Kingdom of Cambodia

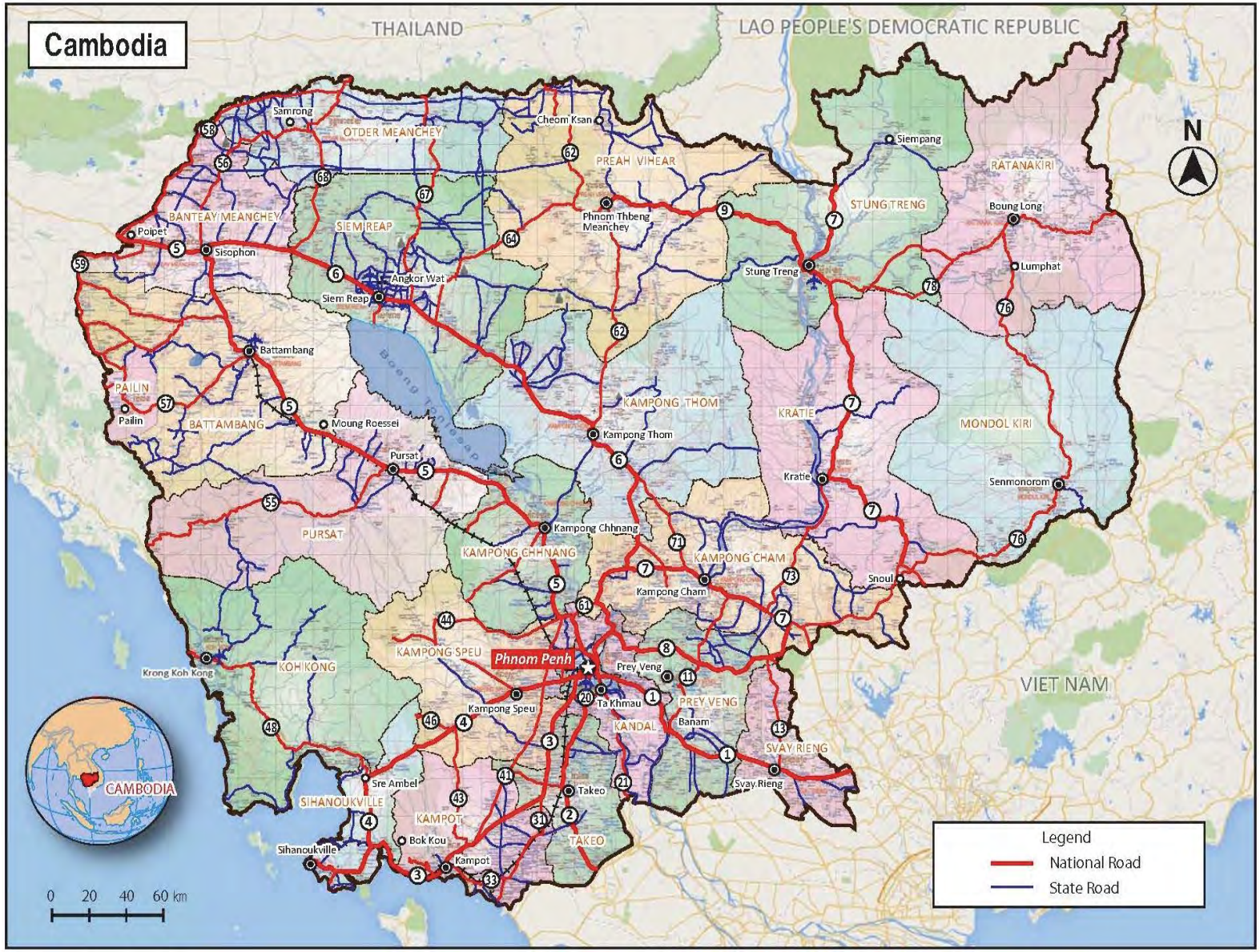
The Project for Strengthening Capacity for Maintenance of Roads and Bridges

Activity Report

February 2018

MINISTRY OF PUBLIC WORKS AND TRANSPORTS

JAPAN INTERNATIONAL COOPERATION AGENCY



Location Map

List of Abbreviation

AC	Asphalt Concrete
ADB	Asian Development Bank
AusAID	Australian Agency for International Development
BOQ	Bill of Quantities
C/P	Counter Part
CAMRA	Cambodia Road Association
CAMTA	Cambodia Truck Association
CD	Critical Damage
CDC	Council for the Development of Cambodia
CFC	Carbon Fiber Cloth
CTIE	CTI Engineering Co.Ltd.,
CTII	CTI Engineering International Co.Ltd.,
D	Damaged
DB	Database
DBST	Double Bituminous Surface Treatment
DPWT	Provincial Department of Public Works and Transport
DRIMS	Dynamic Response Intelligent Monitoring System
DTC	Department of Technical and Transport
EC	Executing Committee
EOJ	Embassy of Japan
EXMID	Expressway and Mega Bridge and Investment Department
FWD	Falling Weight Defelectometer
FY	Fiscal Year
GDI	General Department of Inspection
GDPW	General Department of Public Works
GIS	Geological Information System
GMS	Greater Mekong Subregion
GOC	Government of Cambodia
GPS	Global Positioning System
HDM4	Highway Development and Maintenance. Management System 4
HEC	Heavy Equipment Center
HERCD	Heavy Equipment and Road Construction Department
HSWIM	High Speed Weigh in Motion, Fast WIM
HV	Heavy Vehicle
IDA	International Development Association
IRI	International Roughness Index
ITC	Institute of Technology of Cambodia
JCC	Joint Coordination Committee
JCI	Japan Concrete Institute
JICA	Japan International Cooperation Agency
LIMS	Laboratory Information Management System
LSWIM	Low Speed Weigh in Motion
LV	Light Vehicle
LV-AADT	Large Vehicle Annual Average Daily Traffic
M/P	Master Plan
MC	Motorcycle
MCD	Macadam
ME	Maintenance Expert
MEF	Ministry of Economy and Finance
MFA	Ministry of Foreign Affairs
MOF	Ministry of Foreign Affairs
MOM	Maintenance Operation Meeting
MOU	Minutes of Understanding

MPWT	Ministry of Public Work and Transport
MRC	Road Maintenance Center
MRD	Ministry of Rural Development
MT	Master Trainer
MOI	Ministry of interior
N	No Damaged
NAOCC	National Axle Overloading Control Committee
NDT	No Damage Test
NPO	Non Profit Organization
NR	National Roads
NSDP	National Strategic Development Plan
O	Observation Required
OJT	On the Job Training
OPEC	Organization of the Petroleum Exporting Countries
PBC	Performance Based Contract
PDCA	Plan, Do, Check and Action
PDM	Project Design Matrix
PEAC	Procurement Evaluation Award Committee
PIC	Project Implementation and Supervision Consultant
PK	Post Kilometer
PMU3	Project Management Unit 3 (of MPWT)
PO	Plan of Operation
PR	Provincial Road
PTC	Project Technical Committee
PWRC	Public Works Research Center
PWTTD	Public Works and Transport Technique Department
QA	Quality Assurance
QAW	Operations
QC/QA	Quality Control and Quality Assurance
RAMO	Road Asset Management Organization
RAMP	Road Asset Management Program
RBL	Result Based Lending
RCAF	Royal Cambodian Army Force
RDCMU	Road Data Collection Management Unit
RFID	Radio Frequency Identification Tag
RID	Road Infrastructure Department
RMC	Roads Maintenance Center
RMD	Road Maintenance Department
RNIP	Road Network Improvement Project
ROMDAS	ROad Measurement Data Acquisition System
ROW	Right of Way
SBST	Single Bituminous Surface Treatment
SD	Seriously Damaged
SEC	Southern Economic Corridor
SIP	Cross-ministerial Strategic Innovation Promotion Program
SPCC	Secretariat of Permanent Coordination Committee for Inspection of Overloaded Trucks
SPIED	Sub-National Public Infrastructure and Engineering Department
TA	Technical Assistance
TCP	Technical Cooperation Project
TIC	Technical Institute of Cambodia
WB	World Bank
WIM	Weigh in Motion
WS	Weight Station

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Chapter 1. Outline of the Project

1.1. Background

In Cambodia, roads are the primary mode of transport. Cambodia has a road network of 58,400 km, of which 7,248 km is national road. Almost all roads in Cambodia were constructed from the 1920s to 1930s. However due to civil conflict in the 1970s, the main roads were damaged. In addition, overloading of vehicles and periodic floods has also contributed to poor road conditions. After the end of the civil war, roads and bridges were rehabilitated and constructed by GOC and multilateral donors.

The pavement ratio grew to 99.1% for single digit national roads as a result of past projects implemented by multilateral donors including JICA. The road maintenance advisors and experts in Technical Cooperation Projects who were dispatched by JICA strengthened the road maintenance capacity of MPWT. However, maintenance of roads and bridges in Cambodia in comparison to other Asian countries is still far behind.

The main challenges hindering the maintenance of roads and bridges are: 1) lack of finance; 2) lack of skilled manpower with technical know-how; 3) Lack of Equipment for Road Development/Maintenance Works.

In order to meet some of the challenges above, the GOC requested the Japanese government to conduct a technical cooperation project to strengthen capacity for maintenance of roads and bridges.

1.2. This Report

This is the Final Report describing project results and activities by end of February 2018.

1.3. Project Design Matrix

The Project Outline is summarized in the box below.

The Project Design Matrix (PDM) has been amended 4 times during the project as Table 1-1.

The PDM (ver. 4) and PO (ver. 4) are attached in Attachment 1 in the last part of this chapter.

Project Outline

1. **Project Title:** The Project for Strengthening Capacity for Maintenance of Roads and Bridges
2. **Project Period:** April 2015 – March 2018
3. **Overall Goal:** Appropriate Maintenance of roads and bridges is managed by MPWT
4. **Project Purpose:** Enhance Capacity of RID to supervise implementing bodies maintaining roads and bridges.
5. **Outputs:**
   (1) The bridge maintenance cycle is established.
   (2) The Road and bridge inspection capacity of RID is enhanced.
   (3) The Road and bridge repair capacity of RID is enhanced.
   (4) The Road and bridge maintenance cycle is introduced to other DPWTs and concerned agencies.
6. **Activities**

【Related to Output (1)】

1-1. To review the present bridge maintenance cycle and RID works in comparison to the existing Japanese system
1-2. To propose a 3 year bridge maintenance strategic plan with an annual action plan to establish a proper bridge maintenance cycle
1-3. To practice the action plan
1-4. To hold workshops for the bridge maintenance cycle
1-5. To prepare a draft annual bridge maintenance budget

【Related to Output (2)】

2-1. To review and develop a Road Maintenance Manual
2-2. To review and develop Bridge Maintenance Manual, including a database frame
2-3. To hold training workshops on roads and bridges inspection
2-4. For bridges, to inspect roads and bridges and prepare a rough cost estimation of the repair works at target DPWTs
2-5. For roads, to inspect roads using IRI and prepare rough cost estimation of the repair work at target DPWTs
2-6. To register the inspection results in the database by RID
2-7. To revise the road and bridge maintenance manuals incorporating lessons learned from the above activities by organizing review workshops
2-8. To conduct preliminary study on overloading control (at Tsubasa Bridge)

【Related to Output (3)】

3-1. To review and establish a Road Repair Manual
3-2. To review and establish a Bridge Repair Manual
3-3. To hold training workshops on roads and bridges repair
3-4. To identify roads and bridges for the pilot repair works based on the inspection results at the target DPWTs
3-5. To establish a repair plan for the identified roads and bridges at the target DPWTs
3-6. To repair the identified roads and bridges at the target DPWTs
3-7. To evaluate the above repair works
3-8. To revise the road and bridge repair manual incorporating lessons learned from the above activities by organizing review workshop by organizing review workshop

【Related to Output (4)】

4-1. To organize seminars for other DPWTs – trainings on road and bridge inspection
4-2. To organize seminars for other DPWTs – trainings on road and bridge repair
4-3. To organize the project wrap-up seminar.

7. Counterpart: Road Infrastructure Department of Ministry of Public Works and Transport (RID MPWT)

Table 1-1 History of PDM amendment

Version	Date	Amendment of PDM
Version 0	Oct 17 2014	Original
Version 1	July 2015	1. Project Purpose [Amendment] "Maintenance budget of road and bridge is prepared by RID according to the road and bridge maintenance cycle" was added. [Reason] RID is responsible to prepare nationwide road and bridge maintenance budget. PDM ver.0 did not include RID's role. 2. Outputs [Amendment] Amendment was made for following clarifications; 1) Clarification of time 2) Clarification of number of RID staff to be passed exam Clarification of coverage of DPWTs to attends seminars.
Version 2	January 2016	1. Outputs 1) Output 1 [Amendment] "1-4. 3 Year Bridge Maintenance Strategic Plan of short term is prepared by RID/MPWT every August" was added. [Reason] In order to prepare annual maintenance budget, short term plan (3 years) should be prepared in order to clarify the priority of maintenance and to foresee the achievement and future required budget. 2) Output 2 [Amendment] 2-2. The selected bridges of **all DPWTs** are inspected according to the maintenance manual. 2-3. The selected roads in the **targeted DPWTs** are inspected according to the maintenance manual [Reason] The PDM ver.0 stated to inspect bridges in the 3 target bridges and expand the practice to other DPWTs at the end of the project by seminar. However, considering to the RID's responsible to prepare nationwide budget plan, inventory and condition assessment of bridges under all DPWTs were required because there was no database built in the past. The amendment of PDM to expand the target from 3 DPWTs to 25 DPWTs for bridge inspection was proposed and agreed. Tablet bridge inspection system contributed to make it possible to collect all the data in the first year, and use that data to prepare a maintenance plan and budget preparation. In result, budget plan in 2017 and 2018 for bridge inspection and repair were approved by MEF. For road the PDM remain the same target DPWT, because inspection and database on roads were sufficiently well practiced. The project concentrated on introduction of using IRI in the prescribed target DPWTs for road. 2. Activities 1) Following activities were added related to amendment of output [Amendment] 1-2. To propose 3 year bridge maintenance strategic plan with the annual action plan to establish a proper bridge maintenance cycle 2-4. For bridge, to inspect bridges and prepare rough cost estimation of the repair works for all DPWTs 2-5. For roads, to inspect roads using IRI and prepare rough cost estimation of the repair works at the target DPWTs

Version	Date	Amendment of PDM
		2-6. To register the inspection results in the database by RID 2-1. To conduct preliminary study on overloading control (at Tsubasa Bridge) 2) Addition of Overloading Control at Tsubasa bridge [Amendment] "2-8. To conduct preliminary study on overloading control (at Tsubasa Bridge)" was added. [Reason] Overloading is one of the most important causes of damage on roads and bridges. Tsubasa bridge has been damaged by overloaded trucks and there was no efficient countermeasure taken. In order to build efficient data collection and to set system, it was agreed to conduct pilot project at Tusbasa bridge.
Version 3	December 2016	[Amendment] Addition of Equipment Procurement engineer [Reason] For a smooth procurement of equipment for pilot projects, procurement engineer was added.
Version 4	June 2017	[Amendment] Addition of 1) Bridge Inspection Engineer (2) 2) Bridge Repair Engineer (3) 3) Database Expert [Reason] In order to sensitize the project activity and conduct Maintenance Expert training to all DPWT, bridge inspection engineer and bridge repair engineer were added. Document Management System which collects technical standards and drawings (such as AS-built drawing) was added.

1.4. Project Approach

The outputs are incorporated each other as shown in Figure 1-1.

[Output 1]

The Project shall commence with the inspection of 2000 Bridges to collect data on the existing bridges along the national roads. While the original PDM covers data collection activity within the target DPWTs only, the Project widens the scope to cover all DPWT. This is because RID requires the supervision of all bridges on national roads. The collected data will be used for visualization of current issues and development of a maintenance plan.

[Output 2 and Output 3]

The activities of Output 2 and Output 3 shall be conducted on selected DPWTs including pilot projects.

[Output 4]

The activities shall be expanded to include other DPWTs and other organizations within MPWT (e.g., Road Maintenance Center, Heavy Equipment Center etc.)

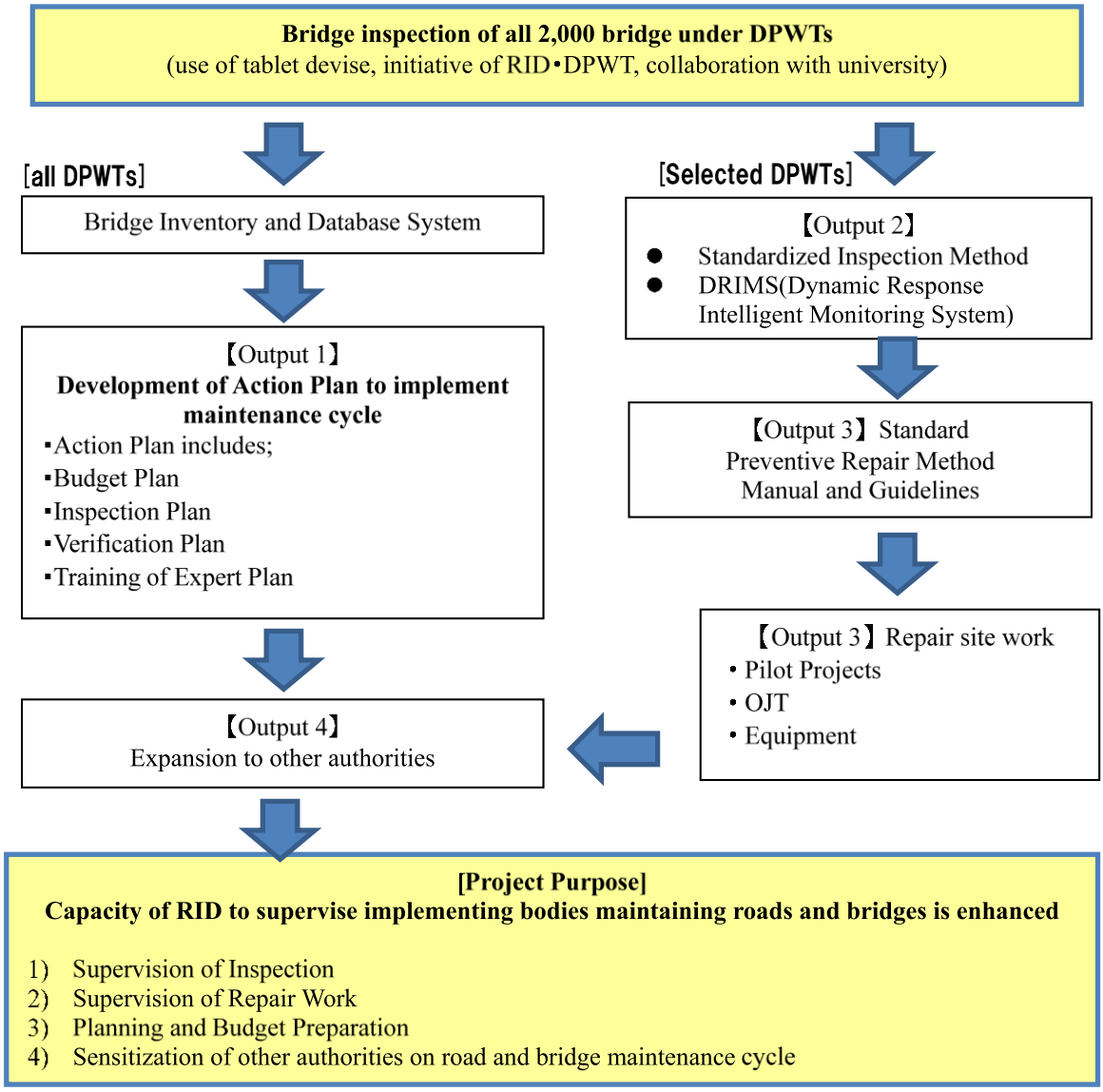


Figure 1-1 Technical Approach of the Project

1.5. Project Flow Chart

The Project Flow Chart is shown in

Figure 1-2.

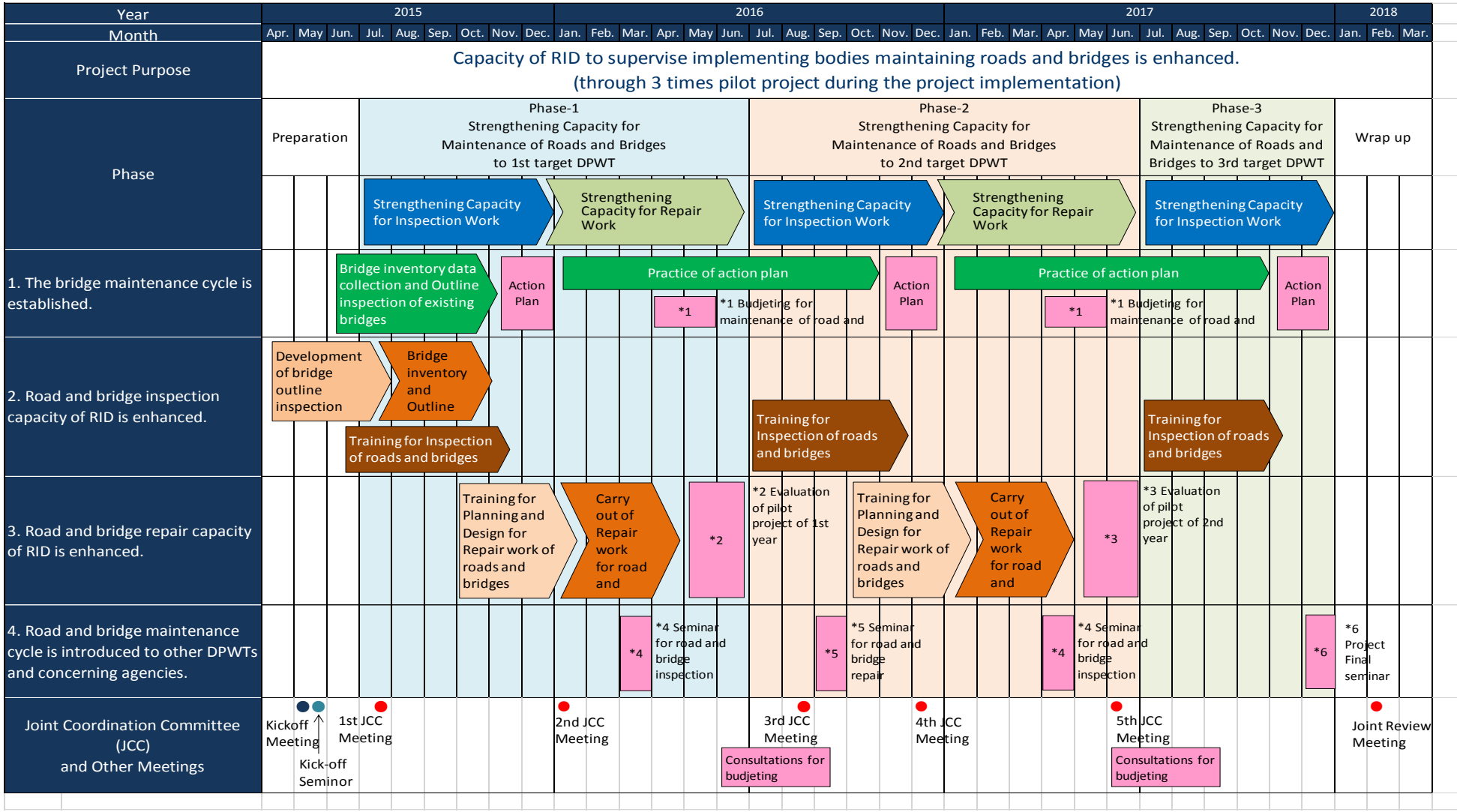


Figure 1-2 Project Flow Chart

Project Monitoring Sheet I (Revision of Project Design Matrix)

Version 4

Dated June 2017

Project Title: The Project for Strengthening Capacity for Maintenance of Roads and Bridges
Implementation Agency: Road Infrastructure Department of Ministry of Public Work and Transport (RID MPWT)
Target Groups: Engineers of RID
Period of Project: April 2015 – March 2018
Project Site: Cambodia
Target Area: Roads and Bridges under MPWT

Project Summary	Objectively Verifiable Indicators	Means of Verification	Important Assumptions	Achievement	Remarks
<u>Overall Goal</u> Appropriate maintenance of roads and bridges is managed by MPWT.	1. The road and bridge database is updated once / a year. 2. Road and bridge maintenance plans are updated once / a year base on the result of the road and bridge database updated.	1. Log record of the database, random sample check of individual data 2. The maintenance plans, corresponding data from the database 3. The maintenance record, the maintenance plans and manuals 4. Minutes of the review meeting	- Country's socio-political situation does not change rapidly.	Prototype bridge database which covered all the bridges on national roads was developed and installed in RID office. [Road] Maintenance plans for road sections inspected in Kandal province has been drafted and to be used in the budget proposal for FY2017. [Bridge] 3-year bridge maintenance plan has been drafted based on information in the database. Part of the plan is to be used in the budget proposal for FY2017.	

Project Summary	Objectively Verifiable Indicators	Means of Verification	Important Assumptions	Achievement	Remarks
	3. Road and bridge maintenance is carried out based on the road and bridge maintenance plan and the maintenance and repair manuals, under supervision of RID. 4. The road maintenance and repair manuals, and the bridge maintenance and repair manuals are regularly reviewed.			Road and bridge maintenance will be conducted based on the 3-year bridge maintenance plan and the road maintenance plan for the FY 2017 under supervision of RID All the road and bridge pilot repair projects have been completed. [Road] Khmer version of road repair manual has been completed. [Bridge] Khmer version of bridge repair manual has been completed. Khmer version of bridge inspection manual has been drafted and under review.	
Project Purpose Capacity of RID to supervise implementing bodies maintaining roads and bridges is enhanced.	1. Inspection results done by the three target DPWTs are approved by RID based on the manuals by the end of the Project.	1. DPWT inspection reports and on-site confirmation by RID 2. DPWT repair reports and on-site confirmation by RID. 3. The said draft budget and its submission date 4. Number and name of the participated offices and unit 5. Interest level of the participants through the questionnaire.	- Organizational arrangement of MPWT is not changed drastically.	[Road] 1-digit roads throughout the nation and the selected roads in Kandal and Takeo provinces have been successfully inspected by IRI-based inspection. [Bridge] Inspection of all the bridges in Cambodia has been completed in December, 2015. Additionally, 173	

Project Summary	Objectively Verifiable Indicators	Means of Verification	Important Assumptions	Achievement	Remarks
				damaged bridges were identified and detailed inspection for the bridges has been carried out.	
	2. Repair results done by the two target DPWTs are approved by RID base on the manuals by the end of the Project.			[Road] The 1st pilot project for road repair work has been implemented for selected roads in Kandal province. [Bridge] 3 bridges from Kandal DPWT and 2 bridges from Phnom Penh DPWT were repaired by crack sealing method under the 1st pilot project. Also, a bridge in Preah Sihanouk province was repaired by carbon fiber sheet method through 2nd pilot project.	
	3. The above two target DPWTs prepare a draft budget for roads and bridge maintenance for FY 2018 respectively within pre-agreed schedule.			[Road] The road condition evaluated by IRI is to be used for the FY 2017 budget request to MEF. [Bridge] Budget for bridge maintenance was proposed for FY 2017 to MEF using the 3-year maintenance plan (Chapter 21 and Chapter 61)	

Project Summary	Objectively Verifiable Indicators	Means of Verification	Important Assumptions	Achievement	Remarks
	4. Road and bridge maintenance cycle is explained and shared to concerning offices and units at the project wrap-up seminar.			Instructions for road and bridge maintenance cycle have been given to MPWT and DPWT officials through Maintenance Expert (ME) training program. The project team has been in cooperation with Institute of Technology of Cambodia (ITC) on bridge database system and bridge repair pilot projects.	
	5. Maintenance budget of road and bridge is prepared by RID according to the road and bridge maintenance cycle			[Road] The road condition evaluated by IRI is to be used for the FY 2017 budget request to MEF through ME program for understanding maintenance cycle. [Bridge] Budget on bridge maintenance for FY 2017 has been proposed to MEF based on the 3-year maintenance plan. [Road/Bridge] The budget for road and bridge inspection has been approved by MEF.	

Project Summary	Objectively Verifiable Indicators	Means of Verification	Important Assumptions	Achievement	Remarks
Outputs 1. The bridge maintenance cycle is established.	1-1. The annual action plan for bridge maintenance cycle is developed and approved by August every year for each targeted DPWT. 1-2. At least 5 officials of RID engineers pass exam of bridge maintenance cycle. 1-3. The annual bridge maintenance budget is drafted at the target DPWTs of 2nd year and 3rd year by May every year.	1-1. The annual action plan and it's date developed and approved 1-2. The exam results and participants list 1-3. The drafted budget and its date 1-4. 3 Year Bridge Maintenance Strategic Plan	- The trained staff/officers remain at the job. - Roles of DPWTs and other concerning offices and units are not changed including budget preparation system.	Annual action plan for bridge maintenance cycle has been drafted through the activities for budgeting of FY 2017 to MEF using the 3-year nationwide maintenance plan (Chapter 21 and Chapter 61). Also, the action plan for the final year of the project was prepared to practically implement the plan for bridge maintenance cycle circulation. Seventeen (17) RID officials completed Maintenance Expert (ME) program required by Japanese experts. For budget request of FY 2017, following supports are the major: 1. Budget request for "bridge" for Chapter 61 routine maintenance and Chapter 21 Investment 2. 3-year bridge maintenance plan 3. Road routine maintenance for measurement of IRI	

Project Summary	Objectively Verifiable Indicators	Means of Verification	Important Assumptions	Achievement	Remarks
	1-4. 3-year Bridge Maintenance Strategic Plan of short term is prepared by RID/MPWT every August			A nationwide 3-year maintenance plan was updated.	
2. Road and bridge inspection capacity of RID is enhanced.	2-1. The road and bridge maintenance manuals are drafted by August 2015 and finalized by June 2017.	2-1. The manuals and its' date prepared 2-2. Inspection record and sample on-site confirmation 2-3. Inspection record and corresponding data for sample check 2-4. The test results and participants list		The road and bridge maintenance manuals are drafted. Khmer version for bridge maintenance manual is being prepared.	
	2-2. The selected bridges of all DPWTs are inspected according to the maintenance manual.			The selected bridges of all DPWTs were inspected according to the maintenance manual. Additionally, 173 damaged bridges were identified and detailed inspection for the bridges has been carried out. A pilot project for overloading control at Tsubasa Bridge started behind the proposed schedule of preliminary study.	
	2-3. The selected roads in the targeted DPWTs are inspected according to the maintenance manual			1-digit roads throughout the nation and the selected roads in Kandal and Takeo province were successfully inspected by IRI-based inspection method according to the	

Project Summary	Objectively Verifiable Indicators	Means of Verification	Important Assumptions	Achievement	Remarks
				maintenance manual. IRI measurement in Kep province is planned as the next activity.	
	2-4. The inspection results are registered to the road and bridge database by RID until November every year.			Database was created and installed in RID office. All the inspection results have been registered in the database.	
3. Road and bridge repair capacity of RID is enhanced.	2-5. At least 5 officials of RID's engineers pass road and bridge inspection test.			Two (2) RID officials have passed road ME training program. Seventeen (17) RID officials have passed bridge ME training program.	
	3-1. The road and bridge repair manuals are drafted by January 2016 and finalized by June 2017.	3-1. The manuals and its' date prepared 3-2. Repair record and sample on-site confirmation		The road and bridge repair manuals are drafted. Also, Khmer versions have been drafted.	
	3-2. The identified roads and bridges in the targeted DPWTs are repaired according to the repair manuals and the inspection results.	3-3. Repair record and corresponding data for sample check 3-4. The test results and participants list		The 1st pilot project for road repair work has been implemented for selected roads in Kandal province. 3 bridges from Kandal province and 2 bridges from Phnom Penh were repaired by crack sealing method through the 1st pilot project. A bridge in Preah	

Project Summary	Objectively Verifiable Indicators	Means of Verification	Important Assumptions	Achievement	Remarks
				Sihanouk province was repaired by carbon fiber sheet method through 2nd pilot project.	
4. Road and bridge maintenance cycle is introduced to other DPWTs and concerning agencies.	3-3. The repair results are registered to the road and bridge database by RID within 1 month after the completion of repair works.			The repair record format for data input has been prepared in the database system. Repair results of the 1st and 2nd pilot project have been registered in the database.	
	3-4. At least 5 officials of RID's engineers pass road and bridge repair test.			Three (3) RID officials completed road ME training program, and Six (5) RID officials completed bridge Maintenance Expert (ME) training program, instructed by Japanese experts.	
	4-1. Bridge inspection is carried out at the more than 80% DPWTs (20/25 DPWTs).	4-1. Bridge inventory data 4-2. The participants list 4-3. Publicity matter		Bridge inspection was conducted in all the DPWTs' jurisdictions.	
	4-2. More than 80% DPWTs attends the seminar held in the Project.			Twenty two (22) DPWTs attended the series of workshops and seminars. Attendance of DPWTs: 88% (22 out of 25 DPWTS)	

Project Summary	Objectively Verifiable Indicators	Means of Verification	Important Assumptions	Achievement	Remarks
	4-3. The project activities are disseminated to other agencies concerning road/bridge maintenance. (number is not specified but with increments through the project)			Kickoff Seminar on 22 May 2015: MPWT, DPWTs, MEF, WB, ADB SIP seminar in March 2016: road and bridge maintenance jointly held with ITC Coordination of bridge database utilization with university (ITC) Participation of database training from HEC, RMC and SPEAD Bridge inspection jointly with ITC	

Activities	Inputs		
1-1. To review the present bridge maintenance cycle and the works of RID in comparison to the existing Japanese system 1-2. To propose 3 year bridge maintenance strategic plan with the annual action plan to establish a proper bridge maintenance cycle 1-3. To propose annual action plan for bridge maintenance cycle to establish a proper bridge maintenance cycle based on the review results 1-4. To practice the action plan 1-5. To hold workshop of the bridge maintenance cycle 1-6. To prepare draft annual bridge maintenance budget 2-1. To review and develop road maintenance manual 2-2. To review and develop bridge maintenance manual, including a database frame 2-3. To hold training workshops on road and bridge inspections 2-4. For bridge, to inspect bridges and prepare rough cost estimation of the repair works for all DPWTs 2-5. For roads, to inspect roads using IRI and prepare rough cost estimation of the repair works at the target DPWTs 2-6. To register the inspection results in the database by RID 2-7. To revise the road and bridge maintenance manuals incorporating lessons learned from the above activities by organizing review workshops 2-8. To conduct preliminary study on overloading control (at Tsubasa Bridge) 3-1. To review and establish road repair manual 3-2. To review and establish bridge repair manual 3-3. To hold training workshops on road and bridge repairs 3-4. To identify roads and bridges for the pilot repair works based on the inspection results at the target DPWTs 3-5. To establish repair plan for the identified roads and bridges at the target DPWTs 3-6. To repair the identified roads and bridges at the target DPWTs	(Japan side) 1. A chief advisor / A long term expert 2. Short term experts 1) Team Leader / Bridge Maintenance Engineer 2) Deputy-team leader / Road Maintenance Planner 3) Bridge Inspection Engineer (1) 4) Bridge Inspection Engineer (2) 5) Bridge Repair Engineer (1) (Planning and Design) 6) Bridge Repair Engineer (2) (Repairing work Expert) 7) Bridge Repair Engineer (3) 8) Bridge Maintenance Planner 9) Road Maintenance Engineer(1) / Equipment procurement engineer 10) Road Maintenance Engineer(2) 11) Coordinator / Assistant for Road and Bridge Inspection 12) Coordinator for other relevant project / C/P training Supervision 13) Road Maintenance Engineer (3) (Overloading Control) 14) Database Expert 3. Equipment for road and bridge maintenance 4. C/P training 5. Cost for seminars and Trainings as the project activities	(Cambodia side) 1. Arrangement of counterpart personnel 1) Project Director 2) Project Manager 3) Other Necessary Personnel 2. Implementation cost for the pilot repair works 3. Travel expenses and allowances for the participants of the seminars and trainings organized as the project activities 4. Maintenance cost of the JICA project equipment 5. Office space including its utility cost (electricity, water, internet and other necessary office facilities) 6. Etc.	- Conditions of roads and bridges under MPWT are not rapidly deteriorated. - Flood with large scale is not occurred annually. Pre-condition N/A

3-7. To evaluate the above repair works 3-8. To revise the road and bridge repair manual incorporating lessons learned from the above activities by organizing review workshop by organizing review workshop 4-1. To organize seminars for other DPWTs – trainings on road and bridge inspection 4-2. To organize seminars for other DPWTs – trainings on road and bridge repair 4-3. To organize the project wrap-up seminar			

Chapter 2. Achievements of the Project

2.1. General

The achievements of the Project are hereinafter confirmed and explained in accordance with the Project Design Matrix (PDM) to achieve the target objectively verifiable indicators (hereinafter called "indicators"). The overall goal, purpose, and four (4) objectives are as shown below.

Table 2-1 Outline of the Project

Overall Goal	Appropriate maintenance of roads and bridges is managed by MPWT.
Purpose	Enhance Capacity of RID to supervise implementing bodies maintaining roads and bridges.
Output-1	The bridge maintenance cycle is established.
Output-2	The Road and bridge inspection capacity of RID is enhanced.
Output-3	The Road and bridge repair capacity of RID is enhanced.
Output-4	The Road and bridge maintenance cycle is introduced to other DPWTs and relevant agencies.

A series of manuals/guidelines that needed content improvement to comply with the new road/bridge maintenance system has been updated as shown in the following table.

