oil and wax containing layers as well as laitance must be completly removed.
- The prepared surface should be dampened down with clean water.

Steel :

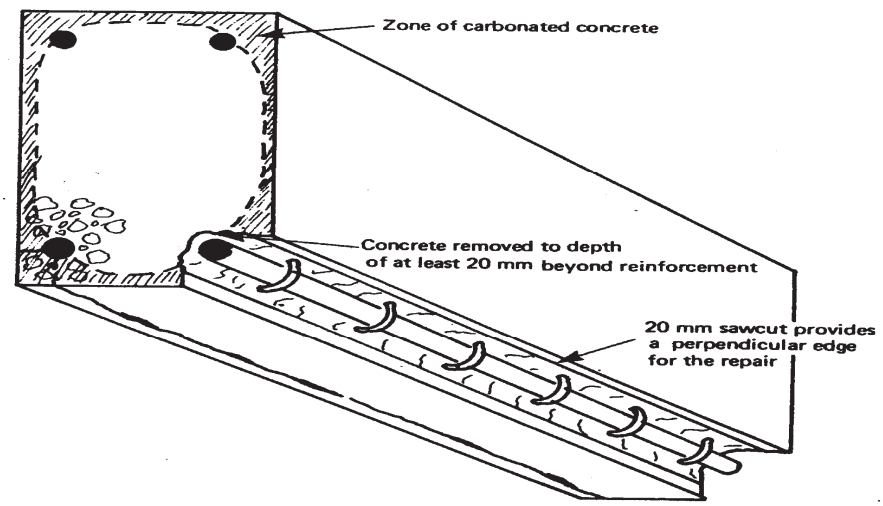
- Reinforcement must be suitably wire-brushed or water/grit-blasted to provid a surface free of rust, oil, grease or any other contaminants.

Sika (Thailand) Limited

Construction

Concrete Repair and Protection System

Surface preparation :



Sika (Thailand) Limited

Construction

Concrete Repair and Protection System

Marking &
Square edge perimeter

Sika (Thailand) Limited

Construction

Concrete Repair and Protection System

Remove deteriorated concrete

Sika (Thailand) Limited

Construction

Concrete Repair and Protection System

Steel Surface Preparation

Sika (Thailand) Limited

Construction

Concrete Repair and Protection System

Steel Corrosion Protection : SikaTop® Armatec -110EC

Sika (Thailand) Limited

Construction

Concrete Repair and Protection System

Bonding Bridge Coating : Sika MonoTop® 610

Sika (Thailand) Limited

Construction

Concrete Repair and Protection System

Concrete Replacement : Sika® MonoTop® 412TH

Sika (Thailand) Limited

Construction

Concrete Repair and Protection System

Concrete Replacement : Sika® MonoTop® 412 TH

Sika (Thailand) Limited

Construction

Concrete Repair and Protection System

Concrete Replacement : Sika® MonoTop® 412 TH

Sika (Thailand) Limited

Construction

Concrete Repair and Protection System

Add grout slowly whilst mixing.
Mix at low speed for 3 minutes.

Sika®

Sika (Thailand) Limited

Construction

Concrete Repair and Protection System

Form and Pump
SikaGrout® -214-11

Sika®

Sika (Thailand) Limited

Construction

Concrete Repair and Protection System

Hydrophobic Impregnation
Sikagard® -700S

Sika (Thailand) Limited

Construction

Crack Repair on concrete structures

Application Method

1. Pressure methods
   - *High pressure injection– pressure > 20 bar*
   - *High pressure injection – pressure < 20 bar*
   - *Low pressure injection – pressure < 2 bar*

2. Non-pressure methods
   - Gravity feeding
   - Surface Sealing

Sika®

Innovation & Consistency since 1910

Construction

Crack Repair on concrete structures

Low pressure injection – pressure < 2 bar

SikaGrout® Plug-A

SikaGrout® Pump4
SikaGrout® Pack1

Innovation & Consistency since 1910

Construction

Epoxy injection material

Sikadur® -52TH (former Sikadur® -752RT)

Low Viscosity 2-Component Injection Resin

Description	A 2-component, solvent-free, low viscosity injection-liquid, based on high strength epoxy resins. After mixing, it is injected into cavities and cracks in concrete where it cures to a rigid high strength material.
Standard	Complies with ASTM C 881-78 Type I, Grade 1 Class B+C
Uses	Sikadur® -52TH is used to fill and seal cavities and cracks in structural components such as columns, beams, foundations, decks and water-re taining structures. It not only forms an effective barrier against water infil tration, but also bonds the concrete sections, together, thereby restoring original structural strengths.
Advantages	Sikadur® -52TH is a deeply penetrative liquid with high adhesive qualities. ***Other benefits are :*** - Solvent free - Suitable in both, dry and damp conditions - Usable at low temperatures - Shrinkage-free hardening - High mechanical and adhesive strength

Innovation & Consistency since 1910

Construction

SikaGrout® Plug-A
SikaGrout® Pack1
Sikadur® 52TH

Innovation & Consistency since 1910

Construction

Crack Repair on concrete structures

Application Method

1. Pressure methods
   - *High pressure injection– pressure > 20 bar*
   - *High pressure injection – pressure < 20 bar*
   - *Low pressure injection – pressure < 2 bar*

2. Non-pressure methods
   - Gravity feeding
   - Surface Sealing

Innovation & Consistency since 1910

Construction

Crack Repair on concrete structures

Sealing Method – Non Structural Cracks

Sikadur® -31 CF Normal

2-Part Thixotropic Epoxy Adhesive

Product Description	Sikadur®-31 CF Normal is a moisture tolerant, thixotropic, structural two part adhesive and repair mortar, based on a combination of epoxy resins and special fillers, designed for use at temperatures between +10°C and +30°C.
Uses	As a structural adhesive and mortar for: ■ Concrete elements ■ Hard natural stone ■ Ceramics, fiber cement ■ Mortar, Bricks, Masonry ■ Steel, Iron, Aluminium ■ Wood ■ Polyester, Epoxy ■ Glass As a repair mortar and adhesive: ■ Corners and edges ■ Holes and void filling ■ Vertical and overhead use Joint filling and crack sealing: ■ Joint and crack arris / edge repair

Innovation & Consistency since 1910

Construction

Crack Repair on concrete structures

Sealing Method – Non Structural Cracks

Sikadur® -31CF

Innovation & Consistency since 1910

Construction

ขอขอบพระคุณผู้ฟังทุกท่าน

รัฐพร ระนองธานี

Mobile: (081) 945 0100

E-mail: rataporn.r@th.sika.com

Innovation & Consistency since 1910

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Inspec0on-results-
29-May-2013-
Bridges-In-Suvannakhet

Sole Distributor in Laos: SBL construction solutions
Thadeua Road KM4 ,P.O. BOX 3944, Vientiane, Lao PDR

Expansion-Joints-

Problems-and-Causes-:--

- Loss-of-steel-profiles-

BFailure-in-anchorage-

Bnot-the-right-leveling-for-installa0on-

ความเสียหายจากเหล็กยึด

Bเสียหายเนื่องจากสมอยึด

Bระดับของเหล็กทั้งสองข้างไม่เสมอกัน เกิดการรับแรงกระแทกด้านใดด้านหนึ่งมากกว่า-

Sole Distributor in Laos: SBL construction solutions
Thadeua Road KM4 ,P.O. BOX 3944, Vientiane, Lao PDR

Expansion-Joints-

Problems-and-Causes-:--

BGap-is-blocked-by-gravels-=-no-Gap-

ความเสียหายจากการที่ช่องว่างมีสิ่งกีดขวางการเคลื่อนตัว-

Sole Distributor in Laos: SBL construction solutions
Thadeua Road KM4 ,P.O. BOX 3944, Vientiane, Lao PDR

Expansion-Joints-

Problems-and-Causes-

- Cracks:-No-gap-allowed-for-the-temperature-movement.-

รอยแตกเนื่องจากการขยายตัวเมื่ออุณหภูมิสูงขึ้น-

Bridges in Suvannakhet, 29 May 13
www.reisnerwolff.com-

Sole Distributor in Laos: SBL construction solutions
Thadeua Road KM4 ,P.O. BOX 3944, Vientiane, Lao PDR

Bridge-Bearing-

Problems-and-Causes-

- Burs0ng-in-Bearing-area-

BBurs0ng-caused-by-insufficient-bearing-area.-

BWrong-alignment-(only-one-girder-fail),-not-same-leveling-for-all-girder.-

BBearing-is-too-rigid-for-impact-load-and-wrong-alignment.-

รอยร้าวของคานเนื่องจากพื้นที่ในการรับแรงน้อยเกินไป

Bอาจเกิดเนื่องจากระดับคานตัวที่แตกต่ำกว่าทำให้น้ำหนักมากกว่า

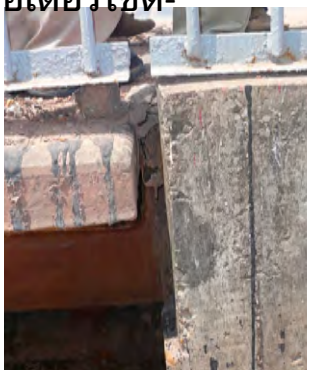
Bตัวรับน้ำหนักไม่มีความยืดหยุ่นในการรับแรงกระแทก-

Sole Distributor in Laos: SBL construction solutions
Thadeua Road KM4 ,P.O. BOX 3944, Vientiane, Lao PDR

Expansion-Joints-

Same-Problem-as-the-first-bridge-caused-serious-motorbike-accident-

ปัญหาเหมือนกับที่แรก ทำให้เกิดอุบัติเหตุกับมอเตอร์ไซด์-



Sole Distributor in Laos: SBL construction solutions
Thadeua Road KM4 ,P.O. BOX 3944, Vientiane, Lao PDR

Bridge-Bearing-

Problems-of-water-leakage-crack-start-underneath-bearing-and-expand-by-steel-corrosion-

Sole Distributor in Laos: SBL construction solutions
Thadeua Road KM4 ,P.O. BOX 3944, Vientiane, Lao PDR

Expansion-Joints-

Water-leakage-and-gap-blocked-

น้ำรั่วที่รอยต่อและรอยต่อไม่สามารถเคลื่อนตัวได้-

Fixed-side-

Movable-side-

Sole Distributor in Laos: SBL construction solutions
Thadeua Road KM4 ,P.O. BOX 3944, Vientiane, Lao PDR

Expansion-Joints-Fixed-side-

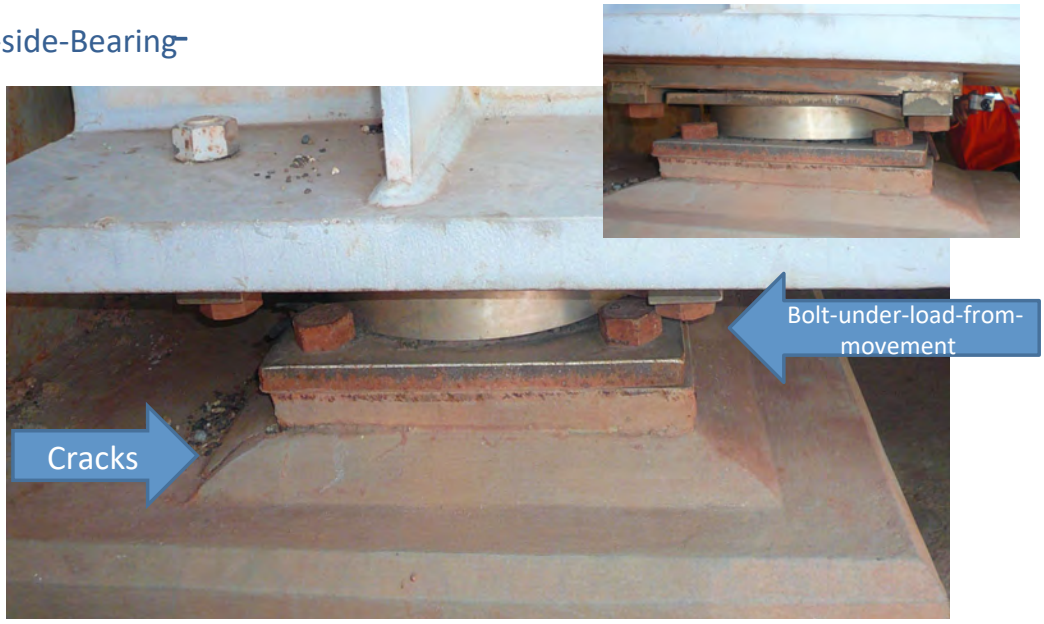
Water-leakage-and-gap-blocked-

น้ำรั่วที่รอยต่อและรอยต่อไม่สามารถเคลื่อนตัวได้-

Fixed-side-

Bearing-on--Fixed-Side-

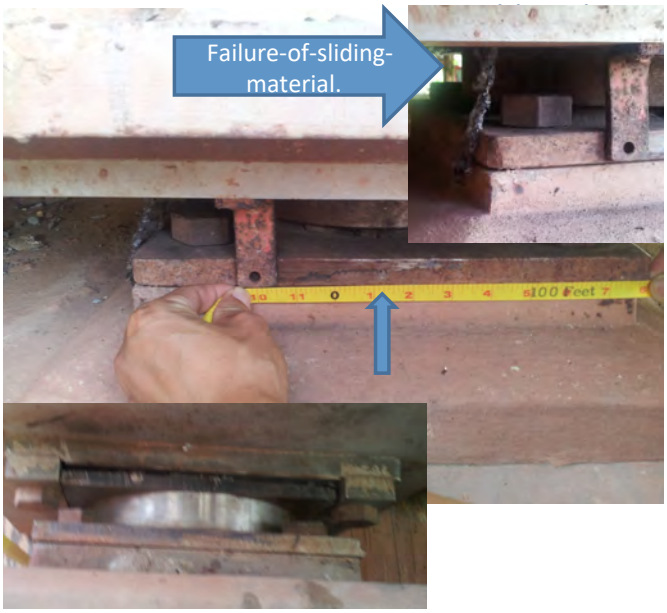
Fixed-side-Bearing-



Expansion-Joints-Movable-side-

Gap-is-too-small-

ช่องว่างแคบเกินไป-



Sole Distributor in Laos: SBL construction solutions
Thadeua Road KM4 ,P.O. BOX 3944, Vientiane, Lao PDR

Appendix 2-13

Evaluation Report on Slope Maintenance Manual

Japan International Cooperation Agency (JICA)
Lao People's Democratic Republic (Lao PDR)

THE PROJECT FOR IMPROVEMENT OF ROAD MANAGEMENT CAPABILITY IN LAO PDR

INTENSIVE TRAINING PROGRAM

SLOPE MAINTENANCE MANUAL

1st – 5th April 2013

International Development Center of Japan lnc. (IDCJ)
& Oriental Consultants Co., Ltd. (OC)

Table of Contents

1. INTRODUCTION

1.1 Background of the Project

Mountainous terrain is a dominant feature in Lao PDR and many of the National Roads have been laid on the mountainous terrain since they were used as footpath. Natural disaster is a well-recognized problem within the terrain, and causes many negative impacts on the livelihood and productivity of the country.

Whereas Lao PDR is dependent its internal and external freight/passenger transport on roads, the road network is fragile against natural disaster and closure of road due to disaster would be easy to hold the country's socio-economic activities.

It is important to maintain slopes on roads in order to provide safe and reliable road network, which reduces accident against natural disaster, provides equal opportunity to all citizens to reduce poverty and enables access to destinations of education and social services.

As part of the JICA-funded Capacity Building Project for improvement of road maintenance in Lao PDR, this document has been prepared for technical staff of slope maintenance in order to (1) acknowledge problems on current maintenance activities; (2) assist their daily maintenance works and (3) keep slope stable against natural disaster.

This intensive training on slope maintenance focused primarily to the roads in mountainous terrain and delivered knowledge of principles and practical activities for slope maintenance.

1.2 Project Goal, Purpose and Output

The overall project goal is that roads and bridge in Laos will be properly maintained. Through this training, maintenance planning ability for road/bridge maintenance will be enhanced, technical manual for road/bridge maintenance work will be prepared and capability of DPWT engineers in the pilot province (Vientiane and Savannakhet Provinces) will be enhanced.

1.3 Outline of Training Program

The major issues on current maintenance activities are (1) maintenance works are taken only after occurrence of disaster and proper preventive measures for slope stability are

not taken enough due to the limited amount of maintenance budget, (2) proper construction works are not taken and unstable cut slops, which would be collapsed during/after next wet season, still remain along roads.
In order to improve above mentioned situation, the training program was designed as introduction of the way of preventive maintenance. This training is intended mainly for field engineers and inspectors of DPWT and OPWT, who is in charge of slope maintenance, in order to build a technical knowledge on slope stability and assist maintenance activities in order to keep slopes in stable against natural disaster and provide safe and reliable road network in Laos.

1.4 Training Site

The section between Vang Vieng and Phou Khoun of the National Road No.13 North were selected for the fieldwork in the training program.

2. DETAIL OF THE TRAINING PROGRAM

2.1 Training Schedule

Training program for slope maintenance was set from 1st (Monday) to 5th (Friday) April 2013 and the details of the training are prepared as shown in Table 2.1.

Table 2.1 Training Schedule

Date	*Time*	*Contents*
Mon, April 1st	08:30 – 09:00	- **Opening Remarks** by Deputy Director of DPWT Vientiane District
		- **Explanation of training schedule** by JICA Expert Team
	09:00 – 10:00	- Classwork -1: **Skill test**
		- Classwork -2: **Outline of slope maintenance manual**
		- Classwork -3: **Type of slope failure**
	10:00 – 10:20	- Tea break
	10:20 – 11:50	- Classwork -4: **Inspection**
	11:50 – 13:00	- Lunch break in Vang Vieng (KM156)
	13:00 – 14:30	- Classwork -5: **Evaluation**
		- Classwork -6: **Selection of countermeasures/ rehabilitation**
	14:30 – 14:50	- Tea break
	14:50 – 16:20	- Classwork -7: **Introduction of slope protection measure** by Mr. Mori
Tue, April 2nd	08:30 – 10:00	- Classwork -8: **Plan and execution**
	10:00 – 11:00	- Fieldwork-1: **Explanation of slope failures on site**
	11:00 – 12:00	- Lunch break at Kasi (KM212)
	12:00 – 17:00	- Resume fieldwork-1
	17:00	- Return to Vang Vieng
Wed, April 3rd	08:00 – 16:00	- Fieldwork-2: **Investigation of problem slopes**
		Explanation of inspection method on site
	12:00 – 13:00	- Lunch break at Roadside restaurant near Phou Khoun (KM248)
	13:00 – 16:00	- Resume fieldwork-2
	17:00	- Return to Vang Vieng
Thu, April 4th	08:00 – 11:00	- Fieldwork-3: **Trial of routine inspection work**
	11:00 – 12:00	- Lunch break at Guest House near Phou Khoun (KM253)
	13:00 – 15:00	- Fieldwork-4: **Trial of detailed inspection work**
	15:00 – 16:00	- Classwork-9: **Finalization of inspection sheet**
		Selection of countermeasures
Fri, April 5th	08:00 – 10:30	- Classwork-10: **Presentation of results**
		Skill test
	10:30 – 10:45	- Tea break
	10:45 – 11:15	- **Handover of certificate**
	11:15 – 11:30	- **Closing Remarks** by Deputy Director of DPWT Vientiane District

2.2 Personnel of Trainers

The lecture in classroom and fieldwork were conducted by collaboration of JICA Expert Team (CaRoL) and PTTC. Names of the trainers are listed in the table below.