The manuals/ guidelines were prepared in Khmer for the ones may not familiar to English. Also, pocket size edition was prepared for the road and bridge repair manual for the ease of use on sites.

Table 2-2 List of Manuals/Guidelines

Required Manuals under PDM	Title of Manuals (Guidelines)	Revision /New	English Version	Khmer Version
I Road Maintenance				
Road Maintenance Manual	Guideline for Routine Road Maintenance Using IRI	New	✓	
	Guidelines for Operation of Dynamic Response Intelligent Monitoring System	New	✓	
Road Repair Manual	Guideline for Road Defects Repair	Revision	✓	✓
	Guideline for Road Defects Repair (Pocket Edition)	New	✓	✓
II Bridge Maintenance				
Bridge Maintenance Manual	Bridge Inspection Manual	New	✓	✓
	Bridge Inspection Manual Handbook	New	✓	✓
Bridge Repair Manual	Bridge Repair Manual	New	✓	✓
	Cambodia Bridge List	New	✓	
III Annual Action Plan				
Bridge Maintenance Annual Action Plan	Bridge Maintenance Annual Action Plan	New	✓	✓
3-Year Bridge Maintenance Strategic Plan	3-Year Bridge Maintenance Strategic Plan	New	✓	

2.2. Project Completion Report

The achievements of the project comparing to the PDM was evaluated in the Project Completion Report through a joint review with the counter parts, JICA Cambodia Office and JICA Headquarters.

The draft project completion report was submitted in December to JICA after the joint review meeting with RID.

The project completion report was adopted in the final joint review meeting on 5th February 2018.

A summary of the project completion report is described hereinafter.

2.3. Summary of Project Result

2.3.1 Inputs

(1) Inputs from Japan Side

Planned	Actual	Remark
1. A chief advisor/ Along term expert 2. Short term experts 1) Team Leader/Bridge maintenance engineer 2) Deputy-project manager/ Bridge repair engineer 3) Bridge Inspection Engineer 4) Road Engineer 5) Coordinator 3. Equipment for road and bridge maintenance 4. C/P training 5. Cost for Seminars and Trainings as the project activities	1. A chief advisor / A long term expert 2. Short term experts 1) Team Leader / Bridge Maintenance Engineer 2) Deputy-team leader / Road Maintenance Planner 3) Bridge Inspection Engineer (1) 4) Bridge Inspection Engineer (2) 5) Bridge Repair Engineer (1) (Planning and Design) 6) Bridge Repair Engineer (2) (Repair works Expert) 7) Bridge Repair Engineer (3) 8) Bridge Maintenance Planner 9) Road Maintenance Engineer (1) 10) Equipment procurement engineer 11) Road Maintenance Engineer (2) 12) Coordinator / Assistant for Road and Bridge Inspection 13) Coordinator for other relevant project / C/P training Supervision 14) Road Maintenance Engineer (3) (Overloading Control) 15) Database Expert 3. Equipment for road and bridge maintenance 4. C/P training 5. Cost for seminars and Trainings as the project activities	Support of pilot project Support for ME training Support for ME training Procurement of equipment Replacement of Road Maintenance Engineer (1) Addition of the activity for overloading control at Tsubasa bridge
86.00 MM	93.02 MM	

(2) Inputs from Cambodian Sides

Planned	Actual	Remark
1. Arrangement of counterpart personnel 1) Project Director 2) Project Manager 3) Other Necessary Personnel 2. Implementation cost for the pilot repair works 3. Travel expenses and allowances for the participants of the seminars and trainings organized as project activities 4. Maintenance cost of the JICA project equipment 5. Office space including its utility cost (electricity, water, internet and other necessary office facilities) 6. Etc.	1. Arrangement of counterpart personnel 1) Project Director 2) Project Manager 3) Other Necessary Personnel 2. Implementation cost for the pilot repair works 3. Travel expenses and allowances for the participants of the seminars and trainings organized as the project activities 4. Maintenance cost of the JICA project equipment 5. Office space including its utility cost (electricity, water, internet and other necessary office facilities) 6. Etc.	No change

2.3.2 List of Guidelines and Manuals

I Road Maintenance

1. Guideline for Routine Road Maintenance Using IRI (English)
2. Guideline for Road Defects Repair (English)
3. Guideline for Road Defects Repair (Khmer)
4. Guideline for Road Defects Repair – *Handbook n* (English)
5. Guideline for Road Defects Repair – *Handbook* (Khmer)

II Bridge Maintenance

1. Bridge Inspection Manual (English)
2. Bridge Inspection Manual (Khmer)
3. Bridge Inspection Manual – *Handbook* (English)
4. Bridge Inspection Manual – *Handbook* (Khmer)
5. Bridge Repair Manual (English)
6. Bridge Repair Manual (Khmer)
7. Bridge Repair Manual – *Handbook* (English) * included in the Guideline for Road Defects Repair – *Handbook*
8. Bridge Repair Manual (Khmer) * included in the Guideline for Road Defects Repair – *Handbook*
9. Bridge List Book

III Action Plan

1. Action Plan for Bridge Maintenance Cycle (English)

2. Action Plan for Bridge Maintenance Cycle (Khmer)

IV Training Material

Maintenance Expert Training Program

2.3.3 Training in Japan

Year	Program	Schedule	Number of participants
1st	THE PROJECT FOR STRENGTHENING CAPACITY DEVELOPMENT FOR MAINTENANCE MANAGEMENT OF ROADS AND BRIDGES IN THE KINGDOM OF CAMBODIA	14 October to 23 October 2015	7(2)
2nd		30 October 2016 to 12 November 2016	7(2)
3rd		5 November 2017 to 18 November 2017	7(2)

Note :( ) indicates number of trainees from MEF.

2.3.4 List of JCC

No	Date
1st	23 July 2015
2nd	18 January 2016
3rd	10 August 2016
4th	15 December 2016
5th	23 June 2017

2.4. Summary of review based on DAC Evaluation Criteria

2.4.1 Summary of the Project Evaluation Result

Project Rate: **Highly Satisfactory**

Evaluation result of DAC evaluation criteria as below;

Criteria	Result
Relevance	High
Effectiveness	High
Efficiency	Fair
Impact	Fair
Sustainability	High

2.4.2 Key Factors Affecting Implementation and Outcomes

The following factors were identified:

1) Basic knowledge and practice of quality control
2) Lack of bridge structure engineer in the ministry
3) Overloading

4) Allocation of sufficient counterpart personnel to the project
5) Budget required for the 1st year activity

2.5. For the Achievement of Overall Goals after the Project Completion

The following table is the summary of the action to take to achieve the overall goals.

Overall Goal: Appropriate maintenance of roads and bridges is managed by MPWT.		
Indicators	Target in 3 years	Actions to take
1) The road and bridge database is updated once / a year.	[Road] 1) Data collection to cover all major road inspected (target 5,000km/ year→5,000kmx3 =15,000km) 2) Increase of the DRIMS team (target 4 teams in RID and 4 teams in DPWTs (2 experts / team)) 3) Maintenance of DRIMS equipment	1) To make clear division of area / province of responsibility for inspection. RID 4 team Expand to selected 4 DPWTs for operation of DRIMS 2) Set the "Annual Road Condition Survey" using DRIMS in 5,000 km every year 3) Allocate budget for DRIMS survey
	[Bridge] 1) Implementation of bridge inspection plan Target: ● Periodic Inspection: 1,500 ● Detailed Inspection: 20 2) Database system ● Continue to use the provided server and program 3) System improvement ● License update of File Maker 4) Data sharing and communication ● Share bridge database within MPWT	1) Mark clearly the area/ province of responsibility for inspection. 2) Assign one person to be in charge of database maintenance. The Road Inventory and Ferry Department will be in charge 3) Employ a support staff for database operations. 4) Allocate budget for routine bridge inspection
2) Road and bridge maintenance plans are updated once a year based on the result of the road and bridge database updates.	[Road/Bridge] 1. Maintenance plan Revision of bridge maintenance list ~~for 3 times~~ 2. Implementation of MOM periodically FY 2018: 2 times FY 2019: 2 times FY 2020: 2 times Total 6 times	1) To survey road and bridge condition for planning purposes (related to Item 1) 2) Based on 1) update the Long Term Plan 3) Expand and share the Long Term Plan with the provincial level (RID → DPWT)

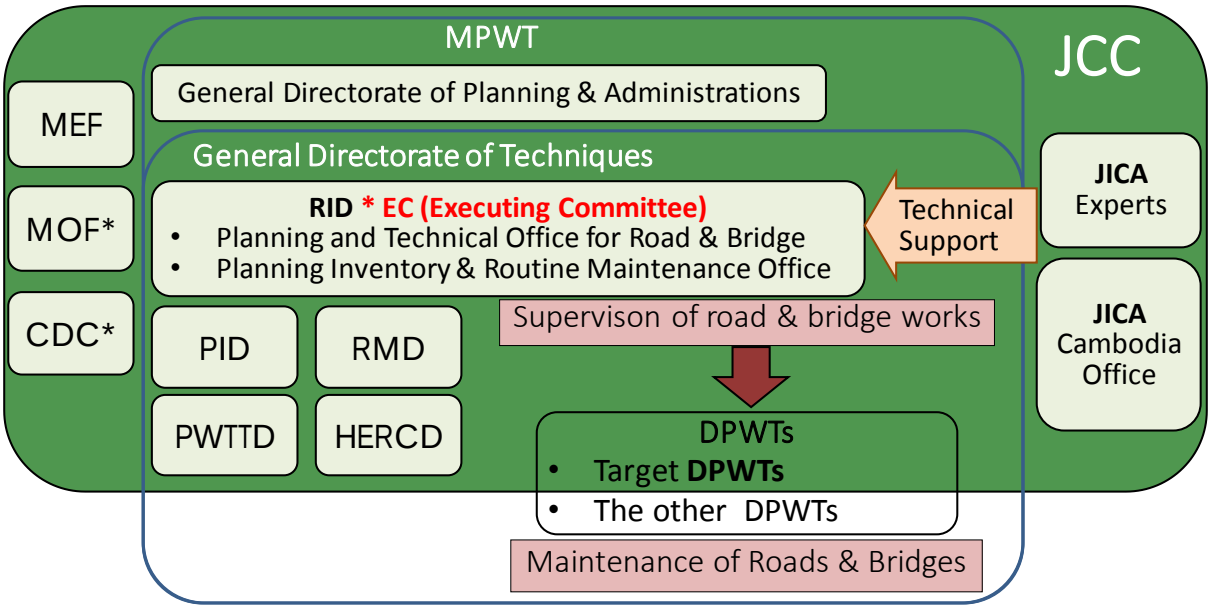
Overall Goal: Appropriate maintenance of roads and bridges is managed by MPWT.		
Indicators	Target in 3 years	Actions to take
3) The maintenance of Roads and bridges is carried out based on the road and bridge maintenance plan and according to the maintenance and repair manuals, through the supervision of RID.	1. Status of the bridge should be improved; In 2020 SD 63 → 48 (5 bridges reconstruction /year x 3 = 15, so the number of SD bridges will be reduced from 63 to 48) D 167 →143 (8 bridges repair / year x 3 = 24, so the number of D bridges will be reduced from 167 to 143)* assuming crack sealing and CFC	1) Budget request to MEF Chapter 21 (2.0M/ year) Chapter 61 (0.2 M/year) 2) To set periodical skill (technical) training (Maintenance Expert Program) in repair 3) Use of repair method introduced in the project Crack sealing (Bridge) CFC (Bridge) Cold Mix Asphalt (Road)
4) The road maintenance and repair manuals and the bridge maintenance and repair manuals are regularly reviewed.	1) Dissemination of road and bridge repair manual to DPWTs 10 manuals each to DPWT 2) Review of manual and guideline including addition and revision of the job code 1 time in 3 years 3) Implementation of Maintenance Expert Training 1 time / year x 3=3 times	1) To set periodical technical training of RID and DPWT 2) To set standard/ guideline review group (3 RID officials to be in charge) 3) Budget request for ME training

Chapter 3. Project Organization

3.1. Project Organization Chart

Figure 3-1 shows the Project Organization Chart confirmed in the 1st JCC meeting held on 10 July 2015. The Project is directed by JCC (Joint Coordination Committee) as supervisor of the Project. EC (Executing Committee) is formed under JCC for implementation of the Project.

The member lists for both committees are shown in Section 3.3 and 3.4.



Source: 1st JCC Meeting, 10 July 2015

Figure 3-1 Project Organization Chart

MEF: Ministry of Economy and Finance
MOF: Ministry of Foreign Affairs
CDC: Council for the Development of Cambodia
PID: Department of Public Infrastructure (former SPIED (Department of Sub-National Public Infrastructure and Engineering))
RMD: Department of Roads Repair and Maintenance (former RMC (Road Maintenance Center))
PWTTD: Department of Technical Public Works and Transport (former PWRC(Public Works Research Center))
HERCD: Department of Equipment and Roads Rehabilitation (former HEC (Heavy Equipment Center))

3.2. JICA Expert Team Organization

JICA Experts Team Organization is shown in Figure 3-2.

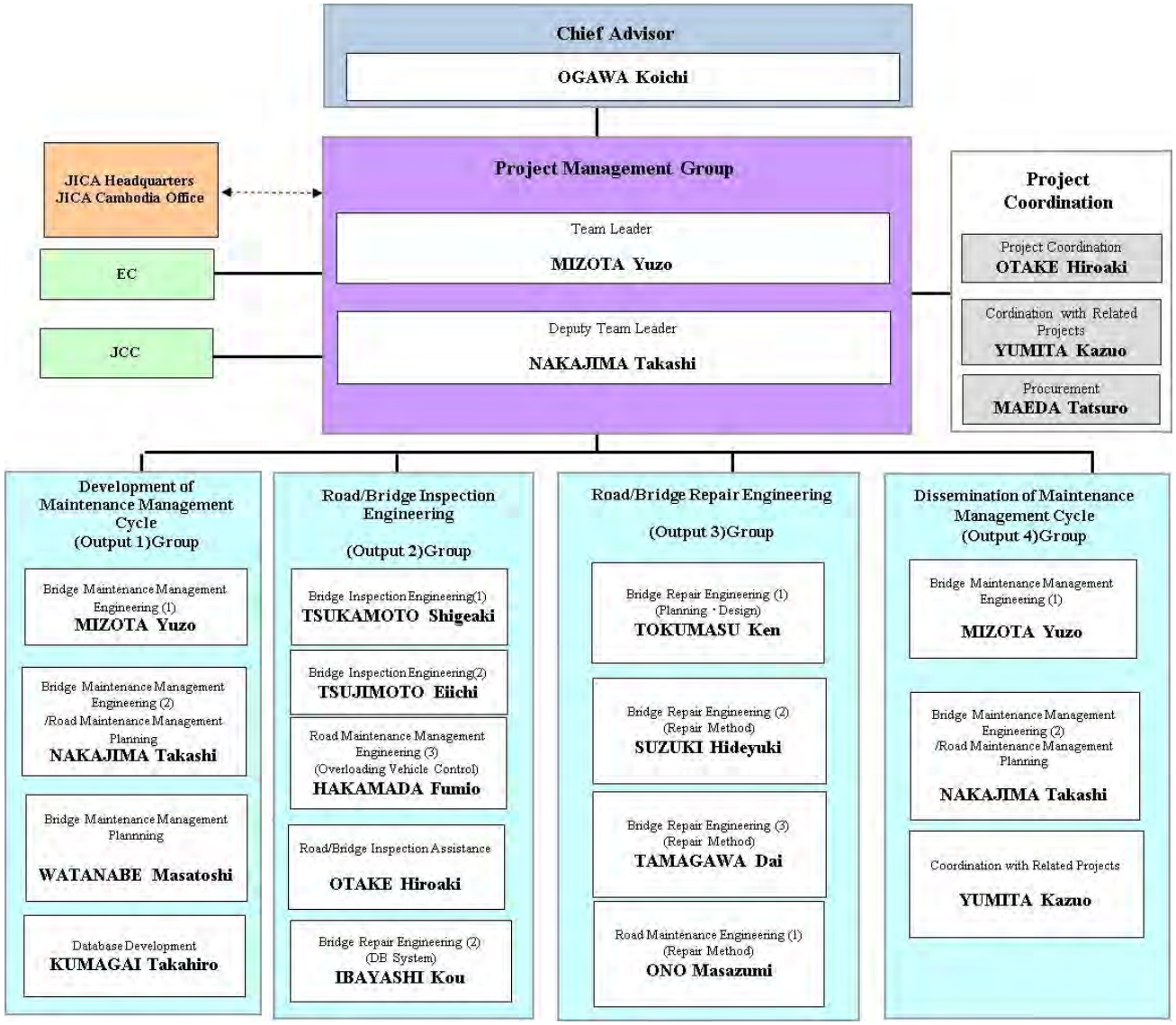


Figure 3-2 Organization of JICA Expert Team

3.3. Joint Coordination Committee (JCC)

Joint Coordination Committee Member List

1.	H.E. TAUCH Chankosal	Secretary of State,	President
2.	H.E. RHY Sophort	Director General of Public Works,	Permanent Vice-president
3.	H.E VASIM Soriya	Director General of Administration	Vice-president
4.	Mr. NOU Vaddhanak	Deputy General of Public Works	Member
5.	Representative from Ministry of Foreign Affairs and International Cooperation,		Member
6.	Representative from Ministry of Economy and Finance		Member
7.	Representative Council for Development of Cambodia		Member
8.	Director of Road Infrastructure Department		Member
9.	Director of Public Works Research Center		Member
10.	Director of Heavy Equipment Center		Member
11.	Director of Road Maintenance Center		Member
12.	Director of Sub-national Public Infrastructure Engineering Department		Member
13.	Director of Accounting and Finance Department	Member	
14.	Director of International and Cooperation Department	Member	
15.	Representative of JICA Cambodia Office		Member
16.	Second Secretary, Embassy of Japan		Member
17.	JICA Experts for the Project		Member

3.4. Executing Committee (EC)

Executing Committee Member List

1.	Mr. Chhim Phalla, Director of Road Infrastructure Department (Mr. Heng Rathpiseth, Director of Road Infrastructure Department) (Mr. Nay Chamnang Director of Road Infrastructure Department)			Project Director
2.	Mr.Chao Sopheak Phibal Deputy Director of Road Infrastructure Department			Deputy Project Director
3.	Mr. YOU Dara	Deputy Director of Road Infrastructure Department		Permanent Member
4.	Representative from Ministry of Economy and Finance			Member
5.	JICA Experts			Member
6.	Mr. KEM Socheat	Chief Office	(RID)	Member
7.	Mr. KHOUN Kompheak	Chief Office	(RID)	Member
8.	Mr. SA Sivutha	Chief Office	(RID)	Member
9.	Mr. POU Manith	Chief Office	(RID)	Member
10.	Mr. EM Sovisoth	Deputy Chief Office	(RID)	Member
11.	Mr. NIN Menakak	Deputy Chief Office	(RID)	Member
12.	Ms. THOU Saovry	Deputy Chief Office	(RID)	Member
13.	Mr. NGIM Nouba	Deputy Chief Office	(RID)	Member
14.	Mr. HAI Chandara	Deputy Chief Office	(RID)	Member
15.	Mr. NOP Kilarith	Deputy Chief Office	(RID)	Member
16.	Mr. SETHY Phanavuth	Deputy Chief Office	(RID)	Member
17.	Mr. VETH Piseth	Deputy Chief Office	(RID)	Member
18.	Mr. EM Bunnara	Deputy Chief Office	(SPIED)	Member
19.	Mr. LEAS Thlork	Deputy Chief Office	(SPIED)	Member
20.	Mr. LUN Virakvicheatra	Deputy Chief Office	(RMC)	Member
21.	Mr. HIN Son Odom	Deputy Chief Office	(RMC)	Member
22.	Mr. BOU Lindo	Officer	(RMC)	Member
23.	Mr. LONG Marly	Officer	(RID)	Member
24.	Mr. HOUT Sara	Officer	(RID)	Member
25.	Ms. CHHAY Chakriya	Officer	(RID)	Member
26.	Mr. PROMCHAN Moni Odom	Officer	(PWRC)	Member
27.	Mr. CHAN Rith	Officer	(PWRC)	Member
28.	Mr. VORK Sovan	Officer	(HEC)	Member
29.	Mr. HOUNG Sopheaktra	Officer	(HEC)	Member
30.	Representative from Department of Public Works Kandal Province			Member
31.	Representative from Department of Public Works K.Cham Province			Member
32.	Representative from Department of Public Works Battambang Province			Member
33.	Representative from Department of Public Works Seim Reab Province			Member
34.	Representative from Department of Public Works K.Thom Province			Member
35.	Representative from Department of Public Works Phnom Penh			Member

Chapter 4. Administration related to Roads and Bridges Maintenance

4.1. Road network

The road network development has contributed greatly to the transport sector in Cambodia by connecting the country to the outside world as well as linking the internal distribution system. Efforts to rehabilitate and upgrade the road network started in the 1990s with various international donors contributing to the development projects some of which have long been completed while others are being implemented.

At present, the Cambodian Road Network covers about 58,400 km of paved and unpaved roads, consisting of 7,248 km of national roads (both 1-Digit and 2-Digits), 12,249 km of provincial roads and approximately 39,000km of rural or tertiary roads. Table 4-1 shows the road length by their classification as of year 2016.

Table 4-1 Road Length by Road Classification (as of 2017)

Road Classification	Network	Paved %	Road Length (km)	Road Administration
1-Digit National Road	9 Lines	100%	2,254	MPWT
2-Digit National Road	66 Lines	70%	5,007	
Provincial Road (3 & 4-Digits)	528 Lines	30%	9,031	
Total	603 Lines		16,292	
Rural Road			38,931*(data year 2014)	MRD

Source : MPWT,MRD

However, there is still room to improve the pavement condition of the road network. The percentage of paved road, that is, 2-Digit national road and provincial road is still low even though the 1-Digit national road is 100% paved. NSDP, 2014-2018 has clearly mentioned the improvement of the road network. The MPWT shall be responsible for implementing the national policy concerning construction of all public works.

To implement the prioritized policies during the Fifth Legislature, MPWT shall carry out the following activities:

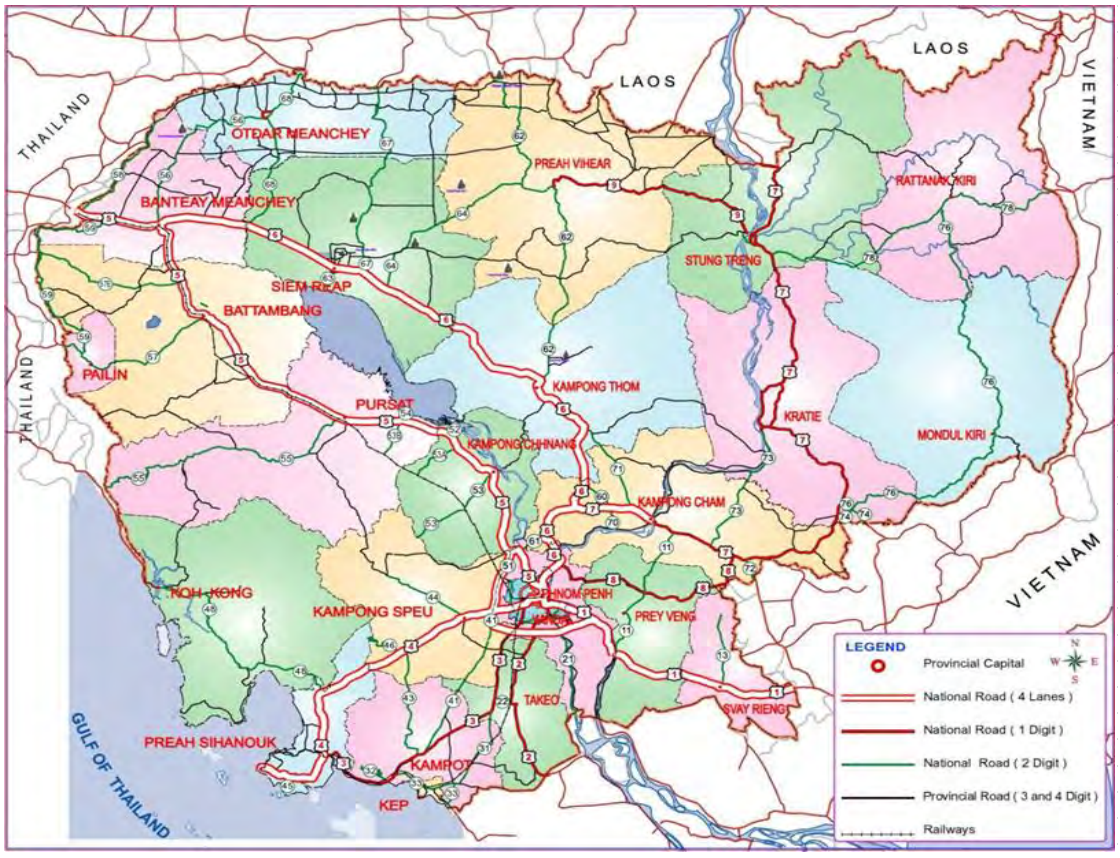
- Improve 3,500 km more of road infrastructure in the next 5 years.
- Improve 1-Digit National Roads – expand from DBST to AC pavement.
- Widen 1-Digit NRs from 2 lanes to 4 lanes in and around major cities.
- Increase the pavement ratio on 2-Digit National Roads from 50% to 90%.
- Install drainage facilities on 1-Digit National Roads for flood control.

4.2. Road Development plan

As mentioned above: MPWT has planned to develop 3,500 km of new pavement roads in the next 5 years. The Ministry has also planned to widen the roads in and around major cities from 2 lanes to 4 lanes in accordance with NSDP, 2014～2018. These developments shall be based on the following 6 strategies:

Strategy 1: Enhancement of multi growth pole development
Strategy 2: National Integration
Strategy 3: Development of international corridors for Cambodian Regional Integration
Strategy 4: Enhancement of rural socio-economic development mainly agriculture development for poverty reduction
Strategy 5: Strengthening of economic growth corridor development
Strategy 6: Promotion of tourism development

In order to achieve a proactive growth based on the above strategies, the MPWT has prepared the future road network plan targeting year 2030. See Figure 4-1 below.



Source: MPWT

Figure 4-1 Road Development Plan (Year 2030)

4.3. Organization of MPWT

The functions of the Ministry of Public Works and Transport (MPWT) are stipulated in the Sub-decree on the Organization and Function of MPWT; and those of the Department of Public Works and Transport (DPWT) in provinces and cities are stipulated in the Declaration on the Management and Process of DPWT.

There were six departments in the Directorate of Public Works as of September 2016:

1) Department of Road Infrastructure, RID
2) Department of Sub-National Public Infrastructure and Engineering, SPIED
3) Heavy Equipment Center, HEC
4) Technical Research Center, PWRC
5) Roads Maintenance Center, RMC
6) Expressway, Mega Bridge and Investment Department, EXMID

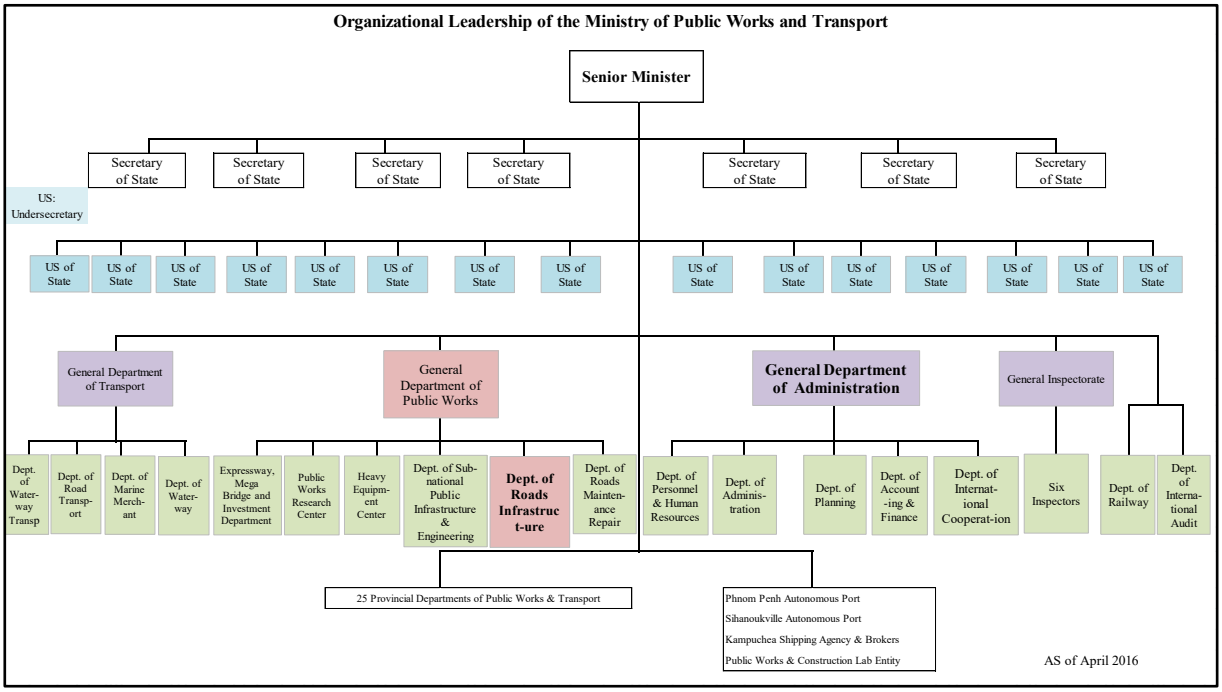


Figure 4-2 Organization of MPWT as of April 2016

Although personnel resources have not been allocated (employed), the MPWT has been reformed under the Senior Minister appointed on May, 2016. The Sub-decree of the organization and its functions was officially published on 13 October 2016. See Figure 4-3 on the next page.

The following are the main difference in comparison to the previous organization.

(1) *General Department of Technique*

Newly established to strengthen the development of international technical standards and capacity building of MPWT engineers as directed by the Senior Minister.

(2) *General Department of Road Transport and General Department of Inland Waterway, Maritime & Port*

Newly established to enhance Land Transport and Maritime Administration.

(3) *General Department of Planning & Policy*

Newly established to strengthen the practical financial and planning management.

(4) *General Department of Logistic*

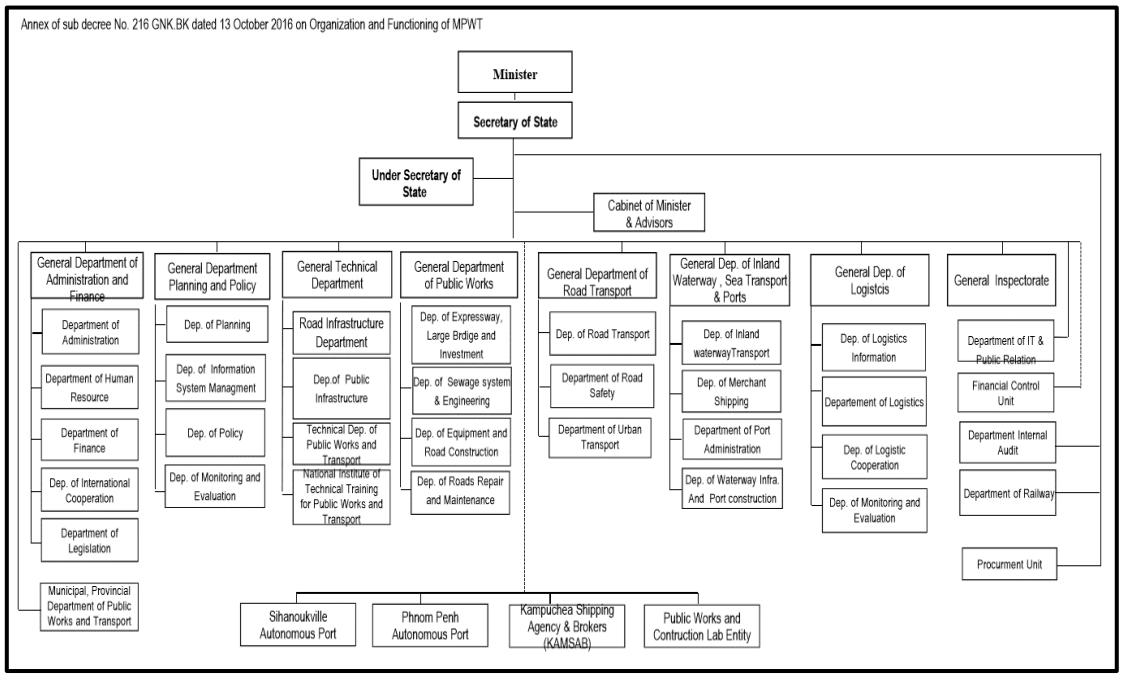
Newly established, the mandate of the department is to support solid planning of logistic policy in situation of moving logistics business between ASEAN countries as per the directive of the Senior Minister.

(5) Other remarks

- The Department of Expressway, Large Bridge & Investment is not promoted to General Department level.
- The General Department has been increased to 7 organizations from 3 as per the directive of the Senior Minister.

Table 4-2 below is a summary of the comparison of the main duties of the General Department of Technique and General Department of Public Works between the old and the new organizations.

The duties of RID remains the same even under the General Department of Technique. This means that RID shall be in charge of planning and quality control of maintenance works of roads and bridges'. However, there is a possibility for the reallocation of each RID office due to organization reforms within MPWT. In that case, the RID organization chart shall not be displayed in this Chapter.



Source: MPWT

Figure 4-3 New MPWT Organization as of October 2016

Table 4-2 Comparison of Duties between the Previous and Newly

Department	Previous Functions	New Functions
General Department of Public Works	Responsible for managing, monitoring and supervising the construction, repair, and maintenance of roads and bridges infrastructure, monitoring public property, controlling the construction and rehabilitation of the state heritages.	Responsible for managing, monitoring and orienting on construction, repair, and maintenance of public works infrastructure, public property, business investment for developing Public Works sector to provide effective services of transportation and logistics.
Department of Expressway, Mega Bridge and Investment	Duties: — To prepare policies, short-term, medium-term, and long-term strategic plans related to construction, repair, and maintenance of Expressway and Mega Bridge infrastructure; — To identify schemes of Expressway and Mega Bridge construction projects; — To prepare investment and M/P for development program for Expressway and Mega Bridge; — To prepare and publish all documents related to technical standards, investment, procedure, concession, managements of Expressway and Mega Bridge, and construction projects; — To study architectural and engineering drawings for Expressway and Mega Bridge construction projects invested on by both public and private sector; — To manage, inspect, observe, and evaluate the implementation works of Expressway and Mega Bridge projects following the technical standard; — To manage, inspect, observe, and evaluate the implementation works of Expressway and Mega Bridge projects, for both completed and on-going projects, following technical standards, and make proposals for amendment of project implementation plan whenever necessary; — To prepare maintenance programs for Expressway and Mega Bridges for both public and private projects; — To observe and inspect the service provision and traffic safety;	Duties: — To prepare policies, strategies and expressway and large bridge development plan; — To establish M/P, study and research on both architectural engineering and cost; — To prepare action plan to monitor, inspect and evaluate implementation works of expressway and large bridge constructions; — To inspect the existing old expressway and large bridges; — To organize rehabilitation project regularly; — To draft laws, legal regulations for business and investment on expressways and large bridges; — To prepare documents for public procurement for bidding; — To monitor and evaluate the investment; — To implement business corporation contract, repairing, maintaining, income and expense; and, — To prepare timely activity reports and submit to the ministry.

Department	Previous Functions	New Functions
	— To encourage cooperation and national, international, regional, and sub-regional integration of Expressway and Mega Bridge infrastructure: — To prepare activity reports every month, quarter, semester, 9-month and year for leaders; and, — To implement other tasks assigned by leaders of the Ministry.	
Department of Sewage System Construction	New Department	Duties: — To monitor and inspect Sewage filter system infrastructure; — To prepare provisions, policies, strategies, sewage system development plan; — To propose projects for rehabilitating, constructing and repairing sewage system; — To raise ideas on sewage system development in the city, town, provinces, districts, communes; — To study and research on new technology to develop sewage system in Cambodia; — To prepare timely activity reports and submit to the ministry.
Department of Equipment and Roads Rehabilitation (Former HEC)	Duties: — To plan the research for new road and bridge construction. Propose road, bridge construction plan. Perform major repairs on roads and bridges and make interventions for emergency road and bridge repair work; — To study and prepare machinery training of staff. — Prepare and disseminate technical standards for machinery use and maintenance; — Research on and disseminate regulation on job security and maintenance; — Conduct training of drivers and machinery operators, and perform driving license checks — Prepare activity reports.	Duties: — To study on the project, implementing road construction and rehabilitation, — To manage all spare parts/equipment under supervision and to provide repair service to all kinds of equipment, — To train how to drive heavy equipment, — To research and advertise provisions regarding the work safety and establish technical standard of how to use and maintain equipment and — To prepare activity reports and summit to the ministry timely.
Department of Roads Repair and Maintenance	Duties: — To intervene urgently for repair of roads, bridges and drainage,	Duties: — To intervene in urgent repair tasks on roads, bridges and sewer and construction of all types of roads, bridges and

Department	Previous Functions	New Functions
(Former RMC)	— To manage and maintain machinery and other equipment belonging to the organization; — To construct, repair and maintain roads, bridges, and all types of drainage along national roads and provincial roads; — To control the quality of bridges, roads and all types of drainage; — To prepare annual plans and source for sponsors for maintenance works, repair and construction of bridges, roads and drainage; — To conduct research to update the technical construction, repair and maintenance of bridges, roads and drainage; — To train and share construction and repair techniques with subordinate organization and relevant organization.	sewer in the road network and other public works infrastructures; — To research to develop the technical construction, maintenance, repair of bridges and roads, — To manage and take care of equipment and other spare parts properly; — To monitor the condition of bridges, roads and sewer along national roads and provincial roads; — To prepare annual plan and to seek for financial support in maintaining, repairing, and constructing roads and sewers; — To prepare timely activity reports and submit to the ministry; and, — To implement other works entrusted by the head of ministry.
General Department of Technique	New Organization	The General Department of Technique has duties to manage, monitor and coordinate the preparation of provisions and technical standards, Road Network Development Master Plan, construction layout, quality of materials and to evaluate the quality of the road construction or construction of public works and transport infrastructure.
Road Infrastructure Department (Shift from General Department of Public Works)	Duties: — To prepare roads & bridges maintenance plan and management; — To manage and control site construction of roads & bridges and ferry sites; — To manage municipality and provincial Departments of Public Works and Transport (DPWTs) in terms of public works and technical aspects relating to roads and bridges repair and maintenance.	Duties: — To control national and provincial roads and public wealth related to public works sector at sub-national level; — To plan, monitor and evaluate construction, repair and maintenance projects, construction site of roads, bridges and ferries along national road and provincial roads; — To control, register and issue license for business, corporation, laboratories to both private and public investment in the field of public works; — To monitor, examine and evaluate the quality of road construction or public works and transport infrastructures that fall under the authority of MPWT; — To prepare activity reports and submit to the ministry on time; and, — To implement other works entrusted by the head of the ministry.