Table 2.2 List of Trainers

No.	Name	Organization	Position	Remarks
1	Mr. Iwao YOKOKAWA	CaRoL	Road Disaster Prevention Expert	Supervisor
2	Mr. Sisomphon SOUTHAMMAVONG	PTTC	Lecturer	Lecturer
3	Mr. Noriyuki MORI	MPWT	JICA Expert	Lecturer
4	Mr. Hiroyuki MORIMOTO	CaRoL	Road Planning Expert	Advisor

2.3 Personnel of Trainees

The trainees were invited from several parties who are in charge of road/slope maintenance activities. List of trainees are as shown in the table below.

Table 2.3 List of Trainees

No.	Name	Organization
1	Mr. Chansy	RAD/MPWT
2	Mr. Khamlar	RAD/MPWT
3	Mr. Lamphoun	PTI
4	Mr. Saphone	PTTC
5	Mr. Santi	LRD/MPWT
6	Mr. Homepheng	DPWT VTE
7	Mr. Korrakan	DPWT VTE
8	Mr. Somsanouk	DPWT VTE
9	Mr. Phouxay	DPWT ZVK
10	Mr. Souksavanh	DPWT ZVK
11	Mr. Thanongsak	DPWT ZVK
12	Mr. Bandith	OPWT Hinheaup
13	Mr. Chantha	OPWT Hinheaup
14	Mr. Phounguen	OPWT Hinheaup
15	Mr. Bounlearth	OPWT Kasi
16	Mr. Bouthsady	OPWT Kasi
17	Mr. Phouthasack	OPWT Kasi
18	Mr. Khamsouk	OPWT Vangvieng
19	Mr. Kongsin	OPWT Vangvieng
20	Mr. Sisomphou	OPWT Vangvieng
21	Mr. Sengphachan	Lao Consulting Group

3. CONTENTS OF TRAINING

3.1 Lecture

Lecture of training course is mainly divided in to 4 parts, namely (i) basic knowledge of slope failure, (ii) slope inspection works, (iii) evaluation of the inspection results and (4) planning and execution of countermeasures/ rehabilitation works. Adding that, introduction of slope protection measure was made by Mr. Mori.

(1) Basic knowledge of slope failure

Basic knowledge of slope failure and slope stability is explained to the trainees in order to understand the necessity of slope protection works. The contents of this lecture consisted of the classification of slope failure, namely (i) Soil / weathered rock slope failure, (ii) Rock slope failure, (iii) Mass movement of slope, (iv) Road slip and (v) Debris flow. Causes and signs of these failures were also explained subsequently.

(2) Slope inspection works

The following contents of slope inspection works were presented:

- Baseline Inspection
- Routine Inspection
- Detailed Inspection
- Emergency Inspection

Frequency of inspection and safety measures at inspection were also presented.

(3) Evaluation of the inspection results

It was presented that risk of slope failure is evaluated based on (i) probability of slope failure in terms of potential of instability and (ii) economic and social loss caused by the slope failure.

(4) Planning and execution of countermeasures/ rehabilitation works

The measures to select locations requiring countermeasures/rehabilitation works and

possible candidates of construction methods were presented. Also, a sample of detailed design is presented with required information for the design to be obtained from investigation.


Lecture on slope maintenance by Mr. Sisomphone


Lecture on slope maintenance by Mr. Sisomphone

(5) Introduction of slope protection measure by Mr. Mori

In connection with the main contents presented by Mr. Sisomphon, Mr. Mori explained the necessity of protection works with vegetation.


Lecture on slope protection by Mr. Mori


Lecture on slope protection by Mr. Mori

3.2 Training on Site

(1) Explanation of slope failures and investigation of problem slopes

The trainees visited the sites on National Road No.13 North (the section between Vang Vient and Phou Khoun and observed the sites of slope failure and learned current problems.


Explanation of slope failure


Site visit at big cut slope area

(2) Explanation of inspection method on site

The trainees learned the way of routine/detailed inspection on site as well as the point of view during inspection works. At the large cut section damaged in 2011, the trainees learned the way of using survey equipment and tips for identify rock/soil type using hammer.


Explanation of rock type


Explanation of erosion

(3) Trial of routine/detailed inspection work

Based on the knowledge gained in the training program, the trainees conduct a practice of routine and detailed inspection. The trainees were divided to four (4) teams and each team conduct a trial inspection work at particular ten (10) kilometer section on National Road No.13 North and kept a record on inspection sheets.


Trial of routine inspection


Trial of detailed inspection

(4) Finalization of inspection sheet and selection of countermeasures

Based on the trial inspection result, the trainees finalize the inspection sheets and made presentation of it. Mr. Yokokawa made comments for the trainees' presentation and supplemental explanation for the inspection works.


Finalization of inspection sheet


Presentation of inspection result by Trainee

4. EVALUATION OF TRAINING

4.1 Skill Test

In order to evaluate the capacity of the trainee and the level of improvement of their skill through this intensive training, skill tests were carried out before and after the training course. Before the intensive training, only two (2) participants could pass the skill test (over 70%), eight (8) participants could the same test after the training.

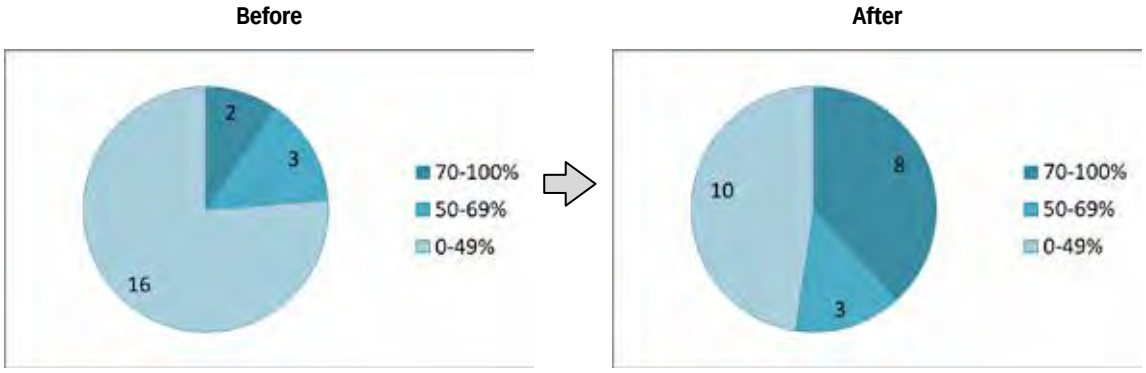


Figure 4.1 Result of Skill Test

The following figure shows the result of skill test by each organization. According to the figure, it was found that the level of understanding of the participants from DPWT and MPWT were improved but that from OPWT were not improved so much.

Considering that many of actual inspection works will be conducted by the inspectors of OPWT, the test result is not preferable as the output of the training.

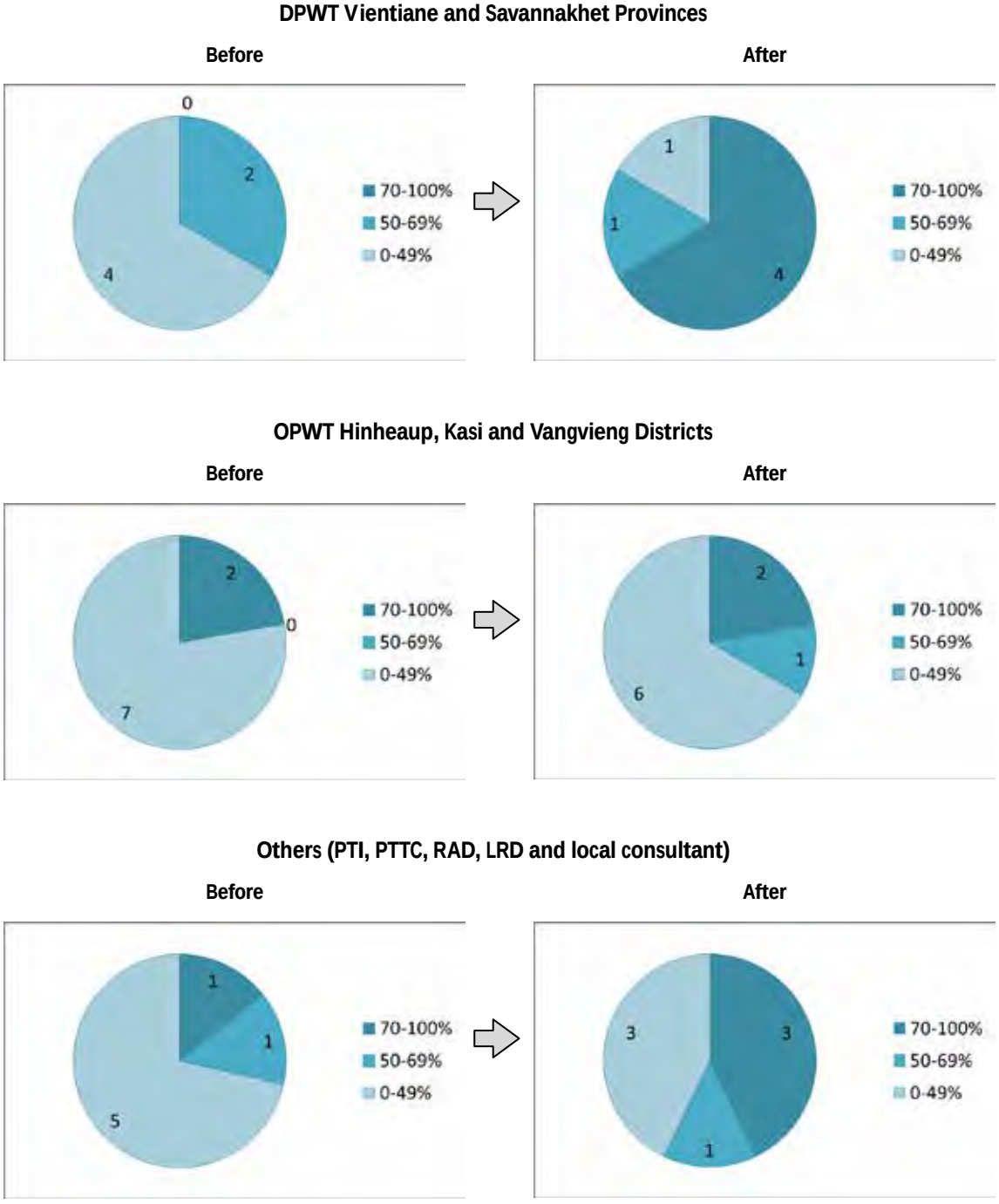


Figure 4.2 Result of Skill Test by Organization

4.2 Self-Evaluation of Slope Maintenance Skill

Through the intensive training course, the level of slope maintenance skill was increased around 0.8 point in average by the lecture and fieldworks.

Table 4.1 Result of Self-Evaluation of Slope Maintenance Skill

	Before	After	Difference
1. Inspection			
(1) Baseline inspection			
a. Preparation of necessary input for the inspection work	2.6	3.5	+0.9
b. Selection of slope/structure for inspection	2.6	3.4	+0.9
c. Carrying out inspection	2.8	3.6	+0.8
d. Estimation of cause of failure	3.0	3.6	+0.6
e. Estimation of consequences of failure, if no measures will not be taken	3.0	3.6	+0.7
f. Finalizing inspection sheets	2.9	3.6	+0.6
(2) Routine inspection			
a. Preparation of necessary input for the inspection work	2.7	3.8	+1.1
b. Carrying out inspection	2.9	3.8	+0.9
c. Recording straight line diagrams	3.0	3.7	+0.7
(3) Emergency inspection			
a. Preparation of necessary input for the inspection work	2.6	3.7	+1.0
b. Judgment of emergency case or not	2.8	3.3	+0.5
c. Carrying out inspection	2.9	3.6	+0.6
d. Decision of emergency measures at the site	3.0	3.7	+0.7
e. Preparation of the inspection report	2.9	3.8	+0.9
(4) Detailed inspection			
a. Preparation of necessary input for the inspection work	2.6	3.7	+1.0
b. Carrying out inspection	2.9	3.7	+0.8
c. Estimation of cause of failure	2.9	3.6	+0.7
d. Estimation of consequences of failure, if no measures will not be taken	3.1	3.6	+0.5
e. Measurements of crack, settlement, etc	3.2	3.6	+0.5
f. Finalizing inspection sheets	3.1	3.8	+0.8
2. Evaluation			
a. Rating of hazard	2.9	3.5	+0.6
b. Rating of influence on road by failure of slope/structure	2.9	3.6	+0.7
c. Prioritize location of slopes/structures for implementation of countermeasures/ rehabilitation works	2.5	3.6	+1.0
d. Selection of countermeasures/rehabilitation works	2.8	3.6	+0.8
e. Preliminary cost estimation	2.7	3.3	+0.6
f. Preparation of the evaluation report	2.9	3.6	+0.7
3. Planning and Execution			
a. Planning investigation	2.7	3.4	+0.7
b. Design of gabion and mortared masonry walls	2.9	3.6	+0.7
c. Design of concrete wall	2.8	3.4	+0.6
d. Design of cut slope	2.9	3.6	+0.8
e. Design of other slope protection works	2.8	3.6	+0.8
f. Slope stability analysis	2.4	3.2	+0.8
g. Quantity calculation	3.4	3.9	+0.5
h. Cost estimation	2.9	3.6	+0.6
i. Preparation of the work implementation program	2.9	3.6	+0.7
j. Supervision of the work execution on site	3.1	4.0	+0.8
k. Preparation of recording sheet for the completed works	3.0	3.9	+0.9
Aberage	**2.9**	**3.6**	**+0.8**

Note:

Level 1: I cannot or do not know how to achieve the results even with support provided by other skilled staffs / manuals.

Level 2: I can or know how to achieve the results with fully support provided by other skilled staffs / manuals.

Level 3: I can or know how to achieve the results with occasionally or proper support by skilled staffs / manuals.

Level 4: I can or know how to achieve the results without any support / manuals.

Level 5: I am able to train other staffs.

5. CONCLUSION

Although the trainees learned wide range of knowledge on slope maintenance, the technical level of it seems a bit too high for district level (OPWT). Considering that the many of inspection work will be carried out by district level, it is necessary to provide instructions to OPWT. Also, the level of understanding by engineers from central level (MPWT, PTI) and provincial level (DPWT) need to be increased. Therefore, continuous trainings for the engineers of central level to district level are required.

- Japan International Cooperation Agency (JICA)
- Lao Peoples Democratic Republic (Lao P.D.R)

Report

Of

Bridge Condition Survey Rout 13N
in
Vientiane Province

4th June 2012

International Development Center of Japan Inc.
Oriental Consultants Co., Ltd

I. Purpose of Survey

As the aim of the Project is to improve the road management capability in Lao PDR, technical manuals for road/bridge maintenance is one of the main output of the project. In order to develop the technical manuals, understanding of current situation in maintenance works, especially the inspection and the evaluation is important.

According to 2007-2008 statistic, there are 49 Bridges along Rout 13N, which are Managed by National Road Management Division, DPWT, Vientiane Province. However, Bridge condition survey had not been done and the inventory of those bridges itself was not update since then.

Main purpose of this survey is to collect basic information about existing bridges along national road R13 North in Vientiane province, which will be use for making a plan for OJT, together with developing of technical manual. Bridge condition survey by visual inspection in selected bridges will be done and bridges inventory will also be updated.

II. Scope of Work

(1) Bridge inventory Survey
The inventory of all bridges (45 bridges) along National Road rout 13N, which are managed by DPWT Vientiane province base on the 2007-2008 statistic of Road Management Division, DPWT Vientiane province will be updated.

(2) Bridge condition Survey
Visual inspection of 11 selected bridges, which are bridge No.7, No.8, No.21, No.22, No.23, No.24, No.29, No.30, No.33, No.37 and No.45 in Phon Hong District, Hin Herp District, Vang Vieng and Kasi District (See the attached Updated Inventory sheet), will be done by using the proposed inspection sheet.

III. Personal

(1) JICA Expert Team
Dr. Kongkeo PHAMVANH, Bridge Maintenance Expert, Survey Team leader

(2) DWPT, Vientiane Province
Mr. Sengmany THAMMAVONG, Road Division DPWT Vientiane Province, Counterpart

(3) Assistance
Two assistances provided by JICA Expert team, Surveyors
- Mr. Littana KHATTIYAVONG
- Mr. Khonsavanh SINSAYVORAVONG

IV. Works Schedule

30th May 2012	6:00	Departed from Vientiane Capital
	8:00	Picked up Staff from DPWT
	8:30	Brief discussion with DG of DPWT, Vientiane Province
	9:00	Moved to Kasi District
	14:00	Started Survey from Kasi District to Vang Vieng District
	18:30	Stay at Vang Vieng
31st May 2012	7:30	Start Survey from Vang Vieng District to Phon Hong
	17:00	Return to DPWT, Vientiane Province

Work Schedule

No.	Date	Item	Btridge No.																																												
			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	43	44	45	46	47	48	49
1	30-May-12	Depart from Vientiane Capital	Pick up DPWT, Vientiane Province Staff at Phon Hong District (DPWT, Vientiance Province office)																																										
		Update Bridge Inventory																																											
2		Bridge Survey																																											
3		Stay at Vang Vieng City																																											
4	31-May-12	Update Bridge Inventory																																											
5		Bridge Survey																																											
6		Return to Vientiane Province	Survey Team return to Vientiane Capital																																										

V. Result

(1) Discussion

In order to issue bridge inventory and bridge condition survey, brief discussion between JICA Expert and DPWT, Vientiane province is done. Main purpose of the survey was explained as to update the bridge inventory and demonstrate bridge condition survey together with DPWT Staff. Through the survey, the problems of bridge maintenance work in Vientiane Province will be studied. Revision of Technical Manual, Planning of OJT and Training program will be develop based on these information.

Participant List

No.	Name	Position	Remark
1	Mr. Thenekham THONGBON	Director General	DPWT, Vientiane Province
2	Mr. Sengmany THAMMAVONG	Technical Staff	Road and Water way Division, DPWT, Vientiane Province
3	Mr. Vilath BOUATHONG	Head of Division	Road and Water way Division, DPWT, Vientiane Province
4	Dr. Kongkeo PHAMAVANH	JICA Expert Team	Bridge Maintenance Expert
5	Mr. Littana KHATTIYAVONG	Surveyor	
6	Mr. Khonsavanh SINSAYVORAVONG	Surveyor	

(3) Inventory Survey

Bridges inventory of all bridges along Route No.13 North located in Vientiane Province were updated. As the result, there are 46 bridges (Old inventory was 45 bridge) located in Vientiane Province. There were several of Bridges had a wrong information about the length, width and type of bridge. Through this survey, all of the information were corrected and updated (Appendix 1: Inventory Sheet).

Photo 1: Inventory Survey

(4) Bridge Condition Survey

In bridge condition survey, 11 bridges of 46 bridges in selected. In this survey, inspection method, point of view and brief evaluation were demonstrated to the staff of DPWT, Vientiane Province. Mainly, the following items such as: approach, girder, pier, bearing, expansion joint, abutment, embankments and fill in front of bridge, bridge surface, guard Rails at bridge approach, Parapets on bridge are the point of inspection.

As the result, bridge structure itself such as main girders, Piers, still have a good condition. However, Expansion joint, Bridge surface, parapets on bridge, especially bridge surface and parapets on bridge had a significant damage which is need to be repair as soon as possible. Also maintenance (Cleaning) surround drainage, abutment, fill in front of bridge and bearing, which is main cause of damage in the future. (Appendix 2: Visual Inspection sheet)

Bridge Condition Survey


Road No. Post-13N
Location: KM206+700

VI. Conclusion

According to the inventory survey, demonstration of bridge condition survey, the following features are found.

1) DPWT staff have not much experience on Bridge condition survey / Bridge maintenance Management.
2) Lake of understanding the Purpose of Survey, Survey Item and also the method.
3) Never use technical manual for bridge maintenance
4) Lake of knowhow in the evaluation on damage of the bridge structure.
5) Lake of knowledge in design code such as design load, design span of using, etc., …
6)

No.	Road No.	Bridge No.	Location	River Name	Bridge Name	District	No. Span	Longest Span (m)	Shortest (m)	Total Length (m)	Width (m)	Type of Slabe	Capacity (Ton)	Year of Finish	Lastest Mantenance	Bridge Type
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
I	***National Road***															
1	13N	5	KM55+700	Nam PHA NAI	Na Bone	Phon Hong	1	25.0	25.0	25.0	8.0 (7.0)	RC	40	-	-	PC-T
2	13N	6	KM63+500	Houay Thonh	Houay Thonh	Phon Hong	1	20.0	20.0	20.0	9.0 (7.5)	RC	40	-	-	PC-T
3	13N	7	KM66+400	Nam Cheng	Nam Cheng	Phon Hong	3	26.0	23.0	72 (23-26-23)	9.0 (8.0)	RC	40	-	-	PC-T
4	13N	8	KM73+900	Nam Chim	Nam Chim	Phon Hong	2	20.0	20.0	20-20	7.5 (6.0)	RC	40	-	-	PC-T
5	13N	9	KM94+000	Nam Leak	Hin Heup	Hin Heup	5	-	-	195.0	11.0 (8.0)	PC	40	-	-	PC-Box
6	13N	10	KM101+400	Houay Souane	Houay Souane	Hin Heup	2	20.0	17.0	37 (20-17)	6.5 (6.0)	RC	40	-	-	PC-T
7	13N	11	KM101+800	Houay Pong Song	Houay Pong Song	Hin Heup	2	20.0	20.0	40 (20-20)	6.5 (6.0)	RC	40	-	-	PC-T
8	13N	12	KM103+800	Houay Hin Tid (1)	Pong Song	Hin Heup	2	20.0	17.0	37 (20-17)	7.5 (6.0)	RC	40	-	-	PC-T
9	13N	13	KM106+900	Houay Hin Tid (2)	Park Vang	Hin Heup	2	17.0	14.0	31 (17-14)	6.5 (6.0)	RC	40	-	-	PC-T
10	13N	14	KM111-200	Houay Dok Mai (1)	Houay Dok Mai (1)	Hin Heup	1	26.0	26.0	26.0	6.5 (6.0)	RC	40	-	-	PC-T
11	13N	15	KM112+100	Houay Koh Khai (1)	Tao Tane	Hin Heup	1	26.0	26.0	26.0	6.5 (6.0)	RC	40	-	-	PC-T
12	13N	16	KM114+100	Houay Koh Khai (2)	Tao Tane	Hin Heup	1	20.0	20.0	20.0	7.5 (6.0)	RC	40	-	-	PC-T
13	13N	17	KM114+700	Houay Dok Mai (2)	Phon Tong Neua	Hin Heup	1	23.0	23.0	23.0	7.5 (6.0)	RC	40	-	-	PC-T
14	13N	18	KM116+200	Houay Phung	Van Khy	Hin Heup	1	26.0	26.0	26.0	6.5 (6.0)	RC	40	-	-	PC-T
15	13N	19	KM116+500	Houay Lan Phai	Van Khy	Hin Heup	1	23.0	23.0	23.0	6.5 (6.0)	RC	40	-	-	PC-T
16	13N	20	KM117+400	Houay Van Khy (1)	Houay Van Khy (1)	Hin Heup	1	26.0	26.0	26.0	6.5 (6.0)	RC	40	-	-	PC-T
17	13N	21	KM117+900	Houay Van Khy (2)	Houay Van Khy (2)	Hin Heup	2	17.0	17.0	34 (17-17)	6.5 (6.0)	RC	40	-	-	PC-T
18	13N	22	KM120+000	Houay Pat	Houay Pat	Hin Heup	2	20.0	20.0	40 (20-20)	6.5 (6.0)	RC	40	-	-	PC-T
19	13N	23	KM124+876	Houay Som Sa Nuk	Houay Som Sa Nuk	Hin Heup	2	20.0	20.0	40 (20-20)	7.0 (6.0)	RC	40	-	-	PC-T
20	13N	24	KM128+000	Houay Pa Mom (1)	Houay Pa Mom (1)	Vang Vieng	3	23.0	14.0	51 (14-23-14)	6.5 (6.0)	RC	40	-	-	PC-T
21	13N	25	KM129+629	Houay Pa Mom (2)	Houay Pa Mom (2)	Vang Vieng	1	26.0	26.0	26.0	7.5 (6.0)	RC	40	-	-	PC-T
22	13N	26	KM132+866	Houay Mo (1)	Houay Mo(1)	Vang Vieng	1	26.0	26.0	26.0	7.5 (6.0)	RC	40	-	-	PC-T
23	13N	27	KM134+900	Houay Mo (2)	Houay Mo (2)	Vang Vieng	1	26.0	26.0	26.0	6.5 (6.0)	RC	40	-	-	PC-T
24	13N	28	KM136+000	Houay Mo (3)	Houay Mo (3)	Vang Vieng	1	23.0	23.0	23.0	6.5 (6.0)	RC	40	-	-	PC-T
25	13N	-	KM139+800	Houay Hin Cha	Houay Hin Cha	Vang Vieng	1	20.0	20.0	20.0	6.5 (6.0)	RC	40	-	-	PC-T
26	13N	29	KM140+950	Nam Ngad	Nam Ngad	Vang Vieng	3	20.0	20.0	20.0	7.5 (6.0)	RC	40	-	-	PC-T
27	13N	30	KM142+300	Nam Mone	Nam Mone	Vang Vieng	2	23.0	23.0	46.0	7.5 (6.0)	RC	40	-	-	PC-T

No.	Road No.	Bridge No.	Location	River Name	Bridge Name	District	No. Span	Longest Span (m)	Shortest (m)	Total Length (m)	Width (m)	Type of Slabe	Capacity (Ton)	Year of Finish	Lastest Mantenance	Bridge Type
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
28	13N	31	KM150+950	Houay Ngam	Houay Ngam	Vang Vieng	1	27.0	27.0	27.0	7.5 (6.0)	RC	40	-	-	Arch
29	13N	32	KM153+500	Nam Lao	Nam Lao	Vang Vieng	1	26.0	26.0	26.0	7.5 (6.0)	RC	40	-	-	PC-T
30	13N	33	KM161+400	Nam Po	Nam Po	Vang Vieng	3	26.0	13.0	52.0	7.0 (6.0)	RC	40	-	-	PC-T
31	13N	34	KM166+100	Nam Pong	Nam Pong	Vang Vieng	1	23.0	23.0	23.0	6.5 (6.0)	RC	40	-	-	PC-T
32	13N	35	KM168+500	Nam Pad	Nam Pad	Vang Vieng	1	17.0	17.0	17.0	6.5 (6.0)	RC	40	-	-	PC-T
33	13N	36	KM170+980	Houay Hin Sor	Houay Hin Sor	Vang Vieng	1	20.0	20.0	20.0	6.5 (6.0)	RC	40	-	-	Arch
34	13N	37	KM173+000	Nam Song	Nam Song	Vang Vieng	3	26.5	26.5	79.5	7.0 (6.0)	RC	40	-	-	PC-T
35	13N	38	KM179+800	Houay Nam Pang	Houay Nam Pang	Vang Vieng	1	14.0	14.0	14.0	6.5 (6.0)	RC	40	-	-	PC-T
36	13N	39	KM181+725	Houay Nam Khang	Houay Nam Khang	Vang Vieng	1	14.0	14.0	14.0	6.5 (6.0)	RC	40	-	-	PC-T
37	13N	40	KM181+825	Houay Nam Sa Dao	Houay Nam Sa Dao	Vang Vieng	1	20.0	20.0	20.0	6.5 (6.0)	RC	40	-	-	PC-T
38	13N	41	KM197+100	Nam Pang (1)	Nam Pang (1)	Kasi	1	12.3	12.3	12.3	6.5 (6.0)	RC	40	-	-	PC-T
39	13N	42	KM197+400	Nam Pang (2)	Nam Pang (2)	Kasi	1	26.0	26.0	26.0	6.5 (6.0)	RC	40	-	-	PC-T
40	13N	43	KM201+030	Houay Nam Chiang	Houay Nam Chiang	Kasi	1	26.0	26.0	26.0	6.5 (6.0)	RC	40	-	-	PC-T
41	13N	44	KM205+700	Houay Nam Khom	Houay Nam Khom	Kasi	1	26.0	26.0	26.0	6.5 (6.0)	RC	40	-	-	PC-T
42	13N	45	KM208+600	Nam Sa Nha	Nam Sa Nha	Kasi	3	12.0	12.0	36.0	6.5 (6.0)	RC	40	-	-	PC-T
43	13N	46	KM211+500	Houay Hin Cha (1)	Houay Hin Cha (1)	Kasi	1	14.0	14.0	14.0	6.5 (6.0)	RC	40	-	-	PC-T
44	13N	47	KM215+200	Houay Hin Cha (2)	Houay Hin Cha (2)	Kasi	1	20.0	20.0	20.0	6.5 (6.0)	RC	40	-	-	PC-T
45	13N	48	KM215+835	Nam Khean	Nam Khean	Kasi	3	12.0	12.0	36.0	6.5 (6.0)	RC	40	-	-	PC-T
46	13N	49	KM234+400	Nham Khean	Nham Khean	Kasi	1	26.0	26.0	26.0	6.5 (6.0)	RC	40	-	-	PC-T

Visual Inspection Survey for Bridge

Inspection Date	30/5/2012		Inspector	Kongkeo PHAMAVANH	
Road No.	R13N		Bridge No.	7	
Bridge Name	Nam Cheng		River Name	Nam Cheng	
Location (KM) +	KM66+400		DPWT	Vientiane Province	
Superstructure	PC-T				
Substructure	Abutment	Wall	Pier	Wall	
Length@Span (m)	72.0	m	3	span	23+26+23
Width (Effective)	9.0	m	8.0	m	
Year Build	-				

Surrounding	Rural Area	Last Maintenace	-	Ref. No.	-

Check Items/Parts	Visual Inspection Items			Evaluation					No. of Photo
	*1 Essential	Applicable	Inspection Items	CR	SI	Repl.	MAC	Quantity	
Superstructure Steel Beam/Truss & Steel Slab Concrete Beam & Girder (RC/PC) Concrete Slab			① Progress of collision	-					
			② Crack condtions	-					
			③ Tightening of bolts	-					
			④ Occurrence of vibration and noise	-					
	■		⑤ Cracking	1					
	■		⑥ Detachment, exposure of steel	1					
	■		⑦ Free lime	1					
Bearing (Steel/ Rubber)	■		① Progress of corrosion	1					
	■		② Deform, damage, move and settle	1					
	■		③ Mounting debris	1					
Piers	■		① Cracking	1					
	■		② Detachment, exposure of steel	1					
	■		③ Free lime	1					
	■		④ Scouring and washing out	1					
Abutment, Wing Walls and Retaining Walls	■		① Cracking	1					
	■		② Detachment, exposure of steel	1					
	■		③ Free lime	1					
	■		④ Scouring and washing out	1					
Parapets on Bridge (Steel/Concrete/others)			① Progress of corrosion	-					
			② Deform, damage, move and settle	2					
			③ Cracking, other damages	2					No.7-37
Guard Rails at Bridge Approach (Steel/Concrete/others)			① Progress of corrosion	-					
			② Deform, damage, move and settle	-					
			③ Cracking, other damages	-					
Bridge Surface and Footpaths (Asphalt/Concrete)			① Pothole	2					No.7-08
			② Cracking	2					
Expansion Joint (Steel/ Rubber)	■		① Differencial level	3					No.7-39
	■		② Abnormal movement	1					
	■		③ Deform, damage, move and settle	3					
Drainage			① Mounting debris	2					No.7-36
			② Progress of corrosion	-					
			③ Others	-					
Embankmens and fill in front of abutment			① Surrounding condition	2					
River Bed			① Surrounding condition	1					
Bridge in general (The Bridge seen as a whole)			① Overview	2					

CR: Condition Rating

0: No damage, element as new
1: Insignificant damage, no repair needed
2: Minor damage, repair when convenient
3: Damage, repair soon
4: Sever damage, repair immediately
5: Ultramate damage, element has failed
?: The condition could not be determined at the inspection

SI: Special Inspection required (✓)
MAC: Maintenance Activity Code
Repl.: Replacement element (✓)
If Repl. Is ticked (✓), No Mac should be applied

*1Note "■" is critial items for verifying the essential damages of major membre of bridge at the visual inspection

Photos at Visual Inspection Sheet (Particular points)

Photo No.	No.7-39	Span No.	1
Subject	Expension Joint		
Memo	Damage, Different Level		

Photo No.	No.7-08	Span No.	2
Subject	Bridge Surface and Footpaths		
Memo	Minor Pothole and Crack		

Photo No.	No.7-23	Span No.	1
Subject	Drainage		
Memo	Mounting debris		

Photo No.	No.7-19	Span No.	2
Subject	Main Girder		
Memo	Minor of Damage (opening) in the Joint		

Photo No.	No.07-27	Span No.	3
Subject	Pier		
Memo	Water from Jointing		

Photo No.	No.07-17	Span No.	3
Subject	Abutment		
Memo	Fill in front of abutment		

Visual Inspection Survey for Bridge

Inspection Date	31/5/2012		Inspector	Kongkeo PHAMAVANH	
Road No.	R13N		Bridge No.	8	
Bridge Name	Nam Chim		River Name	Nam Chim	
Location (KM) +	KM73+900		DPWT	Vientiane Province	
Superstructure	PC-T				
Substructure	Abutment	Wall	Pier	Wall	
Length@Span (m)	40.0	m	2	span	20 – 20
Width (Effective)	7.5	m	6.0	m	
Year Build	–				

Surrounding	Rural Area	Last Maintenace	-	Ref. No.	-

Check Items/Parts	Visual Inspection Items			Evaluation					No. of Photo
	*1 Essential	Applicable	Inspection Items	CR	SI	Repl.	MAC	Quantity	
Superstructure Steel Beam/Truss & Steel Slab Concrete Beam & Girder (RC/PC) Concrete Slab			① Progress of collision	-					
			② Crack condtions	-					
			③ Tightening of bolts	-					
			④ Occurrence of vibration and noise	-					
	■		⑤ Cracking	1					
	■		⑥ Detachment, exposure of steel	1					
	■		⑦ Free lime	1					
Bearing (Steel/ Rubber)	■		① Progress of corrosion	1					
	■		② Deform, damage, move and settle	1					
	■		③ Mounting debris	1					
Piers	■		① Cracking	1					
	■		② Detachment, exposure of steel	1					
	■		③ Free lime	1					
	■		④ Scouring and washing out	1					
Abutment, Wing Walls and Retaining Walls	■		① Cracking	1					
	■		② Detachment, exposure of steel	1					
	■		③ Free lime	1					
	■		④ Scouring and washing out	1					
Parapets on Bridge (Steel/Concrete/others)			① Progress of corrosion	1					
			② Deform, damage, move and settle	3					No.8-31
			③ Cracking, other damages	3					
Guard Rails at Bridge Approach (Steel/Concrete/others)			① Progress of corrosion	-					
			② Deform, damage, move and settle	-					
			③ Cracking, other damages	-					
Bridge Surface and Footpaths (Asphalt/Concrete)			① Pothole	1					
			② Cracking	1					
Expansion Joint (Steel/ Rubber)	■		① Differencial level	1					
	■		② Abnormal movement	1					
	■		③ Deform, damage, move and settle	1					
Drainage			① Mounting debris	2					
			② Progress of corrosion	-					
			③ Others	-					
Embankmens and fill in front of abutment			① Surrounding condition	1					
River Bed			① Surrounding condition	1					
Bridge in general (The Bridge seen as a whole)			① Overview	2					

CR: Condition Rating

0: No damage, element as new
1: Insignificant damage, no repair needed
2: Minor damage, repair when convenient
3: Damage, repair soon
4: Sever damage, repair immediately
5: Ultramate damage, element has failed
?: The condition could not be determined at the inspection

SI: Special Inspection required (✓)
MAC: Maintenance Activity Code
Repl.: Replacement element (✓)
If Repl. Is ticked (✓), No Mac should be applied

*1Note "■" is critial items for verifying the essential damages of major membre of bridge at the visual inspection

Photos at Visual Inspection Sheet (Particular points)

Photo No.	No.8-31	Span No.	1
Subject	Parapets on Bridge		
Memo	Damage		

Photo No.	No.8-02	Span No.	2
Subject	Expension Joint		
Memo	Still good condition but damage on approach road		

Photo No.	No.8-08	Span No.	1
Subject	Drainage		
Memo	Need to be cleaned up		

Photo No.	No.8-23	Span No.	2
Subject	Bearing		
Memo	Need to be cleaned up		

Photo No.	No.08-25	Span No.	1
Subject	Abutment		
Memo	Need to be clean		

Photo No.	No.08-24	Span No.	2
Subject	Main Girder		
Memo	Still good condition for survice		