Department	Previous Functions	New Functions
Department of Public Infrastructure (Shift from General Department of Public Works) (Former SPIED)	Duties: — To supervise the sub-national public infrastructure, including underground public infrastructure, on-ground public infrastructure, roads, road facilities, drainage facilities, infrastructure construction, for-road reserved land, public services on for-road reserved land, roads for pedestrians, vehicle stopping and parking places, parking premises, gardens and plantations in capitals, provinces, cities and towns; — To study, prepare and propose the underground public infrastructure development and construction projects, including tunnels, drainage facilities, networked canals, water reservoirs, drainage piping systems, and infrastructure related to the waste water treatment systems, waste water treatment stations and waste water pumping stations, — To study, prepare and propose the on-ground public infrastructure development and construction projects, including roads, road facilities, infrastructure construction, intersected roads, cross-over roads (aerial roads), divided roads, roads for pedestrians, roads for bicycles, public spaces, in order to reduce traffic jams and facilitate the food protection system in capitals, provinces, cities and towns; — To study, prepare and propose the development and construction projects for vehicle stopping and parking spaces, parking premises, roads for pedestrians, gardens and plantations along the public streets in capitals, provinces, cities and towns; — To publish and to educate people on the maintenance and protection of the underground and on-ground public infrastructure, roads, road facilities, drainage facilities, infrastructure construction, vehicle stopping and parking places, parking premises, roads for pedestrians, gardens and plantations along the public streets in capitals, provinces, cities and towns.	Duties: — To control public infrastructures, public wealth fare at sub-national level under supervision of the ministry, — To manage road and bridge constructions implemented by the engineering unit, — To cooperate with the ministries, related institutions and sub-national administration to develop Infrastructure Network Master Plan in provinces, towns, districts, communes and city, — To manage the projects of parking space, garden and forestry in capital city and provinces, — To prepare technical standards for managing public works infrastructure at sub-national level and engineering, — To prepare activity reports and submit to the ministry on time; and, — To implement other works entrusted by the head of the ministry.

Department	Previous Functions	New Functions
Department of Technical Public Works and Transport (Shift from General Department of Public Works) (Former PWRC)	Duties: — To prepare technical standards and workings; — To research on public works construction projects; — To research on quality equipment demonstration and new technology for supporting ministry works; — To extract soil information relevant to public construction works such as roads, bridges, ports, ferries, railways and airports; — To improve the infrastructure map data; — To cooperate with relevant departments to study technical standards and construction equipment quality; — To research and perform analysis of technical quality and quantity of the materials related to public works sectors; — To research a standard and common form for bridge, port, ferry and structure; — To set basic standards for construction works of bridge, port, ferry and other structures such as: • Standards for project work • Standards for the use of the equipment, raw materials, machinery • Standards for construction work — To study the project construction designs for bridges, ports, ferries and structures; — To carry out environmental impact assessment of development of the infrastructure; — To forecast transportation growth, transport environment and make plans accordingly; — To carry out research on standards and conduct a study on project design of construction works of roads, railways and airport infrastructure; — To research on new programs for road, railway and airport works cost estimates; — To cooperate on research on road, railway and airport infrastructure with local and international institutions and organizations.	Duties: — To prepare technical regulations and standards for public works and transport sector; — To study, research and prepare construction layout of public works infrastructure; — To study, research and prepare construction features, quality of materials, and insert experience and new technologies for implantation work in the field of public works and transport; — To manage technical document library, construction features, quality of materials, and insert experience and new technologies for implantation work in the field of public works and transport; — To study the layout and monitor the construction of public works infrastructure; — To prepare timely activity reports and submit to the ministry; and, — To implement other works entrusted by the head of the ministry.

Department	Previous Functions	New Functions
Institute of Technical Vocation of Public Works and Transport	New Organization	Duties: — To prepare technical regulations and standards for public works and transport sector; — To prepare policies, cooperation planning to strengthen and develop human resource capacity for both officials of MPWT, national and international students; — To study, research and collect any relevant information for job market training in order to determine the level and the need for technical skills training; — To prepare a library to keep technical documents, laboratory room for studying and researching; — To facilitate on-site practice at construction sites in order to develop capacity of students and trainees; — To coordinate, orientate and cooperate with both private and public entities and other relevant public enterprises in order to examine, research, and also to prepare lesson, schedule, and curriculum for responding to the training needs as well as the current situation and both present and future job market in order to ensure the quality and efficiency in accordance with the standard of Ministry of Education Youth and Sport; — To coordinate and communicate with both national and international development partners in order to get support, such as technical assistance, budget for study and research plus training course in and out country; — To enrich the cooperation coordination within the ministry and also with other ministries, relevant institutions and development partners both national and international in order to strengthen and enhance the management and development human resource capacity; — To prepare timely activity reports and submit to the ministry; and, — To implement other works entrusted by head of ministry.

4.4. Standards for Road Maintenance Operation

The Government of Cambodia (GOC) together with the Technical Cooperation Project (TCP) of Japan established the Quality Control and Quality Assurance (QC/QA) system for roads and bridges construction and maintenance in 2012. The TCP team prepared and published the "Standard Guideline" and "Regulations" in the MPWT as detailed below:

[Objectives of "Standard Guideline" and "Regulations"]

- To help MPWT staff conduct quality controls and ascertain quality of construction appropriately in accordance with the new institutional regulations, engineering standards and guidelines.
- To improve annual plan making procedures and methods including basic design and rough cost estimate.
- To improve detailed design and cost estimation methods and procedures.
- To improve methods and procedures of supervising construction works including daily quality control, and;
- To improve inspection methods and procedures.

[Reference documents]

The MPWT prepared and compiled five (5) guidelines for road maintenance together with the JICA experts during the period of the project mentioned above. The maintenance works are being carried out in accordance with the guidelines. Below are the published guidelines:

1) Guideline for Regular Inspection
2) Guideline for Supervision of Routine Maintenance
3) Guideline for Supervision of Periodic Maintenance
4) Guideline for Road Defects Repair
5) Technical specification for road maintenance

According to the "Standard Guideline", road maintenance works are classified into three types: namely, routine, periodic and emergency maintenance. For the routine maintenance, the typical maintenance work items are given code numbers and registered as standard methodology. The guidelines should be amended in this project.

[Routine Maintenance]

Routine Maintenance is planned based on regular (daily) inspection of the road condition as per the check list below:

— Pavement: potholes, cracks, ruts/settlements, deformations, local aggregate loss, edge break, scratches, bleeding etc.
— Cut and fill slopes
— Drainage
— Bridges: bottom, expansion joint etc.

— Other structures and facilities: markings, guardrails/handrails, signboards etc.

The results of regular inspection are promptly reported to the operation office for follow-up. The maintenance works should be undertaken either continually throughout the year or at intervals.

[Periodic Maintenance]

Periodic maintenance consists of substantial repairs carried out at an appropriate time interval (every 3-year, 5-year, 8-year, 10-year etc.) based on the age, investment and initial design of the road. It could also be carried out when and if the vehicle weight and traffic volume increase. This type of maintenance includes reconstruction, improvement, or rehabilitation works on any road section.

[Emergency Maintenance]

Emergency Maintenance comprises works to restore road and road related facilities to their normal operating conditions after damages caused by road accidents or natural causes. It is impossible to foresee the frequency, but such maintenance requires immediate attention.

4.5. Roles and Responsibilities in Force Account Project

Road and bridge infrastructure maintenance and reconstruction in force account are implemented, supervised and inspected according to the chapter budget allocated as shown in Table 4-3 below.

Table 4-3 Roles of Department concerned as of September 2016

<table>
<tr><th colspan="2"></th><th>Executor: Party B</th><th>Checking party / Supervisor: Party C</th><th>Inspector: Party D</th></tr>
<tr><td colspan="2">Chapter 21 Investment
(New Construction, Reconstruction, Periodic)BOQ</td><td>HEC
MRC
DPWT/RCAF</td><td>PWRC
RID
SPIED</td><td rowspan="4">PEAC
/GDI</td></tr>
<tr><td rowspan="3">Chapter 61
(Routine Maintenance, Periodic Maintenance)</td><td>Routine</td><td>DPWT</td><td>RID</td></tr>
<tr><td>Periodic</td><td>DPWT/MRC/
HEC/RCAF</td><td>RID/PWRC/SPIED</td></tr>
<tr><td>Emergency</td><td>MRC</td><td>RID</td></tr>
<tr><td colspan="2">Roles in design stage</td><td>1. Preparation of Basic Design
2. Preparation of Preliminary Cost Estimate for Construction
3. Preparation of Detailed Design
4. Preparation of Cost Estimate for Construction</td><td>1. Checking Basic Design
2. Preparation of Preliminary Cost Estimate for Supervision
3. Check and Sum of Preliminary Project Cost
4. Checking Detailed Design
5. Preparation of Cost Estimate for Supervision
6. Check and Sum of Project Cost</td><td></td></tr>
<tr><td colspan="2">Roles in execution stage</td><td>Execution</td><td>Supervising</td><td>Inspection</td></tr>
</table>

Note : HEC : Heavy Equipment Center
RID : Road Infrastructure Department
DPWT : Provincial Department of Public Works and Transport
RCAF : Royal Cambodian Army Force
PWRC : Public Works Research Center
PEAC : Procurement Evaluation Award Committee
GDI : General Department of Inspection
MRC : Prepare and Maintenance Roads Center
SPIED : Sub-National Public Infrastructure and Engineering Department

4.6. The Contract

The Contract shall be made between concerned parties in March to February of the year of project implementation. The formation of Party A, Party B, Party C and Party D during project implementation is shown in Figure 4-4 below.

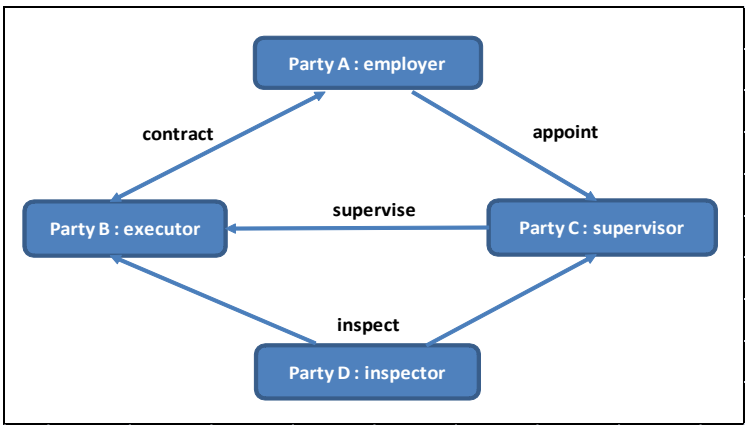


Figure 4-4 Formation of Each Party

- Party A, Party B, Party C and Party D

The following parties shall be the party to the force account project:

[Party A] The Employer, Director General of Public Works represents Party A. The main roles and responsibilities of the Employer are:

1) To give permission to Party B to work on site;
2) To appoint Party C as the Supervisor and inform Party B of the appointment;
3) To request the MEF to pay an amount to Party B and Party C from time to time.

[Party B] The Executor represents Party B. The main roles and responsibilities of the Executor are:

1) To carry out the Works as per the Contract Documents;
2) To commence and complete the Works within the construction period;
3) To carry out quality tests and keep records in accordance with the standard guideline;
4) To submit monthly report to Party C.
5) To never subcontract any part of the Works, without the prior consent of Party C for such subcontract;
6) To inform Party C of any unforeseen conditions when encountered.
7) To request Party C for extension of time with reasons if the Works delay.
8) To request for inspections in accordance with the standard guideline and the regulation for interim payment, payment at completion and remaining payment after warranty period.
9) To submit to Party A through party C upon completion of the works, all contract documents with as-build drawings and important papers (one hard copy and soft copy in PDF format).

[Party C] The Supervisor represents Party C. The main roles and responsibilities of the Supervisor are:

1) To supervise the Works carried out by Party B;
2) To witness quality tests and check the records in accordance with the standard guideline;
3) To review monthly report submitted by Party B and compile monthly report adding observations of Party C;
4) To review unforeseen conditions reported by Party B and make concept design change, if necessary;
5) To review request of extension of time by Party B and to make decision within a reasonable time;
6) To stop and/or suspend the Works, if the Works are not as per the Contract and/or for any valid reason;
7) To instruct Party B in order to achieve the set standards as per the Contract and to make design change, if necessary;
8) To check the Works and review the records upon requests of inspection from Party B for interim payment, payment at completion and remaining payment after warranty period and to inform Party D for their inspection, if satisfied with the works.

[Party D] The Inspector represents Party D. The main roles and responsibilities of the Inspector are:

1) To check the Contract prior to signing by both Party A and Party B.
2) To conduct inspection upon request by Party B through Party C in accordance with the regulation and the standard guideline for interim payment, payment at completion and remaining payment after warranty period.

4.7. National Budget for Road and Bridge Maintenance

The estimated National Budget for Maintenance and New Construction of the Road Network from Year 2008 to 2017 and the projections for year 2018 are shown in Table 4-4, Figure 4-5 and Figure 4-6. Figure 4-7 shows the typical process for the annual budget requirements and disbursement.

Table 4-4 Transition of National Budget for Maintenance

Fiscal Year	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Total Budget (Million US Dollar)	39.29	78.05	80.95	137.8	127.25	113.75	123.75	118.5	133	193.75	205
Annual Growth Rate (%)	-	98.65%	3.72%	70.23%	-7.66%	-10.61%	8.79%	4.24%	12.24%	45.57%	5.8%
Routine Maintenance (Chapter61)	8.81	17.14	17.86	16.1	15.75	20	23	30.75	31.25	41.75	41.75
Periodic Maintenance (Chapter61)	14.29	13.29	15	26.59	32.5	37.5	27	14	18.25	18.25	18.25
New Construction (Chapter21)	11.9	45.24	45.24	50	51.25	51.25	61.25	61.25	70	123.75	135
Maintenance after Flooding	2.38	-	-	41.45	23.75	-	-	-	-	-	-
Emergency Maintenance	1.9	2.38	2.86	3.66	4	5	12.5	12.5	13.5	10	10

Source: MPWT

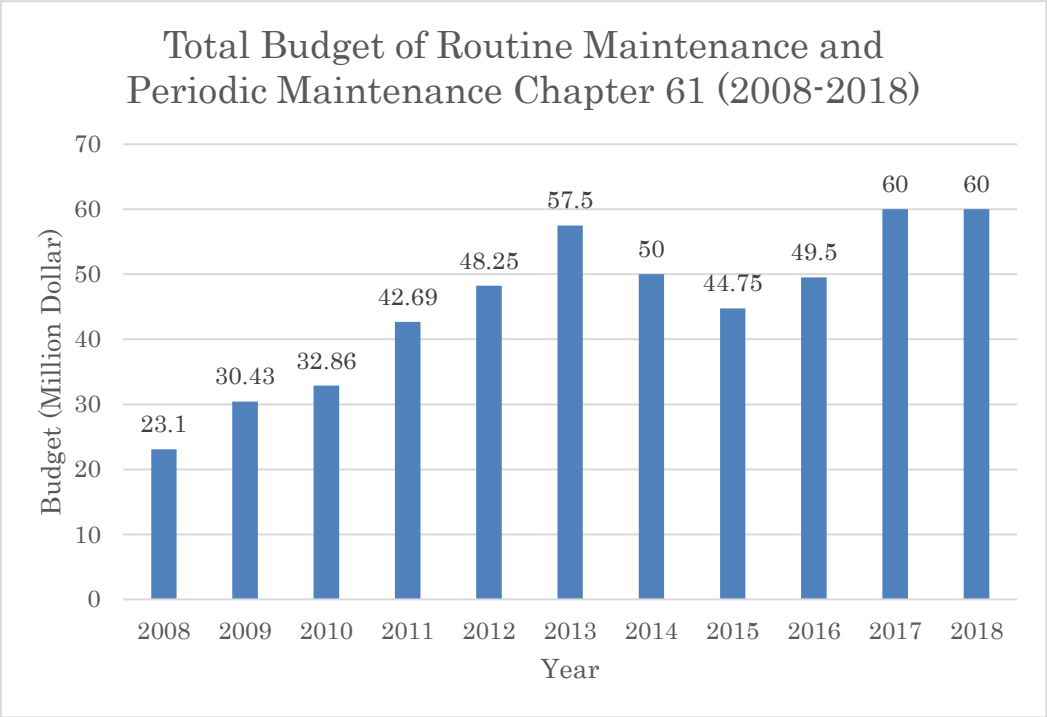


Figure 4-5 Transition of National Budget for Chapter 61

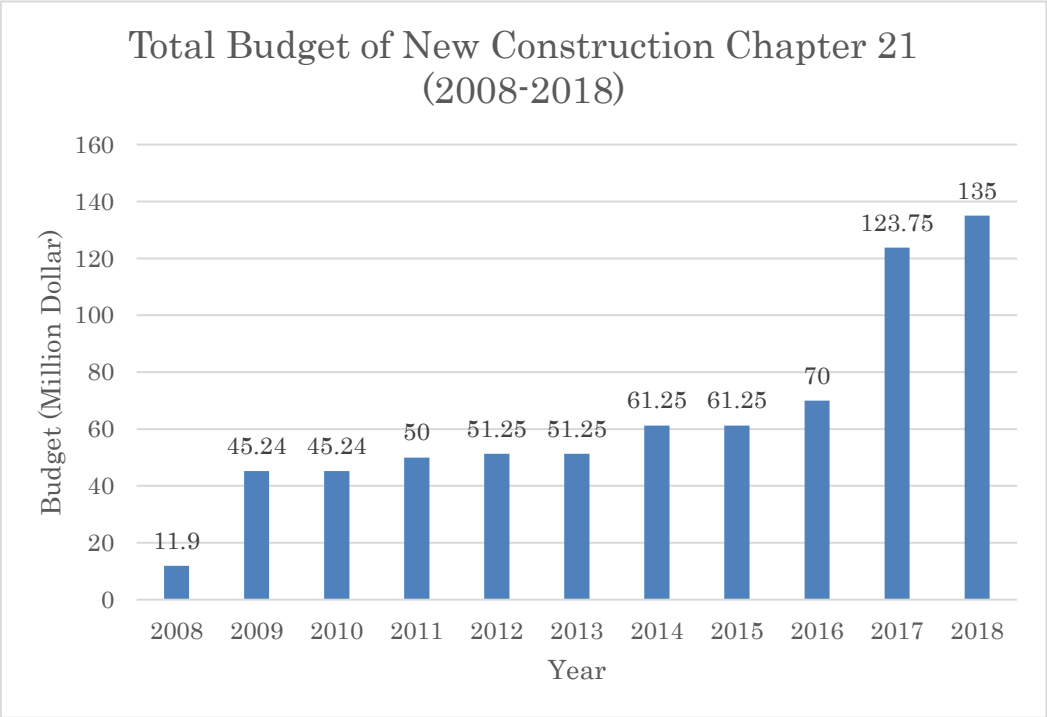


Figure 4-6 Transition of National Budget for Chapter 21

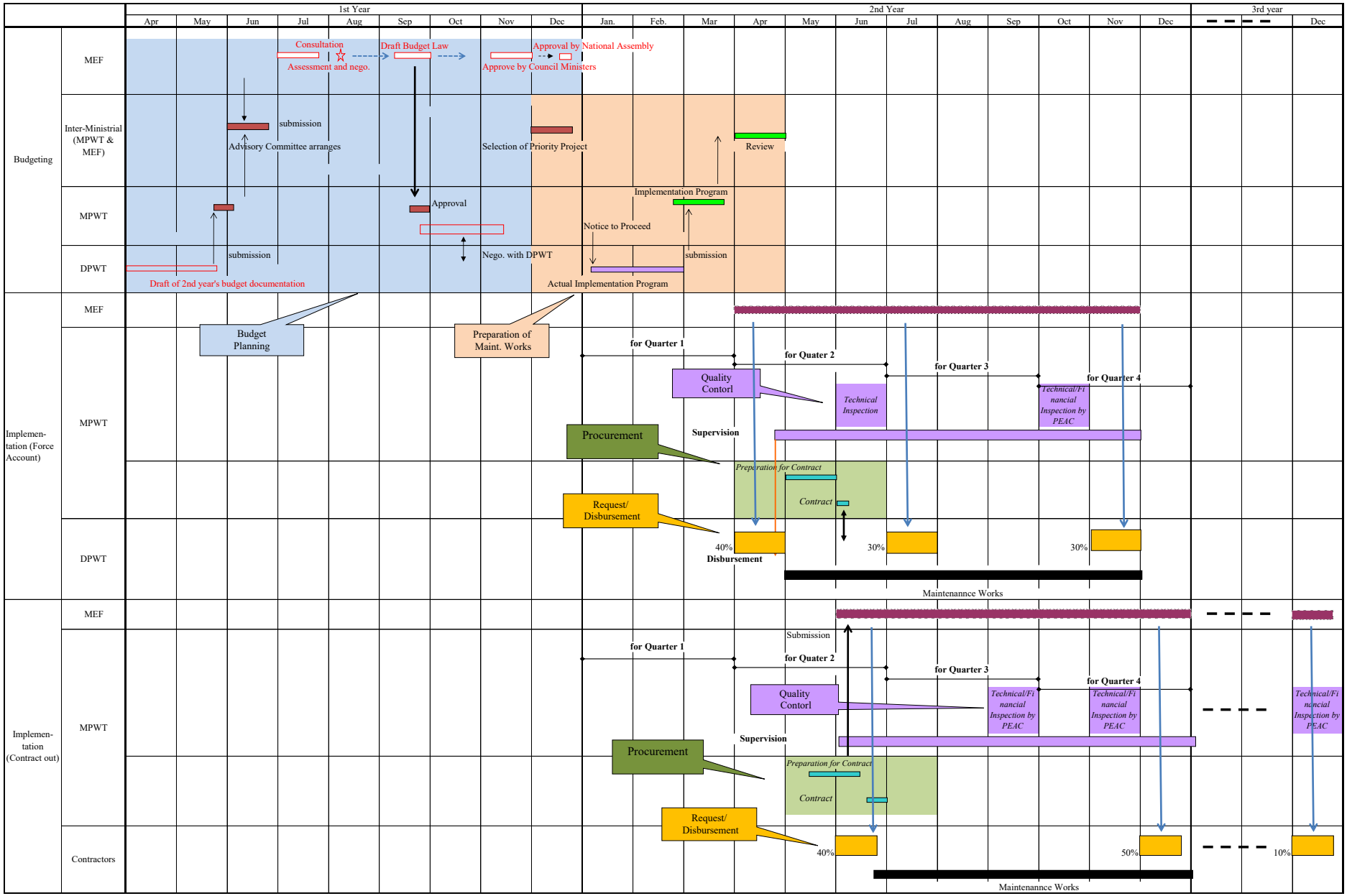


Figure 4-7 Process of Budget Requirement and Disbursement

4.8. Comparison of other donors programs for related maintenance work

4.8.1 The WB and ADB program

Since the establishment of the road network in Cambodia, the MPWT has been receiving support from various programs such as JICA, WB, ADB and other donors for road maintenance works. In this regard, the MPWT has planned to establish the "PUBLIC WORKS STREAMLINING PROGRAMS" to focus particularly on quality control. The program aims to maintain the proper quality of the road network. The program shall have six important roles to play:

i. Quality Assurance & Quality Control (QA & QC) Program (ADB Loan 3576 – RNIP on-going)
ii. Institutional Capacity Building and Regulatory Framework Program (CDTA 9300, on-going)
iii. Axle Overload Control Strengthening Program (CDTA 9300, on-going)
iv. Road Maintenance Planning Program (WB RAMP 2, on-going)
v. Road Safety Improvement Program (Q4 2017 – 2019)
vi. Climate Resilience Infrastructure Program (Proposed to ADB)

Table 4-5 below outlines the support for past and on-going projects under the Road Asset Management Project (RAMP). These projects have been guided to MPWT planned programs.

Table 4-5 Outline of donor supported projects

	RAMP	RAMP 2	2nd RAMP
Donor	IDA, ADB, AusAID, OPEC	WB	ADB *(only TA)*
Project Structure	Road Asset Management Organization (RAMO) is the executive arm of the RAMP and RAMO had support from Project Technical Committee (PTC), National Road Safety Committee and MEF in the decision making process.	RAMO is the Regulatory Authority to manage.	PMU3 is the Executing Authority.
			
Project Period	19 Dec. 2008 to 31 Dec. 2014	Oct. 2016 to Apr. 2022	・ *Mar.* 2015 *to Sep. 2016 (TA)* ・ 2017～2022, changed name to NRIP
Project Cost	63 million	65 million (including 4.8 million from National Budget)	*1 million (TA)* 95 million (estimated by TA survey)

	RAMP	RAMP 2	2nd RAMP
Supporting Policy	1) Ensure continued effective use of rehabilitated national and provincial road network in support of economic development in Cambodia 2) Improving the institutional and technical capacity of MPWT for road maintenance planning, budgeting and operations	1) Establishment of Road Assets Management 2) Capacity Development of RDCMU (Road Data Collection Management Unit) 3) Education on Traffic Safety 4) Implementation of Emergency fund use	*TA:* ・ *Adequate Roads rehabilitation* ・ *Axle Load Control Study* Loan: ・ Implementation of Road rehabilitation with Performance Based Contract (PBC) ・ Enhancement of Axle Load Control and Capacity Development
Content of Project	1) Road Asset Management through implementation on the following roads: ・NR5-1, NR5-2 ・NR1-1, NR1-2 ・NR7-1, NR7-2, NR7-3 ・NR73 ・NR71 ・NR2714 ・NR11 ・NR2 2) Capacity development of institutional, organizational and personnel related to road asset management 3) Establishment of Increasing private sector involvement 4) Establishment of personnel incentive system	1) Rehabilitation of the roads listed below: ・NR3 64 km (AC) ・NR7 164 km (AC) (May 2017 to Apr. 2020) 2) Training program for Road analysis and decision of priority roads using ROMDAS and FWD through HDM4 Procurement of ROMDAS & FWD: 3 units 3) Education on traffic safety: (May 2017～) 4) Planning of RAMP3 (150millionUS$)	*TA;* *1) Feasibility Study on below roads* *・NR8 98 km (AC)* *・NR76 88 km (AC)* *・NR78 153 km(AC)* *・NR64 92 km(AC)* *・NR67 135 km(AC)* *・NR1 96.9 km (AC* *・NR6 49.9 km (AC)* *・PR23 19.9 km (DBST)* *・PR312 28.5 km (DBST)* *2) Plan for Enhancement of Axle Load Control* *3) Plan for contract out scheme for National budget* *4) Study on Result Based Lending(RBL)* Loan: 1) Implementation of below roads NR1,6 and PR23, 312 NR:AC, PR: DBST 2) Introduction of Axle Load Control system 3) Quality Assurance System 4) Enhancement of Road Safety
Output	1) Road inventory using ROMDAS 2) Implementation of 12 roads rehabilitation 3) Training program for personal improvement 4) Detailed design and tender documents for NR3 and NR7 under RAMP2	1) Education program on Data analysis using ROMDAS & FWD 2) Implementation of 2 roads with PBC (Performance Based Contract)	*TA:* *1) Report on each rehabilitated roads* *2) Procurement schedule of Way station* *3) Study report on introduction of RBL* Loan: 1) Implementation of rehabilitation of roads through the PBC scheme

	RAMP	RAMP 2	2nd RAMP
	budget		2) Capacity development of weigh station and selection of axle load control 3) Community based safety program
Lessons learnt * Completion Stage Benefit Monitoring and Evaluation Report (June 2014)	1) Lack of adequate number of contractors with project management skill 2) Disregard for environmental impact and on-site safety 3) Lack of drainage system 4) Lack of awareness of construction schedule 5) Poor construction of pavement structure 6) Payment delays due to failure to assess progress 7) Inadequate data collection due to lack of incentive 8) Very good at management of RAMO		

4.8.2 Detailed Activity for ADB Project concern about Quality Control

[Road Network Improvement Project (RNIP)]

The Road Network Improvement Project (RNIP) aims to provide more efficient transport on the national road sections of the Greater Mekong Subregion (GMS) Southern Economic Corridor (SEC) (National Road [NR] 1 and NR6) through the provinces Prey Veng, Svay Reing and Seam Reap and on the provincial roads (Provincial Road [PR]23 and PR312) through Prey Veng and Kandal provinces of Cambodia with high poverty incidence. The national roads NR1 and NR6 are main international linkages to Vietnam and Thailand. The provincial roads PR23 and PR312 are priority roads included in government's key infrastructure development agenda and connected to NR1 of the GMS SEC in southeastern of Cambodia. The improved project roads are expected to maximize the economic potential of the GMS SEC and provide increased economic and employment opportunities and year-round access to larger markets, health centers, and education facilities.

All four project roads are prone to climate change effects such as frequent flooding when the level in Tonle Sap and Mekong rises and classified as "moderate risk". The project will rehabilitate the 146.8 km national roads NR1 (upgrade to asphalt concrete from double bituminous surface treatment (DBST)) and NR6 and rehabilitate/reconstruct PR23 and PR312 with DBST surface and provide the

climate resiliency measures estimated to $3.0 million for NRs and $8.3 million for PRs, such as road elevation, localized full replacement of pavement structure, reinforced embankment slope protection, increased drainage capacity, and additional urban drains and outlets.

In addition to improving the priority roads, the project aims to help the Government in resolving the sector issues: (i) lack of sustainability of the road asset being resulted partly from the inadequate construction quality and vehicle overloading, and (ii) high road crashes largely impacting on the vulnerable road users. To this end, the project aims to (i) improve the MPWT's quality assurance mechanism, (ii) provide necessary equipment and facilities for better controlling vehicle axle loads, and (iii) improve road safety on the project roads and in communes along the project roads.

The project will have four following outputs and implementation schedule (see Table 4-6):

Output 1: Safe and climate resilient national and provincial roads completed.

The Project will improve about 195.2 km of national and provincial roads. The NRs will have 3.5 x 2 + 1.5 x 2 = 10 meter (m) widths with paved shoulders. However, in some of the major developed areas, the number of existing traffic lanes is 4 and shoulder widths increase to up to 2.5 m. The PRs will have 3.25 x 2 + 1.5 x 2 = 10 m widths with bituminous shoulders. The project will provide the climate adaptation measures on the project roads, such as road elevation, localized full replacement of pavement structure, reinforced embankment slope protection, increased drainage capacity, and additional urban drains and outlets.

Table 4-6 Lists of Project Roads

Sub-output	Location	Road No.	From	To	Length (km)
1.1	Prey Veng & Svay Rieng	NR-1	km 62.1 (junction with Neak Loeang)	km 159.00 (the western edge of Bavet city)	96.9
1.2	Siem Reap	NR-6	km 317.1 (junction with airport road north edge of Siem Reap)	km 367.0 (south end of river bridge)	49.9
				Sub-total (national roads) =	**146.8**
1.3	Kandal	PR-23	PR110, Koh Thom Bridge	PR118, Peam Raing commune	19.9
1.4	Prey Veng	PR-312	NR1, PK77+100 Samroung, Lvear, Pras sdach district	Banteay Chakrey Border	28.5
				Sub-total (provincial roads) =	**48.4**
				Total =	**195.2**

Output 2: Axle load control enhanced.

The Project will (i) improve the operation of six weigh stations by (a) purchasing required equipment for three weigh stations at Bavet on NR1, at Puok on NR6, at Thnal Tutoeng on NR7, and (b) providing necessary building structures for another three weigh stations at Kratie and Steuong Treng on NR7 and at Kompong Thom on NR6; (ii) operationalize two mobile teams by providing weigh scales and vehicles; and (iii) provide on-the-job training for weigh-stations staff and mobile teams. The project will also undertake pilot control of axle load at sources and introduce particular conditions

to the civil works contract to enforce contractors to obey the load limits.

Output 3: Quality assurance system in MPWT strengthened.

The project will (i) establish laboratory network by providing four regional laboratories in Siem Reap, Kampot, Pursat and Kratie provinces equipping it with good quality test equipment and qualified and trained laboratory personnel, (ii) provide field laboratory test equipment for soils, aggregates and concrete to all 25 provinces to enhance testing services in the provinces plus 5 sets for GDPW, MPWT, (iii) establish a dedicated Quality Assurance wing within MPWT, (iv) develop a Quality Management System and Standard Operating Procedures for both regional laboratory management and Quality Assurance Wing, (v) provide a computerized Laboratory Information Management System (LIMS) by integrating the activities of the regional laboratories, (vi) recruit/redeploy MPWT staff and train them in the operation of the new QA process and procedures (vii) prepare a long term development plan for the effective and continual improvement of the quality assurance system in MPWT, (viii) provide field survey equipment to assess road pavement condition.

Output 4: Road safety along project roads improved.

This output will focus on a three-stream approach to establish sustainability in road safety on project roads: (i) data compilation and analysis; (ii) provision of school safety zones; and (iii) law enforcement in project.

Table 4-7 Implementation Schedule of NRIP

Table 4-7 Implementation Schedule

Activities	By When	2016		2017				2018				2019				2020				2021				2022				2023			
		3Q	4Q	1Q	2Q	3Q	4Q	1Q	2Q	3Q	4Q	1Q	2Q	3Q	4Q	1Q	2Q	3Q	4Q	1Q	2Q	3Q	4Q	1Q	2Q	3Q	4Q	1Q	2Q	3Q	4Q
A. Management Activities																															
1. Recruitment of project implementation and supervision consultant (PIC) (advanced action)	Jun-17																														
2. Mobilization / engagement of projecct implementation and supervision consultant	Mar-18																														
3. Land acquisition and resettlement	Feb-18																														
4. Annual and/or midterm review	Dec-18																														
5. Project completion report	Jun-23																														
B. Outputs																															
1. Safe and climate-resilient national and provincial roads improved																															
1.1 Undertake detailed design, update safetguard documents, and procurement support *(financed under TA-8784 CAM additional financing - Project Readiness Improvement Fund)*	3Q 2017																														
1.2 Procurement of civil works contractors	4Q 2017																														
1.3 Construction of civil works: rehabilitation and maintenance contracts																															
Rehabilitation and maintenance of national roads (NR-1 and NR-6; total = 146.8 km)	3Q 2018																														
Provincial roads (PR-23 and PR-312; total = 48.4 km)	4Q 2018																														
2. Axle load control enhanced.																															
2.1 Procurement and supply of portable weigh scales, generator-2KWA, vehicles for 2 mobile teams; and on-the-job training	2Q 2018																														
2.2 Procurement, supply and installation of equipment and software to upgrade existing 3	2Q 2018																														
2.3 Procurement and implementation of civil works contract to improve 3 weigh stations	4Q 2018																														
2.4 Commence Controlling axle loads at weigh stations and by mobile team	2Q 2019																														
3. Quality assurance system in MPWT strengthened.																															
3.1 Undertake detailed design and prepare bidding documents for laboratory buildings	1Q 2018																														
3.2 Procurement and implementation of civil works contract for laboratory buildings	2Q 2018																														
3.3 Procurement, supply and installation of QA laboratory equipment	4Q 2018																														
Field laboratory equipment for 25 PDPWTS and 5 sets for MPWT																															
Regional and main laboratory equipment																															
FWD and road roughness profiler																															
3.4 Recruitment and training for engineers/techincians	2Q 2019																														
3.5 Commence laboratory and QAW operations	3Q 2019																														
4. Road safety along project roads improved																															
3.1 Selection of consulting firm	4Q 2017																														
3.2 Implement community-based road safety program	2Q 2018																														
3.3 Construction of school zones	4Q 2019																														

under TA-8784 CAM additional financing
maintenance period

[Institutional Capacity Building and Regulatory Framework Program]

Advisory TA, US$ 1.50 Million, has been mobilized since July 2017. The TA will help MPWT in refining the business process to effectively implement the Road law and managing the national and provincial road asset through optimizing the organization structure and strengthening staff capacity of the General Department of Public Works (GDPW), the General Department of Administration and Finance (GDA) and the National Axle Overloading Control Committee (NAOCC) Secretariat which are involved in managing the road asset and controlling vehicle overloading.