Visual Inspection Survey for Bridge

Inspection Date	31/5/2012		Inspector	Kongkeo PHAMAVANH	
Road No.	R13N		Bridge No.	21	
Bridge Name	Houay Vang Khi (2)		River Name	Houay Vang Khi (2)	
Location (KM) +	KM117+400		DPWT	Vientiane Province	
Superstructure	PC-T				
Substructure	Abutment	Wall	Pier	Wall	
Length@Span (m)	34.0	m	2	span	17 – 17
Width (Effective)	6.5	m	6.0	m	
Year Build	–				

Surrounding	Rural Area	Last Maintenace	-	Ref. No.	-

Check Items/Parts	Visual Inspection Items			Evaluation					No. of Photo
	*1 Essential	Applicable	Inspection Items	CR	SI	Repl.	MAC	Quantity	
Superstructure Steel Beam/Truss & Steel Slab Concrete Beam & Girder (RC/PC) Concrete Slab			① Progress of collision	-					
			② Crack condtions	-					
			③ Tightening of bolts	-					
			④ Occurrence of vibration and noise	-					
	■		⑤ Cracking	1					
	■		⑥ Detachment, exposure of steel	1					
	■		⑦ Free lime	1					
Bearing (Steel/ Rubber)	■		① Progress of corrosion	1					
	■		② Deform, damage, move and settle	2					No.21-19
	■		③ Mounting debris	1					
Piers	■		① Cracking	1					
	■		② Detachment, exposure of steel	1					
	■		③ Free lime	1					
	■		④ Scouring and washing out	1					
Abutment, Wing Walls and Retaining Walls	■		① Cracking	?					
	■		② Detachment, exposure of steel	?					
	■		③ Free lime	?					
	■		④ Scouring and washing out	?					
Parapets on Bridge (Steel/Concrete/others)			① Progress of corrosion	2					No.21-09
			② Deform, damage, move and settle	3					No.21-12
			③ Cracking, other damages	3					
Guard Rails at Bridge Approach (Steel/Concrete/others)			① Progress of corrosion	-					
			② Deform, damage, move and settle	-					
			③ Cracking, other damages	-					
Bridge Surface and Footpaths (Asphalt/Concrete)			① Pothole	2					No.21-28
			② Cracking	2					
Expansion Joint (Steel/ Rubber)	■		① Differencial level	2					No.21-05
	■		② Abnormal movement	1					
	■		③ Deform, damage, move and settle	2					No.21-15
Drainage			① Mounting debris	2					No.21-14
			② Progress of corrosion	-					
			③ Others	-					
Embankmens and fill in front of abutment			① Surrounding condition	?					
River Bed			① Surrounding condition	1					
Bridge in general (The Bridge seen as a whole)			① Overview	2					

CR: Condition Rating

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1: Insignificant damage, no repair needed
2: Minor damage, repair when convenient
3: Damage, repair soon
4: Sever damage, repair immediately
5: Ultramate damage, element has failed
?: The condition could not be determined at the inspection

SI: Special Inspection required (✓)
MAC: Maintenance Activity Code
Repl.: Replacement element (✓)
If Repl. Is ticked (✓), No Mac should be applied

*1Note "■" is critial items for verifying the essential damages of major membre of bridge at the visual inspection

Photos at Visual Inspection Sheet (Particular points)

Photo No.	No.21-05	Span No.	2
Subject	Expension Joint, Approach		
Memo	Damage		

Photo No.	No.21-12	Span No.	2
Subject	Parapets on Bridge		
Memo	Damage		

Photo No.	No.21-14	Span No.	2
Subject	Drainage		
Memo	Need to be cleaned up		

Photo No.	No.21-19	Span No.	2
Subject	Bearing		
Memo	Need to be cleaned up		

Photo No.	No.21-23	Span No.	1
Subject	Abutment		
Memo	Need to be clean		

Photo No.	No.21-28	Span No.	1
Subject	Bridge Surface and Footpaths		
Memo	Minor of Pothole		

Visual Inspection Survey for Bridge

Inspection Date	31/5/2012		Inspector	Kongkeo PHAMAVANH	
Road No.	R13N		Bridge No.	22	
Bridge Name	Houay Pat		River Name	Houay Pat	
Location (KM) +	KM120+000		DPWT	Vientiane Province	
Superstructure	PC-T				
Substructure	Abutment	Wall	Pier	Wall	
Length@Span (m)	40.0	m	2	span	20 – 20
Width (Effective)	6.5	m	6.0	m	
Year Build	–				

Surrounding	Rural Area	Last Maintenace	-	Ref. No.	-

Check Items/Parts	Visual Inspection Items			Evaluation					No. of Photo
	*1 Essential	Applicable	Inspection Items	CR	SI	Repl.	MAC	Quantity	
Superstructure Steel Beam/Truss & Steel Slab Concrete Beam & Girder (RC/PC) Concrete Slab			① Progress of collision	-					
			② Crack condtions	-					
			③ Tightening of bolts	-					
			④ Occurrence of vibration and noise	-					
	■		⑤ Cracking	1					
	■		⑥ Detachment, exposure of steel	1					
	■		⑦ Free lime	1					
Bearing (Steel/ Rubber)	■		① Progress of corrosion	?					
	■		② Deform, damage, move and settle	?					
	■		③ Mounting debris	?					
Piers	■		① Cracking	1					
	■		② Detachment, exposure of steel	1					
	■		③ Free lime	1					
	■		④ Scouring and washing out	1					
Abutment, Wing Walls and Retaining Walls	■		① Cracking	?					
	■		② Detachment, exposure of steel	?					
	■		③ Free lime	?					
	■		④ Scouring and washing out	?					
Parapets on Bridge (Steel/Concrete/others)			① Progress of corrosion	2					
			② Deform, damage, move and settle	3					
			③ Cracking, other damages	3					No.22-17
Guard Rails at Bridge Approach (Steel/Concrete/others)			① Progress of corrosion	-					
			② Deform, damage, move and settle	-					
			③ Cracking, other damages	-					
Bridge Surface and Footpaths (Asphalt/Concrete)			① Pothole	2					No.22-21
			② Cracking	2					
Expansion Joint (Steel/ Rubber)	■		① Differencial level	2					
	■		② Abnormal movement	1					
	■		③ Deform, damage, move and settle	2					
Drainage			① Mounting debris	2					
			② Progress of corrosion	-					
			③ Others	-					
Embankmens and fill in front of abutment			① Surrounding condition	?					
River Bed			① Surrounding condition	1					
Bridge in general (The Bridge seen as a whole)			① Overview	2					

CR: Condition Rating

0: No damage, element as new
1: Insignificant damage, no repair needed
2: Minor damage, repair when convenient
3: Damage, repair soon
4: Sever damage, repair immediately
5: Ultramate damage, element has failed
?: The condition could not be determined at the inspection

SI: Special Inspection required (✓)
MAC: Maintenance Activity Code
Repl.: Replacement element (✓)
If Repl. Is ticked (✓), No Mac should be applied

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Photos at Visual Inspection Sheet (Particular points)

Photo No.	No.22-01	Span No.	–
Subject	Approach		
Memo	Damage		

Photo No.	No.22-04	Span No.	2
Subject	Drainage		
Memo	Need to be cleaned up		

Photo No.	No.22-17	Span No.	1
Subject	Parapets on Bridge		
Memo	Damage, Progess of Corrosion		

Photo No.	No.22-08	Span No.	1
Subject	Pothole		
Memo	Minor Damage		

Photo No.	No.22-17	Span No.	1
Subject	Abutment		
Memo	Need to be clean		

Photo No.	No.22-22	Span No.	2
Subject	Abutment		
Memo	Need to be clean		

Visual Inspection Survey for Bridge

Inspection Date	31/5/2012		Inspector	Kongkeo PHAMAVANH	
Road No.	R13N		Bridge No.	23	
Bridge Name	Houay Som Sa Nuk		River Name	Houay Som Sa Nuk	
Location (KM) +	KM124+876		DPWT	Vientiane Province	
Superstructure	PC-T				
Substructure	Abutment	Wall	Pier	Wall	
Length@Span (m)	40.0	m	2	span	20 – 20
Width (Effective)	7.0	m	6.0	m	
Year Build	–				

Surrounding	Rural Area	Last Maintenace	-	Ref. No.	-

Check Items/Parts	Visual Inspection Items			Evaluation					No. of Photo
	*1 Essential	Applicable	Inspection Items	CR	SI	Repl.	MAC	Quantity	
Superstructure Steel Beam/Truss & Steel Slab Concrete Beam & Girder (RC/PC) Concrete Slab			① Progress of collision	-					
			② Crack condtions	-					
			③ Tightening of bolts	-					
			④ Occurrence of vibration and noise	-					
	■		⑤ Cracking	1					
	■		⑥ Detachment, exposure of steel	1					
	■		⑦ Free lime	1					
Bearing (Steel/ Rubber)	■		① Progress of corrosion	1					
	■		② Deform, damage, move and settle	2					No.23-23
	■		③ Mounting debris	1					
Piers	■		① Cracking	1					
	■		② Detachment, exposure of steel	1					
	■		③ Free lime	1					
	■		④ Scouring and washing out	1					
Abutment, Wing Walls and Retaining Walls	■		① Cracking	?					
	■		② Detachment, exposure of steel	?					
	■		③ Free lime	?					
	■		④ Scouring and washing out	?					
Parapets on Bridge (Steel/Concrete/others)			① Progress of corrosion	2					
			② Deform, damage, move and settle	3					No.23-17
			③ Cracking, other damages	4					N0.23-18
Guard Rails at Bridge Approach (Steel/Concrete/others)			① Progress of corrosion	-					
			② Deform, damage, move and settle	-					
			③ Cracking, other damages	-					
Bridge Surface and Footpaths (Asphalt/Concrete)			① Pothole	3					No.23-05
			② Cracking	3					
Expansion Joint (Steel/ Rubber)	■		① Differencial level	3					
	■		② Abnormal movement	1					
	■		③ Deform, damage, move and settle	3					No.23-14
Drainage			① Mounting debris	2					No.23-09
			② Progress of corrosion	-					
			③ Others	-					
Embankmens and fill in front of abutment			① Surrounding condition	2					No.23-25
River Bed			① Surrounding condition	2					
Bridge in general (The Bridge seen as a whole)			① Overview	2					

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1: Insignificant damage, no repair needed
2: Minor damage, repair when convenient
3: Damage, repair soon
4: Sever damage, repair immediately
5: Ultramate damage, element has failed
?: The condition could not be determined at the inspection

SI: Special Inspection required (✓)
MAC: Maintenance Activity Code
Repl.: Replacement element (✓)
If Repl. Is ticked (✓), No Mac should be applied

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Photos at Visual Inspection Sheet (Particular points)

Photo No.	No.23-14	Span No.	-
Subject	Approach		
Memo	Damage		

Photo No.	No.23-09	Span No.	1
Subject	Drainage		
Memo	Need to be cleaned up		

Photo No.	No.23-18	Span No.	1
Subject	Parapets on Bridge		
Memo	Damage, Progess of Corrosion		

Photo No.	No.23-05	Span No.	2
Subject	Pothole		
Memo	Damage		

Photo No.	No.23-23	Span No.	-
Subject	Bearing		
Memo	Need to be cleaned and Minor Damage		

Photo No.	No.23-25	Span No.	2
Subject	Abutment		
Memo	Need to be clean		

Visual Inspection Survey for Bridge

Inspection Date	31/5/2012		Inspector	Kongkeo PHAMAVANH	
Road No.	R13N		Bridge No.	24	
Bridge Name	Houay Pa Mom (1)		River Name	Houay Pa Mom (1)	
Location (KM) +	KM128+800		DPWT	Vientiane Province	
Superstructure	PC-T				
Substructure	Abutment	Wall	Pier	Wall	
Length@Span (m)	51.0	m	3	span	14-23-14
Width (Effective)	6.5	m	6.0	m	
Year Build	-				

Surrounding	Rural Area	Last Maintenace	-	Ref. No.	-

Check Items/Parts	Visual Inspection Items			Evaluation					No. of Photo
	*1 Essential	Applicable	Inspection Items	CR	SI	Repl.	MAC	Quantity	
Superstructure Steel Beam/Truss & Steel Slab Concrete Beam & Girder (RC/PC) Concrete Slab			① Progress of collision	-					
			② Crack condtions	-					
			③ Tightening of bolts	-					
			④ Occurrence of vibration and noise	-					
	■		⑤ Cracking	1					
	■		⑥ Detachment, exposure of steel	1					
	■		⑦ Free lime	1					
Bearing (Steel/ Rubber)	■		① Progress of corrosion	1					
	■		② Deform, damage, move and settle	1					
	■		③ Mounting debris	1					
Piers	■		① Cracking	1					
	■		② Detachment, exposure of steel	1					
	■		③ Free lime	1					
	■		④ Scouring and washing out	1					
Abutment, Wing Walls and Retaining Walls	■		① Cracking	1					
	■		② Detachment, exposure of steel	1					
	■		③ Free lime	1					
	■		④ Scouring and washing out	1					
Parapets on Bridge (Steel/Concrete/others)			① Progress of corrosion	1					
			② Deform, damage, move and settle	1					
			③ Cracking, other damages	1					
Guard Rails at Bridge Approach (Steel/Concrete/others)			① Progress of corrosion	-					
			② Deform, damage, move and settle	-					
			③ Cracking, other damages	-					
Bridge Surface and Footpaths (Asphalt/Concrete)			① Pothole	2					No.24-30
			② Cracking	2					
Expansion Joint (Steel/ Rubber)	■		① Differencial level	2					
	■		② Abnormal movement	1					
	■		③ Deform, damage, move and settle	2					No.24-11
Drainage			① Mounting debris	2					No.24-12
			② Progress of corrosion	-					
			③ Others	-					
Embankmens and fill in front of abutment			① Surrounding condition	2					
River Bed			① Surrounding condition	1					
Bridge in general (The Bridge seen as a whole)			① Overview	1					

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2: Minor damage, repair when convenient
3: Damage, repair soon
4: Sever damage, repair immediately
5: Ultramate damage, element has failed
?: The condition could not be determined at the inspection

SI: Special Inspection required (✓)
MAC: Maintenance Activity Code
Repl.: Replacement element (✓)
If Repl. Is ticked (✓), No Mac should be applied

*1Note "■" is critial items for verifying the essential damages of major membre of bridge at the visual inspection

Photos at Visual Inspection Sheet(Particular points)

Photo No.	No.24-02	Span No.	-
Subject	Approach		
Memo	Minor Damage		

Photo No.	No.24-03	Span No.	1
Subject	Drainage		
Memo	Need to be cleaned up		

Photo No.	No.24-07	Span No.	1
Subject	Parapets on Bridge		
Memo	Minor of Damage		

Photo No.	No.24-08	Span No.	1
Subject	Pothole		
Memo	Minor Damage		

Photo No.	No.24-20	Span No.	-
Subject	Bearing		
Memo	Need to be cleaned and Minor Damage		

Photo No.	No.24-19	Span No.	2
Subject	Abutment		
Memo	Need to be cleaned up		

Visual Inspection Survey for Bridge

Inspection Date	31/5/2012		Inspector	Kongkeo PHAMAVANH	
Road No.	R13N		Bridge No.	29	
Bridge Name	Nam Ngad		River Name	Nam Ngad	
Location (KM) +	KM140+950		DPWT	Vientiane Province	
Superstructure	PC-T				
Substructure	Abutment	Wall	Pier	Wall	
Length@Span (m)	60.0	m	3	span	20 – 20 – 20
Width (Effective)	7.5	m	6.0	m	
Year Build	–				

Surrounding	Rural Area	Last Maintenace	-	Ref. No.	-

Check Items/Parts	Visual Inspection Items			Evaluation					No. of Photo
	*1 Essential	Applicable	Inspection Items	CR	SI	Repl.	MAC	Quantity	
Superstructure Steel Beam/Truss & Steel Slab Concrete Beam & Girder (RC/PC) Concrete Slab			① Progress of collision	-					
			② Crack condtions	-					
			③ Tightening of bolts	-					
			④ Occurrence of vibration and noise	-					
	■		⑤ Cracking	1					
	■		⑥ Detachment, exposure of steel	1					
	■		⑦ Free lime	1					
Bearing (Steel/ Rubber)	■		① Progress of corrosion	1					
	■		② Deform, damage, move and settle	2					
	■		③ Mounting debris	1					
Piers	■		① Cracking	1					
	■		② Detachment, exposure of steel	1					
	■		③ Free lime	1					
	■		④ Scouring and washing out	1					
Abutment, Wing Walls and Retaining Walls	■		① Cracking	1					
	■		② Detachment, exposure of steel	1					
	■		③ Free lime	1					
	■		④ Scouring and washing out	1					
Parapets on Bridge (Steel/Concrete/others)			① Progress of corrosion	1					
			② Deform, damage, move and settle	1					
			③ Cracking, other damages	1					
Guard Rails at Bridge Approach (Steel/Concrete/others)			① Progress of corrosion	-					
			② Deform, damage, move and settle	-					
			③ Cracking, other damages	-					
Bridge Surface and Footpaths (Asphalt/Concrete)			① Pothole	2					No.29-22
			② Cracking	2					
Expansion Joint (Steel/ Rubber)	■		① Differencial level	2					
	■		② Abnormal movement	1					
	■		③ Deform, damage, move and settle	2					No.29-07
Drainage			① Mounting debris	2					No.29-10
			② Progress of corrosion	-					
			③ Others	-					
Embankmens and fill in front of abutment			① Surrounding condition	2					No.29-32
River Bed			① Surrounding condition	1					
Bridge in general (The Bridge seen as a whole)			① Overview	1					

CR: Condition Rating

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2: Minor damage, repair when convenient
3: Damage, repair soon
4: Sever damage, repair immediately
5: Ultramate damage, element has failed
?: The condition could not be determined at the inspection

SI: Special Inspection required (✓)
MAC: Maintenance Activity Code
Repl.: Replacement element (✓)
If Repl. Is ticked (✓), No Mac should be applied

*1Note "■" is critial items for verifying the essential damages of major membre of bridge at the visual inspection

Photos at Visual Inspection Sheet(Particular points)

Photo No.	No.29-07	Span No.	2
Subject	Approach		
Memo	Damage		

Photo No.	No.29-10	Span No.	1
Subject	Drainage		
Memo	Need to be cleaned up		

Photo No.	No.29-09	Span No.	1
Subject	Parapets on Bridge		
Memo	Minor of Damage		

Photo No.	No.29-22	Span No.	1
Subject	Pothole		
Memo	Damage		

Photo No.	No.29-29	Span No.	-
Subject	Bearing		
Memo	Need to be cleaned and Minor Damage		

Photo No.	No.29-32	Span No.	2
Subject	Abutment		
Memo	Need to be cleaned up		

Visual Inspection Survey for Bridge

Inspection Date	31/5/2012		Inspector	Kongkeo PHAMAVANH	
Road No.	R13N		Bridge No.	30	
Bridge Name	Nam Mone		River Name	Nam Mone	
Location (KM) +	KM142+300		DPWT	Vientiane Province	
Superstructure	PC-T				
Substructure	Abutment	Wall	Pier	Wall	
Length@Span (m)	46.0	m	2	span	23 – 23
Width (Effective)	7.5	m	6.0	m	
Year Build	–				

Surrounding	Rural Area	Last Maintenace	-	Ref. No.	-

Check Items/Parts	Visual Inspection Items			Evaluation					No. of Photo
	*1 Essential	Applicable	Inspection Items	CR	SI	Repl.	MAC	Quantity	
Superstructure Steel Beam/Truss & Steel Slab Concrete Beam & Girder (RC/PC) Concrete Slab			① Progress of collision	-					
			② Crack condtions	-					
			③ Tightening of bolts	-					
			④ Occurrence of vibration and noise	-					
	■		⑤ Cracking	1					
	■		⑥ Detachment, exposure of steel	1					
	■		⑦ Free lime	1					
Bearing (Steel/ Rubber)	■		① Progress of corrosion	1					
	■		② Deform, damage, move and settle	2					
	■		③ Mounting debris	1					
Piers	■		① Cracking	1					
	■		② Detachment, exposure of steel	1					
	■		③ Free lime	1					
	■		④ Scouring and washing out	1					
Abutment, Wing Walls and Retaining Walls	■		① Cracking	1					
	■		② Detachment, exposure of steel	1					
	■		③ Free lime	1					
	■		④ Scouring and washing out	1					
Parapets on Bridge (Steel/Concrete/others)			① Progress of corrosion	1					
			② Deform, damage, move and settle	3					
			③ Cracking, other damages	3					No.30-14
Guard Rails at Bridge Approach (Steel/Concrete/others)			① Progress of corrosion	-					
			② Deform, damage, move and settle	-					
			③ Cracking, other damages	-					
Bridge Surface and Footpaths (Asphalt/Concrete)			① Pothole	2					No.30-03
			② Cracking	2					
Expansion Joint (Steel/ Rubber)	■		① Differencial level	2					
	■		② Abnormal movement	1					
	■		③ Deform, damage, move and settle	2					No.30-02
Drainage			① Mounting debris	3					No.30-17
			② Progress of corrosion	-					
			③ Others	-					
Embankmens and fill in front of abutment			① Surrounding condition	2					No.30-30
River Bed			① Surrounding condition	1					
Bridge in general (The Bridge seen as a whole)			① Overview	1					

CR: Condition Rating

0: No damage, element as new
1: Insignificant damage, no repair needed
2: Minor damage, repair when convenient
3: Damage, repair soon
4: Sever damage, repair immediately
5: Ultramate damage, element has failed
?: The condition could not be determined at the inspection

SI: Special Inspection required (✓)
MAC: Maintenance Activity Code
Repl.: Replacement element (✓)
If Repl. Is ticked (✓), No Mac should be applied

*1Note "■" is critial items for verifying the essential damages of major membre of bridge at the visual inspection

Photos at Visual Inspection Sheet (Particular points)

Photo No.	No.30-20	Span No.	2
Subject	Approach		
Memo	Damage		

Photo No.	No.30-17	Span No.	2
Subject	Drainage		
Memo	Need to be cleaned up		

Photo No.	No.30-14	Span No.	1
Subject	Parapets on Bridge		
Memo	Damage		

Photo No.	No.30-03	Span No.	1
Subject	Pothole		
Memo	Minor Damage		

Photo No.	No.30-31	Span No.	-
Subject	Bearing		
Memo	Need to be cleaned and Minor Damage		

Photo No.	No.30-30	Span No.	-
Subject	Abutment		
Memo	Minor Damage		

Visual Inspection Survey for Bridge

Inspection Date	30/5/2012		Inspector	Kongkeo PHAMAVANH	
Road No.	R13N		Bridge No.	33	
Bridge Name	Nam Mone		River Name	Nam Mone	
Location (KM) +	KM161+400		DPWT	Vientiane Province	
Superstructure	PC-T				
Substructure	Abutment	Wall	Pier	Wall	
Length@Span (m)	52.0	m	3	span	13 - 26 - 13
Width (Effective)	7.0	m	6.0	m	
Year Build	-				

Surrounding	Rural Area	Last Maintenace	-	Ref. No.	-

Check Items/Parts	Visual Inspection Items			Evaluation					No. of Photo
	*1 Essential	Applicable	Inspection Items	CR	SI	Repl.	MAC	Quantity	
Superstructure Steel Beam/Truss & Steel Slab Concrete Beam & Girder (RC/PC) Concrete Slab			① Progress of collision	-					
			② Crack condtions	-					
			③ Tightening of bolts	-					
			④ Occurrence of vibration and noise	-					
	■		⑤ Cracking	1					
	■		⑥ Detachment, exposure of steel	1					
	■		⑦ Free lime	1					
Bearing (Steel/ Rubber)	■		① Progress of corrosion	1					
	■		② Deform, damage, move and settle	2					No.33-27
	■		③ Mounting debris	1					
Piers	■		① Cracking	1					
	■		② Detachment, exposure of steel	1					
	■		③ Free lime	1					
	■		④ Scouring and washing out	1					
Abutment, Wing Walls and Retaining Walls	■		① Cracking	1					
	■		② Detachment, exposure of steel	1					
	■		③ Free lime	1					
	■		④ Scouring and washing out	1					
Parapets on Bridge (Steel/Concrete/others)			① Progress of corrosion	1					
			② Deform, damage, move and settle	3					No.33-19
			③ Cracking, other damages	3					
Guard Rails at Bridge Approach (Steel/Concrete/others)			① Progress of corrosion	1					
			② Deform, damage, move and settle	1					
			③ Cracking, other damages	1					
Bridge Surface and Footpaths (Asphalt/Concrete)			① Pothole	2					No.33-12
			② Cracking	2					
Expansion Joint (Steel/ Rubber)	■		① Differencial level	2					
	■		② Abnormal movement	1					
	■		③ Deform, damage, move and settle	2					No.33-10
Drainage			① Mounting debris	2					No.33-20
			② Progress of corrosion	-					
			③ Others	-					
Embankmens and fill in front of abutment			① Surrounding condition	3					No.33-14
River Bed			① Surrounding condition	1					
Bridge in general (The Bridge seen as a whole)			① Overview	2					

CR: Condition Rating

0: No damage, element as new
1: Insignificant damage, no repair needed
2: Minor damage, repair when convenient
3: Damage, repair soon
4: Sever damage, repair immediately
5: Ultramate damage, element has failed
?: The condition could not be determined at the inspection

SI: Special Inspection required (✓)
MAC: Maintenance Activity Code
Repl.: Replacement element (✓)
If Repl. Is ticked (✓), No Mac should be applied

*1Note "■" is critial items for verifying the essential damages of major membre of bridge at the visual inspection

Photos at Visual Inspection Sheet (Particular points)

Photo No.	No.33-20	Span No.	1
Subject	Approach		
Memo	Minor Damage		

Photo No.	No.33-06	Span No.	1
Subject	Drainage		
Memo	Need to be cleaned up		

Photo No.	No.33-19	Span No.	1
Subject	Parapets on Bridge		
Memo	Damage		

Photo No.	No.33-13	Span No.	1
Subject	Pothole		
Memo	Damage		

Photo No.	No.33-14	Span No.	-
Subject	Embankmens and fill in front of Abutment		
Memo	Damage		

Photo No.	No.33-32	Span No.	-
Subject	Abutment		
Memo	Minor Damage		

Visual Inspection Survey for Bridge

Inspection Date	30/5/2012		Inspector	Kongkeo PHAMAVANH	
Road No.	R13N		Bridge No.	37	
Bridge Name	Pa Tang		River Name	Nam Song	
Location (KM) +	KM173+000		DPWT	Vientiane Province	
Superstructure	PC-T				
Substructure	Abutment	Wall	Pier	Double Cylinder	
Length@Span (m)	79.5	m	3	span	26.5 – 26.5 – 26.5
Width (Effective)	7.0	m	6.0	m	
Year Build	–				

Surrounding	Rural Area	Last Maintenace	-	Ref. No.	-

Check Items/Parts	Visual Inspection Items			Evaluation					No. of Photo
	*1 Essential	Applicable	Inspection Items	CR	SI	Repl.	MAC	Quantity	
Superstructure Steel Beam/Truss & Steel Slab Concrete Beam & Girder (RC/PC) Concrete Slab			① Progress of collision	-					
			② Crack condtions	-					
			③ Tightening of bolts	-					
			④ Occurrence of vibration and noise	-					
	■		⑤ Cracking	1					
	■		⑥ Detachment, exposure of steel	1					
	■		⑦ Free lime	1					
Bearing (Steel/ Rubber)	■		① Progress of corrosion	1					
	■		② Deform, damage, move and settle	1					
	■		③ Mounting debris	1					
Piers	■		① Cracking	1					
	■		② Detachment, exposure of steel	1					
	■		③ Free lime	1					
	■		④ Scouring and washing out	1					
Abutment, Wing Walls and Retaining Walls	■		① Cracking	1					
	■		② Detachment, exposure of steel	1					
	■		③ Free lime	1					
	■		④ Scouring and washing out	1					
Parapets on Bridge (Steel/Concrete/others)			① Progress of corrosion	1					
			② Deform, damage, move and settle	2					No.37-39
			③ Cracking, other damages	2					
Guard Rails at Bridge Approach (Steel/Concrete/others)			① Progress of corrosion	1					
			② Deform, damage, move and settle	1					
			③ Cracking, other damages	1					
Bridge Surface and Footpaths (Asphalt/Concrete)			① Pothole	2					No.37-08
			② Cracking	2					
Expansion Joint (Steel/ Rubber)	■		① Differencial level	2					
	■		② Abnormal movement	1					
	■		③ Deform, damage, move and settle	2					No.37-05
Drainage			① Mounting debris	2					No.37-06
			② Progress of corrosion	-					
			③ Others	-					
Embankmens and fill in front of abutment			① Surrounding condition	1					
River Bed			① Surrounding condition	1					
Bridge in general (The Bridge seen as a whole)			① Overview	1					

CR: Condition Rating

0: No damage, element as new
1: Insignificant damage, no repair needed
2: Minor damage, repair when convenient
3: Damage, repair soon
4: Sever damage, repair immediately
5: Ultramate damage, element has failed
?: The condition could not be determined at the inspection

SI: Special Inspection required (✓)
MAC: Maintenance Activity Code
Repl.: Replacement element (✓)
If Repl. Is ticked (✓), No Mac should be applied

*1Note "■" is critial items for verifying the essential damages of major membre of bridge at the visual inspection

Photos at Visual Inspection Sheet(Particular points)

Photo No.	No.37-02	Span No.	2
Subject	Approach		
Memo	Damage		

Photo No.	No.37-06	Span No.	1
Subject	Drainage		
Memo	Need to be cleaned up		

Photo No.	No.37-08	Span No.	1
Subject	Parapets on Bridge		
Memo	Minor of Damage		

Photo No.	No.37-11	Span No.	1
Subject	Pothole		
Memo	Minor of Damage		

Photo No.	No.37-32	Span No.	-
Subject	Main Girder		
Memo	No Insignificant Damage		

Photo No.	No.37-29	Span No.	-
Subject	Bearing		
Memo	Minor Damage		

Visual Inspection Survey for Bridge

Inspection Date	30/5/2012		Inspector	Kongkeo PHAMAVANH	
Road No.	R13N		Bridge No.	45	
Bridge Name	Nam Sa Nha		River Name	Nam Sa Nha	
Location (KM) +	KM208+600		DPWT	Vientiane Province	
Superstructure	PC-T				
Substructure	Abutment	Wall	Pier	Double Cylinder	
Length@Span (m)	79.5	m	3	span	26.5 – 26.5 – 26.5
Width (Effective)	7.0	m	6.0	m	
Year Build	–				

Photo for Sideview of Bridge

Surrounding	Rural Area	Last Maintenace	-	Ref. No.	-

Check Items/Parts	Visual Inspection Items			Evaluation					No. of Photo
	*1 Essential	Applicable	Inspection Items	CR	SI	Repl.	MAC	Quantity	
Superstructure Steel Beam/Truss & Steel Slab Concrete Beam & Girder (RC/PC) Concrete Slab			① Progress of collision	-					
			② Crack condtions	-					
			③ Tightening of bolts	-					
			④ Occurrence of vibration and noise	-					
	■		⑤ Cracking	1					
	■		⑥ Detachment, exposure of steel	1					
	■		⑦ Free lime	1					
Bearing (Steel/ Rubber)	■		① Progress of corrosion	1					
	■		② Deform, damage, move and settle	1					
	■		③ Mounting debris	1					
Piers	■		① Cracking	1					
	■		② Detachment, exposure of steel	1					
	■		③ Free lime	1					
	■		④ Scouring and washing out	1					
Abutment, Wing Walls and Retaining Walls	■		① Cracking	1					
	■		② Detachment, exposure of steel	1					
	■		③ Free lime	1					
	■		④ Scouring and washing out	1					
Parapets on Bridge (Steel/Concrete/others)			① Progress of corrosion	1					
			② Deform, damage, move and settle	2					No.37-39
			③ Cracking, other damages	2					
Guard Rails at Bridge Approach (Steel/Concrete/others)			① Progress of corrosion	1					
			② Deform, damage, move and settle	1					
			③ Cracking, other damages	1					
Bridge Surface and Footpaths (Asphalt/Concrete)			① Pothole	2					No.37-08
			② Cracking	2					
Expansion Joint (Steel/ Rubber)	■		① Differencial level	2					
	■		② Abnormal movement	1					
	■		③ Deform, damage, move and settle	2					No.37-05
Drainage			① Mounting debris	2					No.37-06
			② Progress of corrosion	-					
			③ Others	-					
Embankmens and fill in front of abutment			① Surrounding condition	1					
River Bed			① Surrounding condition	1					
Bridge in general (The Bridge seen as a whole)			① Overview	1					

CR: Condition Rating

0: No damage, element as new
1: Insignificant damage, no repair needed
2: Minor damage, repair when convenient
3: Damage, repair soon
4: Sever damage, repair immediately
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?: The condition could not be determined at the inspection

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Repl.: Replacement element (✓)
If Repl. Is ticked (✓), No Mac should be applied

*1Note "■" is critial items for verifying the essential damages of major membre of bridge at the visual inspection

Photos at Visual Inspection Sheet(Particular points)

Photo No.	No.37-02	Span No.	2
Subject	Approach		
Memo	Damage		

Photo No.	No.37-06	Span No.	1
Subject	Drainage		
Memo	Need to be cleaned up		

Photo No.	No.37-08	Span No.	1
Subject	Parapets on Bridge		
Memo	Minor of Damage		

Photo No.	No.37-11	Span No.	1
Subject	Pothole		
Memo	Minor of Damage		

Photo No.	No.37-32	Span No.	-
Subject	Main Girder		
Memo	No Insignificant Damage		

Photo No.	No.37-29	Span No.	-
Subject	Bearing		
Memo	Minor Damage		

Site Visit for Road Disaster on National Road No. 13 North

Preliminary Report

05 May 2012

1. Duration

Wed, April 25 – Wed, May 02 (8 days)

2. Purpose

- To understand current condition of National Road No.13 North (NR13N) from Vang Vieng to Luang Prabang
- To identify areas which have risk of slope disaster on NR13N
- To categorize types of disaster prone area

3. Member

Mr. Phitsaphonh PHILAVONG	Department of Roads, MPWT
Mr. Somsanouk	DPWT Vientiane
Mr. Iwao YOKOKAWA	JICA Expert: Road Disaster Prevention
Mr. Kazuo HIRAYAMA	JICA Expert: Geological Condition
Mr. Hiroyuki MORIMOTO	JICA Expert: Road Planning

4. Overview of Survey (Numerical numbers in this report are provisional value)

(1) Slope Failure

- The survey team observed 347 locations of slope failure. It consists of 38 in Vientiane Province and 309 in Luang Prabang Province.

(2) Findings

Road Transport

- The surveyed road is a part of NR13N, which connects Vientiane Capital and Luang Prabang through Vang Vieng. About 90 km length of the road from Vang Vieng is under jurisdiction of Vientiane Province and remaining 142 km length of the road is under Luang Prabang Province.
- Heavy vehicles such as tourist bases and freight trucks were observed as major through traffic on the road, so it is obvious that NR13N contributes as an important route for tourism and logistics within this area.
- However, the geometric condition of the road (e.g.: road width, horizontal and vertical alignment) does not meet the required design standard because about 80 % of the section between Vang Vieng and Luang Prabang (the road length is 230 km) is located in mountainous terrain. For example, the 6 m-width of road is too narrow for heavy vehicles especially passing in the curve sections and stopping sight distances are not secured on consecutive sharp curves.
- The surveyed road was paved with Double Bituminous Surface Treatment (DBST). Although about

20 km-length of the road in rolling terrain of Vientiane Province is under rehabilitation work, the pavement on NR13N was generally in good condition. However, some of the sections in mountainous terrain were rehabilitated in bad quality without spreading gravel or sand. The rehabilitation work in Vientiane Province was expected to complete by the end of May 2012.

- On the other hand, two new roads are under construction in the area. The one is National Road No. 4 (NR4) from Xiang Nguen, which is located at about 25 km south from Luang Prabang and is funded by Korean loan. Another is Army Road from Kasi to NR4.
- The route through above two roads from Kasi to Xiang Nguen has better road alignment, wider roadway width and shorter road length than NR13N. Thus, the route would be a bypass road of NR13N from Kasi to Xiang Nguen after completion of the construction. The reduction of travel time is expected about 2 hours (from 5 hours to 3 hours).

Slope Stability

- The majority of the slope failures in the observed 347 locations were categorized in "shallow failure".
- The rehabilitation works taken by local government of Lao PDR were (i) removal of slid soil from cut slope, (ii) dispose the soil to vale side (foreslope) without enough surface compaction and (iii) cut backslope in gradient 1 (vertical) : 0.5 (horizontal). Due to lack of slope protection (e.g.; vegetation) or slope drainage, the rehabilitated slopes are still prone to slide again after heavy rain.
- The method of above removal work has other two problems. One is that upper end of the cut slopes were not rounded. And another is that all of the slid soil was not removed from the backslopes, which cause 2nd slide.
- Disposal of soil to vale side without enough surface compaction would cause mudslide at downstream. The Slope Maintenance Manual, which was prepared by SEACAP 21 project funded by DFID (UK), also noted same problem.
- Geological condition of the survey area is dominant with soft/weathered rock and soil are on the soft rock. Based on the construction experience in Japan, cut slope gradient for such geological condition should be 1 (vertical) : 0.8-1.0 (horizontal).
- In order to protect cut slope, slope drainage and protection work (e.g.: cover with vegetation, concrete or mortal) should be installed.
- JICA experts will transfer their technical experience and knowledge on the designing of cut slope and slope protection method for staff of DOR and DPWT.