1) Link to Country Partnership Strategy/Regional Cooperation Strategy:

The TA will assist MPWT in addressing the key sector issues: incomplete regulatory framework, lack of sustainability due to inadequate funding and overloading, and lack of private sector participation. The NSDP, 2014-2018, aims to reduce poverty and vulnerability in Cambodia by assisting the government agencies in the implementation of sector reforms, building institutional capacity, catalyzing resource flows, and promoting private sector participation. The objective of the proposed TA aligns with the NSDP' priorities. It is expected that the updated and/or newly prepared strategies, polices, and roadmaps will help MPWT engage stakeholders for long-term collaboration in more systemic way and achieve MPWT's goal to deliver a safe and sustainable road network to GMS and domestic road users and support social and economic growth in Cambodia. The TA will supplement the planned assistance under the Road Network Improvement Project (RNIP) in resolving the technical and operational issues of the weigh stations thereby it is expected that the TA will be sufficient to help achieve the expected outcome and impact of this TA and RNIP, in general for controlling axle overloading in Cambodia.

2) Impacts

The expected TA impact will be transport infrastructure contributing to the enhancement of national competitiveness and people's welfare developed.

3) Outcome

The expected TA outcome will be MPWT's capacity in delivering road services strengthened.

4) Outputs

Output1: Institutional and regulatory frameworks strengthened

The TA will help MPWT (i) draft required procedures; regulations, and guidelines for implementing the Road Law; (ii) prepare time bound action plan for approving such procedures, regulation and guidelines; (iii) determine road sector financing needs up to2025 and preparing a policy note on road sector financing options for future direction; (iv) optimize organizational structure of GDPW, GDA and NAOCC, and (v) update the human resource

development plan including strengthening institutional capacity for gender mainstreaming both through the Gender Mainstreaming Action Group and divisions.

Output 2: Strategic framework for engaging private sector in road maintenance

The TA will help MPWT in (i) developing a strategy for engaging private sector in road maintenance that give overall direction to MPWT to further outsource road maintenance works in systematic way, (ii) preparing a roadmap for implementing the strategy with clear indicators and targets to monitor the change and performance, (iii) refining the business process of GDPW and GDA in managing outsourcing force account works, (iv) strengthening the standard bidding documents for road maintenance and the manual for maintenance supervision.

Output 3: Axle overload control operations strengthened

The TA will help MPWT in (i) developing a strategy to combat vehicle overloading that give direction to MPWT in introducing implementable and step-wise approaches and cost effective technologies to achieving reduced vehicles overloading, (ii) preparing a roadmap for implementing the strategy with clear indicators and targets to monitor the change and performance, (iii) refining the business process of NAOCC Secretariat, and (iv) preparing procedure for internal calibrating of weigh scales being used in weigh stations and mobile team.

Chapter 5. Output 1: The Bridge Maintenance Cycle is Established

5.1. To review the present bridge maintenance cycle and the works of RID in comparison to the existing Japanese system

(1) Observed Bridge Maintenance Cycle in Cambodia

In order to observe the actual practice on bridge maintenance cycle, the JICA Experts Team carried out investigations on activities by DPWT in 2 Provinces of Kandal and Takeo near Phnom Penh, (see Photo 5-1). The Experts Team observed that the works should be conducted taking account the basic civil engineering standards in order to meet the desired quality for bridge repair (for example: concrete should never be mixed in the rain). In order to correct such on-site practices, there should be a strong management structure to issue guidance.

To support these issues, during the training in Japan, the JICA Experts Team carried out basic lectures and practices on bridge inspection and repair.



Photo 5-1 Investigation by the Experts Team on Current Bridge Maintenance Practices

Studies on the major issues on establishment of bridge maintenance cycle were conducted jointly with the Counterparts. Table 5-1 summarizes major issues observed for establishment of the Bridge Maintenance Cycle. It was noted that not only a manual and database are important for bridge maintenance, but also organization and human resource development.

Table 5-1 Observations for the Establishment of Bridge Maintenance Cycle

<Manual>

Name	Issues to be considered
Bridge maintenance manual on framework	· There is a need to establish a framework for bridge maintenance cycle. · Standardization of procedure on bridge maintenance · Coding of required jobs for budget allocation · Visualization of the current condition of the bridge is recommended
Bridge maintenance manual on defect repair	· It is necessary to identify typical defects in Cambodia and standardize the repair method and manual · Consider contracting private companies to carry out specific repair works · There is a need to make specific maintenance program for mega-bridges (e.g. Tsubasa Bridge, Kizuna Bridge, Monivon Bridge, Chroy Changwar Bridge etc.)

<Bridge Database>

Name	Issues to be considered
Bridge Database	· A standardized method (item, system and tool) for bridge database is required. · Database server and maintenance unit is required.
Bridge Inspection Data	· Standardized method for bridge inspection is required. · Integration of the inspection results to the database is required.

<Organization >

Name	Issues to be considered
Technical capability	· It is absolutely necessary to train experts on bridge maintenance (including inspection, database and repair) · Administrative mechanism to promote such experts in government and private sector. · It is highly necessary to train DPWTs for typical repair items for concrete bridges, for example, concrete crack repair methods. (**Note:** More than 90% of bridges in Cambodia are concrete)
Clarification of section in charge	· Highly necessary to create a section in charge of bridge maintenance within RID.
Reporting Line/ Action	· It is necessary to redefine reporting line for bridge damages / accidents from DPWT to RID as well as action to be taken
Sharing information and document	· While RID is the responsible for all maintenance of the road and bridge infrastructure, technical document such as design report, design drawing, AS built drawing etc., is not well collected from PMU.

< Tools and Equipment >

Name	Issues to be considered
Tools	· It is highly necessary for RID and DPWTs to have basic bridge inspection tools (e.g. Bridge inspection hammer, binoculars etc.,)
Equipment	· It is highly necessary for RID and DPWTs to be equipped with bridge repair equipment (e.g. bridge inspection vehicles, epoxy resin, high pressure washing machine and so on.) · It is highly necessary to prepare urgent repair kits (ex. concrete bond, anti-corrosion spray etc.) · Scaffolding is required for detailed bridge inspection.

5.2. To Propose 3 Year Bridge Maintenance Strategic Plan with the Annual Action Plan to Establish a Proper Bridge Maintenance Cycle

5.2.1 Annual Action Plan

(1) Bridge Maintenance Cycle to adopt in Cambodia

The bridge maintenance cycle to adopt in Cambodia is proposed as shown in Figure 5-1.

It is composed of 5 technical steps and support by MOM (Maintenance Operation Meeting) and ME (Maintenance Expert [Training]).

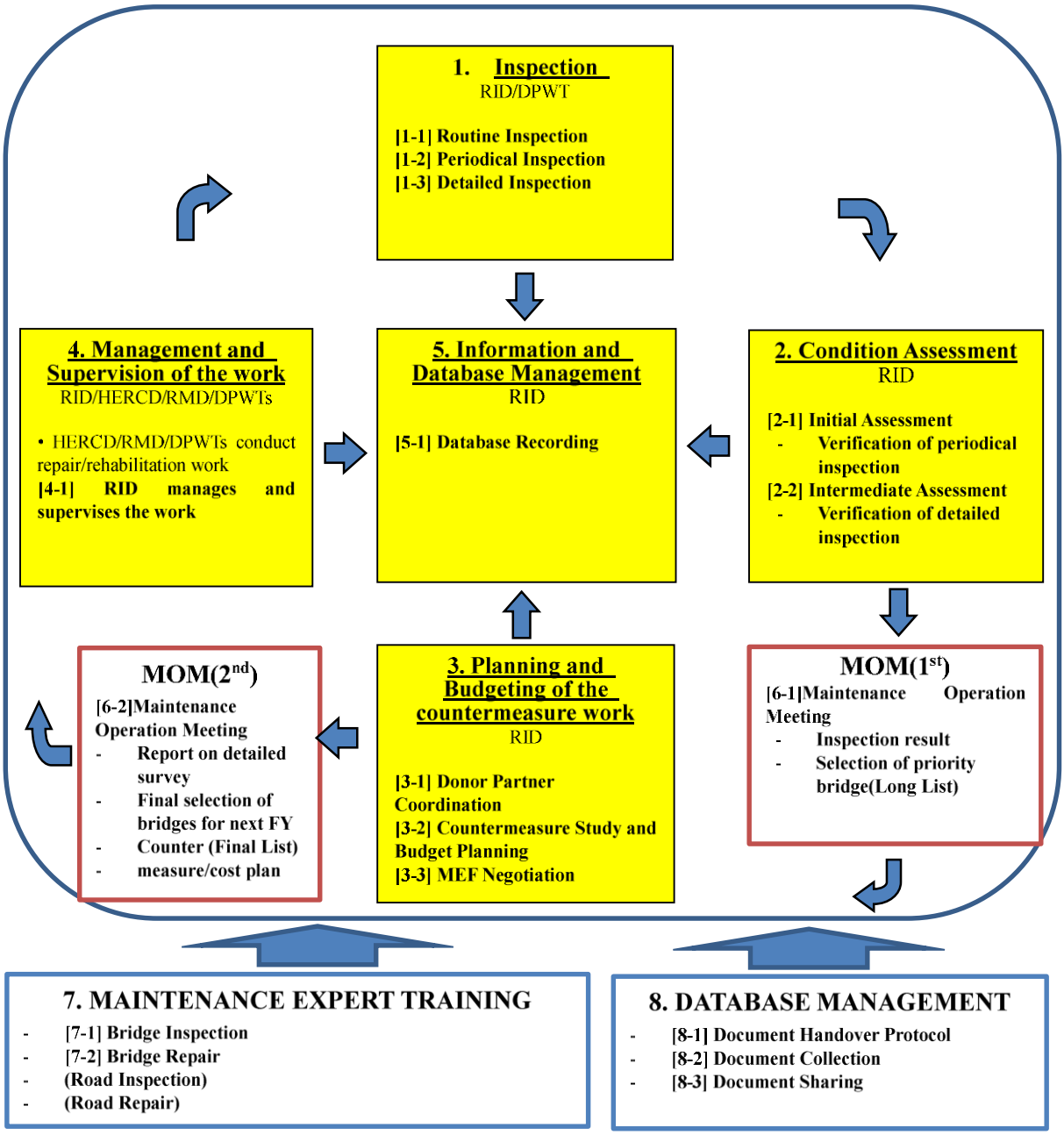


Figure 5-1 Schematic Image of Bridge Maintenance Cycle for Cambodia

(2) Annual Action Plan

In order to adopt the procedure, an action plan for adoption of the bridge maintenance cycle was drafted to practice all procedure for FY 2018 (Figure 5-2). 'Bridge Inspection Manual' and 'Bridge Repair Manual' were prepared by MPWT staff. The details of these manuals are explained in Chapter 6. The following were key points to set the annual action plan. The plan was elaborated through discussions with the relevant departments of MPWT and MEF. The 1st Maintenance Operation Meeting (MOM) was held in May 2017. The Intermediate meeting was held in September and 2nd in December.

Routine Inspection:
The ideal inspection method is the close inspection. However, considering budget constraints, the afar inspection by binoculars once/bridge/5 year is proposed. This is the same frequency as the 2000 bridge inspection by ipad. This is to say that every year, routine inspection shall be conducted for the 1/5 of total number of bridges. The cost for the inspection and mobilization is accordingly equalized per year.

Detailed Inspection:
According to the result of 2300 bridge inspection, 153 bridges over 2300 total number (=6.6%) was identified as the ones which require detailed inspection during routine inspection. The cost for detailed inspection should consider scaffoldings on site for all the 153 bridges.

Maintenance Operation Meeting (MOM)
The Maintenance Operation Meeting (MOM) is proposed to be held twice every year, in April and November.

Maintenance Expert Training (ME)
Maintenance Experts (ME) are in charge of verification of bridge inspection results, prioritization and decision making of the countermeasures. Training of ME is to provide back-up to the maintenance cycle.

Document Management
This is to update document system created in 2012 for road and bridge maintenance.

The system is managed by the Public Works Research Center.

(3) Institutional Framework

In order to enhance institutional framework of the bridge maintenance cycle, administrative framework was prepared.

The MOM (Maintenance Operation Periodic Meeting) is to identify the severity of the damage and to make decision to reflect the maintenance plan. The meeting flowchart is as shown in Figure 5-3.

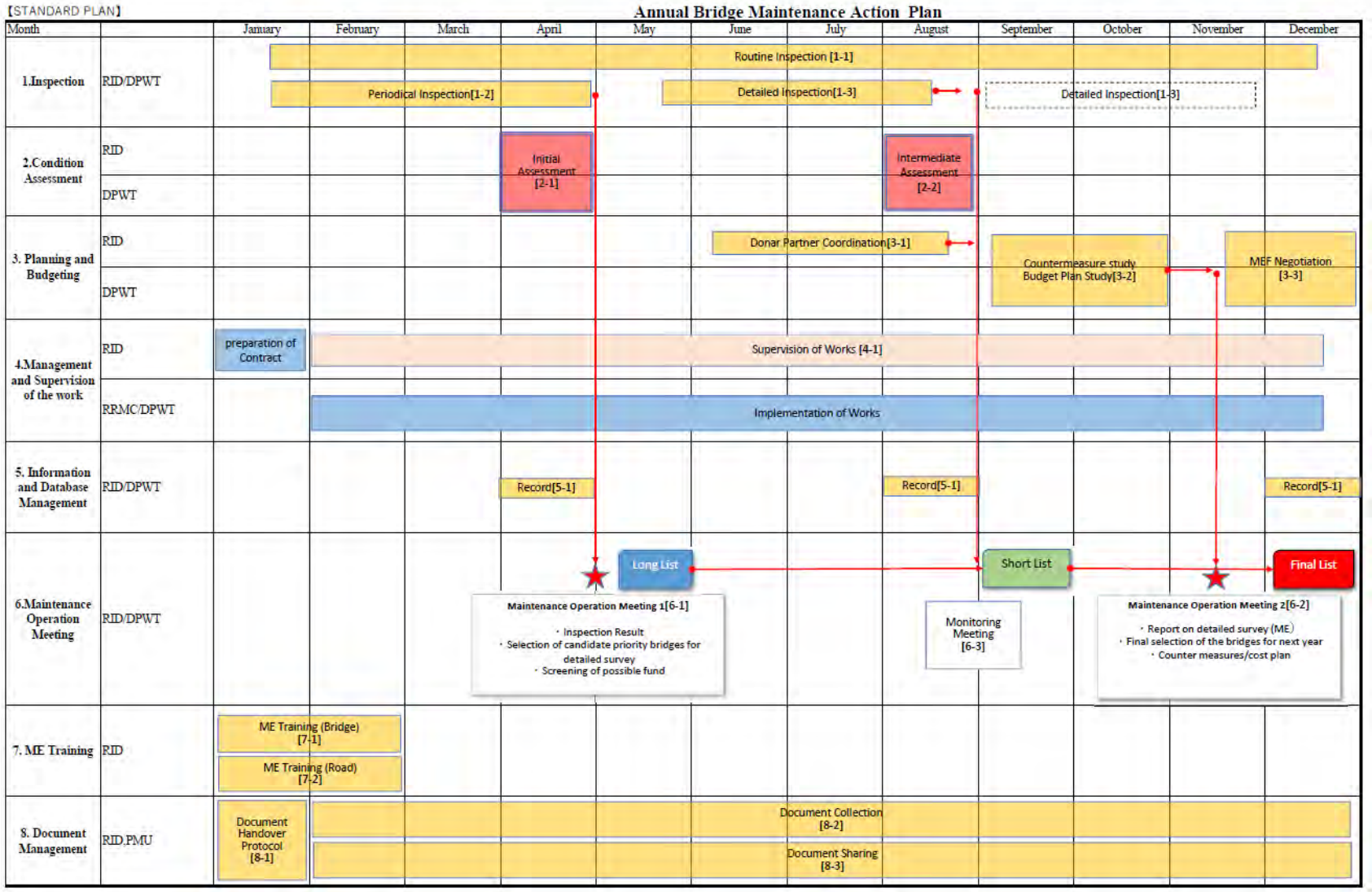


Figure 5-2 Annual Action Plan for Bridge Maintenance

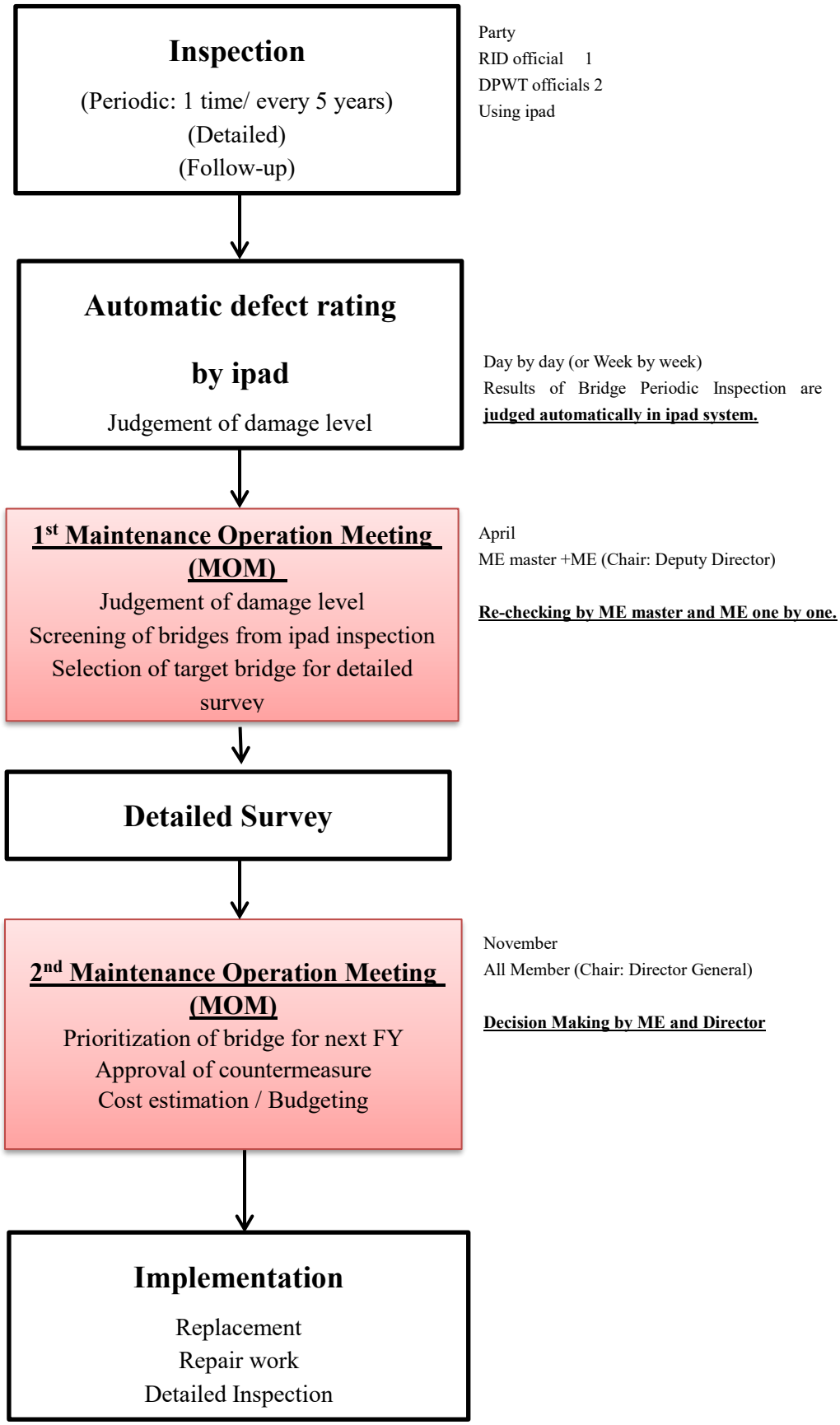


Figure 5-3 MOM Flow (Maintenance Operation Meeting)

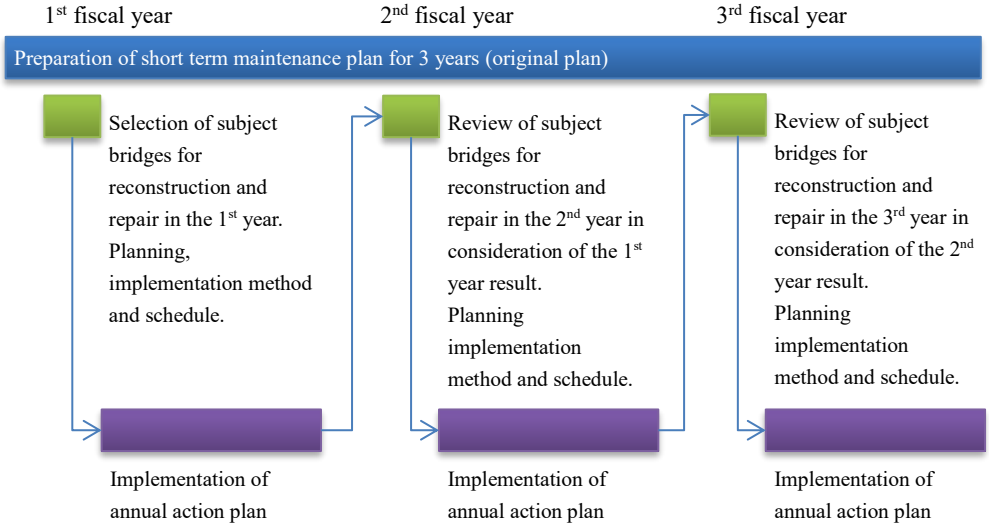


Figure 5-4 3 Year Plan and Annual Action Plan

5.2.2 3 Year Bridge Maintenance Strategic Plan

(1) Concept of the 3 Year Bridge Maintenance Strategic Plan

It is important to note that the necessity of a short term maintenance strategic plan (3years) was expressed during the 1st JCC meeting for a more sustainable and accountable maintenance plan for MPWT and for effective budgeting and use of the allocated budget.

The 1st draft of the 3 year bridge maintenance strategic plan was drafted through the project activity.

As shown in Figure 5-5, the 3 year bridge maintenance strategic plan is to give priority to the bridges for maintenance. The annual plan will be formulated in accordance with it. The 1st draft of the 3 year bridge maintenance strategic plan was proposed using bridge database.

The relationship between the flow and the manuals is mentioned in Table 5-2.

Table 5-2 Relationship between the Bridge Maintenance Cycle and the Manual

Step	Description	Reference Manual
1	Bridge Inspection	Bridge Maintenance Manual
2	Evaluation of Bridge Inspection Result	Bridge Maintenance Manual
3	Preparation of Bridge Lists	Bridge Maintenance Manual
4	Planning and Prioritization of Bridge Maintenance Work	Bridge Maintenance Manual
5	Budget Estimation for Bridge Repair and Inspection Work **“3 Year Bridge Maintenance Strategic Plan”**	Bridge Maintenance Manual Bridge Repair Manual 3 Year Bridge Maintenance Strategic Plan
6	Implementation of Bridge Repair Work	Bridge Repair Manual

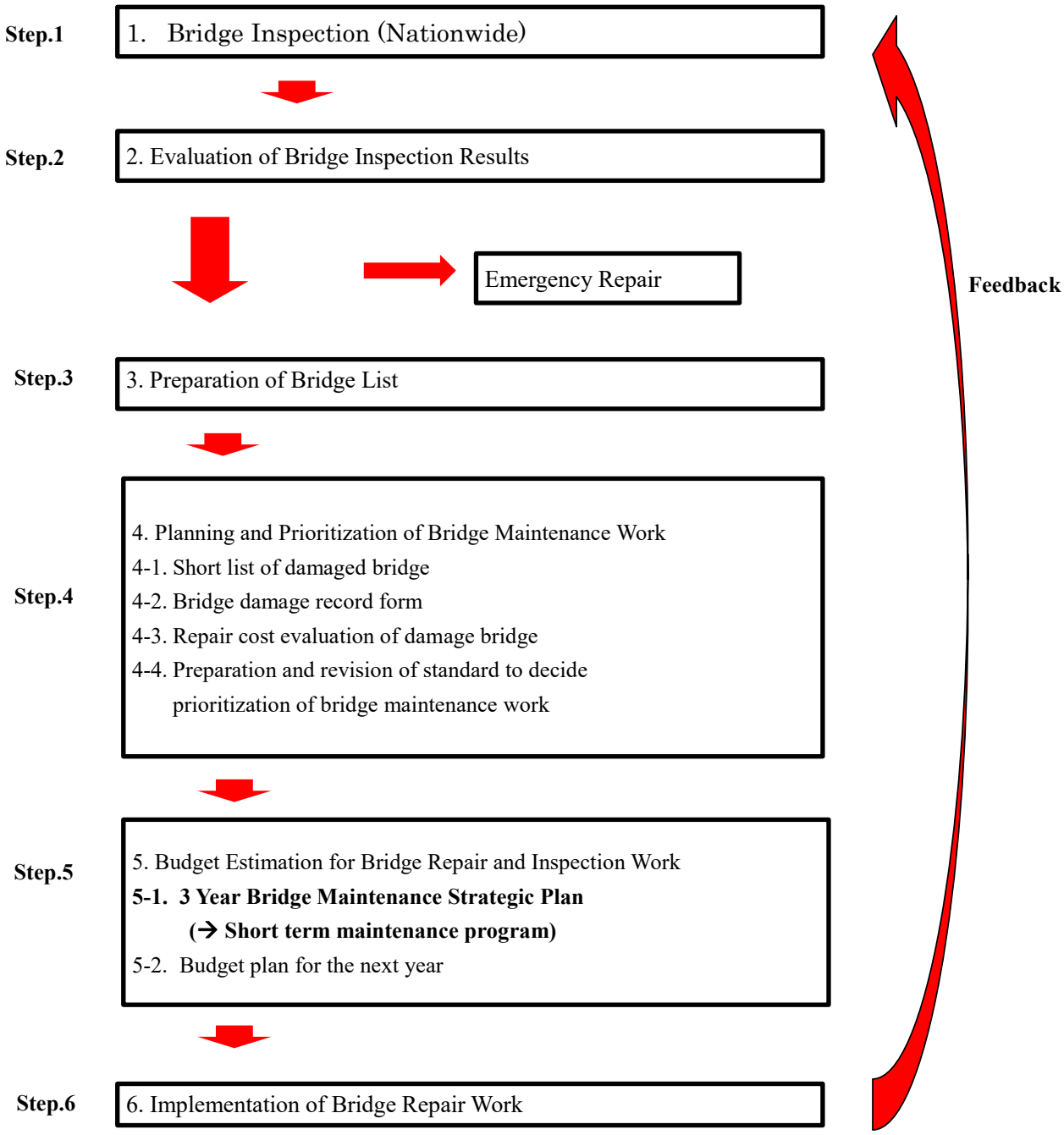


Figure 5-5 Bridge Maintenance Cycle

(2) Budget Framework for Bridge Maintenance

The 3 year bridge budget plan was drafted based on the bridge database collected in 2015.

The budget for bridge maintenance is proposed to be categorized into two (2) Chapters as road maintenance budget. (Chapter 21 and Chapter 61). The required budget for bridge maintenance is expected to change by time as shown in Figure 5-7.

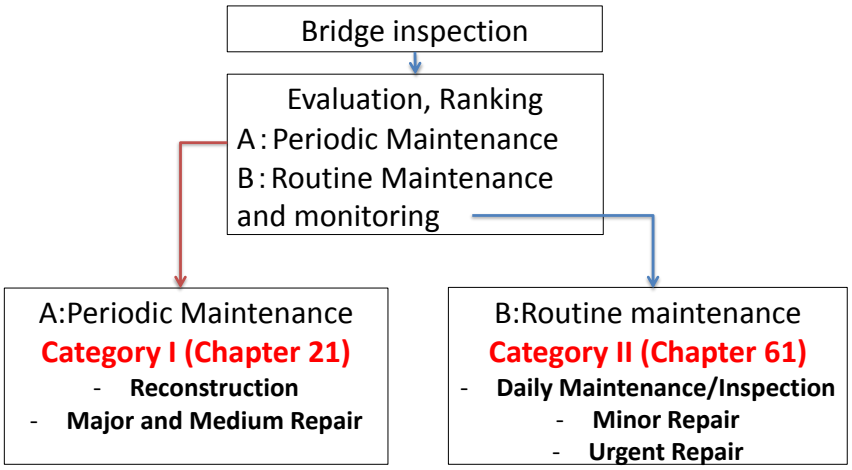


Figure 5-6 Bridge Maintenance Budget Category

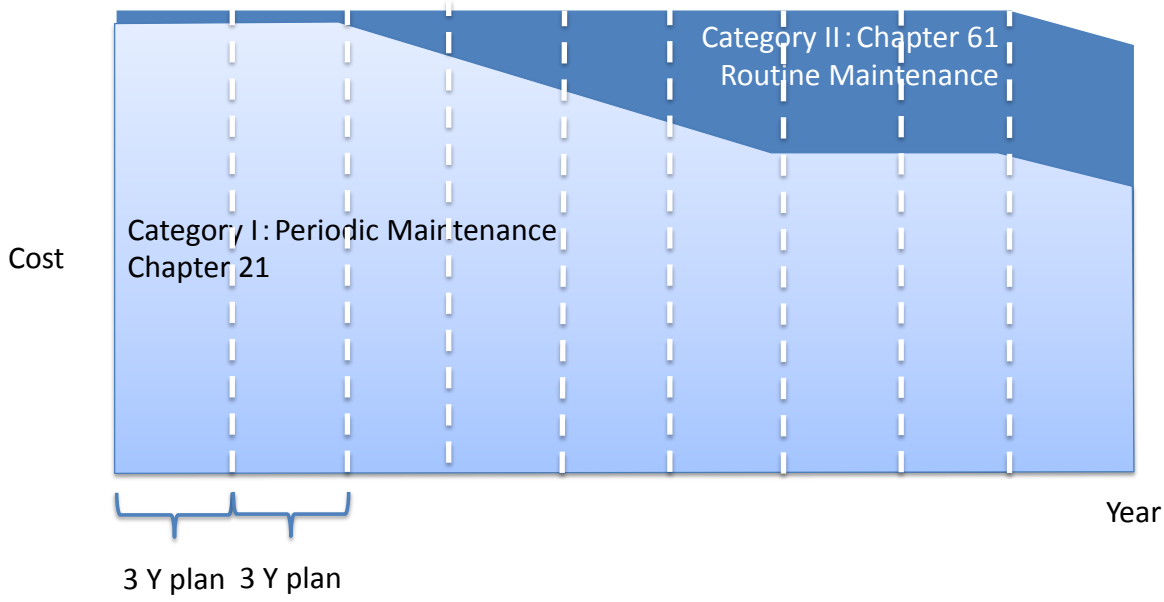


Figure 5-7 Bridge maintenance budget category and 3 year plan

(3) Outline of the 3 Year Bridge Maintenance Strategic Plan

Flow chart for 3 year bridge maintenance strategic plan is shown in Figure 5-8.

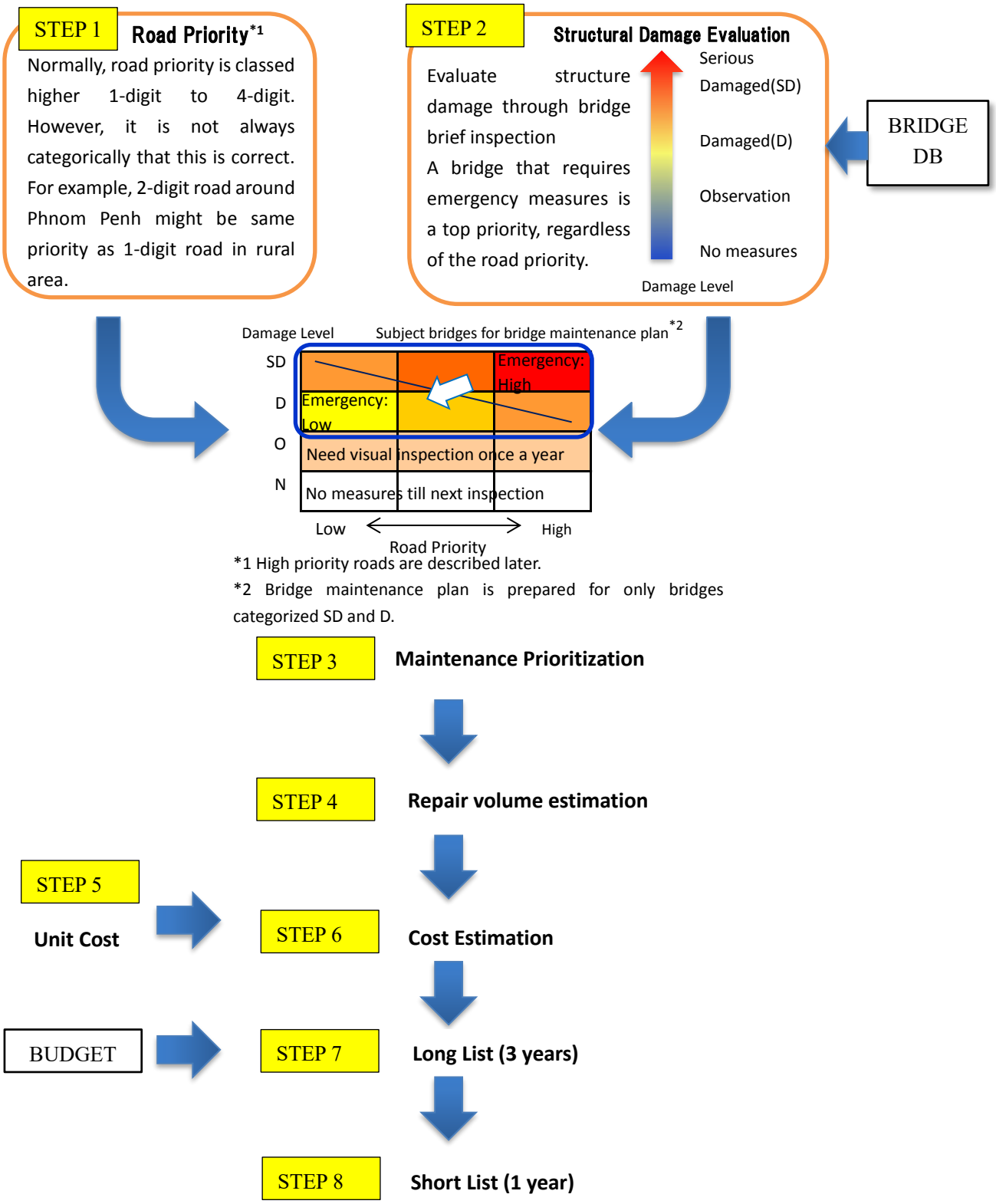


Figure 5-8 Flow of 3 year bridge maintenance strategic plan

The following conditions are to be considered while making the long list for the bridge maintenance priority:

- The annual budget for bridge maintenance is approximately US$ 10 million.
- Both reconstruction and repair work should be executed every year.
- The number of subject bridges in a year should be increased because capacity enhancement for bridge management works by RID is expected.

Table 5-3 Bridges Definition

Class	Definition	Condition
SD	Seriously Damaged Bridges	Bridges with structural damages observed: - concrete member - steel member
D	Damaged Bridges	Other bridges with damages - pavement - bearing - railing etc.,
O	Observation	No significant damage observed, only minor damages
N	No measures (No problem)	No damage observed - new bridges

The Road priority is as defined in Table 5-5 while the unit cost is defined in Table 5-4.

Table 5-4 Unit Cost for Cost Estimation (Draft)

Bridge	Item	Unit Cost	Remark	Chapter*
SD	Reconstruction Cost	1500 USD/m^2		
	Removal Cost	50% of reconstruction cost		
D	Periodic maintenance cost	400 USD/m^2	Large scale: Bridge structure maintenance ex. structural member, superstructure, substructure	Chapter 21
		250 USD/m^2	Medium scale: Other related maintenance ex. Road surface, railing, poles etc.,	
O	Routine Maintenance	40 USD/m	Small scale: Minor repairs ex. Painting	Chapter 61
N	Routine Maintenance	4 USD/m	Cleaning	

Table 5-5 Road Priority for Bridge Maintenance/Improvement

Priority	Road Number	Reason
1st	1	Asian Highway 1, International Corridor
	4	Connecting international port Sihanouk and PP
	5	Asian Highway 1, International Corridor
2nd	2	Connecting Vietnam border and PP
	6	Connecting PP and Siem Reap (the biggest tourism city)
	7	Connecting Laos border and PP
3rd	3	Detour PP to Sihanouk
	8	1-digit road
	9	1-digit road
	20	One of ring road of PP
	21*	One of ring road of PP
	42	One of ring road of PP
	51	One of ring road of PP
	61	One of ring road of PP
	11	Cross-cutting NR1, NR8, and NR7
	73	Shortcut of NR7
	76	Connecting Mondul Kiri and NR7
	78	Connecting Rattanak Kiri and NR7
	64	Connecting Preah Vihear and NR6
	68	Connecting Oddar Meanchey and NR6
	57	Connecting Pailin and NR5
	48	Connecting Koh Kong and NR4
4th	55	Connecting Thailand border and NR5
	62	Connecting Laos border and NR6 via Preah Vihear
	76	Connecting Rattanak Kiri and Mondul Kiri
5th	Other 2-digit road	
6th	3- and 4-digit road	

* Include branch number

5.3. To practice the annual action plan

This activity is under implementation in accordance with the adoption plan in the Action Plan by RID.

5.4. To hold workshops of the bridge maintenance cycle

Workshops on road/bridge maintenance cycle were held as shown in **Table 5-6**.

The JICA Experts Team supported the management of the workshop through presentation materials and lecture draft. More than 20 staff from the MPWT and DPWT participated in every workshop. Presentations were made by the MPWT staff in principle, followed by the exchange of opinions amongst the participants.