5. Way Forward

(1) Preparation of Slope Maintenance Manual

- Based on the slope failure database collected from this site survey, draft table of contents for maintenance manual and technical transfer program will be prepared.
- Totally 7 locations, which are shown in the location map in page 4, were selected for borehole/topographic survey. The locations consist of 2 circular failures, 4 shallow slides and 1

swelling of backslope.

- After reviewing of the Slope Maintenance Manual, which was prepared by SEACAP 21 project, the manual will be revised if necessary.
- It is necessary to build a mechanism to fully utilize the Slope Maintenance Manual by local government staff and contractors.

(2) On the Job Training

- STEP 1: Taking place of seminar on slope maintenance for staff of DOR and DPWT
- STEP 2: Study tour to NR13N to understand geological condition and mechanisms of slope failures with explanation of technical knowledge on site. On the way back to Vientiane, the approach road of Hin Hoeup Bridge would be a candidate for a good example of slope protection.

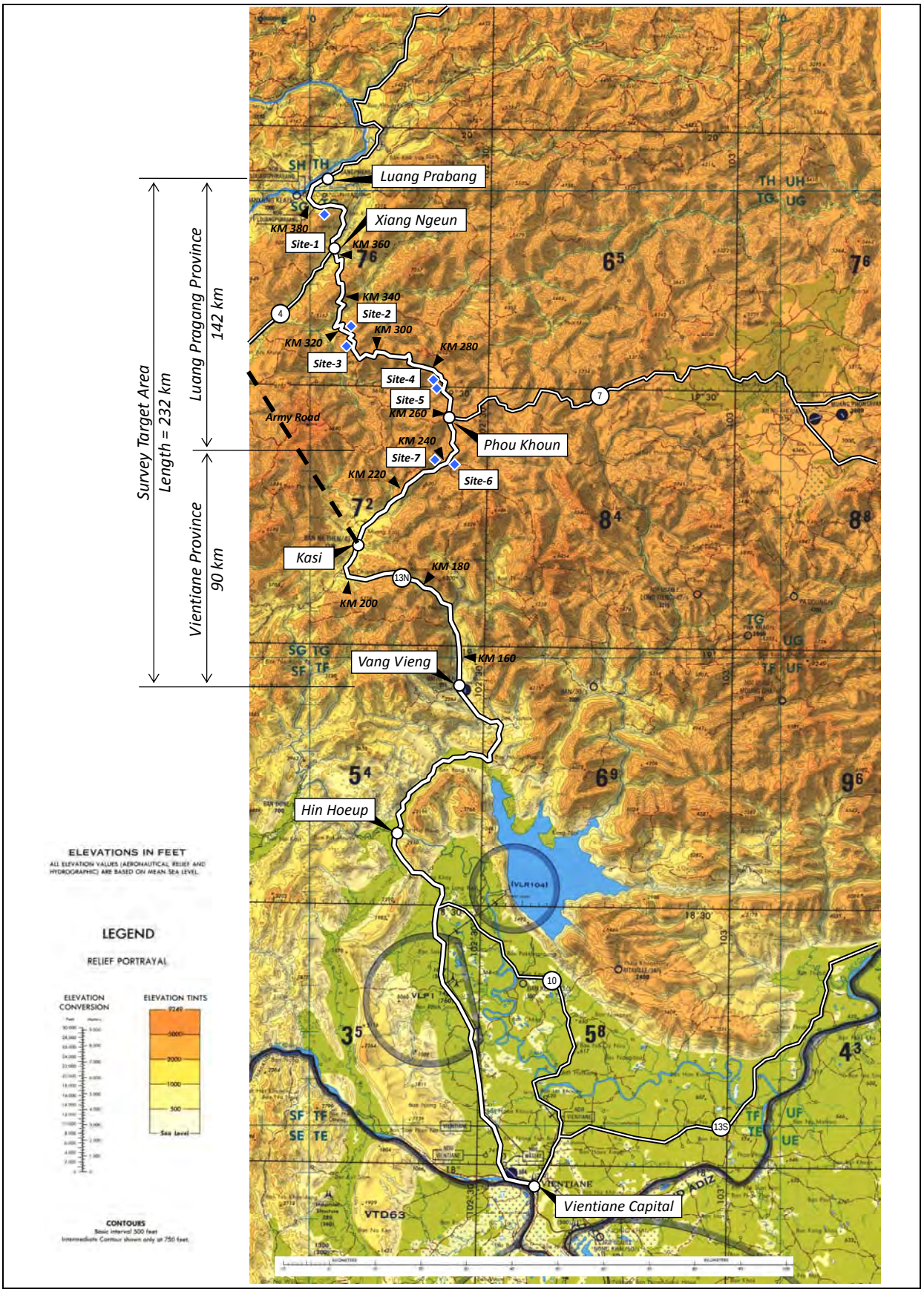
(3) Pilot Project

- JICA expert will propose JICA or other donors for implementation of pilot project on slope protection in Vientiane Province as much as possible. However, slopes in Luang Prabang Province would also be a candidate for the pilot project site, if possible.

6. Collected Information

- SEACAP 21/002: Feasibility Study for a National Programme to Manage Slope Stability, Final Report (Main Report, Slope Maintenance Manual, Slope Maintenance Site Handbook), September 2008

- Feasibility Study and Preliminary Design for Upgrading of the National Road 13 N (Section: Muang Kasi – Luang Prabang), Final Report, March 2010



Survey Location Map

Shallow failure

Gabions have been installed after fill slope failure.

Cut slope was under excavating after disaster.

The slope gradient (1:0.5) would be too steep for such large cut slope.

Crack was occurred on fill slope. This area would be collapsed after heavy rain.

There were many slope failures on NR13N.

One of the pilot project site of SEACAP 21 project seemed stable with vegetation (completion year is 2008).

One of the pilot project site of IDI project (Japan) seemed also stable (completion year is 2005).

All of the debris of shallow failure was not removed so that secondary failure would be caused after heavy rain.

Gabion boxes were often used for protection of fill slope on NR13N. The basements of the gabions were not properly supported by rock or compacted soil so that many erosions under gabion were observed.

JICA experts explain the stability of cut slope to staffs from DOR and DPWT Vientiane.

JICA experts explain a mechanism of slope failure to staffs from DOR and DPWT Vientiane.

Location of Borehole/Topographic Survey

	Backslope (Cut)		Foreslope (Fill)	
	Failure Type	Countermeasures	Failure Type	Countermeasures
Site-1	Circular failure (stable)	Monitoring	Erosion around crossing culvert	Gabion
Site-2	Shallow failure (no rock on the slope)	Re-cutting and rounding, vegetation, slope drainage	Failure of fill material	Retaining wall, vegetation
Site-3	N/A	N/A	Slope erosion due to luck of roadside drainage	Retaining wall, vegetation, roadside/slope drainage
Site-4	Shallow failure (with gullies)	Rounding, vegetation and check dam	N/A	N/A
Site-5	Shallow failure (with cracks)	Removal or cracked soil, rounding and vegetation	N/A	N/A
Site-6	Swelling of backslope	Dewatering with horizontal drains	N/A	N/A
Site-7	Circular failure (unstable)	Removal of debris, vegetation	N/A	N/A

SITE-1: KM375-376 (WP-156)

Slope failure type: (Backslope) Circular failure (stable), (Foreslope) Erosion around crossing culvert

Possible countermeasures: (Backslope) Monitoring of slope stability, (Foreslope) Installation of gabion

SITE-2: KM327

Slope failure type: (Backslope) Shallow failure and no rocks on the slope, (Foreslope) Fill slope failure due to not enough fill compaction

Possible countermeasures: (Backslope) Re-cutting of the slope and rounding, installation of slope drainage, slope protection with vegetation, (Foreslope) Retaining wall, vegetation

SITE-3: KM311-312 (WP-376)

Slope failure type: (Foreslope) Fill slope failure due to luck of roadside drainage

Possible countermeasures: (Foreslope) Retaining wall, roadside/slope drainage

SITE-4: KM278-279 (WP-587)

Slope failure type: (Backslope) Shallow failure (Volcanic Rock, some gullies)

Possible countermeasures: (Backslope) Mitigate erosion with rounding, vegetation and check dam

SITE-5: KM275-276 (WP-598)

Slope failure type: (Backslope) Shallow failure (Volcanic Rock, some cracks)

Possible countermeasures: (Backslope) Removal of cracked surface soil

SITE-6: KM240 (WP-696)

Slope failure type: (Foreslope) Swelling of backslope

Possible countermeasures: (Foreslope) Dewatering with installation of horizontal drain

SITE-7: KM235 (WP-801)

Slope failure type: (Backslope) Circular failure (unstable)

Possible countermeasures: (Backslope) Removal of debris, vegetation, monitoring of deformation

Appendix 2-17
Concept Design Report for Rehabilitation Project of National Road No. 9

CONCEPT DESIGN REPORT
FOR
REHABILITAION PROJECT OF NATIONAL ROAD NO. 9
IN
LAO PEOPLE'S DEMOCRATIC REPUBLIC

October, 2013

DEPARTMENT OF ROAD, **THE MINISTRY OF PUBLIC WORKS AND TRANSPORT,** **LAO PEOPLE'S DEMOCRATIC REPUBLIC**	**JICA EXPERT TEAM FOR** **THE PROJECT FOR IMPROVEMENT OF ROAD MANAGEMENT CAPABILITY IN LAO PEOPLE'S DEMOCRATIC REPUBLIC (CaRoL)**

Concept Design Report for
Rehabilitation Project of National Road No.9

TABLE OF CONTENTS

Appendix

Concept Design Report for Rehabilitation Project of National Road No.9

1. Introduction

National Road No.9 (NR9) is a principal trunk road traversing through Savannakhet Province. Furthermore, NR9 also has highly important function in the international road network because this road consists of East-West Economic Corridor (Vietnam to Myanmar) in Indochina peninsula.

However, currently serviceability of NR9 has been significantly degraded due to severely damaged asphalt concrete pavement.

Considering the above situation, Ministry of Public Works and Transport (MPWT) decided for implementation of the large scaled rehabilitation project of NR9 from site survey work to construction work by applying the own financial resources. JICA Expert Team (CaRoL) provided technical assistance called as "concept design work" to MPWT. The design work is composed of the following components.

- Design of pavement structure
- Design of drainage facility
- Preliminarily cost estimate of the project.

Detail discussion is described in the following clauses.

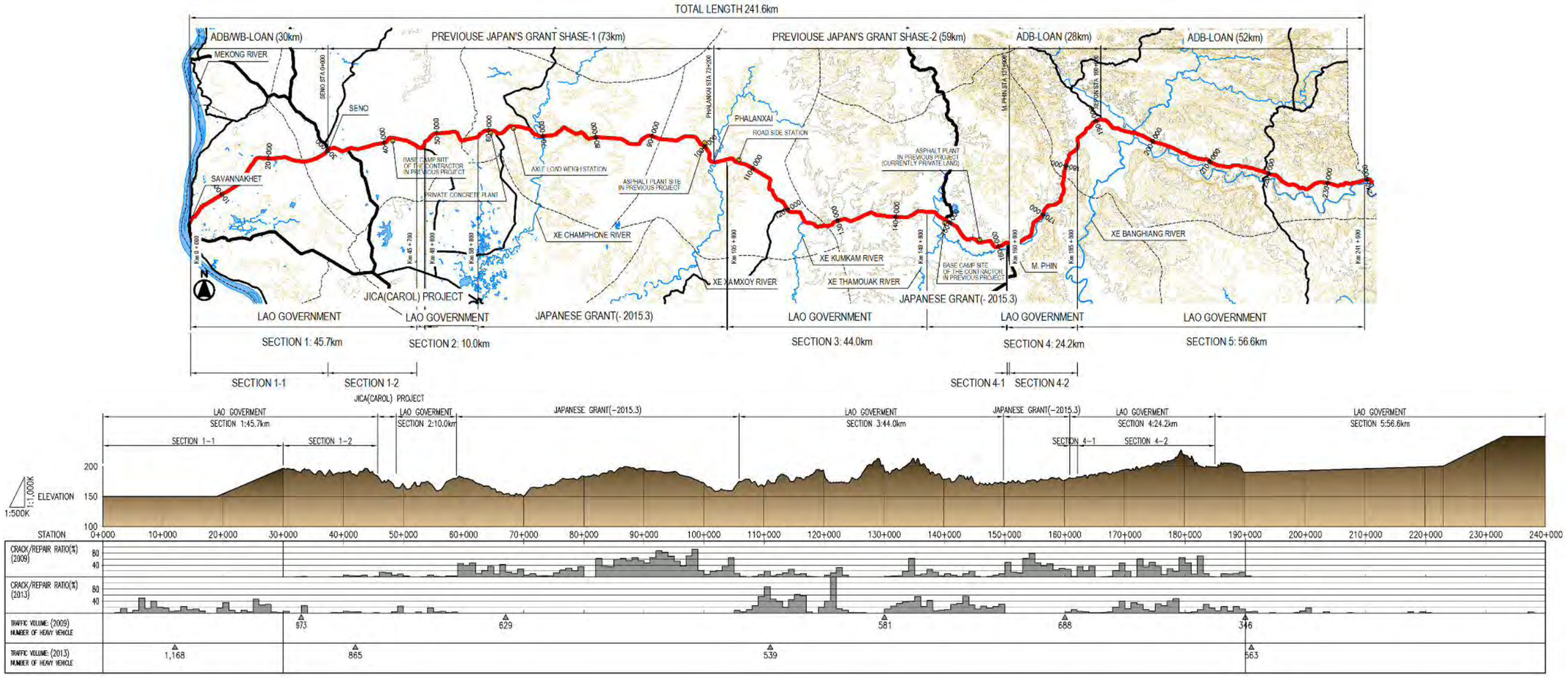
2. Project Outline

NR9 is divided into 7 sections as shown in Table 2.1.1. Furthermore, the project location map is as shown in Figure 2.1.1.

Table 2.1.1 Project Sections in NR9

Section		BP (km)	EP (km)	L (km)
1	1-1	0.0	30.0	30.0
	1-2	30.0	45.7	15.7
2		48.8	58.8	10.0
3		105.8	149.8	44.0
4	4-1	160.8	162.1	1.3
	4-2	162.1	185.0	22.9
5		185.0	241.6	56.6
			Total	**180.5**

Concept Design Report for
Rehabilitation Project of National Road No.9



Design Period	Cost	Section 1-1 Km0.0 – 30.0 30.0km	Section 1-2 Km30.0 – 45.7 15.7km	CaRoL PP1 Section	Section 2 Km48.8 – 58.8 10.0km	Grant Section-1	Section 3 Km105.8 – 149.8 44.0km	Grant Section-2	Section 4-1 Km160.8 – 162.1 1.3km	Section 4-2 Km162.1 – 185.0 22.9km	Section 5 Km185.0 – 241.6 56.6km	**Total 180.5km**
5 years	Overlay thickness	t=8.0cm	t=9.5cm		t=8.0cm		t=7.5cm		t=5.0cm	t=5.0cm	t=5.0cm	
	Pavement	$ 9.3 million	$ 4.9 million		$ 3.0 million		$ 12.5 million		$ 0.27 million	$ 5.3 million	$ 9.6 million	$ 44.9 million
	Drainage	$ 1.6 million	$ 0.8 million		$ 0.5 million		$ 2.4 million		$ 0.07 million	$ 1.2 million	$ 3.0 million	$ 9.6 million
	Total	**$ 11.0 million**	**$ 5.8 million**		**$ 3.5 million**		**$ 14.9 million**		**$ 0.34 million**	**$ 6.5 million**	**$ 12.6 million**	**$ 54.5 million**
8 years	Overlay thickness	t=9.0cm	t=11.5cm		t=9.5cm		t=9.0cm		t=6.5cm	t=5.0cm	t=5.0cm	
	Total amount	$ 10.2 million	$ 5.9 million		$ 3.5 million		$ 14.5 million		$ 0.3 million	$ 5.3 million	$ 9.6 million	$ 49.3 million
	Drainage	$ 1.6 million	$ 0.8 million		$ 0.5 million		$ 2.4 million		$ 0.1 million	$ 1.2 million	$ 3.0 million	$ 9.6 million
	Total	**$ 11.9 million**	**$ 6.7 million**		**$ 4.0 million**		**$ 16.8 million**		**$ 0.4 million**	**$ 6.5 million**	**$ 12.6 million**	**$ 58.9 million**
Cost per km	5 years	$ 0.37 million/km	$ 0.37 million/km		$ 0.35 million/km		$ 0.34 million/km		$ 0.26 million/km	$ 0.28 million/km	$ 0.22 million/km	$ 0.30 million/km
	8 years	$ 0.40 million/km	$ 0.43 million/km		$ 0.40 million/km		$ 0.38 million/km		$ 0.31 million/km	$ 0.28 million/km	$ 0.22 million/km	$ 0.33 million/km

Figure 2.1.1 Project Location Map on NR9

3. Design Work

3.1 Pavement Design

3.1.1 Design Conditions

Applied design conditions are listed in Table 3.1.1. Furthermore, the details are described in the following sub-clauses.

Table 3.1.1 Design Conditions

Item		Applied Figure	Remarks
1. Design variable	Design period	8 years (2017 – 2024) & 5 years (2017 – 2021)	
	Reliability (R)	85%	Described in (1)
	Reliability coefficient (Z_R)	-1.037	
	Standard deviation (Z_0)	0.45	
2. Serviceability	Initial serviceability (P_0)	4.2	
	Terminal serviceability (P_t)	2.5	
3. Damage factor of design vehicle (DF)	Large bus (2-axles)	1.005	Described in (2)
	Truck	0.113	
	Large truck (2-axles)	0.899	
	Large truck (3-axles or more)	2.225	
	Trailer	3.887	
	Double trailer	5.959	
4. Accumulative numbers of single axle weight (8.16t) in design period (W18)		Described in (3)	
5. Characteristics of material	Design CBR of subgrade	Described in (4)	
	Layer coefficient of asphalt concrete (a)	0.42	
6. Drainage coefficient	Base course (m_2)	1.00	
	Sub base course (m_3)	0.95	

(1) Determination of Reliability (R)

Reliability (R) is the probability that the pavement structure will fulfill the desired performance under the estimated traffic volume and environment in the design period. R is classified according to required function (i.e. importance) of the road in the AASHTO method. Table 3.1.2 shows recommended values of R. R=85% (i.e. middle value of principal arterial road in rural area) is applied for the design work. Furthermore, Reliability coefficient (Z_R) is automatically determined according to applied R as shown

in Table 3.1.3.

Table 3.1.2 Recommended R by Road Function

Functional Classification	Recommended Level of Reliability	
	Urban	Rural
Interstate and Other Freeways	85–99.9	80–99.9
Principal Arterials	80–99	75–95
Collectors	80–95	75–95
Local	50–80	50–80

Source：AASHTO pavement design manual

Table 3.1.3 Reliability Coefficient (Z_R) by Determined R

R (%)	Z_R
50	0.000
60	-0.253
70	-0.524
75	-0.674
80	-0.841
85	**-1.037**
90	-1.282
95	-1.645
99.9	-3.090

Source：AASHTO pavement design manual

(2) Determination of Damage Factor (DF) of Design Vehicle

1) Determination Method

Damage factor (DF) for each design vehicle is determined to estimate accumulative numbers of single axle weight (=8.16t) in the design period (W18). DF is computed by the following method as shown in Figure 3.1.1 on the basis of the axle weight survey result at the weigh station along National Road No. 9 (NR9).