Table 5-6 List of Workshops and Seminars

Date	Title	Organization	Participants
22 May 2015	Kickoff Seminar	MPWT, MEF, JICA, EOJ, DPWT, WB, ADB	49
6 July 2015	DRIMS Training	MPWT	3
6 July 2015	Bridge inspection manual and inspection method	RID	
11 July 2015	DRIMS training (calibration)	MPWT	2
25 July 2015	IRI measurement	MPWT	2
31 July 2015	IRI measurement	MPWT	2
7 August 2015	1st workshop ①Road Maintenance Cycle using IRI ②Points on bridge inspection and progress of 2000 bridge inspection	MPWT Mr. You Dara Mr. NIN Menakak Mr. SA Sivutha	31 (RID 18, DPWT 0, Other13)
11 August 2015	Instruction on 2000 Bridge inspection □Field Training□	MPWT	2
17 September 2015	2nd Workshop ①Bridge Maintenance Cycle ②Progress of 2000 Bridge Inspection ③Overloading Control in Cambodia	MPWT JICA Expert Team	23 (RID14, DPWT0, Other9)
5 to 6 October	Site visit on NR5 and NR6	MPWT	5
22 October 2015	3rd Workshop （Introduction of database system and discussion） 1. History of road network development in Japan 2. Database structure and function 3. Discussion on iPad system bridge inspection	MPWT (Inspector Class)	22 (RID11, DPWT0, Other11)
27 October 2015	4th Workshop (Introduction of database and practices, overloading control) 1. Database 2. Progress of 2000 Bridge Inspection 3. Overloading Control	MPWT (Manager Class)	6 (RID6)
11 December 2015	5th Workshop 1. Overloading Control at Tsubasa Bridge 2. Report of Training in Japan	MPWT	61 (RID9, DPWT43, Other9)
25,27 January 2016 29 January 2016	Pilot project for bridge repair (in Phnom Penh)	MPWT, DPWT	6 20 (on 27 January)
1,3,5,6,8,10,11,12 February 2016	Pilot project for bridge repair (Kandal)	MPWT, DPWT	9 Cambodia Institute of Technology on 3 Feb. 5 On 12 Feb
18 February ,2016	6th Workshop ① Bridge and Road Database System ② Database using DRIMS ③ 1st Bridge Maintenance Pilot Project	MPWT, DPWT	31 (RID12, DPWT8, Other11)
1 March 2016	SIP Seminar	Tokyo University, Hokkaido University, Tokyo Metropolitan Expressway	1st March 474 (RID17, DPWT61, ITC327, Other69) 2nd March 57 (RID2, DPWT20,

Date	Title	Organization	Participants
		Company, MPWT, DPWT, CIT	Other35)
14 and 16 March, 2016	Bridge maintenance OJT (Kompong Cham, Kizuna Bridge)	MPWT, DPWT	14 March site visit （4 provinces: Svey Rien, Kompong Cham, Preyven, Tompongkum） 16 attendants 16 March site visit （4 provinces） 12 attendants
31 March 2016	7th Workshop ① Road Repair Guideline Outline and next step to sensitization of the guideline, handbook sample etc.,) ② Monitoring result of excel patch and introduction of local production of excel	MPWT, DPWT	15 (RID6, DPWT2, Other 7)
4,5,10,16 and 18 May 2016	Training on bridge database operation	RID	3
25 May 2016	IRI measurement training□RN129, RN21A, RN110, RN151A□	RID	2
From 6 to 8 June 10 June, 2016	Road Maintenance Expert Training (Inspection)	RID	2
From 13 to 15 June 2016	Bridge Maintenance Expert Training □2 days lecture: 1 day site training□	RID	4
16 June 2016	Road Maintenance Expert Training□Repair□ □1.5 hours lecture and 0.5 hours exam□	RID	3
16 September 2016	Bridge Maintenance Expert Training□Repair□ □2 hours lecture□	RID	5
From 17 to 19 Oct. 2016	2nd Bridge Maintenance Expert Training □2days lecture □1day site training□	RID, Takeo DPWT	13
23 November 2016	Bridge Database Training	RID	28 (RID16, Other12)
14 December 2016	1st Workshop	MPWT, DPWT	24 (RID7, DPWT12 Other5)
15 December 2016	4th JCC	MPWT	34 (RID16, Other18)
16 December 2016	2nd workshop	MPWT, DPWT	14 (RID2, DPWT19, Other3)
19 December 2016	3rd workshop	MPWT, DPWT	13 (RID2, DPWT8 Other3)
20 December 2016	4th workshop	MPWT, DPWT	17 (RID2, DPWT11 Other4)
21 December 2016	5th workshop	MPWT, DPWT	13 (RID2, DPWT10 Other1)
10 February 2017	Bridge Maintenance Cycle Meeting	RID	6
22 February 2017	Bridge Management Plan	MPWT	9 (RID6, Other3)
13 March 2017	Bridge Management Plan	MPWT	9 (RID5, Other4)
21 April 2017	Bridge Management Plan	MPWT	7 (RID4, Otherr3)
19 May 2017	Bridge Inspection Workshop at Siem Reap	MPWT, DPWT	4 (RID3, Other1)
22 May 2017	Bridge Inspection Workshop at Pursat	MPWT, DPWT	4 (RID3, Other1)
23 May 2017	Bridge Inspection Workshop at Sihanouk Vile	DPWT	5 (DPWT4, Other1)
26 May 2017	1st Maintenance Operation Meeting	RID	10 (RID4, Other6)
9 June 2017	Workshop on Bridge Repair	MPWT, DPWT	25 (RID8, DPWT11 Other6)
12 June 2017	Workshop on Bridge Repair	MPWT, DPWT	9 (DPWT6, Other3)
13 June 2017	Workshop on Bridge Repair	DPWT	23

Date	Title	Organization	Participants
			(DPWT23)
14 June 2017	Workshop on Bridge Repair	DPWT	11 (DPWT11)
15 June 2017	Workshop on Bridge Repair	DPWT	15 (DPWT15)
23 June 2017	5th JCC	MPWT, Other	36 (RID18, Other18)
26 June 2017	Maintenance Road Expert	RID	11 (RID11)
02 August 2017	Workshop Bridge Inspection	RID, DPWT, Other	36 (RID7, DPWT15 Other14)
03 August 2017	Workshop Bridge Inspection	RID, DPWT, Other	25 (RID2, DPWT13, Other10)
04 August 2017	Workshop Bridge Inspection	RID, DPWT, Other	24 (RID2, DPWT10, Other12)
08 August 2017	Workshop Bridge Inspection	RID, DPWT, Other	23 (RID4, DPWT13 Other6)
09 August 2017	Workshop Bridge Inspection	RID, DPWT, Other	20 (RID3, DPWT10 Other7)
10 August 2017	Workshop Bridge Inspection	RID, DPWT, Other	19 (RID3, DPWT11 Other5)
13 September 2017	1st Project Review Meeting	RID, Other	10 (RID8, Other2)
05 October 2017	Report Meeting Overload Enforcement	Other	5 (Other5)
10 October 2017	Final Presentation of Overloading Enforcement at Tsubasa Bridge	Other	10 (Other10)
11 October 2017	3rd Bridge Inspection Workshop (Day 1)	RID, DPWT, Other	17 (RID4, DPWT10, Other3)
12 October 2017	3rd Bridge Inspection Workshop (Day 2)	RID, DPWT, Other	18 (RID4, DPWT9, Other5)
13 October 2017	3rd Bridge Inspection Workshop (Day 3)	RID, DPWT, Other	26 (RID4, DPWT9, Other3)
18 October 2017	4th Bridge Inspection Workshop (Day 1)	RID, DPWT, Other	25 (RID4, DPWT17, Other4)
19 October 2017	4th Bridge Inspection Workshop (Day 2)	RID, DPWT	19 (RID4, DPWT15)
11 December 2017	2nd Maintenance Operation	RID,DPWT	11 (RID5,Other6)
13 December 2017	5th Bridge Inspection Workshop (Day 1)	RID,DPWT	32 (RID3,DPWT29)
14 December 2017	5th Bridge Inspection Workshop (Day 2)	RID,DPWT	25 (RID4,DPWT21)
15 December 2017	5th Bridge Inspection Workshop (Day 3)	RID,DPWT	16 (RID5,DPWT11)
20 December 2017	Final Bridge Inspection Seminar	RID,DPWT	96 (RID13,DPWT83)

5.5. To prepare draft annual bridge maintenance budget

5.5.1 Required cost for bridge inspection

The estimated cost for bridge inspection plan on all bridges along national roads was based on the expenses and work productivity from the project. The breakdown is shown in Attachment-1.

Table 5-7 Estimated Cost for Bridge Inspection

Inspection Cost (Each Province and Each year)

(US$)

No	Province/City	Inspection Cost																Total Cost
		Routine Inspection Cost (Every year)	Initial Inspection/ Emergency Inspection (Every year)	Periodic Inspection Cost					Detailed Inspection Cost					Yearly Inspection Cost					
				1st	2nd	3rd	4th	5th	1st	2nd	3rd	4th	5th	1st	2nd	3rd	4th	5th	
1	Kandal	1,923	1,196	3,465	3,465	0	0	0	0	112,692	0	0	0	1,179	1,179	45,987	1,179	1,179	**50,701**
2	Takeo	437	269	1,260	0	0	0	0	25,634	0	0	0	0	1,937	1,937	74,945	1,937	1,937	**82,695**
3	Kompong Speu	3,181	1,879	1,470	0	0	0	0	186,402	0	0	0	0	6,584	119,276	3,119	3,119	3,119	**135,218**
4	Phnom Penh	955	568	840	0	0	0	0	55,952	0	0	0	0	25,066	657	657	657	657	**27,694**
5	Kompong Cham	662	405	0	0	0	0	1,680	0	0	0	0	38,813	1,279	1,279	49,001	1,279	1,279	**54,116**
6	Prey Veng	972	582	0	1,260	0	0	0	0	56,985	0	0	0	1,067	1,067	1,067	1,067	41,560	**45,829**
7	Kompot	1,018	617	2,000	0	0	0	0	59,676	0	0	0	0	1,228	1,228	47,530	1,228	1,228	**52,442**
8	Kep	413	244	210	0	0	0	0	24,199	0	0	0	0	192,931	5,059	5,059	5,059	5,059	**213,169**
9	Preah Sihanouk	1,202	717	0	1,250	0	0	0	0	70,455	0	0	0	2,428	2,428	2,428	92,918	2,428	**102,628**
10	Svay Rieng	415	254	0	1,050	0	0	0	0	24,306	0	0	0	63,311	1,635	1,635	1,635	1,635	**69,851**
11	Tbaung Khmum	208	134	0	0	0	1,250	0	0	0	0	12,191	0	1,319	1,319	1,319	1,319	51,774	**57,049**
12	Kratie	814	505	0	0	0	0	2,750	0	0	0	0	47,706	911	911	911	911	35,055	**38,700**
13	Steung Treng	918	558	0	0	0	0	2,000	0	0	0	0	53,785	1,026	1,026	1,026	1,026	40,822	**44,925**
14	Battambong	1,207	730	0	0	2,250	0	0	0	0	70,757	0	0	864	864	33,280	864	864	**36,737**
15	Pursat	520	352	0	2,375	2,375	0	0	0	0	30,487	0	0	58,315	1,523	1,523	1,523	1,523	**64,406**
16	Mondul Kiri	570	341	0	0	0	0	750	0	0	0	0	33,394	1,919	73,624	1,919	1,919	1,919	**81,301**
17	Ratanak Kiri	846	501	0	0	0	0	500	0	0	0	0	49,594	2,778	2,778	2,778	107,799	2,778	**118,912**
18	Banteay Meanchey	730	448	0	0	2,000	0	0	0	0	42,809	0	0	1,555	59,800	1,555	1,555	1,555	**66,020**
19	Kompong Chhnang	765	463	0	0	1,470	0	0	0	0	44,832	0	0	873	3,248	33,735	873	873	**39,600**
20	Siem Reap	1,334	802	0	0	0	2,000	0	0	0	0	78,182	0	1,347	1,347	1,347	1,347	51,441	**56,830**
21	Kompong Thom	1,523	905	0	0	0	1,250	0	0	0	0	89,240	0	2,136	2,136	2,136	82,318	2,136	**90,862**
22	Koh Kong	802	477	0	0	750	0	0	0	0	46,973	0	0	1,476	1,476	1,476	1,476	57,261	**63,164**
23	Preah Vihear	1,728	1,050	0	0	0	3,750	0	0	0	0	101,271	0	668	26,024	668	668	668	**28,697**
24	Otdor Meanchey	628	398	0	0	0	0	3,000	0	0	0	0	36,796	27,601	706	706	706	706	**30,426**
25	Pailin	540	324	0	0	750	0	0	0	0	31,665	0	0	342	342	342	13,784	342	**15,154**
Total		**24,312**	**14,720**	**9,245**	**9,400**	**9,595**	**8,250**	**10,680**	**351,864**	**264,438**	**267,523**	**280,885**	**260,088**	**400,141**	**312,869**	**316,149**	**328,167**	**309,799**	**1,667,126**

5.5.2 Required Cost for Bridge Repair

From the 3 year bridge maintenance strategic plan, required cost for each province is calculated as shown in **Table 5-10**.

Table 5-8 3 Year Bridge Maintenance Budget Plan (1st Year)

1st year

No.	Road Category	Damage Level	Bridge Name	Province	Road No.	Cost	
1	2	SD	O dong touk	Kampot	43	225,000	
2	2	SD	O chhnang hors	Kampot	43	135,000	
3	2	SD	O Kreang	Kampot	43	675,000	
4	2	SD	Koh Sla 1	Kampot	43	975,000	
5	2	SD	Steung Thom	Kampot	43	900,000	
6	2	SD	Hun Sen Somrong	Svay Rieng	13	558,900	
7	2	SD	Spean Bak	Kampong Speu	43	575,100	
8	2	SD	O Sneat	Preah Vihear	95	490,500	
9	3	SD	In Tha Nou 1	Kampot	700 (Urban)	1,276,800	
10	3	SD	In Tha Nou 2	Kampot	700	1,276,800	
11	3	SD	In Tha Nou 3	Kampot	700	1,276,800	
12	3	SD	Kro Bao	Banteay Meanchey	156C	750,000	
13	3	SD	Tropan srorng	Takeo	125	82,283	
14	3	SD	O Ju	Kratie	375	142,500	
15	3	SD	Beoung Kranh	Pursat	154	339,825	
16	3	SD	Joung Thlong	Pursat	152D	139,500	
17	3	SD	Ta Kot	Pursat	155B	190,650	
18	3	SD	Tadav	Svay Rieng	314D	348,300	
19	3	SD	East Ror Lous	Siem Reap	265E	193,170	Total
20	2	D	Chork	Svay Rieng	13	57,240	10,608,368

Table 5-9 3 Year Bridge Maintenance Budget Plan (2nd Year)

2nd year

No.	Road Category	Damage Level	Bridge Name	Province	Road No.	Cost	
1	3	SD	Kam Pi	Kratie	377	1,433,250	
2	3	SD	Ror leang4	Prey Veng	385	210,938	
3	3	SD	Kom bot	Kratie	279	496,125	
4	3	SD		Kratie	375	95,063	
5	3	SD	Kilometer 7	Kratie	375	120,000	
6	3	SD	Sor Svay	Pursat	155B	91,350	
7	3	SD	Ta Prok	Pursat	152D	799,200	
8	3	SD	Prous Krochab	Pursat	155B	92,250	
9	3	SD	Doth Bat	Pursat	155B	91,800	
10	3	SD	Beoung Ressey	Pursat	154B	189,405	
11	3	SD	Chher Ty 2	Pursat	155D	142,290	
12	3	SD	Chher Ty 3	Pursat	155D	186,000	
13	3	SD	Kbal O	Pursat	155D	243,000	
14	3	SD	Stok Klok 1	Pursat	154E	132,525	
15	3	SD	Stok Klok 2	Pursat	154E	143,925	
16	3	SD	Ka pot Ang	Pursat	154F	181,643	
17	4	SD	Au Daung	Kampong Thom		716,400	
18	4	SD	Prek son dain	Kampong Cham	3KC1	677,250	
19	4	SD	Prek chik	Kampong Thom		365,625	
20	4	SD	Kompong Rokar	Pursat	1PS1	321,000	
21	4	SD	Thnol Dach 1	Pursat	1PS1	183,000	
22	1	D	Krang leav	Takeo	3	63,000	
23	1	D	Kompong por pil	Prey Veng	8	572,000	
24	1	D	Prek Chhloung	Kratie	7	544,000	
25	2	D	Prek TaVa	Kandal	21	29,520	
26	2	D	Areak	Phnom Penh	42	25,600	
27	3	D	Toul Tamar	Kampong Cham	277	62,776	
28	3	D	Beoung Trav 3	Kampong Cham	270	42,008	
29	3	D	Prak Thmey	Kampong Cham	270	77,760	
30	3	D	Peak Leav Thom	Kampong Cham	270	44,520	
31	3	D	Tonle Bati	Takeo	120B	30,000	
32	3	D	Border som roung prey kabas	Takeo	129	112,000	
33	3	D	Somrong	Kratie	377	32,400	
34	3	D	Hannchey	Kampong Cham	279	232,200	
35	3	D	Khset	Svay Rieng	314C	24,960	
36	3	D	Sonday rong	Kratie	279	49,000	
37	3	D	Kon ork	Kratie	375	12,800	
38	3	D	Wat Balang	Pursat	155B	30,744	
39	3	D	Oh pong teuk	Stung Treng	279	10,560	
40	3	D	Ma jong	Stung Treng	379	41,160	
41	3	D	Oh ta Len pen	Stung Treng	379	40,320	
42	3	D	Oh Dom bong	Stung Treng	379	40,320	
43	3	D	Derm thkov	Kampong Chhnang	153C4	28,800	
44	3	D	Sameki	Prey Veng	385	21,600	Total
45	3	D	Ror leang 1	Prey Veng	385	42,000	9,122,087

Note: This table is the same as Table 5-7.

Table 5-10 3 Year Bridge Maintenance Budget Plan (3rd Year)

3rd year

No.	Road Category	Damage Level	Bridge Name	Province	Road No.	Cost	
1	2	SD	Sammaky	Kandal	42	376,000	
2	3	SD		Kampot	133A	153,750	
3	4	SD	Pjek Chrom	Pursat	1551	132,000	
4	4	SD	Olan Plok	Pursat	1551	195,000	
5	4	SD	Ta Than	Pursat	1551	186,930	
6	4	SD	O kbey Ngob 2	Pursat	1551	109,429	
7	4	SD	Pjek chrom	Pursat	1551	150,750	
8	4	SD	Kach changkes	Ratanak Kiri	3785	229,500	
9	3	D	Ror leang2	Prey Veng	385	42,000	
10	3	D	Prek hon	Prey Veng	310	192,000	
11	3	D	Kreang	Kratie	279	61,200	
12	3	D	Oh jar	Stung Treng	376F	81,760	
13	3	D	Ta mom	Siem Reap	265C	60,800	
14	3	D	Kor-Sang	Banteay Meanchey	PR 156 D	25,600	
15	4	D	120	Kampong Chhnang	1534	62,400	
16	4	D	Gy li	Kampong Cham	3KC1	114,000	
17	4	D	Kom Pongchin	Kampong Thom		79,200	
18	4	D	Au Wy	Kampong Thom	Au kanthor	84,000	
19	4	D	Pro Moy	Pursat	1551	187,200	
20	4	D	Spean 1	Preah Vihear	2PVH3	19,680	
21	4	D	Spean 7	Preah Vihear	2PVH3	19,680	
22	4	D	O ta ngy	Ratanak Kiri	3789	41,360	
23	4	D	Teuk Chenh	Battambang	1577	15,580	
24	4	D	O Ponlok	Battambang	Samlot Jas	7,800	
25	4	D	Tek chom	Kampong Chhnang	1KCH1	19,200	
26	4	D	O Rum deng	Stung Treng	2648	43,200	
27	4	D	Spean Thmor 1	Kep	1332	96,000	
28	4	D	Ta Seim	Preah Vihear	2PVH3	14,760	
29	4	D	Kor2	Preah Vihear	2PVH2	33,120	
30	4	D	O Jiom	Battambang	1552	50,400	
31	4	D	Bridge Preah Ponlea	Banteay Meanchey		169,400	
32	4	D	Au Romdeng	Oddar Meanchey	2647	33,600	
33	4	D	O Da	Preah Vihear	2623A	67,200	
34	4	D	Stung Sen	Preah Vihear	Wat Prey Keng	360,000	
35	1-2	D	Green area in the sheet of Matrix for D	30 bridges		2,546,003	Total
36	3-4	D	Blue area in the sheet of Matrix for D	54 bridges		2,555,798	8,616,300

Note: this table is the same as Table 5-8.

5.5.3 Maintenance Budget of Target DPWT

Since it the responsibility of RID to prepare national budget to make budget allocations to DPWTs, the required budget for chapter 61 and chapter 21 was prepared for RID level for negotiations with MEF.

Through this activity, US$ 2 million for chapter 21 for bridge replacement was approved and US$ 0.04 million for periodic bridge inspection was approved.

The plan was concluded into “Action Plan for Bridge Maintenance Cycle” in the name of the RID Director.

5.6. Implementation of Action Plan for adoption of Bridge Maintenance Cycle and Practice of MOM

The action plan for adoption of bridge maintenance cycle was prepared as Appendix 4.

The plan includes the following subjects:

Action plan for Bridge Maintenance Cycle Implementation
Appendix 1 — List of MEs
Appendix 2 — Concept paper of Maintenance Operation Meeting (MOM)
Appendix 3 — Concept paper for Maintenance Expert (ME) Program
Appendix 4 — Bridge Inspection Seminar Program (ME)
Appendix 5 — Bridge Repair Seminar Program (ME)
Appendix 6 — Road Inspection Work Program (ME)

The Maintenance Operation Meeting exercise was held on 27 May 2017.

The following subjects were discussed through the JICA Team initiative (as ME). High prioritized bridges were selected for detailed survey to be completed by the end of August.

The 2nd MOM is to be held in November to finalize the bridge for FY 2018.

— Inspection result of the 173 bridges

— Tentative detailed inspection plan

— Action plan for adoption of bridge maintenance cycle

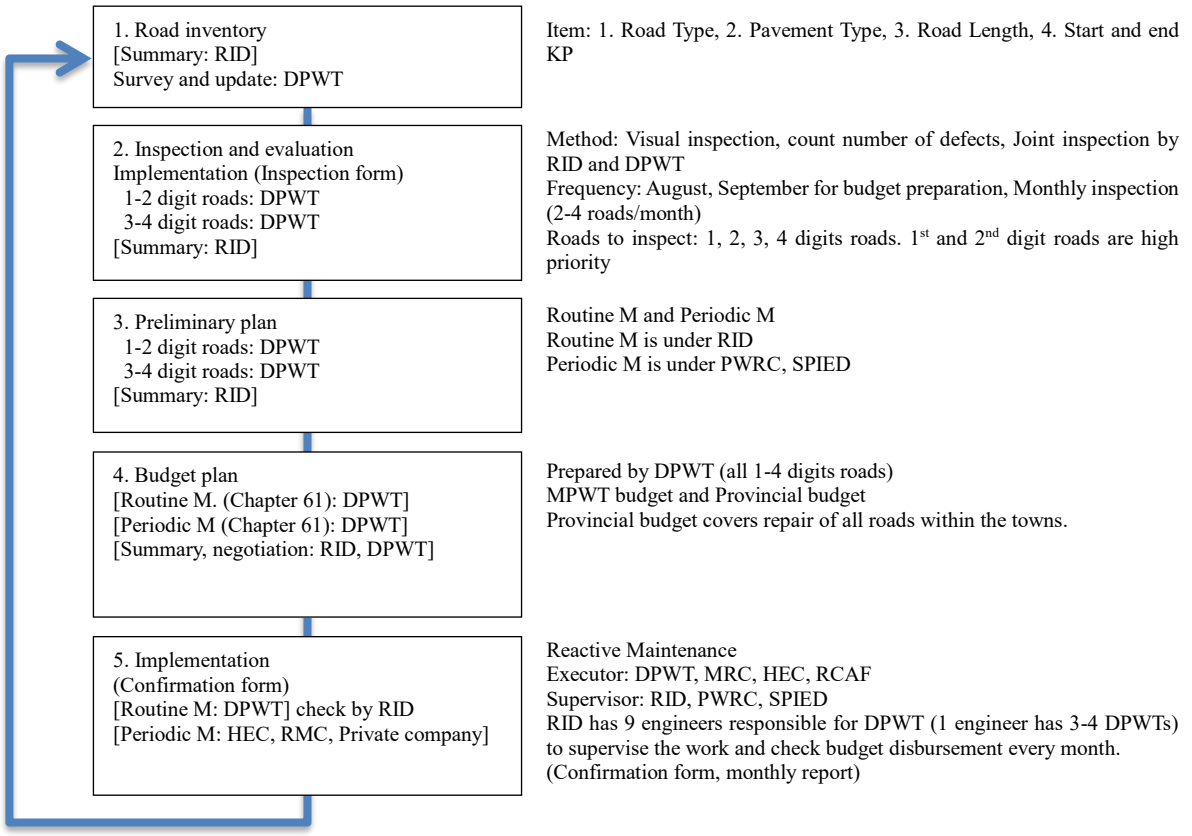
Chapter 6. Output 2: Road and Bridge Inspection Capacity of RID is Enhanced

6.1. To Review and Develop Road Maintenance Manual

6.1.1 Road Maintenance Cycle in Cambodia

The current road maintenance cycle in Cambodia is shown in Figure 6-1.

1. The Fiscal year is from January to December. The budget plan is prepared in July and August, negotiation is between September and October and the approval in December.
2. Approximately 10 roads are in one of the Routine Maintenance Project contracted by MPWT and DPWT.
3. An advance payment of 40%, the 1st payment of 40% made July, the 2nd payment of 20% made in November and the Final confirmation in February
4. The 1st and 2nd payments are to be approved by the handover committee (MPWT, DPWT, MEF) after a joint inspection.



Note:
HEC: Heavy Equipment Center, RID: Road Infrastructure Department, DPWT: Provincial Department of Public Works and Transport, RCAF: Royal Cambodian Army Force, PWRC: Public Works Research Center, MRC: Prepare and Maintenance Roads Center, SPIED: Sub-National Public Infrastructure and Engineering Department

Figure 6-1 Current Road Maintenance Cycle in Cambodia

6.1.2 Existing Road Maintenance Manual

Table 6-1 briefly summarizes the review results on existing routine road maintenance manual.

The existing manuals are composed of three (3) guidelines and three (3) supplemental documents. As for the guidelines, guidelines for 1) routine maintenance and 2) regular inspection have no particular issues. It was noted that a *Guideline for Road Defects Repair* is required.

In addition to the guidelines, supplemental internal documents have been in use for repair work, instruction and cost estimation. Two (2) documents out of the three (3) need revision or updates.

Table 6-1 Result of the Review of the Existing Routine Road Maintenance Manual

Guidelines

Name	Result of review
1. Guideline for Supervision of Routine Maintenance	No particular issues
2. Guideline for Regular Inspection	No particular issues
3. Guideline for Road Defects Repair	Lack of methods/procedures for repair work (except for potholes and cracks)

Supplemental Documents for Road Maintenance

Name	Result of review
1. Work code for repair work Note: About 20 codes are used for repair work	No particular issues
2. Technical specification for road maintenance (Detail of each work code)	Lack of specification for about 10 work codes This document should be included in a guideline.
3. Unit price for routine maintenance	Requires periodic updates based on the latest information

6.1.3 Proposed Road Maintenance Manual

In consideration of the above-stated issues, re-organization of routine road maintenance manuals was proposed in this project as shown in Table 6-2. The major changes would involve the inclusion of International Roughness Index (IRI) into the existing road maintenance system. *The Guideline for Routine Road Maintenance using IRI* has been added to the existing three (3) guidelines besides the revision of the guideline for repair work. A detailed explanation on the revision of the guideline is given in Section 7.1. Figure 6-2 illustrates a newly-developed routine road maintenance cycle that consists of six (6) steps. Four (4) guidelines and a supplemental document shown in Table 6-2 are referred to in the six (6) steps in accordance with Table 6-3 that describes the relationship between the road maintenance cycle and the reference manual.

Table 6-2 Proposed Manual Organization for Routine Road Maintenance

Type	No.	Name	Remark
Guideline	1	Guideline for Supervision of Routine Maintenance	Existing
	2	Guideline for Regular Inspection	Existing
	3	Guideline for Road Defects Repair (revised)	To be Revised
	4	Guideline for Routine Road Maintenance Using IRI	New
Supplemental Document	5	Unit price for routine maintenance	New

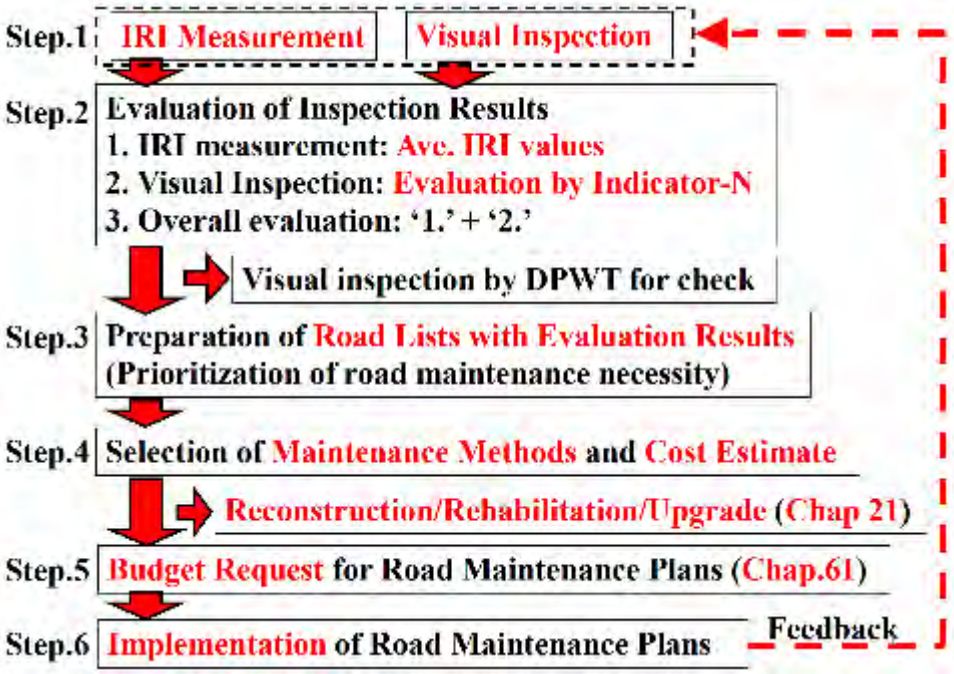


Figure 6-2 Road Maintenance Cycle Using IRI

Table 6-3 The Relationship between Road Maintenance Cycle and Reference Materials

Step	Description	Reference No.
1	IRI Measurement	No. 4
	Visual Inspection	No. 2, No. 4
2	Evaluation of Inspection Results and Prioritization of Roads	No. 2, No. 4
3	Preparation of Road Lists with Evaluation Results	No. 4
4	Selection of Maintenance Methods & Cost Estimation	No. 1, No. 4, No. 5
5	Budget Request to MEF for Road Maintenance Plans	No. 1
6	Implementation of Road Maintenance Plans	No. 1, No. 3

Note: "Reference No." indicates "No." shown in Table 6-2.

6.2. To Review and Develop Bridge Maintenance Manual including a Database

6.2.1 Existing Bridge Maintenance Manual including Database

Table 6-4 briefly summarizes the results of the review of the current conditions of manuals / guidelines on bridge maintenance and bridge database confirmed by RID.

Table 6-4 Current condition of Manual/Guideline and Database on Bridge Maintenance

<Manual/ Guideline>

Name	Result of Review
Bridge maintenance manual on framework	· No framework on bridge maintenance is determined within the ministry. No technical standard has been prepared.
Bridge maintenance manual on defect repair	· No technical standard or manual has been prepared within the ministry.

<Bridge Database and Inspection>

Name	Result of Review
Bridge Database	· No standardized and inter-ministerial uniform data on bridges. · Some bridge inventory data was collected by the project but the data is not recognized by the ministry and already some of the data is old. · Standardized bridge inventory has not been conducted yet. · There is no database system
Bridge Inspection Data	· There is a concept on bridge inspection but a standardized method has not been determined by the ministry. · Bridge inspection is conducted at a time and data is not systematically collected (stored).

6.2.2 Proposed Bridge Maintenance Manual

The purpose of the 'Bridge Maintenance Manual' is to introduce standard maintenance methods and procedures against defects commonly found in bridges under MPWT and DPWT. The target audience of the manual is DPWT bridge inspection staff. Expressions in the manual shall not be too technical but easy to understand even for non-engineers.

The principal framework on bridge maintenance was proposed from the JICA study team and discussed with the counterparts to prepare manuals and further activities. (Figure 6-3)

Interviews were conducted for DPWT staff before drafting of the manual. The manual is jointly prepared by the MPWT staff and the JICA Experts Team. Through these studies, the results of review for the development of the manual are summarized in Table 6-5. The contents of the manual are as shown in Table 6-6. By participating in the preparation of the manual, the counterpart members deepened their understanding and were nominated as master trainers.

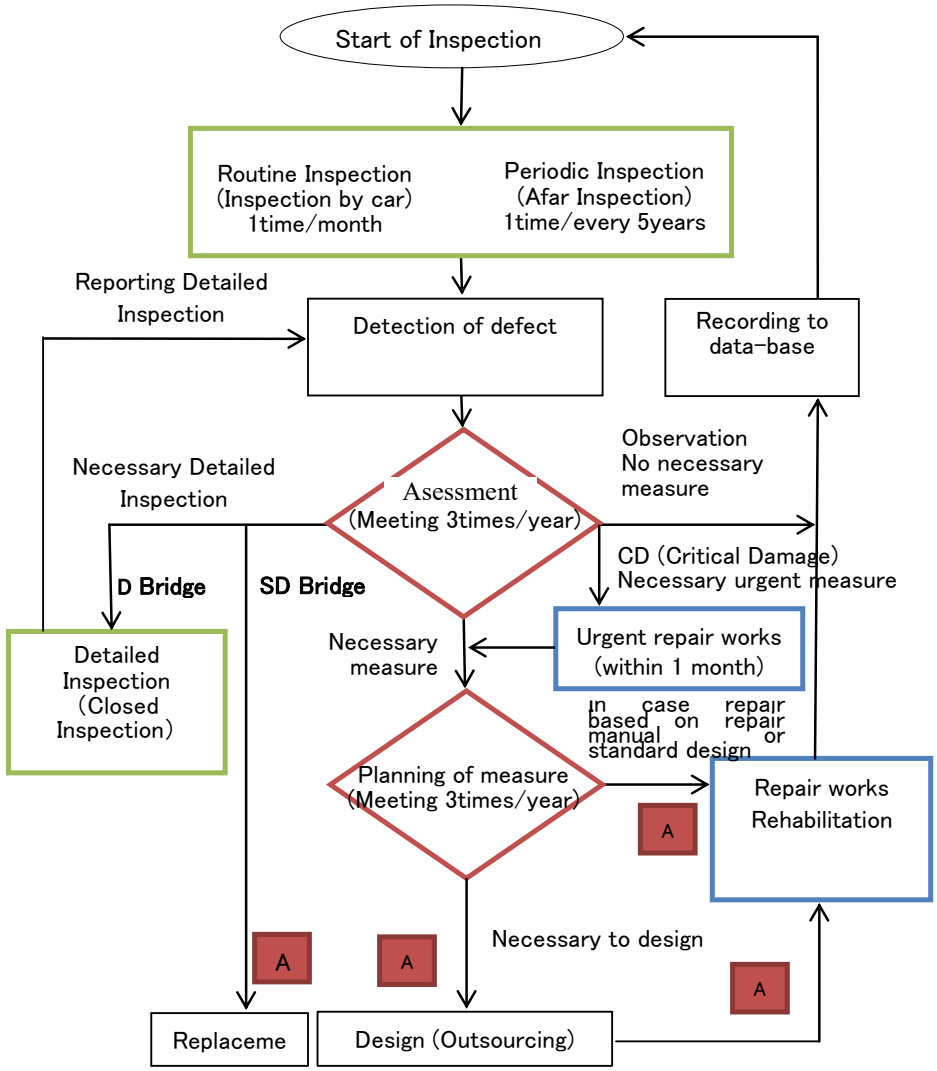
Table 6-5 Result of review for manual making

Name	Result of review
Bridge maintenance manual on framework	· There is need to establish a framework for bridge maintenance cycle. · Standardization of bridge maintenance procedures should be done · Coding of required jobs for budget allocation · Visualization of the current condition of the bridge is recommended
Bridge maintenance manual on defect repair	· It is necessary to identify typical defects in Cambodia · And standardize the repair method and manual · Consider contracting private companies to carry out specific repair works · There is need to make specific maintenance program for mega-bridges (ex Tsubasa Bridge, Kizuna Bridge, Monivon Bridge, Chroy Changwar Bridge etc.,)

Table 6-6 Contents of the Bridge Maintenance Manual

Contents	Key Concepts
CHAPTER 1 Introduction	・The significance of inspection ・Glossary
CHAPTER 2 Organization for bridge maintenance	・Inspection Schedule ・Jurisdiction of Bridge Inspection
CHAPTER 3 General requirements for Bridge inspections	・Preparations before Inspection ・Consideration for Safety Works ・Inspection classification ・Frequency of inspection ・Inspection methods ・General viewpoints for Bridge Inspection
CHAPTER4 Bridge inspection recording	・How to use ‘Bridge Inspection Database System’ ・Inspection Data transmission
CHAPTER 5 Non-Destructive Testing	・Non-Destructive Testing Method

Bridge Inspection and Planning for Maintenance Process



In case impossible to repair early

A Method of Follow-up Inspection

Situation of Defect	Method of Inspection
If possible to see progression of defect by afar inspection	Afar Inspection
If impossible to see progression of defect by afar inspection	Closed Inspection

Situation of Defect	Frequency of Inspection
Damage influence to safety for third party	1 time / month
Damage influence to soundness of structure	1 time / 3 months
Others	1 time / year

Figure 6-3 Principal Framework of Bridge Maintenance

Table 6-7 Proposing Frequency of Bridge Inspection

Classification of inspection	Standard Frequency	Remarks
Initial Inspection	Conducted before in-service	—
Routine Inspection	Once/month	With road inspection
Periodic Inspection	Once/Every 5 years	Afar inspection using binoculars
Detailed Inspection		Closed inspection (Target for SD/D in concrete bridges.)
Follow-up Inspection	Once/1 month or 3 month or year (Depending on situation)	Until repair work is finished or placement
Emergency Inspection	Whenever necessary	Natural disaster, Traffic accident

6.3. To Hold Training Workshops on Road and Bridge Inspections

Roads/bridges inspection workshops were held in order to deepen the newly-introduced inspection systems and procedures in this project. All the workshops and the seminars held are described in Chapter 5.4.