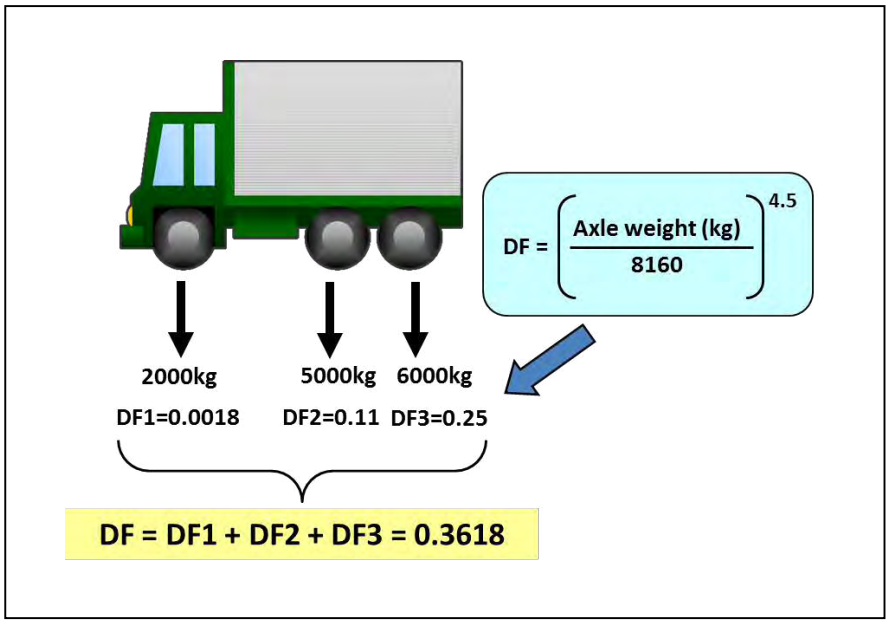


Figure 3.1.1 Determination Method of Damage Factor (Sample)

2) Consideration of Regulation Change of Limitation of Axle Weight

The Government of Lao (GOL) changed the limitation of axle weight in 2009. Since then, cargo of track was supposed be larger and heavier than the former regulation. MPWT/DPWT conducted measuring work of axle weight of the heavy vehicle actually passing through NR9 in this year (2013). Therefore, it can be said that the design work considers the regulation change. Image of the consideration is illustrated in Figure 3.1.2.

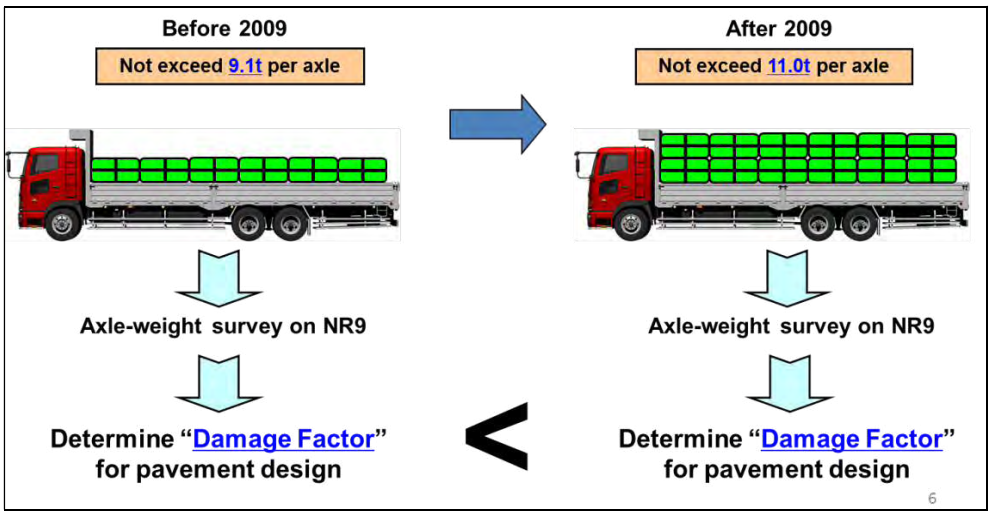


Figure 3.1.2 Image of Consideration of Regulation Change

(3) Estimate of Accumulative Numbers of Single Axle Weight (8.16t) in Design Period (W18)

MPWT/DPWT conducted the traffic count survey to confirm current traffic volume for the design work at 4 locations namely Km12, Km42, Km111 and Km191 on NR9. Annual W18 of each vehicle is estimated by following equation.

$$\text{Annual W18} = \text{Daily traffic volume} \times \text{DF} \times 365 \text{ (days)}$$

Furthermore, traffic growth rate should be included for the estimate of W18 in the design period. The rates of the Japan's grant project as shown in Table 3.1.3 are applied for the design work.

Table 3.1.3 Estimated Annual Traffic Growth Rate

Period	Large Bus	Truck	Large truck (2-axles)	Large truck (3 or more axles)	Trailer	Double trailer
2010-2015	5.00%	11.40%	11.40%	6.40%	9.80%	9.80%
2015-2025	6.31%	5.53%	5.53%	5.72%	5.71%	5.71%

Considering above, W18 in the design period for each section is summarized in Table 3.1.4.

Table 3.1.4 W18 in Design Period by Section (2-directions)

Section 1-1

Year	Daily Traffic Volume						Total W18 (Annual)	Total W18 (5 years)	Total W18 (8 years)
	Large Bus	Truck	Large Truck (2-axle)	Large Truck (3 of more-axle)	Trailer	Double Trailer			
DF	1.005	0.113	0.899	2.225	3.887	5.959			
2013	63	760	86	52	113	94	489,107		
2014	66	847	95	55	124	102	532,764		
2015	69	943	106	58	136	112	582,645		
2016	73	995	112	61	144	118	615,940		
2017	78	1050	118	65	152	125	651,138		
2018	83	1108	125	69	161	132	688,348		
2019	88	1170	131	72	170	140	727,687	**3,649,689**	
2020	94	1234	139	77	180	148	769,275		**6,379,081**
2021	100	1303	146	81	190	156	813,241		
2022	106	1375	155	86	201	165	859,722		
2023	113	1451	163	91	212	175	908,861		
2024	120	1531	172	96	224	185	960,810		

Table 3.1.4 W18 in Design Period by Section (continued)

Section 1-2 & 2

Year	Daily Traffic Volume						Total W18 (Annual)	Total W18 (5 years)	Total W18 (8 years)
	Large Bus	Truck	Large Truck (2-axle)	Large Truck (3 of more-axle)	Trailer	Double Trailer			
DF	1.005	0.113	0.899	2.225	3.887	5.959			
2013	104	245	156	116	133	110	622,687		
2014	109	272	174	123	146	121	678,507		
2015	114	304	194	131	160	133	740,684		
2016	121	321	205	138	169	141	783,103		
2017	129	339	216	146	179	149	827,954		
2018	137	357	228	155	189	157	875,375		
2019	146	377	241	164	200	166	925,514	**4,641,951**	
2020	155	398	254	173	211	176	978,528		**8,115,064**
2021	165	420	268	183	223	186	1,034,580		
2022	175	443	283	193	236	196	1,093,845		
2023	186	468	298	204	249	207	1,156,507		
2024	198	494	315	216	264	219	1,222,762		

Section 3

Year	Daily Traffic Volume						Total W18 (Annual)	Total W18 (5 years)	Total W18 (8 years)
	Large Bus	Truck	Large Truck (2-axle)	Large Truck (3 of more-axle)	Trailer	Double Trailer			
DF	1.005	0.113	0.899	2.225	3.887	5.959			
2013	42	338	27	16	65	52	256,965		
2014	43	376	29	17	71	57	279,312		
2015	45	419	33	18	78	63	306,926		
2016	48	442	35	19	82	67	324,501		
2017	51	467	37	20	87	70	343,083		
2018	54	492	39	21	92	74	362,731		
2019	57	520	41	22	97	79	383,504	**1,923,476**	
2020	61	548	43	24	103	83	405,468		**3,362,576**
2021	65	579	46	25	109	88	428,690		
2022	69	611	48	27	115	93	453,243		
2023	73	645	51	28	122	98	479,204		
2024	78	680	54	30	129	104	506,653		

Section 4 & 5

Year	Daily Traffic Volume						Total W18 (Annual)	Total W18 (5 years)	Total W18 (8 years)
	Large Bus	Truck	Large Truck (2-axle)	Large Truck (3 of more-axle)	Trailer	Double Trailer			
DF	1.005	0.113	0.899	2.225	3.887	5.959			
2013	53	356	36	35	45	37	220,041		
2014	55	397	39	37	49	41	238,091		
2015	58	442	44	40	54	45	260,918		
2016	62	466	46	42	57	48	275,890		
2017	66	492	49	45	60	50	291,721		
2018	70	520	52	47	64	53	308,462		
2019	74	548	55	50	67	56	326,164	**1,635,907**	
2020	79	579	58	53	71	59	344,883		**2,860,409**
2021	84	611	61	56	75	63	364,677		
2022	89	644	64	59	80	66	385,609		
2023	95	680	68	62	84	70	407,744		
2024	101	718	71	66	89	74	431,150		

W18 of 1 direction is applied for pavement design. Therefore, W18s in Table 3.1.4 will be divided by 2. Finally W18 for the design work are indicated in Table 3.1.5.

Table 3.1.5 W18 for the Pavement Design Work

Section		BP (km)	EP (km)	L (km)	W18	
					8 yrs	5 yrs
1	1-1	0.0	30.0	30.0	3,189,541	1,824,845
	1-2	30.0	45.7	15.7	4,057,532	2,320,975
2		48.8	58.8	10.0	4,057,532	2,320,975
3		105.8	149.8	44.0	1,681,288	961,738
4	4-1	160.8	162.1	1.3	1,430,205	817,953
	4-2	162.1	185.0	22.9	1,430,205	817,953
5		185.0	241.6	56.6	1,430,205	817,953

(4) Determination of Design CBR of Sub-grade

MPWT/DPWT conducted subsurface investigation work of soil material to determine bearing strength of sub-grade indicated by CBR value at intervals of 500 – 3000 meter. Determined CBR for each section is indicated in Table 3.1.6.

Table 3.1.6 Design CBR by Section

Section		CBR
1	1-1	8
	1-2	6
2		8
3		6
4	4-1	8
	4-2	12
5		14

3.1.2 Calculation of Overlay Thickness

Overlay thickness is calculated by following formulas.

$$D_{OL} = SN_{OL} \div a \times 2.54$$
$$SN_{OL} = SN_y - F_{RL} \times C_x \times SN_i$$

Where D_{OL} : Thickness of overlay layer (cm)
SN_{OL} : Required structure number for overlay

a : Layer coefficient (asphalt: 0.42)
SN_y : Required structure number in design life
F_{RL} : Remaining life factor of existing pavement
C_x : Structural condition coefficient of existing pavement
SN_i : Initial structure number of existing pavement

SN_y, C_x, F_{RL}, and SN_i are determined as follows.

(1) Determination of SN_y

Required strength represented by overlay layer and existing pavement is indicated by SN_y. SN_y is calculated by the following formula. Furthermore, calculated SN_y for each section is indicated in Table 3.1.7.

$$\log_{10}(W18) = Z_R \times S_0 + 9.36 \times \log_{10}(SN_y + 1) - 0.20 + \frac{\log_{10}\left(\frac{\Delta PSI}{4.2-1.5}\right)}{0.40 + \frac{1094}{(SN_y+1)^{5.19}}} + 2.32 \times \log_{10}(M_R) - 8.07$$

Where SN_y : Required structure number in the design period
W18 : See Table 3.1.5.
M_R : Resilient modulus (1500×CBR) CBR is as shown in Table 3.1.6.
Z_R : Reliability coefficient (See Table 3.1.3)
S_0 : Standard deviation (Asphalt pavement = 0.45)
ΔPSI : Difference between P_0 and P_t (See Table 3.1.1)

Table 3.1.7 SN_y by Section & Design Period

Section		5 years	8 years
1	1-1	3.08	3.38
	1-2	3.57	3.91
2		3.20	3.51
3		3.09	3.39
4	4-1	2.70	2.96
	4-2	2.31	2.53
5		2.17	2.38

(2) Determination of C_x

Structural condition coefficient (C_x) of existing pavement (asphalt layer) is determined by referring Table 3.1.8. **C_x = 0.90** (middle value of 1. and 2.) is applied for the design

work.

Table 3.1.8 Recommended Value of C_x

Current condition of pavement	Visual condition coefficient C_v	Structural condition coefficient C_x
1. The layer still keeps well soundness such as no occurrence of crack and deformation.	0.9 – 1.0	**0.95**
2. Some cracks are occurred intermittently. And/or deformations in low to medium level are occurred. But the layer still keeps certain soundness.	0.7 – 0.9	**0.85**
3. Cracks in medium to severe level are occurred. And/or raveling and deterioration of material are occurred. And/or deformations greater than medium level are occurred.	0.5 – 0.7	**0.70**
4. Cracks in significantly severe level are occurred. And/or raveling and deterioration of material are occurred. And/or severe rutting is occurred.	0.3 – 0.5	**0.60**

(3) Determination of F_{RL}

Remaining life factor of existing pavement (F_{RL}) is determined from 2 elements namely remaining life of existing pavement (R_{Lx}) and remaining life of overlaid pavement (R_{Ly}). R_{Lx} is determined by C_x as shown in Figure 3.1.3. **R_{Lx} = 55%** in case of applying C_x = 0.90.

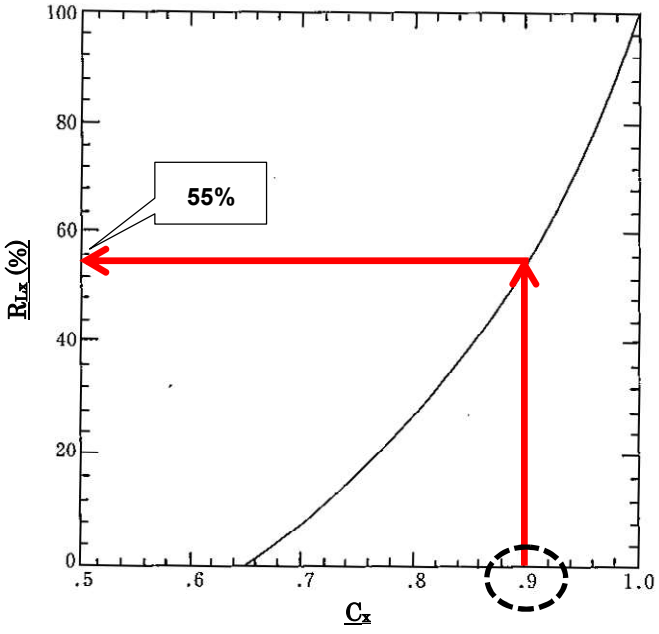


Figure 3.1.3 Correlation between C_x and R_{Lx}

Furthermore, remaining life of overlaid pavement (R_{Ly}) is determined by following formula. Determined R_{Ly} is summarized in Table 3.1.9.

$$R_{Ly} = (N_{fy} - y) \div N_{fy}$$

Where R_{Ly} : Remaining life of overlaid pavement (%)
N_{fy} : W18 which pavement achieves terminal serviceability ($P_t = 2.0$)
y : W18 in the design period (See Table 3.1.5)

Table 3.1.9 R_{Ly} by Section & Design Period

Section		N_{fy}		y		R_{Ly}	
		5 years	8 years	5 years	8 years	5 years	8 years
1	1-1	2,330,000	4,590,000	1,824,845	3,189,541	21.7%	30.5%
	1-2	3,230,000	5,960,000	2,320,975	4,057,532	28.1%	31.9%
2		3,000,000	5,550,000	2,320,975	4,057,532	22.6%	26.9%
3		1,240,000	2,250,000	961,738	1,681,288	22.4%	25.3%
4	4-1	1,000,000	1,790,000	817,953	1,430,205	18.2%	20.1%
	4-2	990,000	1,660,000	817,953	1,430,205	17.4%	13.8%
5		900,000	1,600,000	817,953	1,430,205	9.1%	10.6%

Finally, F_{RL} is determined by as shown in Figure 3.1.4. For example, **$F_{RL} = 0.72$** in case of Section1-1 (8 years, R_{Lx} = 55%, R_{Ly} = 30.5%). Determined F_{RL} is summarized in Table 3.1.10.