6.3.1 Bridge ME Training and Bridge Inspection Workshop in 2017

ME (Maintenance Expert) Training was introduced to the project to enhance sustainability of the training within CPs. For the concept of ME program, refer to Chapter 8

(1) Outline of Bridge ME Training 2016

Bridge ME Training was held on 13th-15th June with 4 RID officials. The Outline and the Bridge ME training Curriculum is shown in Table 6-8.

During the first ME training, the JICA-Experts lectured and instructed 4 RID officials. The officials took a theory and field practical examination. The officials were awarded the Bridge ME certification after passing the examination thereby becoming Master Trainers.

During the second ME training, the RID officials who were certified as Master Trainers after the first training lectured and instructed 12 MPWT and 1 Takeo DPWT official supported by the JICA Experts using text and Bridge Maintenance Manual. The training was held from 17th to 19th October 2017. After second ME Training, 13 RID officials acquired Bridge ME certification.

During the ME training, basic knowledge on defects and inspection was lectured. (see Attachment 1 and 2 for example text).

Table 6-8 Outline of Bridge Maintenance Expert (ME) Training in 2016

ME Training	Date	Attendance (Trainee)	Instructor (Trainer)
1st Training	13-15 June,2016 13-14 Lecture,2016 15 Field training,2016	4 RID Officials (To be Master Trainer)	JICA-Expert
2nd Training	17-19 October,2016 17-18 Lecture,2016 19 Field training,2016	13 MPWT/RID or DPWT Officials	JICA-Expert

Table 6-9 Bridge Maintenance Expert (ME) Training Curriculum

Day	Training Topics	Remarks
Day 1 (Lecture)	Outline of Bridge ME (1 Hour)	9AM-10AM
	Chapter 1:- Introduction (2 Hours)	10AM～12AM
	At the end of this topic the participants should be able to: 1. Explain the Purpose of Bridge Maintenance 2. Explain the Bridge Maintenance Process 3. Explain the Glossary related to Bridges and its maintenance	Lecture
	Chapter 2: - Organization for Bridge Maintenance (2 Hours)	2PM-4PM
	At the end of this topic the participants should be able to: 1. Explain the Jurisdiction of Bridge Maintenance 2. Explain Bridge Maintenance Schedule	Lecture
Day 2 (Lecture)	Chapter 3:- General Requirement for Bridge Inspections (2 Hours)	9AM-0PM
	At the end of this topic the participants should be able to: 1. Understand Classification of inspection and, Plan Inspection (Routine Inspection, Periodic Inspection A, Periodic Inspection B, Emergency Inspection) 2. Understand safety during Inspection 3. Understand typical damages on Concrete Bridge 4. Understand typical damages on Steel Bridge	Lecture
	Chapter 4:- Bridge Inspection Recording (2 Hours)	2PM-4PM
	At the end of this topic the participants should be able to: 3. Understand how to use the ipad system 4. Input Inspection data into the ipad system	Lecture
	Examination: (1 Hour)	4PM-5PM
	Writing test about Bridge Maintenance Purpose, Jurisdiction, Glossary, Typical damage on bridge, ipad system	Writing test
Day 3 (Field)	Field Training -2 (Instruction & Practice) (3 Hours) (Departing MPWT at 7 AM, Arriving MPWT at 4 PM by 2 JICA vehicles)	8:00-11:00
	At the end of this topic the participants should be able to: 5. Understand inspection and safety equipment 6. Inspect bridge 7. Input inspection data into the ipad system 8. Inspect bridge with safety	Instruction Practice
	Examination: (1 Hour)	11:00-12:00
	Field test about Bridge Inspection	Field Test

(2) Outline of Bridge Inspection Workshops in 2017

The Bridge Inspection Workshop 2017 which targeted every DPWT official was scheduled to be held in 2017 in 5 provinces. The Outline of the Bridge ME training Curriculum is as shown in Table 6-10.

It was expected that at least 3 officials from every DPWT would take part in the workshops. The workshop curriculum is shown in Table 6-11. During these workshops, Prof. Vong in ITC will conduct the keynote lecture in every workshop in order to support the project and MPWT.

The participants will be certified as Bridge-ME after passing the examination. It is projected that after these workshops, 70-80 DPWT officials will be certified. This will support the bridge inspection by DPWT in the future.

Table 6-10 Outline of Bridge Maintenance Expert (ME) Training in 2017

Batch	Schedule	Place	DPWT
1st	August 2017 (2nd to 4th)	Phnom Penh	RID, HEC, RMC, SPIED Phnom Penh, Kandal, Takeo, Kampong Spueu, Prey Veng, Svay Rieng, Kampong Cham
2nd	August 2017 (8th to 10th)	Kratie	Kratie, Stueng Traeng, Mondol Kiri, Rotanak Kiri, Tboung Khmum
3rd	October 2017 (11th to 13th)	Pursat	Pursat, Kampong Chhnang, Pailin, Battambong
4th	October 2017 (17th to 19th)	Siem Reap	Siem Reap, Banteay Meanchey, Otdar Meanchey,Preah Vihear, Kompong Thom
5th	December 2017 (13th to 15th)	Sihanouk Vill	Preah Sihanouk, Kampot, Kaoh Kong, Kep

Table 6-11 Bridge Maintenance Workshop Curriculum

Day	Training Topics	Remarks	Instructor
Day 1 (Lecture)	Opening Remark (10 minutes)	9:30～9:40	Director (MPWT/DPWT)
	Outline of Bridge ME (20 minutes)	9:40～10 AM	Master Trainer
	Keynote Lecture 1 (2 Hours)	10AM～12 AM	(Dr. Vong) Dr. Sathaya
	(TENTATIVE) Why and How should bridges be maintained? Purpose of Bridge Maintenance The kind of defect on bridges Cause of defects Critical damage	Lecture	Dr. Narith (ITC)
	Chapter 1(from the Bridge Maintenance Manual): Introduction (2 Hours)	2PM-4PM	Master Trainer (Supporting JICA Expert)
	At the end of this topic the participants should be able to: 1. Explain the Purpose of Bridge Maintenance 2. Explain Bridge Maintenance Process	Lecture	

Day	Training Topics	Remarks	Instructor
	3. Explain the Glossary related to Bridges and its maintenance		
	Chapter 2 (from the Bridge Maintenance Manual): - Organization for Bridge Maintenance (2 Hours)	4PM-5PM	
	At the end of this topic the participants should be able to: 1. Explain the Jurisdiction of Bridge Maintenance 2. Explain the Bridge Maintenance Schedule	Lecture	
Day 2 (Lecture)	Keynote Lecture 2 (1 Hour)	9:30AM～ 10:30AM	JICA Expert
	(TENTATIVIE) Introduce Japanese Bridge Inspection	Lecture	
	Chapter 3(from the Bridge Maintenance Manual): General Requirement for Bridge Inspections (1.5 Hours)	10:30AM-12PM	Master Trainer (Supporting JICA Expert)
	At the end of this topic the participants should be able to: 1. Understand inspection classification and, Plan Inspection (Routine Inspection, Periodic Inspection, Detailed Inspection, Emergency Inspection） 2. Understand safety during Inspection 3. Understand typical damages on Concrete Bridge 4. Understand typical damages on Steel Bridge 5. Scoring Inspection Results	Lecture	
	Chapter 4(from Bridge Maintenance Manual): - Bridge Inspection Recording (2 Hours)	2 PM-4 PM	Master Trainer (Supporting JICA Expert)
	At the end of this topic the participants should be able to: 1. Understand how to use the ipad system 2. Input Inspection data into the ipad system	Lecture	
	Examination: (1 Hour)	4PM-5PM	
	Writing test about Bridge Maintenance Purpose, Jurisdiction, Glossary, Typical damage on the bridge, ipad system	Writing test	
Day 3 (Field)	Field Training – 2(Instruction & Practice) (3 Hour) (Departing MPWT/DPWT at 7:00AM)	8:00-11:00	Master Trainer (Dr. Vong) (Dr. Sathaya) (Dr. Narith) (ITC) (Supporting JICA Expert)
	At the end of this topic the participants should be able to: 1. Explain the cause of defect 2. Understand inspection and safety equipment 3. Inspect bridge 4. Input inspection data into the ipad system 5. Inspect bridge considering safety	Instruction Practice	
	Examination: (1 Hour)	11:00-12:00	
	Field test about Bridge Inspection	Field Training	

Fig6-4 (1) Lecture by ME Master

Fig6-4 (2) Writing Examination

Fig. 6-4(3) Instruct by JICA-Expert

Fig. 6-4(4) Instruct by ME Master

(3) Evaluation of the Bridge ME training

Bridge Inspection ME Master Trainers

1. Nin Menakak
2. Eam Sovisoth
3. Long Davuth
4. Chhouk Sochea
5. Nut Sovanneth

Bridge Inspection ME (RID)

1. Chea Dara
2. Hou Sovannarith
3. Chheng Gyvorn
4. Mak Sopheap
5. Thou Saovry
6. Chhay Chakriya
7. Mam Sovarn
8. Ros Sreng
9. Va Panha
10. Nop Kilarith
11. Veth Piseth
12. Penh Otdom

(4) ME training corporation with Technical Institute of Cambodia

The objective of the Maintenance Expert training is to have a training framework for bridge maintenance. It is important to organize an inter-sector corporation for sustainability of the program and to share issues.

During the project, serious damage on the bridge was encountered but the severity was not fully understood by the inspectors, as a result the bridge was not prioritized.

While technical training continues through the ME initiated by the project, technical corporation with the Technical Institute of Cambodia is recommended. A corporative framework is under study.

Attachment 3 shows a sample damaged bridge found with cracks.

6.3.2 Road ME Training

Routine road maintenance cycle using IRI was established in 2016. Accordingly, Maintenance Expert (ME) system was introduced for improvement of road maintenance management capacities of MPWT/DPWT officials. As part of capacity development, a 3-day training program for road inspection has been formulated. The training focuses on IRI-measurement-based road inspection and subsequent data sorting.

highlights the details of the training program.

The project certified the following five (5) master trainers.

Table 6-12 Maintenance Expert Training Program for Road Inspection Capacity Improvement

Day	Activities	Reference*
Day1	**[Lecture]**	
	1.1 Routine road maintenance system using IRI	Guide-2: P.1-23
	1.2 Outline of DRIMS* operation (instructions for checklist)	Guide-1: P.1-5,45-46
	1.3 Basic operation of DRIMS	Guide-1: P.15-21
	1.4 Hump Calibration	Guide-1: P.24-28
	[DRIMS operation (with trainer's instructions)]	
	1.4 Instruction for checklist application (for 1-5, 1-6)	Guide-1: P. 46
	1.5 Installation of DRIMS equipment into vehicles	Guide-1: P.2, 12-14
	1.6 On-site Hump calibration	Guide-1: P.24-28
Day2	**[DRIMS operation (with trainer's instructions)]**	
	2.1 Instruction for checklist application (for 2-2, 2-3)	Guide-1: P.46
	2.2 Installation of DRIMS equipment into vehicles	Guide-1: P.2, 12-14
	2.3 IRI measurement	Guide-1: P.30-32
	[Lecture]	
	2.4 Analysis for IRI estimation & data storage in database	Guide-1: P.33-40
	[DRIMS operation (with trainer's instructions)]	
	2.5 Analysis for IRI estimation	Guide-1: P.33-40
	2.6 Preparation of inspection outputs & data storage in database	Guide-1: P.41-44

Day	Activities	Reference*
Day3	**[DRIMS operation (without trainer's instructions)]**	
	3.1 Installation of DRIMS equipment into vehicles	Guide-1: P.2, 12-14
	3.2 IRI measurement	Guide-1: P.30-32
	3.3 Analysis for IRI estimation	Guide-1: P.33-40
	3-4 Preparation of inspection outputs & data storage in database	Guide-1: P.41-44
	[Lecture]	
	3.5 Instructions for reviewing inspection results	Guide-2: P.23-37
	3.6 Recommendation & trouble shooting	Guide-1: 16, 20, 29, 31,32

*DRIMS: Dynamic Response Intelligence Monitoring System

*Guide-1: Guideline for Operation of Dynamic Response Intelligent Monitoring System (DRIMS)

*Guide-2: Guideline for Routine Maintenance Using IRI

Road Inspection Master Trainers

Mr You Dara

Mr Sa Sivutha

Mr Hay Chandara

Mr Sitthy Panhavuth

Mr Veth Piseth

6.4. To Inspect Roads and Bridges and Prepare Rough Cost Estimation of the Repair Works at the Target DPWTs

6.4.1 Inspection of Roads

(1) Inspection Plan of Roads

1) **Inspection for 1st Project Year(2015)**

The following eight (8) 1-digit roads were selected as inspection targets for the first year of this project in order to analyze road conditions of the most important road network in Cambodia and reflect the results on development of new routine road maintenance system. The inspection was carried out from July to August, 2015. National Road No.4 (RN4) was excluded from the target since the road was owned by the private sector.

- National Road No. 1 (RN1)
- National Road No. 2 (RN2)
- National Road No. 3 (RN3)
- National Road No. 5 (RN5)
- National Road No. 6 (RN6)
- National Road No. 7 (RN7)
- National Road No. 8 (RN8)
- National Road No. 9 (RN9)

2) **Inspection for 2nd Project Year (2016)**

In addition to the above eight (8) 1-digit roads, the following fifteen (15) road sections were inspected in 2016. NR4 was selected as an inspection target in the second project year since management responsibility of the road was transferred from the private sector to MPWT in January, 2016. The remaining 1) seven (7) road sections in Kandal province and 2) seven (7) road sections in Takeo province were partially inspected so as to collect samples for study on a cost estimate scheme for road maintenance works.

[Nationwide]
- National Road No. 4 (NR4)

[Kandal Province]
- National Road No. 14 (NR14)
- National Road No. 21A (NR21A)
- Provincial Road No. 110 (PR110)
- Provincial Road No. 120 (PR120)
- Provincial Road No. 151A (PR151A)
- Provincial Road No. 261 (PR261)
- Provincial Road No. 383 (PR383)

[Takeo Province]
- National Road No. 22 (NR22)
- National Road No. 31A (NR31A)
- Provincial Road No. 122 (PR122)
- Provincial Road No. 129 (PR129)
- Provincial Road No. 129A (PR129A)
- Provincial Road No. 129E (PR129E)

- Provincial Road No. 132 (PR132)

(2) Inspection Results of Roads at Target DPWTs

1) Examination of the Primary Road Network Condition of Cambodia

Target nine (9) 1-digit roads, which formulate primary road network of Cambodia, were inspected in 2015 through 2016 as shown in Table 6-13. Figure 6-4 shows IRI map of 1-digit roads obtained as a result of IRI measurement using DRIMS. Locations of target DPWTs for pilot projects in the 1st and 2nd project years (Phnom Penh and Kandal) are also indicated in the map.

Also, the inspected roads were evaluated using the criteria shown in Table 6-14, which have been suggested in this project for assessment of road conditions in combination with IRI values and visual inspection results. The conditions of road sections are evaluated by five (5) levels (Rank-5: Good, Rank-4: Fair, Rank-3: Poor, Rank-2: Very poor, Rank-1: Bad) at 5km-intervals. Evaluation results of 1-digit roads are shown in Figure 6-5 as percentage of the five (5) road condition ranks**.**

From the study results explained above, it has been verified that IRI measurement by DRIMS can be practically applied for evaluation of road surface conditions of the entire road network.

Table 6-13 Road Inspection Schedule for 1-digit Roads

Road	Date	Province (Route): IRI measurement by RID
NR1	July 24, 2015	Phnom Penh – PreyVeng - Svay Rieng
NR2	July 31, 2015	Phnom Penh – Kandal –Takeo -
NR3	August 6, 2015	Phnom Penh – Kandal - Takeo - Kampot
NR4	April 21, 2016	Phnom Penh – Kampong Speu – Koh Kong – Preah Sihanouk
NR5	August 25, 2015	Phnom Penh – Kandal – Kampong Chhnang – Pursat – Battambang – Banteay Meanchey
NR6	August 26, 2015	Phnom Penh – Kandal – Kampong Chhnang – Kampong Thom – Siem Reap – Banteay Meanchey
NR7	August 27, 2015	Kampong Cham – Kratie – Stung Treng
NR8	August 4, 2015	Kandal - PreyVeng - Kampong Chhnang
NR9	August 28-29, 2015	Stung Treng – Preah Vihear

Figure 6-4 IRI Map of 1-Digit Roads

Table 6-14 Evaluation Matrix for Road Conditions

Visual Rating / IRI (5km-ave.)	Very good	Good	Fairy Good	Fair	Poor
IRI<3.5	**Rank-5: Good (No or small repair)**			**Rank-4: Fair (Small repair)**	**Rank-3: Poor (Repair)**
3.5 ≤ IRI<5.0	**Rank-3: Poor (Repair)**			**Rank-2: Very Poor (Severe Repair)**	
5.0 ≤ IRI	**Rank-1: Bad (Reconstruction/Rehabilitation/Upgrade)**				

Note: Calculation interval of average IRI values is 5.0 km

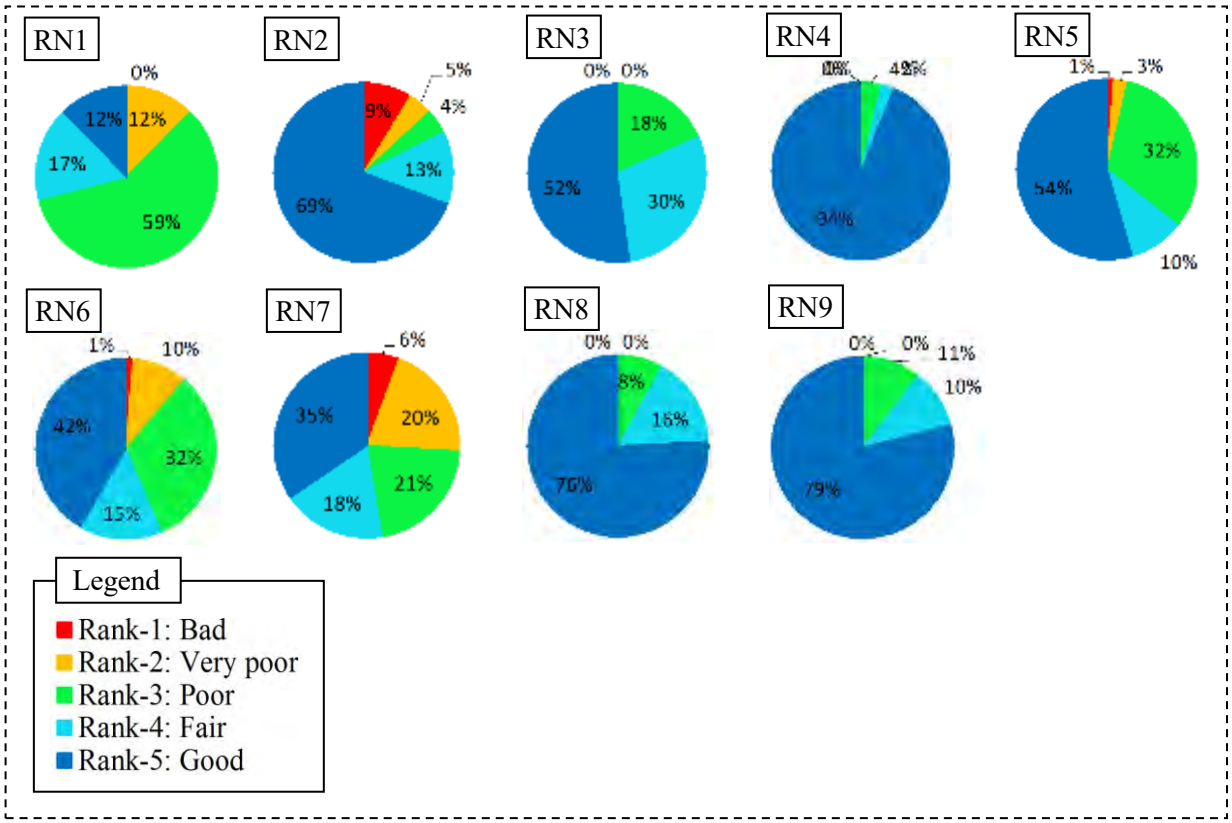


Figure 6-5 Evaluation Result of 1-digit Road Conditions

2) **Study on Accuracy of IRI Values Obtained by DRIMS**

A comparative study has been conducted in order to clarify accuracy of IRI obtained by DRIMS. The study was carried out under the following conditions:

- Equipment: DRIMS (Class III) and ROMDAS Z-250 (Class I)
- Inspection target & course: the National Road No.4 (NR4), the right-side lane
- Road length: 212.4 km (from Chaom Chaor to Sihanouk Ville)
- Allowable difference (evaluation criteria) of average IRI values between DRIMS and ROMDAS:
- Max 1.0 (The criteria are set based on DRIMS specifications.)

(Example of the evaluation)

Road sections	IRI		Difference	Evaluation
	ROMDAS	DRIMS		
Section.1	2.1	1.5	0.6	OK
Section.2	3.0	1.9	1.1	**NG**

The inspection result has been evaluated dividing the inspected course into ten (10) road sections that connected major cities/towns. Figure 6-6 and Table 6-15 outline evaluation of the inspection results. The results can be briefly summarized as follows:

· Nine (9) out of ten (10) road sections have desirable results in which the deference of the average IRI values (hereafter called “the IRI deference”) is much less than the criteria of 1.0.

· The IRI deference ranges from 0.05 to 2.1, and overall average of the IRI difference is 0.38.

- The IRI difference of Road Section 1 (Sec. 1) exceeded the criteria of 1.0 by 1.1 in IRI value. The cause is considered to be data acquisition failure due to slow driving speed of less than 30 km/h during traffic jams.

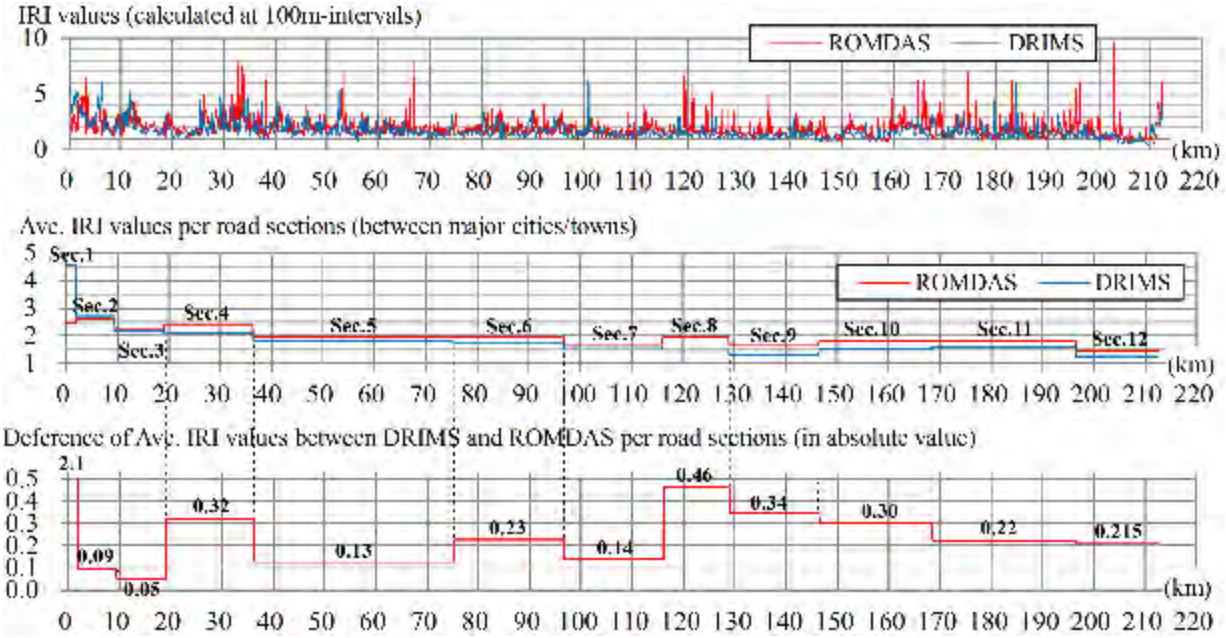


Figure 6-6 Comparison of IRI Values between DRIMS and ROMDAS

Table 6-15 Summary of Ave. IRI Values per Road Sections

Road Sections between Major Cities/Towns		Distance (km)	Ave. IRI per Sections			Difference of IRI	Evaluation
			ROMDAS (A)	DRIMS (B)	Ratio (B)/(A)		
Sec.1	Chaom Chaor - Prey Svay	1.75	2.47	4.56	1.85	2.10	NG
Sec.2	Prey Svay - Bek Chan	7.57	2.63	2.72	1.04	0.09	OK
Sec.3	Bek Chan - Thnal To Tueng	9.52	2.22	2.17	0.98	0.05	OK
Sec.4	Bek Chan - Thnal To Tueng	17.26	2.42	2.10	0.87	0.32	OK
Sec.5	Thnal To Teung - ChbarMorn	38.83	1.96	1.83	0.94	0.13	OK
Sec.6	ChbarMorn - Treng Tro Yeung	21.49	1.94	1.71	0.88	0.23	OK
Sec.7	Stueng Chral - Kampong Sela	19.21	1.70	1.56	0.92	0.14	OK
Sec.8	ampong Sela - Chamkar Loung (road to Srae Ampil)	12.86	1.95	1.49	0.76	0.46	OK
Sec.9	Chamkar Loung (road to Srae Ampil) - Phum Monourom	17.47	1.64	1.30	0.79	0.34	OK
Sec.10	Phum Monourom - Veal Renh	22.09	1.81	1.51	0.83	0.30	OK
Sec.11	Veal Renh - KongKong (Road to Ream)	27.82	1.81	1.59	0.88	0.22	OK
Sec.12	KongKong (Road to Ream) - Sihanouk Ville (Port entrance)	16.00	1.47	1.26	0.85	0.22	OK
					Ave:	0.38	OK

In conclusion, DRIMS has been proved to be reliable enough to be used in the new road maintenance system unless long duration of data acquisition failure occurs due to unexpected events such as traffic jams and continuous extremely large bumps.

3) Study on the New Road Maintenance System through Inspections in Target Provinces

In order to study a series of schemes for inspection, maintenance planning, and cost estimation, IRI measurement and detailed visual inspection were carried out in 2016 for the national/provincial roads in Kandal and Takeo province as shown in Table 6-16 and Table 6-17 respectively. Table 6-18 and Table 6-19 are a summary of the inspection results.

Table 6-16 Road Inspection Schedule (Kandal Province)

Road	Pavement Type	Length (km)	Date	
			IRI measurement by RID	Detailed visual inspection by DPWT
NR1	A/C	44.0	July 24, 2015	January 31, 2016
NR2	MCD, DBST	19.6	July 31, 2015	June 2, 2016
NR3	DBST	11.85	August 6, 2015	May 31, 2016
NR4	A/C, DBST	11.3	April 21, 2016	May 31, 2016
NR5	DBST	8.9	August 25, 2015	May 31, 2016
NR8	A/C	22.2	August 4, 2015	May 30, 2016
NR14	DBST	42.4	June 11, 2015	May 31, 2016
NR21A	A/C, DBST	20.0	May 25, 2016	January 1, 2016
PR110	DBST	78.2	May 25, 2016	June 2, 2016
PR120	DBST	6.7	May 25, 2016	-
PR151A	DBST	6.9	May 25, 2016	-
PR261	DBST	22.0	June 3, 2016	May 30, 2016
PR383	Laterite	10.8	June 3, 2016	-

Table 6-17 Road Inspection Schedule (Takeo Province)

Road	Pavement Type	Length (km)	Date	
			IRI measurement by RID	Detailed visual inspection by DPWT
NR2	DBST	47.9	December 6, 2016	
NR3	DBST	29.9	December 7, 2016	
NR22	DBST	9.4	December 7, 2016	
NR31	DBST	4.7	December 7, 2016	
PR122	DBST	13.6	December 6, 2016	
PR129	DBST	29.5	December 6, 2016	
PR129A	DBST	10.9	December 6, 2016	
PR129E	DBST	14.2	December 6, 2016	
PR132	DBST	33.2	December 7, 2016	

Table 6-18 Conditions of Target Roads in Kandal Province

Road Name	Pavement Type	Inspected Length (km)	Ave. IRI	Indicator-N (visual evaluation)	Repair Neccessity (%)			Remarks
					Rank-1+2+3	Rank-1+2	Rank-1	
NR1	A/C	44.00	2.8	1.51 (Poor)	54.5	11.4	0.0	Bad condition
NR2	MCD, DBST	19.60	2.7	1.15 (Poor)	25.0	0.0	0.0	
NR3	DBST	11.85	2.6	0.80 (Fair)	41.7	0.0	0.0	
NR4	A/C, DBST	11.60	2.1	0.00 (Very good)	0.0	0.0	0.0	Good condition
NR5	DBST	8.90	2.7	0.30 (Good)	0.0	0.0	0.0	Good condition
NR8	A/C	22.20	2.6	1.15 (Poor)	25.0	0.0	0.0	
NR14	DBST	42.4	4.5	10.87 (Poor)	100.0	76.7	34.9	Bad condition
NR21A	A/C, DBST	20.0	2.8	1.10 (Fair)	50.0	0.0	0.0	
PR110	DBST	78.2	3.9	19.98 (Poor)	50.6	44.3	25.3	Bad condition
PR120	DBST	6.7	2.3	0.30 (Good)	0.0	0.0	0.0	Good condition
PR151A	DBST	6.9	3.6	0.30 (Good)	28.6	0.0	0.0	
PR261	DBST	22.0	1.9	0.04 (Very good)	0.0	0.0	0.0	Good condition
PR383	Laterite	10.8	3.4	-	9.1	-	0.0	

1*: Repair ratio consists of "Rank-1(Bad)"+" Rank-2 (Very poor)"+" Rank-3 (Poor)".
2*: Urgency ratio consists of "Rank-1(Bad)"+" Rank-2 (Very poor)".
3*: Ratio of Investment (Chap.21) is the ratio of "Rank-1(Bad)".

Table 6-19 Conditions of Target Roads in Takeo Province

Road Name	Pavement Type	Inspected Length (km)	Ave. IRI	Indicator-N (visual evaluation)	Repair Neccessity (%)			Remarks
					Rank-1+2+3	Rank-1+2	Rank-1	
NR2	DBST	47.9	2.1	0.0 (Very good)	0.0	0.0	0.0	Good condition
NR3	DBST	29.9	2.0	0.0 (Very good)	0.0	0.0	0.0	Good condition
NR22	DBST	9.4	4.6	0.9 (Fair)	47.4	47.4	47.4	Bad condition
NR31	DBST	4.7	2.3	0.0 (Very good)	0.0	0.0	0.0	Good condition
PR122	DBST	13.6	2.6	0.0 (Very good)	0.0	0.0	0.0	Good condition
PR129	DBST	29.5	3.6	0.13 (Very good)	50.7	0.0	0.0	Bad condition
PR129A	DBST	10.9	2.0	0.4 (Fairly good)	45.9	0.0	0.0	Bad condition
PR129E	DBST	14.2	1.8	0.0 (Very good)	0.0	0.0	0.0	Good condition
PR132	DBST	33.2	3.0	0.54 (Fairly good)	15.1	15.1	0.0	

1*: Repair ratio consists of "Rank-1(Bad)"+" Rank-2 (Very poor)"+" Rank-3 (Poor)".
2*: Urgency ratio consists of "Rank-1(Bad)"+" Rank-2 (Very poor)".
3*: Ratio of Investment (Chap.21) is the ratio of "Rank-1(Bad)".

4) Improvement of Road Maintenance Procedure

Road maintenance procedures in accordance with the newly introduced road maintenance cycle have been clarified through the inspections in Kandal province and Takeo province. The procedures are slightly different between paved roads and unpaved roads as explained below.

Table 6-20 describes the road maintenance procedure for paved roads. In Step 1 through Step 2, RID carried out IRI measurement and visual inspection simultaneously, and prepared DRIMS-based road inventory called "Inventory". Inventory is to be summarized as "Inspection Review Sheet" with which RID gives instructions to DPWT for more detailed visual inspection. DPWT then updates Inspection Review Sheet with their inspection results. In Step 3, road lists are prepared based on Inspection Review Sheet, and maintenance necessity of the inspected roads are prioritized. In Step 4, RID and DPWT collaborate to prepare maintenance plans and estimate costs by analyzing the inspection results. Figure 6-7 and Figure 6-8 show Inventory formats and Inspection Review Sheet formats, respectively.

Table 6-20 Road Maintenance Procedure for Paved Roads

Step	Tasks to be Taken	In Charge
Step 1	IRI measurement with visual inspection	RID
Step 2	- Preparation of IRI-based road inventory (Inventory) - Inventory analysis and identification of defective road sections - Preparation of Inspection Review Sheet & analysis of inspection results - Instructions to DPWT for visual inspection, based on Inspection Review Sheet - Visual inspection by DPWT with Inspection Review Sheet (to be updated) - Update of Inspection Review Sheet with DPWT inspection results	RID RID RID RID DPWT RID
Step 3	- Preparation of road lists, based on Inventory - Prioritization of maintenance plans	RID RID/DPWT
Step 4	- Selection of maintenance methods - Preparation of unit prices for work items and cost estimate for maintenance plans	RID/DPWT RID/DPWT
Step 5	Budget request (for Chap. 61) and negotiation with MEF	RID
Step 6	- Supervision of maintenance works - Implementation of maintenance plans	RID DPWT

Table 6-21 gives the road maintenance procedure for unpaved roads. Basically, the procedure is the same as that for paved roads. The difference is that unpaved roads for inspection are selected while all the paved roads are inspection targets. Also, DPWT doesn't carry out detailed visual inspection in Step 2. Instead, DPWT briefly checks the road conditions at the sites, referring to information on Inspection Review Sheet. Figure 6-9 and Figure 6-10 shows Inventory format and Inspection Review Sheet, respectively.

Table 6-21 Road Maintenance Procedure for Unpaved Roads

Step	Tasks to be Taken	In Charge
Step 1	- Selection of road sections (maintenance target) for inspection	RID/DPWT
	- IRI measurement through visual inspection	RID
Step 2	- Preparation of IRI-based road inventory (Inventory 2)	RID
	- Analysis of Inventory 2 and identification of defective road sections	RID
	- Preparation of Inspection Review Sheet and analysis on inspection results	RID RID
	- Instructions to DPWT for visual inspection, based on Inspection Review Sheet	DPWT RID
	- Visual inspection by DPWT with Inspection Review Sheet (to be updated)	
	- Update of Inspection Review Sheet with DPWT inspection results	
Step 3	- Preparation of road lists, based on Inventory2	RID
	- Prioritization of maintenance plans	RID/DPWT
Step 4	- Selection of maintenance methods	RID/DPWT
	- Preparation of unit prices for work items and cost estimate for maintenance plans	RID/DPWT
Step 5	Budget request (for Chap.61) and negotiation with MEF	RID
Step 6	- Supervision of maintenance works	RID
	- Implementation of maintenance plans	DPWT

5) **Advantage of road inspection using IRI**

Introduction of IRI (by DRIMS) for road inspection shall give the following advantages, compared to the traditional method;

Advantage 1: Nationwide standardized evaluation of the roads

Currently, the road conditions are evaluated by joint visual inspection of RID and DPWTs. The reliability of inspection results may depend on the skill and experience of inspectors and some other factors. Introduction of IRI is expected to improve accuracy of inspection results with the standardized inspection method. Table 6-22 shows the difference between visual inspection results by DPWT and IRI-based inspection results by RID, which were conducted in Kandal province.

Table 6-22 The Difference between Visual Inspection Results by DPWT and IRI-based Inspection Results by RID

Road Name	Pavement Type	Inspected Length (km)	Ave. IRI	Indicator-N (visual evaluation)	Repair Ratio*1 (%)	Urgency Ratio*2 (%)	Ratio of Periodic*3 (%)	Repair Cost (US$)		Remarks
								by DPWT	by RID: Standardized	
NR1	A/C	44.00	2.8	1.51 (Poor)	54.5	11.4	0.0	77,739	78,112	
								1.000	1.005	
NR5	DBST	8.90	2.7	0.30 (Good)	0.0	0.0	0.0	4,400	6,440	
								1.000	1.464	
NR4	A/C, DBST	11.60	2.1	0.00 (Very good)	0.0	0.0	0.0	5,786	5,308	
								1.090	1.000	
NR2	MCD, DBST	19.60	2.7	1.15 (Poor)	25.0	0.0	0.0	13,567	22,808	
								1.000	1.681	
NR3	DBST	11.85	2.6	0.80 (Fair)	41.7	0.0	0.0	4,661	17,324	Large gap in cost estimate
								1.000	3.717	
NR8	A/C	22.20	2.6	1.15 (Poor)	25.0	0.0	0.0	105,602	24,307	Large gap in cost estimate
								4.345	1.000	
NR21A	A/C, DBST	20.0	2.8	1.10 (Fair)	50.0	0.0	0.0	25,686	29,107	
								1.000	1.133	
NR14	DBST	42.4	4.5	10.87 (Poor)	100.0	76.7	34.9	86,646	94,669	
								1.000	1.093	
PR110	DBST	78.2	3.9	19.98 (Poor)	50.6	44.3	25.3	9,069	91,694	Large gap in cost estimate
								1.000	10.111	
PR261	DBST	22.0	1.9	0.04 (Very good)	0.0	0.0	0.0	33,729	10,333	Large gap in cost estimate
								3.264	1.000	

1*: Repair ratio consists of "Rank-1(Bad)"+" Rank-2 (Very poor)"+" Rank-3 (Poor)".
2*: Urgency ratio consists of "Rank-1(Bad)"+" Rank-2 (Very poor)".
3*: Ratio of Investment (Chap.21) is the ratio of "Rank-1(Bad)".

Advantage 2: Visualization of road condition

By evaluating numerically, the road condition can be visualized to the decision makers. It is also easy to update the road condition by the use of the equipment.

Advantage 3: More reasonable annual budget preparation

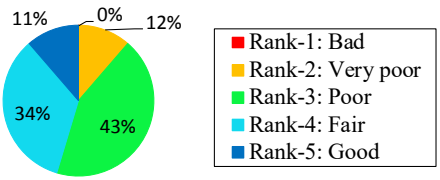
Having a standardized method and visualized result, required budget for the road network maintenance can be more reasonable.

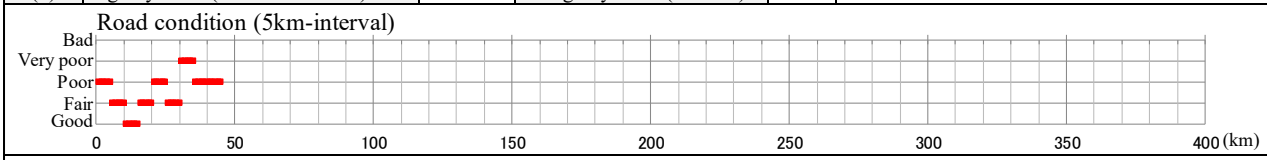
The allocation of the budget for DPWT can be verified based on road condition data and maintenance policy.

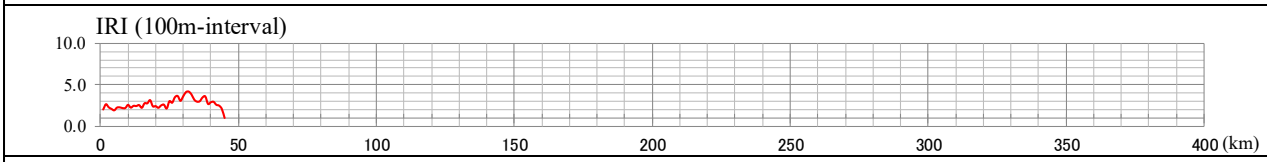
Road Inventory (for Paved Roads)

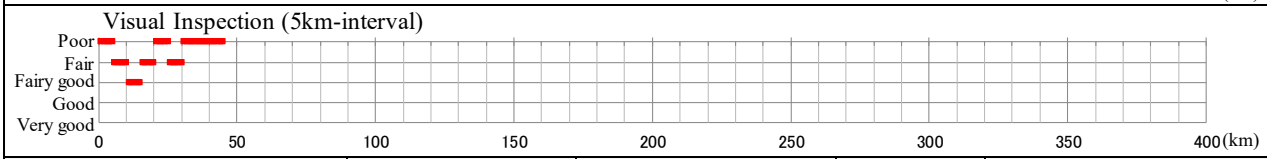
(1)	Road Name	RN1 (Kandal)				
(2)	Road Length (km)	44.0	Inspected road length:	44.1 km		
(3)	Pavement Type	AC				
(4)	Date of IRI measurement	24/July/2015				
(5)	Start Point & End Point	Start	PK016+500	End	PK060+500	
(6)	Average IRI (Total Section)	2.7				
(7)	Visual Rating (Total Section)	Indicator-N	1.51	Evaluation	Poor	
(8)	Repair Ratio (**Rank-1+Rank-2+Rank-3**)		54.6%			
(9)	Urgency Ratio (**Rank-1+Rank-2**)	11.3%	Emergency Ratio (**Rank-1**)	0.0%		

Breakdown of the Road Condition









(10) Location		(11) Average IRI			(12) Visual Rating (Per 5.0km)				(13) Road Condition (Per 5.0km)	(14) Remarks	
From	To	Per 100m	Per 1.0km	Per 5.0km	No.of Defects Per 100m	No.of Defects Per 5.0km	N	Evaluation		No. of Bridge Joints	Major Findings
0 km + 0	0 km + 100	1.5			0					0	
0 km + 100	0 km + 200	1.9			0					0	
0 km + 200	0 km + 300	2.1			0					0	
0 km + 300	0 km + 400	2.0			0					0	
0 km + 400	0 km + 500	1.9	2.0	-	0	-	-	-	-	0	
0 km + 500	0 km + 600	1.8			0					0	
0 km + 600	0 km + 700	1.7			0					0	
0 km + 700	0 km + 800	2.1			0					0	
0 km + 800	0 km + 900	2.5								0	
0 km + 900	1 km + 0	2.6								0	
1 km + 0	1 km + 100	2.6			0					0	
1 km + 100	1 km + 200	2.6			1					0	
1 km + 300	1 km + 400	2.6			0					0	
1 km + 400	1 km + 500	2.8			1					0	
1 km + 500	1 km + 600	2.9	2.7	-	1					0	
1 km + 600	1 km + 700	3.2			0					0	
1 km + 700	1 km + 800	3.0			0					0	
1 km + 800	1 km + 900	2.8			0					0	
1 km + 900	2 km + 0	2.2			0					0	
2 km + 0	2 km + 100	2.4			0					0	
2 km + 100	2 km + 200	2.8			3					0	
2 km + 200	2 km + 300	2.5			2					0	
2 km + 300	2 km + 400	2.0			0					0	
3 km + 400	3 km + 500	1.8			0					0	
3 km + 500	3 km + 600	2.0	2.1	-	0					0	
3 km + 600	3 km + 700	1.9			0					0	
3 km + 700	3 km + 800	1.7			0					0	
3 km + 800	3 km + 900	1.8			0					0	
3 km + 900	4 km + 0	1.9			0					0	
4 km + 0	4 km + 100	1.8			0					0	
4 km + 100	4 km + 200	2.0			0					0	
4 km + 200	4 km + 300	2.0			1					0	
4 km + 300	4 km + 400	1.9			1					0	
4 km + 400	4 km + 500	1.8	1.9	2.2	0	15	3.00	Poor	Rank-3: Poor / Repair (moderate)	0	
4 km + 500	4 km + 600	1.7			0					0	
4 km + 600	4 km + 700	1.8			0					0	
4 km + 700	4 km + 800	1.8			0					1	
4 km + 800	4 km + 900	2.1			0					0	
4 km + 900	5 km + 0	2.1			0					0	

[Definition of Color Indication]
- 10.0≦IRI
- 7.0≦IRI<10.0
- 5.0≦IRI<7.0
- 3.0≦IRI<5.0
- IRI<3.0
- No data

Comments from visual inspection

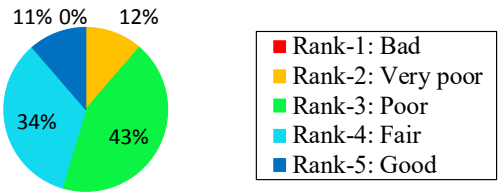
Roads shall be evaluated every 5.0km. The evaluation of each 5.0km-section is shown in the last 1.0km-section.

Figure 6-7 Inventory for Paved Roads

Inspection Review Sheet (for Paved Roads)

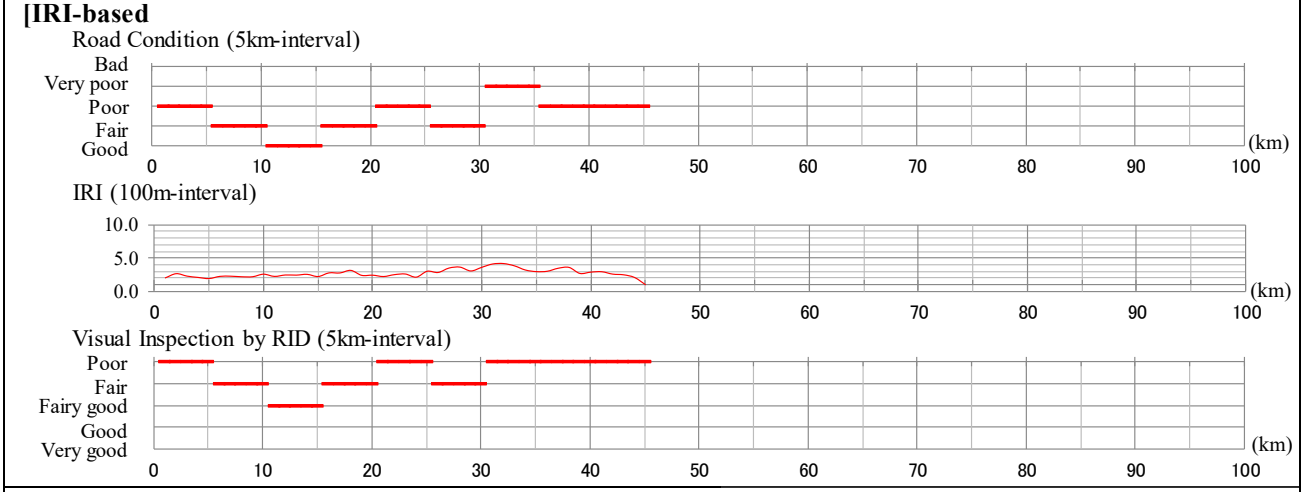
(1)	Road Name	RN1 (Kandal)	
(2)	Road Length (km) (Inspected: 44.1(km))		44.0
(3)	Pavement Type		AC
(4)	Date of IRI measurement		24/July/2015
(5)	Start Point & End Point	Start	PK016+500
		End	PK060+500
(6)	Average IRI (Total Section)		2.7
(7)	Visual Rating (Total Section)	Indicator-N	1.51
		Evaluation	Poor
(8)	Repair Ratio (Rank-1+Rank-2+Rank-3)		**54.6%**
(9)	Urgency Ratio (Rank-1+Rank-2)		**11.3%**

Breakdown of Road Condition

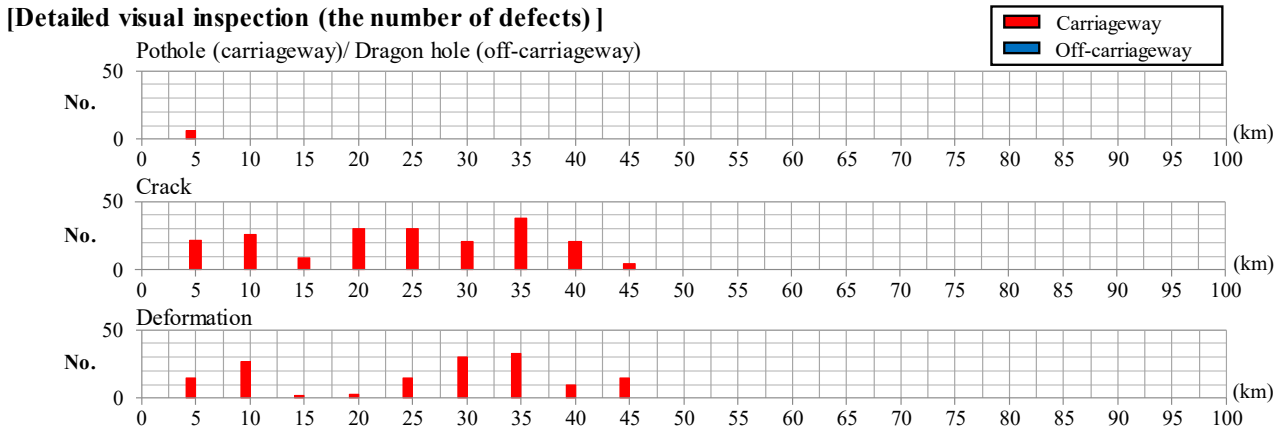


Emergency Ratio (Rank-1)	**0.0%**

[IRI-based



[Detailed visual inspection (the number of defects)]



Location				IRI-based inspection					Visual inspection for check					
							Road condition		Carriageway			Off-carriageway		
From		To		Ave. IRI	Visual rating		Rank: Condition	Discription	Pot-hole	Crack	Defor-mation	Defor-mation	Dragon hole	Update
km	PK	km	PK		N	Evaluation								
0	16.5	**5**	21.5	2.19	3.00	Poor	**3:Poor**	Repair (moderate)	6	22	15			
5	21.5	**10**	26.5	2.30	0.80	Fair	**4:Fair**	Repair (small)		26	27			☑
10	26.5	**15**	31.5	2.38	0.40	Fairly good	**5:Good**	Regular inspection		9	2			
15	31.5	**20**	36.5	2.70	1.00	Fair	**4:Fair**	Repair (small)		30	3			
20	36.5	**25**	41.5	2.50	2.20	Poor	**3:Poor**	Repair (moderate)		30	15			
25	41.5	**30**	46.5	3.33	0.60	Fair	**4:Fair**	Repair (small)		21	30			
30	46.5	**35**	51.5	3.65	2.20	Poor	**2:Very poor**	Repair/ Resurfacing		38	33			
35	51.5	**40**	56.5	3.13	1.20	Poor	**3:Poor**	Repair (moderate)		21	10			
40	56.5	**45**	61.5	2.22	2.20	Poor	**3:Poor**	Repair (moderate)		5	15			
45	61.5	**50**	66.5											

If visual rating is updated based on visual inspection after IRI measurement, mark ☑.

In case that visual rating is updated based on visual inspection results after IRI measurement, mark ☑ in "Update" column.

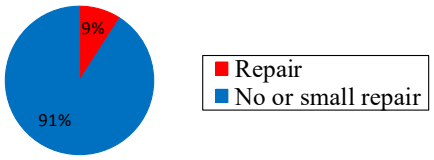
Enter the number of defects detected in visual inspection after IRI measurement

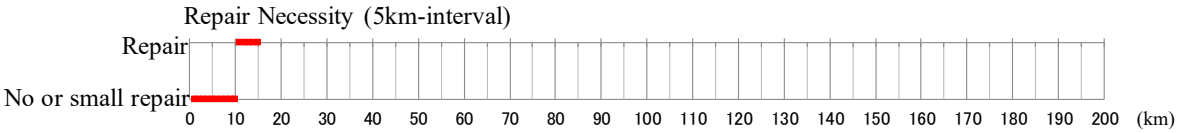
Figure 6-8 Inspection Review Sheet for Paved Roads

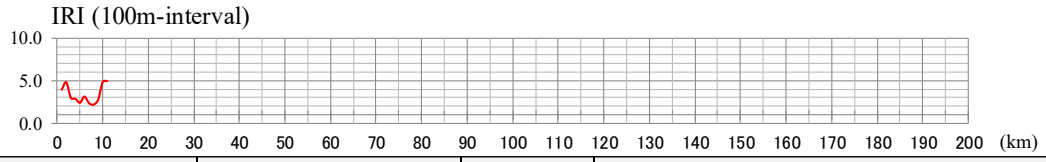
Road Inventory2 (for Unpaved Roads)

(1)	Road Name	RN383			
(2)	Road Length (km)	8.4	Inspected road length:	10.8 (km)	
(3)	Pavement Type	Laterite			
(4)	Date of IRI measurement	3/June/2016			
(5)	Start Point & End Point	Start PK000+000	End	PK008+350	
(6)	Average IRI (Total Section)	3.4			
(7)	Repair Ratio (5.0<IRI)	9.1%			

Breakdown of Road Condition







(8) Location		(9) Average IRI			(10) Priority (Per 5.0km)	(11) Remarks	
From	To	Per 100m	Per 1.0km	Per 5.0km		No. of Bridge Joints	Major Findings
0 km + 0	0 km + 100	3.8				0	
0 km + 100	0 km + 200	2.9				0	
0 km + 200	0 km + 300	2.1				0	
0 km + 300	0 km + 400	2.5				0	
0 km + 400	0 km + 500	3.3				0	
0 km + 500	0 km + 600	4.0	3.9	-	-	0	
0 km + 600	0 km + 700	4.9				0	
0 km + 700	0 km + 800	6.3				2	
0 km + 800	0 km + 900	5.8					
0 km + 900	1 km + 0	4.0					
1 km + 0	1 km + 100	4.7					
1 km + 100	1 km + 200	6.5					
1 km + 200	1 km + 300	5.0					
1 km + 300	1 km + 400	3.6					
1 km + 400	1 km + 500	3.5					
1 km + 500	1 km + 600	4.8	4.8				
1 km + 600	1 km + 700	7.5					
1 km + 700	1 km + 800	5.0					
1 km + 800	1 km + 900	3.8					
1 km + 900	2 km + 0	3.5				0	
3 km + 0	3 km + 100	3.1				0	
3 km + 100	3 km + 200	3.2				0	
3 km + 200	3 km + 300	2.5				0	
3 km + 300	3 km + 400	2.2				0	
3 km + 400	3 km + 500	2.1				0	
3 km + 500	3 km + 600	2.6	2.9	-	-	0	
3 km + 600	3 km + 700	3.2					
3 km + 700	3 km + 800	3.6					
3 km + 800	3 km + 900	3.3					
3 km + 900	4 km + 0	2.8				0	
4 km + 0	4 km + 100	2.6				0	
4 km + 100	4 km + 200	2.4				0	
4 km + 200	4 km + 300	2.3				0	
4 km + 300	4 km + 400	2.8				0	
4 km + 400	4 km + 500	2.9				0	
4 km + 500	4 km + 600	2.0	2.4	3.4	No repair	0	
4 km + 600	4 km + 700	2.1				0	
4 km + 700	4 km + 800	2.3				0	
4 km + 800	4 km + 900	2.3				0	
4 km + 900	5 km + 0	2.2				0	

[Definition of Color Indication]
- 10.0≦IRI
- 7.0≦IRI<10.0
- 5.0≦IRI<7.0
- 3.0≦IRI<5.0
- IRI<3.0
- No data

Comments from visual inspection

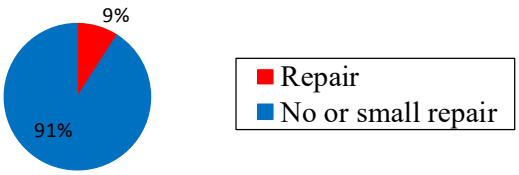
Roads shall be evaluated every 5.0km. The evaluation of each 5.0km-section is shown in the last 1.0km-section.

Figure 6-9 Inventory for Unpaved Roads

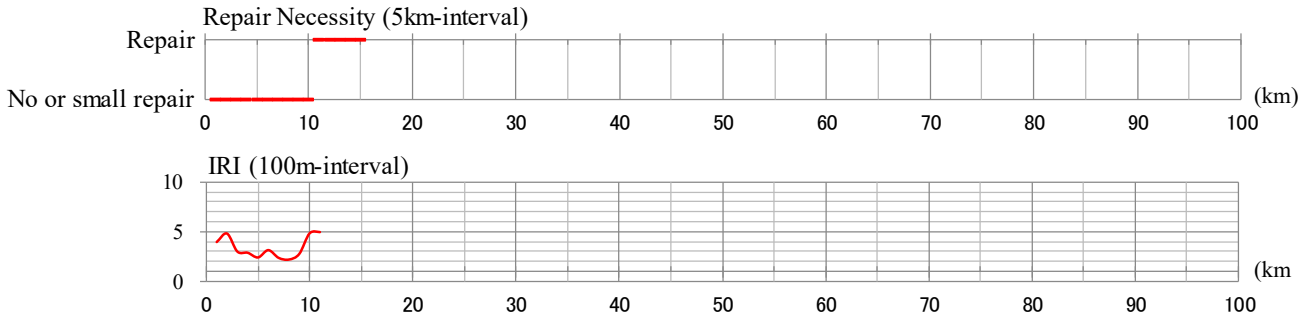
Inspection Review Sheet (for Unpaved Roads)

(1)	Road Name		RN383
(2)	Road Length (km) (Inspected: 10.8(km))		8.4
(3)	Pavement Type		Laterite
(4)	Date of IRI measurement		3/June/2016
(5)	Start Point & End Point	Start	PK000+000
		End	PK008+350
(6)	Average IRI (Total Section)		3.4
(7)	Repair Ratio		**9.1%**

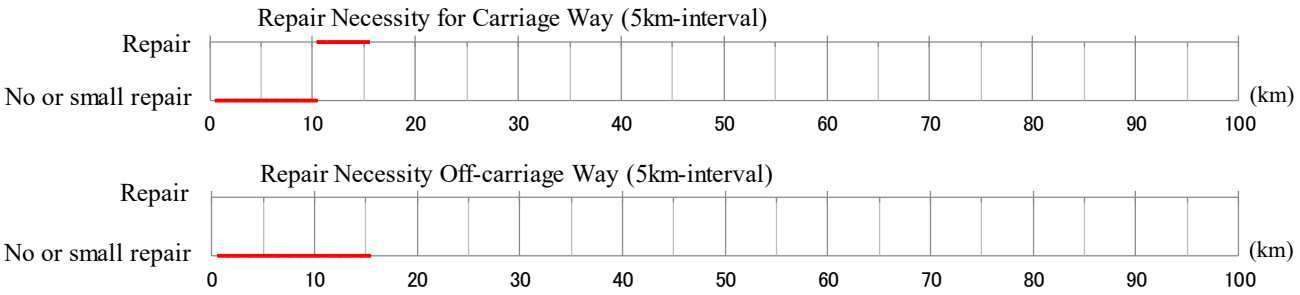
Breakdown of Road Condition



[IRI-based inspection]



[Visual inspection for check]



Location				DRIMS-based inspection		Visual inspection for check		
From		To		Ave. IRI	Repar Necessity	Repar Necessity		Remarks
km	PK	km	PK			Carriage way	Off-carriage way	
0	0.0	**5**	5.0	3.4	No repair	No/small repair	No/small repair	
5	5.0	**10**	10.0	3.0	No repair	No/small repair	No/small repair	
10	10.0	**15**	15.0	4.9	Repair	Repair	No/small repair	
15	15.0	**20**	20.0					
20	20.0	**25**	25.0					

Report the repair necessity based on detailed visual inspection results.

Figure 6-10 Inspection Review Sheet for Unpaved Roads

6) Development of Cost Estimation System for Road Maintenance

(6-1) Outline

A new cost estimation system for road maintenance has been developed. In the new system, the maintenance planning and cost estimation are done at the interval of 5.0 km for maintenance management efficiency. Approximate maintenance costs under Chapter 61 can be obtained by summing up cost estimates of all the 5.0 km-sections. Additionally, in case of paved roads, there are 2 options for maintenance of road sections evaluated as “Rank-1 (Bad)”, either 1) maintenance planning under Chapter 61 or 2) under Chapter 21. A standardized cost estimation system for maintenance plans under Chap. 61 is suggested here in order to streamline the cost

estimation procedure. In the standardized system, maintenance costs consist of 4 cost estimate groups: 1) carriageways, 2) off-carriageway, 3) structures, and 4) road furniture. In this report, cost estimation system is explained, focusing on paved roads.

(6-2) Cost Estimation System for Carriageways of Paved Roads

[Conditions for Selection of Maintenance Methods]

In the new cost estimation system, prior to selection of maintenance methods, the following 3 conditions have to be clarified:

1) Existing pavement types

2) Periodical maintenance intervention

3) Large traffic volume range (LV-AADT: Large Vehicle Annual Average Daily Traffic)

Table 6-23 below summarizes the relationship of the above 3 items. In case that LV-AADT is larger than the specified range, maintenance methods for highly ranked roads should be chosen. For example, if the existing pavement type is DBST and LV-AADT is over 500, the pavement type should be upgraded to AC.

Table 6-23 Conditions for Selection of Maintenance Methods

Existing pavement type	**SBST**	**DBST**	**AC**
Periodical maintenance intervention	3 years	5 years	10 years
Large vehicle traffic volume (LV-AADT*)	(LV-AADT) <200	200< (LV-AADT) <500	500< (LV-AADT)

*LV-AADT: Large Vehicle Annual Average Daily Traffic

[Selection of Maintenance Methods]

Standard maintenance methods are defined for each existing pavement types (SBST, DBST, and AC). Optimal maintenance methods shall be selected according to 5 road condition ranks. Relationship between 5 road condition ranks and standard maintenance methods is shown in Table 6-24.

Table 6-24 Standard Maintenance Methods for Each Road-condition Rank

<table>
<tr><th rowspan="2">Road Condtion</th><th rowspan="2">Method</th><th rowspan="2" colspan="2">Maintenance Category</th><th colspan="3">Standard Maintenance Methods for Each Existing Pavement Type</th></tr>
<tr><th>SBST</th><th>DBST</th><th>AC</th></tr>
<tr><td rowspan="3">Rank-1: Bad</td><td>1</td><td>Chap.21</td><td>Invest-ment</td><td>Reconstruction (SBST)/ Upgrade to DBST or AC</td><td>Reconstruction (DBST) Upgrade to AC</td><td>Overlay with AC/ Reconstruction (AC)</td></tr>
<tr><td>2</td><td rowspan="2">Chap.61</td><td>Routine</td><td colspan="2">Repair (very severe) by DBST</td><td>Repair (very severe) by AC</td></tr>
<tr><td>3</td><td>Periodic</td><td colspan="3">Resurfacing/Overlay</td></tr>
<tr><td rowspan="2">Rank-2: Very poor</td><td>1</td><td rowspan="2">Chap.61</td><td>Routine</td><td colspan="2">Repair (severe) by DBST</td><td>Repair (severe) by AC</td></tr>
<tr><td>2</td><td>Periodic</td><td colspan="3">Resurfacing/Overlay</td></tr>
<tr><td rowspan="2">Rank-3: Poor</td><td>1</td><td rowspan="2">Chap.61</td><td>Routine</td><td colspan="2">Repair (modest) by DBST</td><td>Repair (modest) by AC</td></tr>
<tr><td>2</td><td>Periodic</td><td colspan="3">Resurfacing/Overlay</td></tr>
<tr><td>Rank-4: Fair</td><td>-</td><td>Chap.61</td><td rowspan="2">Routine</td><td colspan="2" rowspan="2">Regular inspection/ Preventive maintenance by DBST</td><td rowspan="2">Regular inspection/ Preventive maintenance by AC</td></tr>
<tr><td>Rank-5: Good</td><td>-</td><td>Chap.61</td></tr>
</table>

Chap.21: Investment (Reconstruction/ rehabilitation (upgrade))
Chap.61: Routine Maintenance and Periodic Maintenance
In case that LV-AADT is beyond the specified range, maintenance methods for highly ranked roads should be chosen.

[Cost Estimation Scheme]

Costs of each standard method for carriageways shall be estimated in accordance with Table 6-25. Costs of maintenance methods under Chap. 61 are estimated with preliminarily defined unit costs (per 1.0 km) while those under Chap. 21 are estimated based on bill of quantities (BOQ) prepared in detailed designs.

Table 6-25 Standard Maintenance Methods and the Cost Estimation Scheme for Carriageways

Road Condtion	Method	Maintenance Category		Standard Maintenance Methods for Each Existing Pavement Type		
				SBST	DBST	AC
Rank-1: Bad	1	Chap.21	Invest-ment	Reconstruction (SBST)/ Upgrade to DBST or AC	Reconstruction (DBST)/ Upgrade to AC	Overlay with AC/ Reconstruction (AC)
				Cost based on bill of quantities (BOQ)		
	2	Chap.61	Routine	Repair (very severe) by DBST: - Crack sealing (1131) - Shape correction (1150) - Pothole patching (1161)		Repair (very severe) by AC: - Crack sealing (1131) - Shape correction (1150) - Pothole patching (1100)
				Unit cost (US$/km)		
	3		Periodic	Resurfacing/Overlay		
				Unit cost (US$/km)		
Rank-2: Very poor	1	Chap.61	Routine	Repair (severe) by DBST: - Crack sealing (1131) - Shape correction (1150) - Pothole patching (1161)		Repair (severe) by AC: - Crack sealing (1131) - Shape correction (1150) - Pothole patching (1100)
				Unit cost (US$/km)		
	2		Periodic	Resurfacing/Overlay		
				Unit cost (US$/km)		
Rank-3: Ppoor	1	Chap.61	Routine	Repair (modest) by DBST: - Crack sealing (1131) - Shape correction (1150) - Pothole patching (1161)		Repair (modest) by AC: - Crack sealing (1131) - Shape correction (1150) - Pothole patching (1100)
				Unit cost (US$/km)		
	2		Periodic	Resurfacing/Overlay		
				Unit cost (US$/km)		
Rank-4: Fair	-	Chap.61	Routine	Repair (small) by DBST: - Crack sealing (1131) - Shape correction (1150) - Pothole patching (1161)		Repair (small) by AC: - Crack sealing (1131) - Shape correction (1150) - Pothole patching (1100)
Rank-5: Good	-	Chap.61				
				Unit cost (US$/km)		

Note: ( ) work code number

Investment (Chap. 21) -

If the maintenance method for road sections whose road condition is evaluated to be Rank-1 (Bad), the road sections are to be excluded from maintenance planning under Chap. 61, and taken over by maintenance under Chap. 21 for reconstruction.

Routine Maintenance (Chap. 61) -

Unit costs for the routine maintenance method under Chap. 61 are defined with the following 3 major work code items that are frequently applied to repair of carriageways:

1) Crack sealing (work code: 1131)

2) Shape correction (work code: 1150)

3) Pothole patching (work code: 1161 for DBST, 1100 for AC)

The above cost estimation scheme for routine maintenance can be applied, together with the standardized repair quantities for each damage condition, to all the 5 road condition ranks

Periodic Maintenance (Chap. 61) -

Unit costs for the periodic maintenance method under Chap. 61 are defined with overlay. The cost estimation scheme for periodic maintenance can be applied to Rank-1(Bad), Rank-2 (Very poor), and Rank-3 (Poor) that need large-scale repair work. Cost estimators need to specify the specific road section length for overlay.

[Unit Costs of Standard Maintenance Methods for Carriageways (Routine Maintenance (Chap. 61)]

An example of unit cost preparation for standard maintenance methods of carriageways is given in Table 6-26. Standardized quantities are preliminarily set for each road condition rank with 3 major work code items: 1) Join and crack filling, 2) Shape correction, and 3) Pothole repair. The same unit costs are applied to maintenance of “Rank-5 (Good)” and “Rank-4 (Fair)” because maintenance scale of these 2 road condition ranks are considered to be equivalent. Unit prices of each work code item are to be determined, referring to the past projects’ information.

Table 6-27 through Table 6-29 show the breakdown of standardized repair quantities for each road condition rank that were extracted from actual visual inspection results obtained by DPWT. The extracted repair quantities are multiplied by a factor of 1.5, which is called “Repetitive Factor”, in order to consider repetitive repair works on the same locations. In regard to unit costs for “Rank-5 (Good)” and “Rank-4 (Fair)” that require no or small repair, extra amount of repair quantities are considered for future deterioration and preventive maintenance.

Table 6-26 An Example of Unit Costs of Standard Routine Maintenance Method (Chap.61)

Rank-1 (Bad):

- Method-2 (Routine Maintenance): Repair (very severe)

Code	Maintenance Work	Unit	Price ($)	Quantity	Cost ($/5km)		
1131	Join and Crack Filling	m2	3.63	2,617.5	9,501.53		
1150	Shape Correction	m2	8.17	3,019.5	24,669.32		
1100	Pothole Repair by AC	m2	11.68	0.0	0.00		Unit cost
				($/5km)	34,170.84	($/km)	6,834.17

Rank-2 (Very poor):

- Method-1 (Routine Maintenance): Repair (severe)

Code	Maintenance Work	Unit	Price ($)	Quantity	Cost ($/5km)		
1131	Join and Crack Filling	m2	3.63	1,522.5	5,526.68		
1150	Shape Correction	m2	8.17	2,300.3	18,793.04		
1100	Pothole Repair by AC	m2	11.68	123.0	1,436.64		Unit cost
				($/5km)	25,756.36	($/km)	5,151.27

Rank-3 (Poor):

- Method-1 (Routine Maintenance): Repair (moderate)

Code	Maintenance Work	Unit	Price ($)	Quantity	Cost ($/5km)		
1131	Join and Crack Filling	m2	3.63	1,496.3	5,431.39		
1150	Shape Correction	m2	8.17	1,317.3	10,762.34		
1100	Pothole Repair by AC	m2	11.68	123.0	1,436.64		Unit cost
				($/5km)	17,630.37	($/km)	3,526.07

Rank-4 (Fair): Repair (small) and preventive maintenance

Code	Maintenance Work	Unit	Price ($)	Quantity	Cost ($/5km)		
1131	Join and Crack Filling	m2	3.63	699.8	2,540.09		
1150	Shape Correction	m2	8.17	543.0	4,436.31		
1100	Pothole Repair by AC	m2	11.68	0.0	0.00		Unit cost
				($/5km)	6,976.40	($/km)	1,395.28

Rank-5 (Good): Preventive maintenance

Code	Maintenance Work	Unit	Price ($)	Quantity	Cost ($/5km)		
1131	Join and Crack Filling	m2	3.63	699.8	2,540.09		
1150	Shape Correction	m2	8.17	543.0	4,436.31		
1100	Pothole Repair by AC	m2	11.68	0.0	0.00		Unit cost
				($/5km)	6,976.40	($/km)	1,395.28

Unit prices of each work code item are to be determined, referring to the past projects' information.

Standardized quantities are preliminarily set for each road condition rank.

Table 6-27 The Breakdown of Standardized Repair Quantities for "Rank-1 (Bad)"

Standard repair quantity for "Rank-1 (Bad)"

Source: RN14 (PK20.0-PK25.0)

Ave. IRI: 5.12

Visual: N=3.8 Poor

Code	PK	Length (m)	Width (m)	Area (m2)
1150	22+450	8	16	128
1150	470	15	3.5	52.5
1150	500	20	2.8	56
1150	530	25	30	750
1131	560	40	7	280
1150	600	15	3	45
1150	650	40	7	280
1150	750	30	3.5	105
1150	930	3	3.5	10.5
1150	23+030	35	3	105
1150	130	25	3	75
1150	370	16	3	48
1150	410	7	10	70
1131	460	50	7	350
1131	650	40	7	280
1131	740	50	7	350
1131	800	50	7	350
1131	890	5	4	20
1150	24+700	8	3	24
1131	24+820	20	2	40
1131	24+280	30	2.5	75
1150	900	18	3	54
1150	940	10	7	70
1150	950			0
1150	970	20	7	140

Total (1131): 1745.0

Total (1150): 2013.0

Consideration of repetitive repair; factor of 1.5 times 1.5

Standardized quantity (1131): 2617.5

Standardized quantity (1150): 3019.5

Standardized repair quantities for each road condition rank that were extracted from actual visual inspection results obtained by DPWT

The extracted repair quantities are multiplied by a factor of 1.5, which is called "Repetitive Factor", in order to consider repetitive repair works on the same locations.