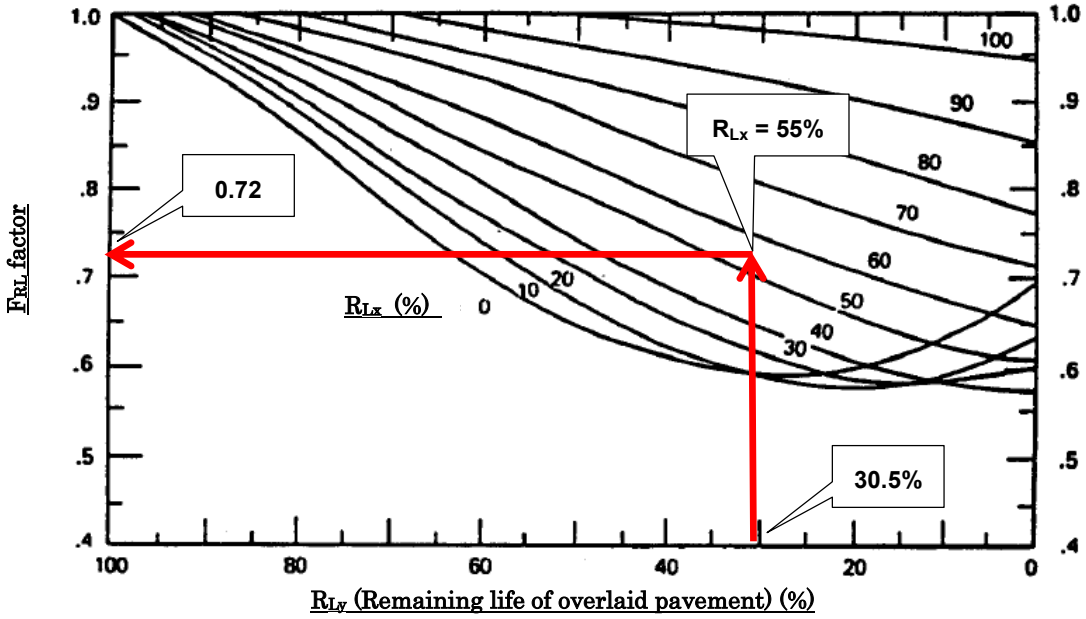


Figure 3.1.4 Correlation between R_{Lx}, R_{Ly} & F_{RL}

Table 3.1.10 F_{RL} by Section & Design Period

Section		F_{RL} 5 years	F_{RL} 8 years
1	1-1	0.69	0.72
	1-2	0.72	0.73
2		0.69	0.71
3		0.69	0.70
4	4-1	0.68	0.68
	4-2	0.67	0.66
5		0.67	0.66

(4) Determination of SN_i

Initial structure number of existing pavement (SN_i) is determined from type of material and thickness of each layer at the initial condition (i.e. just after completion) of the existing pavement structure. SN_i is determined by following formula. Determined SN_i of each section is summarized in Table 3.1.11.

$$SN_i = a_1*d_1 / 2.54 + a_2*m_2*d_2 / 2.54 + a_3*m_3*d_3 / 2.54$$

Where SN_i : Initial structure number of existing pavement

a_n : Layer coefficient

m_n : Drainage coefficient

d_n : thickness of each layer (cm)

Table 3.1.11 SN_i by Section

(1) Section 1-1

Layer	Material	a_n	m_n	d_n (cm)	SN_i
Wearing	Asphalt	0.420	-	5.00	0.827
Base	Sand stone	0.140	1.00	20.00	1.102
Sub-base	Clayey sand	0.108	0.95	25.00	1.010
				Total	**2.939**

(2) Section 1-2, 2, 3 & 4-1

Layer	Material	a_n	m_n	d_n (cm)	SN_i
Wearing	Asphalt	0.420	-	5.00	0.827
Base	As stabilized	0.300	1.00	5.00	0.591
Base	Sand stone	0.140	1.00	10.00	0.551
Sub-base	Clayey sand	0.108	0.95	28.00	1.131
				Total	**3.100**

(3) Section 4-2

Layer	Material	a_n	m_n	d_n (cm)	SN_i
Wearing	Asphalt	0.420	-	9.00	1.488
Base	Sand stone	0.140	1.00	20.00	1.102
Sub-base	Clayey sand	0.108	0.95	30.00	1.212
				Total	**3.802**

(4) Section 5

Layer	Material	a_n	m_n	d_n (cm)	SN_i
Wearing	Asphalt	0.420	-	5.00	0.827
Base	Sand stone	0.140	1.00	20.00	1.102
Sub-base	Clayey sand	0.108	0.95	30.00	1.212
				Total	**3.141**

3.1.3 Determination of Overlay Thickness

Thickness of overlay layer (D_{OL}) is determined on the basis of the above discussion. For example, D_{OL} of Section 1-1 (8 years) is determined as follows. Furthermore, D_{OL} of each section is summarized in Table 3.1.12.

$$SN_{OL} = SN_y - F_{RL} \times C_x \times SN_i$$
$$= 3.38 - 0.72 \times 0.90 \times 2.939$$
$$= 1.476$$
$$D_{OL} = SN_{OL} \div a \times 2.54$$
$$= 1.476 \div 0.420 \times 2.54$$

$= 8.93 \Rightarrow$ **9.00 (cm)**

Table 3.1.12 D_{OL} by Section & Design Period

Section		BP (km)	EP (km)	L (km)	D_{OL} (cm) 5 years	D_{OL} (cm) 8 years
1	1-1	0.0	30.0	30.0	**8.0**	**9.0**
	1-2	30.0	45.7	15.7	**9.5**	**11.5**
2		48.8	58.8	10.0	**8.0**	**9.5**
3		105.8	149.8	44.0	**7.5**	**9.0**
4	4-1	160.8	162.1	1.3	**5.0**	**6.5**
	4-2	162.1	185.0	22.9	**5.0**	**5.0**
5		185.0	241.6	56.6	**5.0**	**5.0**

3.2 Design of Drainage Facility

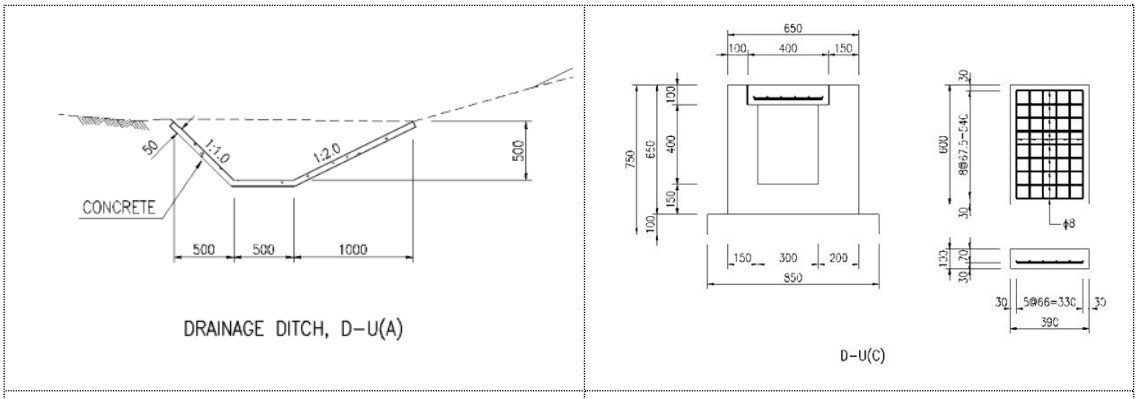
Drainage facilities such as side ditch and pipe culvert will be installed by complying with the following concept.

3.2.1 Side Ditch

V-shaped ditch will be installed on both sides in the rural section of the whole project section excluding the section where pipe culvert (longitudinal direction) will be installed.

Furthermore, U-shaped ditch will be installed on both sides in the village section to allow passing of vehicle over it.

Drawings of the ditches are illustrated in Figure 3.2.1.



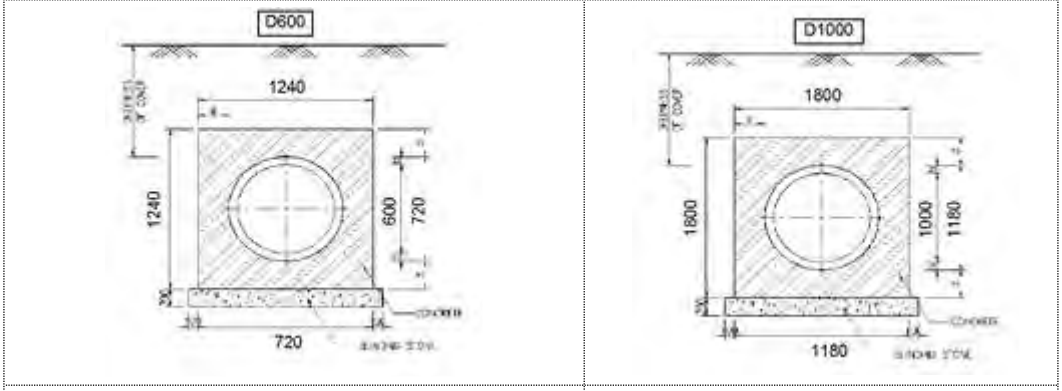
V-shaped ditch (rural section)	U-shaped ditch (village section)

Figure 3.2.1 Side Ditch by Type

3.2.2 Pipe Culvert

Pipe culvert (longitudinal direction) will be buried under connection point between NR9 and local access road as well as the culvert (crossing direction) will be buried under NR9.

Drawings of the culverts are illustrated in Figure 3.2.2.



Pipe culvert (longitudinal direction)	Pipe culvert (crossing direction)

Figure 3.2.2 Pipe Culvert by Type

4. Preliminarily Project Cost Estimate

4.1 Condition of the Estimate

Condition of the estimate is described as below.

(1) Unit Rate applied for the Estimate

Applied unit rate for each work item is quoted from the rate of Pilot Project Phase-1 (Km45.7 – 48.8; L = 3.1km) completed in 2012. Furthermore, applied currency is US dollar.

(2) General Cost

10% of construction cost is appropriated as “General Cost”. The cost includes logistic cost, minor works, construction supervision cost and so on.

(3) Classification of Spot Replacement Work

2 types of spot replacement works are designed for the project as shown in Figure 4.1.1 and 4.1.2. Type (A) will be applied in case that the damage affects up to base course but sub-base course still keeps the soundness. On the other hand, Type (B) will be applied in case that damage reaches up to sub-base course. Quantity of only Type (B) is calculated for the estimate because the cost of Type (B) is higher than Type (A). The quantity will be converted to Type (A) by the Contractor in case that the observed damage is not so severe at the construction stage.

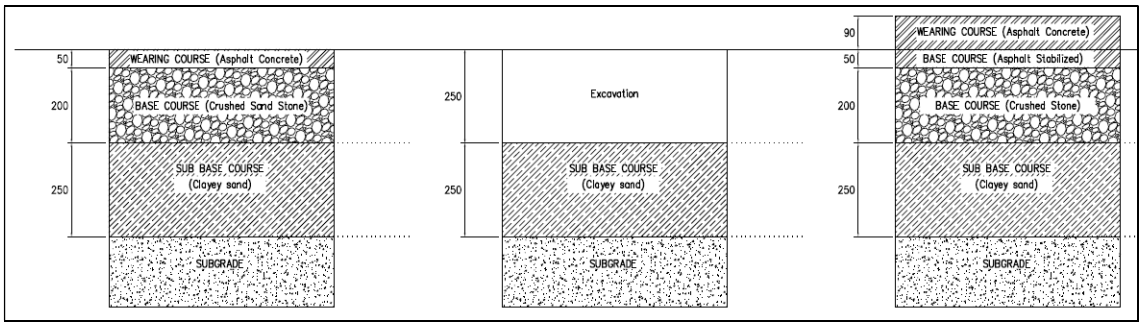


Figure 4.1.1 Spot Replacement (A) (applied for moderate damege)

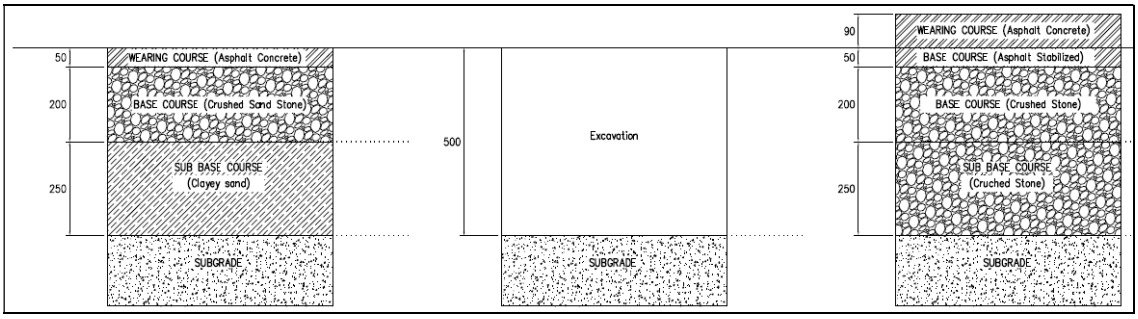


Figure 4.1.2 Spot Replacement (B) (applied for severe damage)

(4) Classification of Type of Side Ditch

V-shaped ditch will be applied in the rural section as well as U-shaped ditch will be in the village section. The quantity of only V-shapes is calculated for the estimate. The quantity will be modified by the Contractor on the basis of the detailed topographic survey result.

Table 4.1.1 Length of Side Ditch (V-shape) by Section

Section		BP (km)	EP (km)	L (km)	Length (m)
1	1-1	0.0	30.0	30.0	59,174
	1-2	30.0	45.7	15.7	30,968
2		48.8	58.8	10.0	19,725
3		105.8	149.8	44.0	86,788
4	4-1	160.8	162.1	1.3	2,564
	4-2	162.1	185.0	22.9	45,169
5		185.0	241.6	56.6	111,641
				Total	**356,029**

(5) Length of Pipe Culvert

Length of pipe culvert is estimated from the length of the Japan's grant aid project currently under construction as shown in Table 4.1.2. Furthermore, estimated length in each section is summarized in Table 4.1.3. Note dimension, quantity and location to be installed will be finalized by the Contractor on the basis of the topographic survey and the hydrological survey.

Table 4.1.2 Unit Length of Pipe Culvert in Grant Project

Road construction	Longitudinal pipe		Crossing pipe	
Total length	Total length	Pipe length per road length	Total length	Pipe length per road length
58,100 (m)	800 (m)	0.01377 (m per m)	242 (m)	0.00417 (m per m)

Table 4.1.3 Pipe Length by Section

Section		BP (km)	EP (km)	L (km)	Length (m)	
					Longitudinal	Crossing
1	1-1	0.0	30.0	30.0	413	125
	1-2	30.0	45.7	15.7	216	65
2		48.8	58.8	10.0	138	42
3		105.8	149.8	44.0	606	183
4	4-1	160.8	162.1	1.3	18	5
	4-2	162.1	185.0	22.9	315	95
5		185.0	241.6	56.6	779	236
				Total	**2,485**	**752**

(6) Finalization of the Estimate

The estimated conducted by CaRoL is designated as “Preliminarily estimate”. The estimate must be modified and finalized by the Contractor on the basis of the detailed survey works such as topographic survey and hydrological survey.

4.2 Result of the Estimate

Result of the estimate for each design period is summarized in Table 4.2.1 and 4.2.2 respectively. BOQ of each sections and the breakdown of the quantity are attached in Appendix-1.

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Table 4.2.1 Result of Cost Estimate (5 years)

All Section			L=	180.5	km			
Work Type	Specification			Unit	Quantity	Rate (USD)	Total Cost (USD)	Remarks
1. Pavement	(1) Spot replacement (A)	Excavation	(t=25cm)	(m3)	28,024	3.6	100,886	Quantity of "(2) Spot replacement (B)" is fully applied in the estimate. Quantity will be converted to "(1) Spot replacement (A)" in case of finding modaretely damaged area (i.e. sub-base still keeps soundness) at the construction stage.
		Crush stone	(t=20.0cm)	(m3)	22,690	36.9	837,260	
		As stabilized	(t=5.0cm)	(m3)	5,586	287.18	1,604,201	
		Prime coat		(m2)	108,576	1.76	191,094	
		Tack coat		(m2)	11,460	0.61	6,991	
	(2) Spot replacement (B)	Excavation	(t=25cm)	(m3)	30,104	3.6	108,376	
		Crush stone	(t=25cm)	(m3)	30,104	36.9	1,110,853	
	(3) Crack seal	Crack seal		(m2)	3,735	3.24	12,100	
	(4) Spot replacement (C)	Excavation	(t=5.0cm)	(m3)	5,340	3.6	19,224	
		As stabilized	(t=5.0cm)	(m3)	5,340	287.18	1,533,507	
		Prime coat		(m2)	71,198	1.76	125,309	
		Tack coat		(m2)	71,198	0.61	43,431	
	(5) Overlay	Hot mix asphalt	(t=5.0cm)	(m2)	727,200	15.1	10,988,800	
			(t=7.5cm)	(m2)	396,000	22.7	8,976,000	
			(t=8.0cm)	(m2)	365,400	24.2	8,834,560	
			(t=9.5cm)	(m2)	141,300	28.7	4,056,880	
		Tack coat		(m2)	2,544,300	0.61	1,552,023	
	(6) Lane mark	Lane mark		(m2)	54,330	12.84	697,597	
	Construction Cost Total (USD)						**40,799,092**	
	General Cost (10% of Construction Cost) (USD)						**4,079,909**	Cost for minor works, construction supervision, etc.
	1. Pavement Work Total (USD)						**44,879,001**	
2. Drainage	(1) V-shaped side ditch			(m)	356,029	22.6	8,030,516	Actual quantities will be determined in the detailed design stage.
	(2) U-shaped side ditch			(m)	0	46.3	0	
	(3) Longitudinal pipe	D600		(m)	2,485	194.2	482,613	
	(4) Crossing pipe	D1000		(m)	752	342.1	257,190	
	Construction Cost Total (USD)						**8,770,318**	
	General Cost (10% of Construction Cost) (USD)						**877,032**	Cost for minor works, construction supervision, etc.
	2. Drainage Work Total (USD)						**9,647,350**	
Total Amount (5 years)							**54,526,351**	
Cost per km (USD)							**302,085**	

Table 4.2.2 Result of Cost Estimate (8 years)

All Section			L=	180.5	km			
Work Type	Specification			Unit	Quantity	Rate (USD)	Total Cost (USD)	Remarks
1. Pavement	(1) Spot replacement (A)	Excavation		(m3)	28,024	3.6	100,886	Quantity of "(2) Spot replacement (B)" is fully applied in the estimate. Quantity will be converted to "(1) Spot replacement (A)" in case of finding modaretely damaged area (i.e. sub-base still keeps soundness) at the construction stage.
		Crush stone		(m3)	22,309	36.9	823,186	
		As stabilized		(m3)	5,715	287.18	1,641,327	
		Prime coat		(m2)	108,576	1.76	191,094	
		Tack coat		(m2)	11,460	0.61	6,991	
	(2) Spot replacement (B)	Excavation		(m3)	30,104	3.6	108,376	
		Crush stone		(m3)	30,104	36.9	1,110,853	
	(3) Crack seal	Crack seal		(m2)	3,735	3.24	12,100	
	(4) Spot replacement (C)	Excavation		(m3)	5,340	3.6	19,224	
		As stabilized		(m3)	5,340	287.18	1,533,507	
		Prime coat		(m2)	71,198	1.76	125,309	
		Tack coat		(m2)	71,198	0.61	43,431	
	(4) Overlay	Hot mix asphalt	(t=5.0cm)	(m2)	715,500	15.1	10,812,000	
			(t=6.5cm)	(m2)	11,700	19.6	229,840	
			(t=9.0cm)	(m2)	666,000	27.2	18,115,200	
			(t=9.5cm)	(m2)	95,400	28.7	2,739,040	
			(t=11.5cm)	(m2)	141,300	34.8	4,910,960	
		Tack coat		(m2)	2,544,300	0.61	1,552,023	
	(5) Lane mark	Lane mark		(m2)	54,330	12.84	697,597	
	Construction Cost Total (USD)						**44,672,058**	
	General Cost (10% of Construction Cost) (USD)						**4,467,206**	Cost for minor works, construction supervision, etc.
	1. Pavement Work Total (USD)						**49,139,264**	
2. Drainage	(1) V-shaped side ditch			(m)	356,029	22.6	8,030,516	Actual quantities will be determined in the detailed design stage.
	(2) U-shaped side ditch			(m)	0	46.3	0	
	(3) Longitudinal pipe	D600		(m)	2,485	194.2	482,613	
	(4) Crossing pipe	D1000		(m)	752	342.1	257,190	
	Construction Cost Total (USD)						**8,770,318**	
	General Cost (10% of Construction Cost) (USD)						**877,032**	Cost for minor works, construction supervision, etc.
	2. Drainage Work Total (USD)						**9,647,350**	
Total Amount (8 years)							**58,786,614**	
Cost per km (USD)							**325,688**	

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Rehabilitation Project of National Road No.9