Table 6-28 The Breakdown of Standardized Repair Quantities for "Rank-2 (Very poor)"

Standard repair quantity for "Rank-2 (Very poor)"

Source: RN1 (PK46.5-PK51.5)
Ave. IRI: 3.65
Visual: N=2.2 Poor

Code	PK	Length (m)	Width (m)	Area (m2)
1131	45+550	20	1	20
1131	560	25	0.6	15
1131	750	8	1	8
1131	751	10	0.7	7
1131	770	8	0.5	4
1131	780	25	1	25
1131	820	12	1.5	18
1131	840	10	1	10
1131	880	6	1	6
1131	880	30	1	30
1131	46+900	40	1	40
1150	920	50	1	50
1131	950	30	0.8	24
1131	960	30	1	30
1131	970	30	1	30
1150	970	30	1	30
1150	47+00	40	2	80
1150	50	50	1	50
1150	60	30	2	60
1150	100	30	1	30
1150	100	100	1.5	150
1150	160	10	1	10
1150	160	50	2	100
1150	260	50	1	50
1150	340	30	1	30
1150	340	30	3	90
1150	400	80	1	80
1150	550	3	1	3
1150	620	3	1	3
1131	47+760	10	0.6	6
1150	800	20	2	40
1131	880	11	1	11
1131	890	10	1	10
1131	890	10	1	10
1131	960	3	1	3
1131	47+960	10	0.6	6

Code	PK	Length (m)	Width (m)	Area (m2)
1131	48+00	30	0.7	21
1131	100	12	1	12
1131	130	100	1	100
1131	170	40	0.5	20
1131	240	40	1	40
1131	450	50	1	50
1131	500	100	1	100
1131	660	5	1	5
1131	680	30	1	30
1150	740	40	2	80
1150	860	15	1	15
1150	880	25	1	25
1150	48+900	10	1	10
1150	910	20	1	20
1150	950	50	2	100
1150	970	10	1	10
1150	970	4	1	4
1150	990	4	1	4
1150	49+010	4	1	4
1150	50	100	1	100
1131	49+550	50	1	50
1150	670	50	2	100
1150	780	60	1.5	90
1150	900	30	1	30
1150	910	40	0.5	20
1150	980	20	1.5	30
1131	970	30	0.8	24
1131	50+000	25	1	25
1131	50+110	40	1	40
1131	190	50	1	50
1131	300	50	1	50
1150	50+400	10	1	10
1131	450	30	1	30
1131	500	50	0.6	30
1131	550	25	1	25
1150	850	17	1.5	25.5

Total (1131): 1015.0
Total (1150): 1533.5

Consideration of repetitive repair; factor of 1.5

Standardized quantity (1131): 1522.5
Standardized quantity (1150): 2300.3

Source: RN1 (PK16.3-PK21.3)
Ave. IRI: 2.19
Visual: N=3.0 Poor

Code	PK	Length (m)	Width (m)	Area (m2)
1161	16+380	2	1	2.0
1161	440	40	0.5	20.0
1161	442	50	0.5	25.0
1161	590	20	0.5	10.0
1161	600	20	1	20.0
1161	18+630	5	1	5.0
			Total:	82.0

Consideration of repetitive repair; factor of 1.5

Standardized quantity : 123.0

Table 6-29 The Breakdown of Standardized Repair Quantities for "Poor" and "Fair"

Standard repair quantity for "Rank-3 (Poor)"
Source: RN1 (PK54.5-PK59.5)
Ave. IRI: 2.52
Visual: N=2.2 Poor

Code	PK	Length (m)	Width (m)	Area (m2)
1131	490	30	0.8	24
1131	54+530	11	0.5	5.5
1150	660	50	0.8	40
1131	55+100	30	0.5	15
1131	380	10	0.6	6
1131	450	8	1	8
1131	480	15	1	15
1131	530	60	1	60
1131	800	20	1	20
1150	56+160	30	1.5	45
1150	210	40	0.8	32
1150	220	10	1	10
1150	300	30	1	30
1150	350	50	1.5	75
1150	480	20	1.5	30
1150	500	50	2	100
1150	640	12	1	12
1150	640	20	1	20
1150	670	18	1.5	27
1150	690	12	2.5	30
1150	56+850	50	1	50
1150	920	40	1.5	60
1150	960	10	1	10
1150	970	30	1.5	45
1150	57+00	30	2	60
1150	600	70	2	140
1150	800			0
1131	900	15	0.6	9
1150	58+020	40	1	40
1150	150	12	0.6	7.2
1150	700	8	1	8
1150	800	7	1	7
1131	900	100	4	400
1131	59+00	180	2	360
1131	180	40	0.5	20
1131	230	10	0.5	5
1131	350	50	1	50

Total (1131): 997.5
Total (1150): 878.2

Consideration of repetitive repair; factor of 1.5
Standardized quantity (1131): 1496.3
Standardized quantity (1150): 1317.3

Standard repair quantity for "Rank-4 (Fair)"
Source: RN1 (PK51.5-PK56.5)
Ave. IRI: 3.13
Visual: N=1.2 Poor

Code	PK	Length (m)	Width (m)	Area (m2)
1131	51+680	20	0.6	12
1131	51+980	20	0.6	12
1131	52+030	20	0.8	16
1131	320	10	1	10
1131	390	20	1	20
1131	490	40	1	40
1131	53+250	50	0.6	30
1131	350	10	1	10
1131	540	46	3	138
1131	54+180	10	1	10
1131	190	30	0.5	15
1131	490	30	0.8	24
1131	54+530	11	0.5	5.5
1150	660	50	0.8	40
1131	55+100	30	0.5	15
1131	380	10	0.6	6
1131	450	8	1	8
1131	480	15	1	15
1131	530	60	1	60
1131	800	20	1	20
1150	56+160	30	1.5	45
1150	210	40	0.8	32
1150	220	10	1	10
1150	300	30	1	30
1150	350	50	1.5	75
1150	480	20	1.5	30
1150	500	50	2	100

Total (1131): 466.5
Total (1150): 362.0

Consideration of repetitive repair; factor of 1.5
Standardized quantity (1131): 699.8
Standardized quantity (1150): 543.0

The same unit costs are applied to maintenance of "Rank-5 (Good)" and "Rank-4 (Fair)" because maintenance scale of these 2 road condition ranks are considered to be equivalent.
For these 2 ranks, extra amount of repair quantities are considered for future deterioration and preventive maintenance.

[Unit Costs of Standard Maintenance Methods for Carriageways (Periodic Maintenance (Chap. 61)]

Contrary to routine maintenance (Chap. 61), repair quantities of maintenance methods under periodic maintenance (Chap. 61) are not standardized. As shown in Table 6-30, the quantities are to be determined based on analysis of inspection results. Unit prices of each work code item are to be determined, referring to the past projects' information as well as those for routine maintenance.

Table 6-30 An Example of Unit Cost of Standard Periodic Maintenance Method (Chap.21)

- Method-2 (Periodic Maintenance): Resurfacing/ Overlay

Maintenance Work	Overlay area (%)	Unit	Price ($)	Quantity	Cost ($/5km)		
Overlay with AC	100	m2	10.00	35,000.0	350,000.00		Unit cost
				($/5km)	350,000.00	($/km)	70,000.00

Enter overlay area ratio (%)

Unit prices of each work code item are to be determined, referring to the past projects' information.

Quantities are to be set based on "overlay area ratio (%)":
If the overlay area is 100%,
(Quantity)= (width: 7m)*(length: 5000m)*(area: 100%)
= 35000(m2)

[Cost Estimation for Maintenance of Carriageways]

Maintenance costs for carriageways are to be estimated as follows:

1) Clarify the percentage of each road condition rank according to inspection results.
2) Calculate the distance of each road condition rank: (percentage)*(total road length) = (distance)
3) Determine the unit prices of each work code items: Refer to the past projects' information.
4) Calculate the maintenance costs for each road condition rank: (distance)*(unit cost) = (cost)

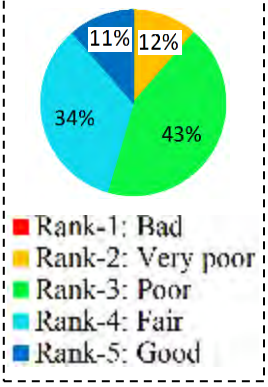
Table 6-31 illustrates the cost estimation scheme in accordance with the above procedure. Road sections evaluated as "Rank-1 (Bad)" have the 3 optional maintenance methods: Method-1 (Investment: reconstruction), Method-2 (Routine maintenance: repair), and Method-3 (Periodic maintenance: overlay). In the case where Method-1 (Investment: reconstruction) is selected, the road sections are to be excluded from the maintenance plans under Chap. 61 and taken over in maintenance plans under Chap. 21. Also, Road sections evaluated as "Rank-2 (Very poor)" and "Rank-3 (Poor)" have the 2 optional maintenance methods: Method-1 (Routine maintenance: repair), and Method-2 (Periodic maintenance: overlay). For, road sections evaluated as "Rank-4 (Fair)" and "Rank-5 (Good)", routine maintenance (repair) is automatically applied.

The cost estimate format shown in Table 6-31 is to be converted into the budget request format shown in Figure 6-11.

Table 6-31 Cost Estimate for Maintenance of Carriageways under Chap.61

Road Condtion		Percentage (%)	Distance (km)	Unit Cost ($/km)	Cost ($)	Maintenance Category	
Rank-1: Bad	Method-1	**0.0**	**0.0**	-	-	Chap.21	Investment (Excluded)
	Method-2	**0.0**	0.0	6,834.17	0.00	Chap.61	Routine Maintenance
	Method-3	**0.0**	0.0	70,000.00	0.00		Periodic Maintenance
Rank-2: Very poor	Method-1	**11.4**	5.0	5,151.27	25,756.36	Chap.61	Routine Maintenance
	Method-2	**0.0**	0.0	70,000.00	0.00		Periodic Maintenance
Rank-3: Poor	Method-1	**43.4**	19.1	3,526.07	67,348.01	Chap.61	Routine Maintenance
	Method-2	**0.0**	0.0	70,000.00	0.00		Periodic Maintenance
Rank-4: Fair		**34.1**	15.0	1,395.28	20,929.21	Chap.61	Routine Maintenance
Rank-5: Good		**11.1**	4.9	1,395.28	6,836.87		
Total:		100	44.0		**120,870.45**	(Chap.61)	

(Distance)*(Unit cost) = (Cost)



Rank-2 (Very poor):

- Method-1 (Routine Maintenance): Repair (severe)

Code	Maintenance Work	Unit	Price ($)	Quantity	Cost ($/5km)
1131	Join and Crack Filling	m2	3.63	1,522.5	5,526.68
1150	Shape Correction	m2	8.17	2,300.3	18,793.04
1100	Pothole Repair by AC	m2	11.68	123.0	1,436.64
				($/5km)	25,756.36
				($/km)	5,151.27

Rank-3 (Poor):

- Method-1 (Routine Maintenance): Repair (moderate)

Code	Maintenance Work	Unit	Price ($)	Quantity	Cost ($/5km)
1131	Join and Crack Filling	m2	3.63	1,496.3	5,431.39
1150	Shape Correction	m2	8.17	1,317.3	10,762.34
1100	Pothole Repair by AC	m2	11.68	123.0	1,436.64
				($/5km)	17,630.37
				($/km)	3,526.07

Rank-4 (Fair): Repair (small) and preventive maintenance

Code	Maintenance Work	Unit	Price ($)	Quantity	Cost ($/5km)
1131	Join and Crack Filling	m2	3.63	699.8	2,540.09
1150	Shape Correction	m2	8.17	543.0	4,436.31
1100	Pothole Repair by AC	m2	11.68	0.0	0.00
				($/5km)	6,976.40
				($/km)	1,395.28

Rank-5 (Good): Preventive maintenance

Code	Maintenance Work	Unit	Price ($)	Quantity	Cost ($/5km)
1131	Join and Crack Filling	m2	3.63	699.8	2,540.09
1150	Shape Correction	m2	8.17	543.0	4,436.31
1100	Pothole Repair by AC	m2	11.68	0.0	0.00
				($/5km)	6,976.40
				($/km)	1,395.28

Road Condtion		Percentage (%)	Distance (km)	Unit Cost ($/km)	Cost ($)	Maintenance Category	
Rank-1: Bad	Method-1	**0.0**	**0.0**	-	-	Chap.21	Investment (Excluded)
	Method-2	**0.0**	0.0	6,834.17	0.00	Chap.61	Routine Maintenance
	Method-3	**0.0**	0.0	70,000.00	0.00		Periodic Maintenance
Rank-2: Very poor	Method-1	**11.4**	5.0	5,151.27	25,756.36	Chap.61	Routine Maintenance
	Method-2	**0.0**	0.0	70,000.00	0.00		Periodic Maintenance
Rank-3: Poor	Method-1	**43.4**	19.1	3,526.07	67,348.01	Chap.61	Routine Maintenance
	Method-2	**0.0**	0.0	70,000.00	0.00		Periodic Maintenance
Rank-4: Fair		**34.1**	15.0	1,395.28	20,929.21	Chap.61	Routine Maintenance
Rank-5: Good		**11.1**	4.9	1,395.28	6,836.87		
Total:		100	44.0		**120,870.45**	(Chap.61)	

To be converted into the budget request format

Code	Maintenance Work	Unit	Quantity	Price ($)	Cost ($)
1131	Join and Crack Filling	m2	10,023.18	3.63	36,384.14
1150	Shape Correction	m2	9,493.48	8.17	77,561.70
1100	Pothole Repair by AC	m2	592.86	11.68	6,924.60
-	Overlay with AC	m2	0.00	10.00	0.00
				Total: ($)	120,870.45

Figure 6-11 Conversion of Cost Estimate Format

(6-3) Cost Estimation System for Off-carriageway/ Structures/ Road Furniture

Maintenance costs for 1) off-carriageway, 2) structures, and 3) road furniture shall be estimated, complying with standard maintenance methods specified in Table 6-32. The standard maintenance methods and specifications have been defined digit-class by digit-class, referring to the past projects' information.

Table 6-32 Standard Maintenance Methods for Off-carriageway/ Structures/ Road Furniture

1-digit roads

Category	Code	Work Type	Unit	Specifications for Cost Estimate
Off-carriage way	1200	Grading shoulders	km	20% of road length
	1201-2	Adding gravel	m3	10% of road length (2sides*0.5m wide*0.5m deep)
	2100	Cleaning channels by labor	m	10% of road length
	2110	Cleaning channels by machine	m	100% of road length
	4150	Vegetation control (shrub, plant and tree)	km	Road length
Structures	3100	Cleaning culvert (transversal)	place	1.5place/km
	3110	Cleaning culvert (longitudinal)	m	3% of road length
	3200	Minor bridge repair (cleaning, painting)	man/h	5(man/h)/km
Road Furniture	5230	Traffic sign repair	pole	0.5pole/km
	6100	Cleaning and painting safety poles	pole	12poles/km
	7100	Cleaning and paiting kilometer posts	pole	1pole/km

2-digit roads

Category	Code	Work Type	Unit	Specifications for Cost Estimate
Off-carriage way	1200	Grading shoulders	km	15% of road length
	1201-2	Adding gravel	m3	8% of road length (2sides*0.5m wide*0.5m depth)
	2100	Cleaning channels by labor	m	10% of road length
	2110	Cleaning channels by machine	m	10% of road length
	4150	Vegetation control (shrub, plant and tree)	km	100% of road length
Structures	3100	Cleaning culvert (transversal)	place	1.5place/km
	3110	Cleaning culvert (longitudinal)	m	3% of road length
	3200	Minor bridge repair (cleaning, painting)	man/h	5(man/h)/km
Road Furniture	5230	Traffic sign repair	pole	0.5pole/km
	6100	Cleaning and painting safety poles	pole	5poles/km
	7100	Cleaning and paiting kilometer posts	pole	1pole/km

3&4-digit roads

Category	Code	Work Type	Unit	Specifications for Cost Estimate
Off-carriage way	1200	Grading shoulders	km	15% of road length
	1201-2	Adding gravel	m3	5% of road length (2sides*0.5m wide*0.5m depth)
	2100	Cleaning channels by labor	m	5% of road length
	2110	Cleaning channels by machine	m	5% of road length
	4150	Vegetation control (shrub, plant and tree)	km	70% of road length
Structures	3100	Cleaning culvert (transversal)	place	1.5place/km
	3200	Minor bridge repair (cleaning, painting)	man/h	2(psn./hr)/km
Road Furniture	5230	Traffic sign repair	pole	0.5pole/km
	6100	Cleaning and painting safety poles	pole	5poles/km
	7100	Cleaning and paiting kilometer posts	pole	1pole/km

Standardized unit costs of the 3 maintenance categories are summarized in Table 6-32 The quantities are set according to the specifications shown in Table 6-33. Also, unit prices of work code items are set based on past projects' information.

Table 6-33 Unit Costs for Off-carriageway/ Structures/ Road Furniture

1-digit roads Road length (km): 100

Category	Code	Work Type	Unit	Quanity	Unit Price (US$/unit)	Cost (US$ per 100km)	Unit Cost (US$/km)
Off-carriage way	1200	Grading shoulders	km	20.0	365.90	7,318.08	700.00
	1201-2	Adding gravel	m3	5,000	7.75	38,758.50	
	2100	Cleaning channels by labor	m	10,000	0.46	4,633.65	
	2110	Cleaning channels by machine	m	10,000	1.23	12,315.48	
	4150	Vegetation control (shrub, plant and tree)	km	100.0	70.05	7,004.85	
Structures	3100	Cleaning culvert (transversal)	place	150	24.65	3,697.26	108.00
	3110	Cleaning culvert (longitudinal)	m	3,000	1.37	4,123.63	
	3200	Minor bridge repair (cleaning, painting)	man/h	500	6.10	3,050.18	
Road Furniture	5230	Traffic sign repair	pole	50	130.68	6,533.84	236.00
	6100	Cleaning and painting safety poles	pole	1,200	11.80	14,161.76	
	7100	Cleaning and paiting kilometer posts	pole	100	29.11	2,910.65	
					Total:	104,507.86 (US$)	1,044.00 (US$/km)

2-digit roads Road length (km): 100

Category	Code	Work Type	Unit	Quanity	Unit Price (US$/unit)	Cost (US$ per 100km)	Unit Cost (US$/km)
Off-carriage way	1200	Grading shoulders	km	15.0	365.90	5,488.56	604.00
	1201-2	Adding gravel	m3	4,000	7.75	31,006.80	
	2100	Cleaning channels by labor	m	10,000	0.46	4,633.65	
	2110	Cleaning channels by machine	m	10,000	1.23	12,315.48	
	4150	Vegetation control (shrub, plant and tree)	km	100.0	70.05	7,004.85	
Structures	3100	Cleaning culvert (transversal)	place	150	24.65	3,697.26	108.00
	3110	Cleaning culvert (longitudinal)	m	3,000	1.37	4,123.63	
	3200	Minor bridge repair (cleaning, painting)	man/h	500	6.10	3,050.18	
Road Furniture	5230	Traffic sign repair	pole	50	130.68	6,533.84	153.00
	6100	Cleaning and painting safety poles	pole	500	11.80	5,900.73	
	7100	Cleaning and paiting kilometer posts	pole	100	29.11	2,910.65	
					Total:	86,665.62 (US$)	865.00 (US$/km)

3&4-digit roads Road length (km): 100

Category	Code	Work Type	Unit	Quanity	Unit Price (US$/unit)	Cost (US$ per 100km)	Unit Cost (US$/km)
Off-carriage way	1200	Grading shoulders	km	15.0	365.90	5,488.56	382.00
	1201-2	Adding gravel	m3	2,500	7.75	19,379.25	
	2100	Cleaning channels by labor	m	5,000	0.46	2,316.83	
	2110	Cleaning channels by machine	m	5,000	1.23	6,157.74	
	4150	Vegetation control (shrub, plant and tree)	km	70.0	70.05	4,903.40	
Structures	3100	Cleaning culvert (transversal)	place	150	24.65	3,697.26	49.00
	3200	Minor bridge repair (cleaning, painting)	man/h	200	6.10	1,220.07	
Road Furniture	5230	Traffic sign repair	pole	50	130.68	6,533.84	153.00
	6100	Cleaning and painting safety poles	pole	500	11.80	5,900.73	
	7100	Cleaning and paiting kilometer posts	pole	100	29.11	2,910.65	
					Total:	58,508.32 (US$)	584.00 (US$/km)

(6-4) Preparation of Budget Request Forms

Budget request forms are to be prepared as follows.

[Road Information]

(1)	Road Name	RN1 (Kandal)
(2)	Road Length (km)	44.0
(3)	Pavement Type	AC
(4)	The number of Lanes	2
(5)	Carriageway width (m)	7.0
(6)	Road Class	1-digit roads

Note: - Standard carriageway width is 7.0m (2 lanes).
- "Carriageway width" is set by 2 lanes even if it has 4 lanes.

[Maintenance Cost for Carriageways]

Code	Maintenance Work	Unit	Quantity	Price ($)	Cost ($)	
1131	Join and Crack Filling	m2	10,023.18	3.63	36,384.14	
1150	Shape Correction	m2	9,493.48	8.17	77,561.70	
1100	Pothole Repair by AC	m2	592.86	11.68	6,924.60	
-	Overlay with AC	m2	0.00	10.00	0.00	Unit cost
				Total:	120,870.45	2,747
					($)	($/km)

[Maintenance Cost for Off-carriageway/ Structures/ Road Furniture (for 1-digit roads)]

Category	Code	Work Type	Unit	Quanity	Unit Price ($/unit)	Cost ($ per 44km)	Unit Cost ($/km)
Off-carriage way	1200	Grading shoulders	km	8.8	365.9	3,219.96	700.00
	1201-2	Adding gravel	m3	2,200	7.8	17,053.74	
	2100	Cleaning channels by labor	m	4,400	0.5	2,038.81	
	2110	Cleaning channels by machine	m	4,400	1.2	5,418.81	
	4150	Vegetation control (shrub, plant and tree)	km	44.0	70.0	3,082.13	
Structures	3100	Cleaning culvert (transversal)	place	66.0	24.6	1,626.80	108.00
	3110	Cleaning culvert (longitudinal)	m	1,320	1.4	1,814.40	
	3200	Minor bridge repair (cleaning, painting)	man/h	220.0	6.1	1,342.08	
Road Furniture	5230	Traffic sign repair	pole	22.0	130.7	2,874.89	236.00
	6100	Cleaning and painting safety poles	pole	528.0	11.8	6,231.17	
	7100	Cleaning and paiting kilometer posts	pole	44.0	29.1	1,280.69	
					Total:	45,983.46	1,044.00

[Budget Request Forms]

Code	Work Type	Unit	Quanity	Unit Price ($/unit)	Cost ($)
1131	Join and Crack Filling	m2	10,023.18	3.63	36,384.14
1150	Shape Correction	m2	9,493.48	8.17	77,561.70
1100	Pothole Repair by AC	m2	592.86	11.68	6,924.60
-	Overlay with AC		0.00	10.00	0.00
1200	Grading shoulders	km	8.80	365.90	3,219.96
1201-2	Adding gravel	m3	2,200.00	7.75	17,053.74
2100	Cleaning channels by labor	m	4,400.00	0.46	2,038.81
2110	Cleaning channels by machine	m	4,400.00	1.23	5,418.81
4150	Vegetation control (shrub, plant and tree)	km	44.00	70.05	3,082.13
3100	Cleaning culvert (transversal)	place	66.00	24.65	1,626.80
3110	Cleaning culvert (longitudinal)	m	1,320.00	1.37	1,814.40
3200	Minor bridge repair (cleaning, painting)	man/h	220.00	6.10	1,342.08
5230	Traffic sign repair	pole	22.00	130.68	2,874.89
6100	Cleaning and painting safety poles	pole	528.00	11.80	6,231.17
7100	Cleaning and paiting kilometer posts	pole	44.00	29.11	1,280.69
				Toatal: ($)	166,853.91

7) Prioritization of Maintenance Plans

Prioritization criteria for road maintenance plans has been suggested in the project as shown in Table 6-34, In the introduced scheme, road maintenance necessity is to be assessed by 3 prioritization criteria (Criteria-A, B, and C). While Criteria-A and B are relevant to road importance that is given as precondition, Criteria-C is set for assessment of road conditions that are fluctuating factors. Criteria-A and B are cited from the master plan prepared by MPWT with assistance of JICA*. Target roads for maintenance works are to be comprehensively prioritized after evaluation of inspection results.

Table 6-34 Prioritization Criteria for Road Maintenance Plans

Maintenance Priority			Road Name	Reasons for Road Importance (Criteria-B)
Criteria-A: Digit-class	Criteria-B: Road Importance	Criteria-C: Road Condition		
1	1		1	Asian Highway 1, International Corridor
			4	Connecting international port Sihanouk and Phnom Penh (PP)
			5	Asian Highway 1, International Corridor
	2		2	Connecting Vietnam border and PP
			6	Connecting PP and Siem Reap (the biggest tourism city)
			7	Connecting Laos border and PP
	3		3	Detour PP to Sihanouk
			8	1-digit road
			9	1-digit road
2			20	Part of the PP ring road
			21*	Part of the PP ring road
			42	Part of the PP ring road
			51	Part of the PP ring road
			61	Part of the PP ring road
			11	Cross-cutting NR1, NR8, and NR7
			73	Shortcut of NR7
			76	Connecting Mondul Kiri and NR7
			78	Connecting Rattanak Kiri and NR7
			64	Connecting Preah Vihear and NR6
			68	Connecting Oddar Meanchey and NR6
			57	Connecting Pailin and NR5
			48	Connecting Koh Kong and NR4
	4		55	Connecting Thailand border and NR5
			62	Connecting Laos border and NR6 via Preah Vihear
			76	Connecting Rattanak Kiri and Mondul Kiri
	5		Other 2-digit roads	
3, 4	6		3- and 4-digit roads	

* The road includes branch numbers/letters such as NR21A.

Note: Prioritization by "Criteria-C: Road Condition" is to be finalized based on inspection results.

*Project name: Data Collection Survey on the Trunk Road Network Planning for Strengthening of Connectivity through the Southern Economic Corridor

(3) Cost Estimation of Road Maintenance

Maintenance costs of the inspected roads have been estimated in accordance with the new cost estimation scheme explained above. Table 6-35 and Table 6-36 shows maintenance cost of inspected roads in Kandal province and in Takeo province, respectively in the road list format with the prioritization rule.

Table 6-35 Road List with Maintenance Cost of Inspected Roads in Kandal Province

Criteria-A: Digit-class
Criteria-B: Road importance
Criteria-C: Road conditions
0≤N<0.2: Very good
0.2≤N<0.4: Good
0.4≤N<0.6: Fairy good
0.6≤N<1.15: Fair
1.15<N: Poor
Rank-1+ Rank-2+ Rank-3
Rank-1+ Rank-2
Rank-1
Maintenance cost for maintenance works categorized as Chap.61
The cost is to be estimated in Step.4
Other Costs:
(Off-carriageway)+(Structures)+(Road furniture)

Project Priority			Road Name	No. of Lanes	Pavement Type	Inspected Length (km)	Overall Condition		Repair Neccessity (%)			Investment (Chap.21) (%)	Maintenance Cost*4					
													Carriageway		Other Costs*5		Total	
A*	B*	C*					Ave. IRI	Indicator-N (visual rating)	Repair Ratio*1 Rank-1&2&3	Urgency Ratio*2 Rank-1&2	Emergency Ratio*3 Rank-1		($)	($/km)	($)	($/km)	($)	($/km)
1	1	1	NR1	2	AC	44.0	2.71	1.51: Poor	54.6	11.3	0.0	0.0	120,870	2,747	45,983	1,044	166,854	3,791
		2	NR5	2	AC	8.9	2.69	0.3: Good	0.0	0.0	0.0	0.0	12,422	1,396	9,247	1,038	21,669	2,434
		3	NR4	4	AC	11.6	2.08	0: Very good	0.0	0.0	0.0	0.0	31,851	2,746	12,144	1,045	43,995	3,791
	2	-	NR2	2	MCD	19.6	2.70	1.15: Poor	23.5	0.0	0.0	0.0	36,923	1,884	20,504	1,044	57,428	2,928
	3	1	NR3	2	DBST	12.0	2.64	0.8: Fair	41.7	0.0	0.0	0.0	27,360	2,280	12,541	1,044	39,901	3,324
		2	NR8	2	AC	19.9	2.55	1.15: Poor	25.1	0.0	0.0	0.0	40,012	2,011	20,821	1,045	60,832	3,056
2		3	NR21A	2	AC	20.1	2.76	1.1: Fair	50.0	0.0	0.0	0.0	51,042	2,539	17,433	866	68,475	3,405
	5	-	NR14	2	AC	42.5	4.51	10.86: Poor	100.0	76.4	35.4	0.0	253,575	5,966	36,833	865	290,409	6,831
3	6	1	PR110	2	DBST	78.1	3.9	19.97: Poor	51.2	44.8	25.6	0.0	303,147	3,882	45,708	584	348,855	4,466
		2	PR151A	2	DBST	7.7	3.57	0.3: Good	27.5	0.0	0.0	0.0	15,218	1,976	4,562	592	19,781	2,568
		3	PR120	2	AC	6.7	2.29	0.3: Good	0.0	0.0	0.0	0.0	9,348	1,395	3,881	577	13,230	1,972
		4	PR261	2	DBST	22.0	1.92	0.04: Very good	0.0	0.0	0.0	0.0	30,859	1,403	12,872	584	43,731	1,987
		5	PR383	2	Laterite	8.4	3.4	-	9.1	-	-	-	3,694	440	4,932	586	8,626	1,026
				Total:		301.5										Total:	1,183,785	3,926

A*: Road classification by "digit class"
B*: Road importance based on road network and traffic volume
C*: Road conditions
1*: "Repair ratio" is ratio of "Rank-1+ Rank-2+ Rank-3" to inspected road length.
2*: "Urgency ratio" is ratio of "Rank-1+ Rank-2" to inspected road length.
3*: "Emergency Ratio" is the ratio of "Rank-1" to inspected road length.
4*: Maintenance cost (Chap.61): Routine road mainetenance cost
5*: (Off-carriageway)+(Structures)+(Road furniture)

IRI (5km-ave.) \ Visual Rating	Very good / Good	Fairy Good	Fair	Poor
IRI<3.5	Rank-5: Good (No or small repair)		Rank-4: Fair (Small repair)	Rank-3: Poor (Repair)
3.5≤IRI<5.0	Rank-3: Poor (Repair)		Rank-2: Very poor (Severe repair)	
5.0≤IRI	Rank-1: Bad (Reconstruction/Rehabilitation/Upgrade)			

Table 6-36 Road List with Maintenance Cost of Inspected Roads in Takeo Province

Criteria-A: Digit-class

Criteria-B: Road importance

Criteria-C: Road conditions

0≤N<0.2: Very good
0.2≤N<0.4: Good
0.4≤N<0.6: Fairy good
0.6≤N<1.15: Fair
1.15<N: Poor

Rank-1+ Rank-2+ Rank-3

Rank-1+ Rank-2

Rank-1

Maintenance cost for maintenance works categorized as Chap.61
The cost is to be estimated in Step.4

Other Costs:
(Off-carriageway)+(Structures)+(Road furniture)

Project Priority			Road Name	No. of Lanes	Pavement Type	Inspected Length (km)	Overall Condition		Repair Neccessity (%)			Maintenance Cost*4					
							Ave. IRI	Indicator-N (visual rating)	Repair Ratio*1 Rank-1&2&3	Urgency Ratio*2 Rank-1&2	Emergency Ratio*3 Rank-1	Carriageway		Other Costs*5		Total	
A*	B*	C*										($)	($/km)	($)	($/km)	($)	($/km)
1	2	-	NR 2	2	AC	48.0	2.12	0: Very good	0.0	0.0	0.0	66,973	1,395	50,164	1,044	117,137	2,439
	3	-	NR 3	2	AC	18.7	2.14	0: Very good	0.0	0.0	0.0	26,510	1,395	19,493	1,041	46,003	2,436
2	5	-	NR 31	2	AC	4.7	2.22	0: Very good	0.0	0.0	0.0	6,976	1,395	4,036	858	11,013	2,253
3,4	6	1	PR 132	2	DBST	33.2	2.91	0.54: Fairy good	14.7	14.7	0.0	66,219	1,948	19,510	586	85,730	2,534
		2	PR 122	2	DBST	13.7	2.55	0: Very good	0.0	0.0	0.0	19,534	1,395	8,073	587	27,607	1,982
		1	PR 129A	2	DBST	10.9	1.93	0.4: Fairy good	45.5	0.0	0.0	26,002	2,364	6,305	577	32,307	2,941
		2	PR 129E	2	DBST	14.2	1.73	0: Very good	0.0	0.0	0.0	20,929	1,395	8,298	583	29,227	1,978
				Total:		143.4									Total:	349,024	2,434

A*: Road classification by "digit class"
B*: Road importance based on road network and traffic volume
C*: Road conditions
1*: "Repair ratio" is ratio of "Rank-1+ Rank-2+ Rank-3" to inspected road length.
2*: "Urgency ratio" is ratio of "Rank-1+ Rank-2" to inspected road length.
3*: "Emergency Ratio" is the ratio of "Rank-1" to inspected road length.
4*: Maintenance cost (Chap.61): Routine road mainetenance cost
5*: (Off-carriageway)+(Structures)+(Road furniture)

Visual Rating / IRI (5km-ave.)	Very good	Good	Fairy Good	Fair	Poor
IRI<3.5	**Rank-5: Good (No or small repair)**			**Rank-4: Fair (Small repair)**	**Rank-3: Poor (Repair)**
3.5≤IRI<5.0	**Rank-3: Poor (Repair)**			**Rank-2: Very poor (Severe repair)**	
5.0≤IRI	**Rank-1: Bad (Reconstruction/Rehabilitation/Upgrade)**				

Table 6-37 Application of ROMDAS and DRIMS

The Project for Strengthening Capacity for Maintenance of Roads and Bridges

Agreement on Application Policy of Two Types of IRI Measurement Equipment

Date of Issue: 12 January 2017

"The Project for Strengthening Capacity for Maintenance of Roads and Bridges in Cambodia (2015-2018)" (hereafter called the project) has been undertaken by Ministry of Public Works and Transport (MPWT) with assistance from Japan International Cooperation Agency (JICA). One of the main features of the project is to establish a road maintenance cycle using International Roughness Index (IRI), which enables quantitative evaluation of road conditions. The project aimed to utilize the latest IRI measurement technology called "Dynamic Response Intelligent Monitoring System (DRIMS)". IRI values can be easily obtained by ordinary cars equipped with DRIMS that consists of laptop, GPS, accelerometer, and road monitor. The compact and user-friendly device is expected to contribute to improvement of road maintenance in Cambodia.

On the other hand, a different type of IRI measurement equipment, called "Road Measurement Data Acquisition System (ROMDAS)", has been already introduced in technical cooperation projects assisted by World Bank (WB) and Asian Development Bank (ADB). Accuracy of ROMDAS, which employs the laser profiling method (accuracy class I), is higher than that of DRIMS, which is based on vibration acquisition method (accuracy class III). Equipment and inspection cost of ROMDAS are relatively higher than that of DRIMS. Therefore, supplementary application of DRIMS, in addition to ROMDAS, is recommended in order to inspect road sections that can't be managed by ROMDAS.

In consideration of the above issues and in consultation with JICA and WB, MPWT will apply the two (2) types of IRI measurement equipment, ROMDAS and DRIMS, under the policy shown in the following table. Main features of ROMDAS and DRIMS are shown in Attachement-1.

Table The Application Policy of ROMDAS and DRIMS

Implementation Stage	Road Digit Class	ROMDAS	DRIMS
Short Term (The next 3 years)	1&2	Planning	Planning
	3&4	N/A	Routine maintenance
	City Roads	N/A	
Mid Term (3 – 10 years)	1&2	Planning	(Routine maintenance)
		Routine Maintenance	
	3&4	N/A	Planning
	City Roads	N/A	Routine maintenance

Note: One office will be responsible for both ROMDAS and DRIMS operation, data analysis and data use.

CONFIRMED BY:

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Secretary of State
MPWT

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Secretary of State
MPWT

Witness
Heng Rathpiseth
Director, Road Infrastructure Department
MPWT

Attachment-1

The Project for Strengthening Capacity for Maintenance of Roads and Bridges

Proposal on the Application of RMDS/ROMDAS and DRIMS

Table-1 Outline of RMDS/ROMDAS and DRIMS

Item	RMDS*/ROMDAS *: Road Management Detection Support System	DRIMS
Obtainable Data ・IRI value ・Video data ・GPS tracking data ・Vehicle speed ・Pavement structure soundness ・Road inventory (Road Type, Width, Lanes, Shoulder Type, Width) ・SII value (visual inspection) ★SII: Surface integrity index ・Evaluation on drainage condition and shoulder height	○ (Accuracy class I) ○ ○ ○ ○ (FWD) ○ ○ ○	○ (Accuracy class III) ○ ○ ○ × × × ×
Condition ・Vehicle speed (km/h) ・Maximum survey distance (km)	V<100km/h 100~120km/Day	30<V<110km/h 250～300km/Day
Survey cost (USD/km)	5 (USD/km) *Data calibration cost: 1700/year (New versions doesn't require calibration.)	2 (USD/km)

Note: DRIMS does not collect visual pavement defects, and just focuses on IRI measurement only.

Table-2 Demarcation of ROMDAS and DRIMS application in Cambodia (tentative)

<table>
<tr><th colspan="2">Item</th><th>ROMDAS+FWD</th><th>DRIMS</th></tr>
<tr><td colspan="2">Survey volume per day</td><td>× (includes pavement Defects Assessment by SII)</td><td>○ (excludes pavement Defects Assessment)</td></tr>
<tr><td colspan="2">Obtainable data</td><td>○</td><td>×</td></tr>
<tr><td colspan="2">Survey Cost</td><td>×</td><td>○</td></tr>
<tr><td colspan="2">Characteristics of tool</td><td>- detailed inspection
- medium operation cost
- high skill needed
⇒ detailed data can be obtained but needs high cost and skill</td><td>- survey only pavement surface
- low survey cost
- simple skill
⇒ easy to survey with low cost</td></tr>
<tr><td rowspan="3">Demarcation of Application</td><td></td><td>Detailed Survey</td><td>Overview/Outline Survey</td></tr>
<tr><td>Short term
(3 years)</td><td><table><tr><th>Road Class</th><th>Application</th></tr><tr><td>1 & 2 digit</td><td>Planning</td></tr><tr><td>3 & 4 digit</td><td>N/A</td></tr><tr><td>City road</td><td>N/A</td></tr></table></td><td><table><tr><th>Road Class</th><th>Application</th></tr><tr><td>1 & 2 digit</td><td>- Planning</td></tr><tr><td>3 & 4 digit</td><td>- Routine</td></tr><tr><td>City road</td><td>maintenance</td></tr></table></td></tr>
<tr><td>Mid term
(3-10 years)</td><td><table><tr><th>Road Class</th><th>Application</th></tr><tr><td>1 & 2 digit</td><td>- Planning
- Routine maintenance</td></tr><tr><td>3 & 4 digit</td><td>N/A</td></tr><tr><td>City road</td><td>N/A</td></tr></table></td><td><table><tr><th>Road Class</th><th>Application</th></tr><tr><td>1 & 2 digit</td><td>(Routine maintenance)</td></tr><tr><td>3 & 4 digit</td><td>- Planning</td></tr><tr><td>City road</td><td>- Routine maintenance</td></tr></table></td></tr>
<tr><td colspan="2">Institutional arrangement</td><td colspan="2">One office/department will be responsible for both ROMDAS and DRIMS operation and data management.</td></tr>
</table>

*Remarks: ○: superior, ×: inferior

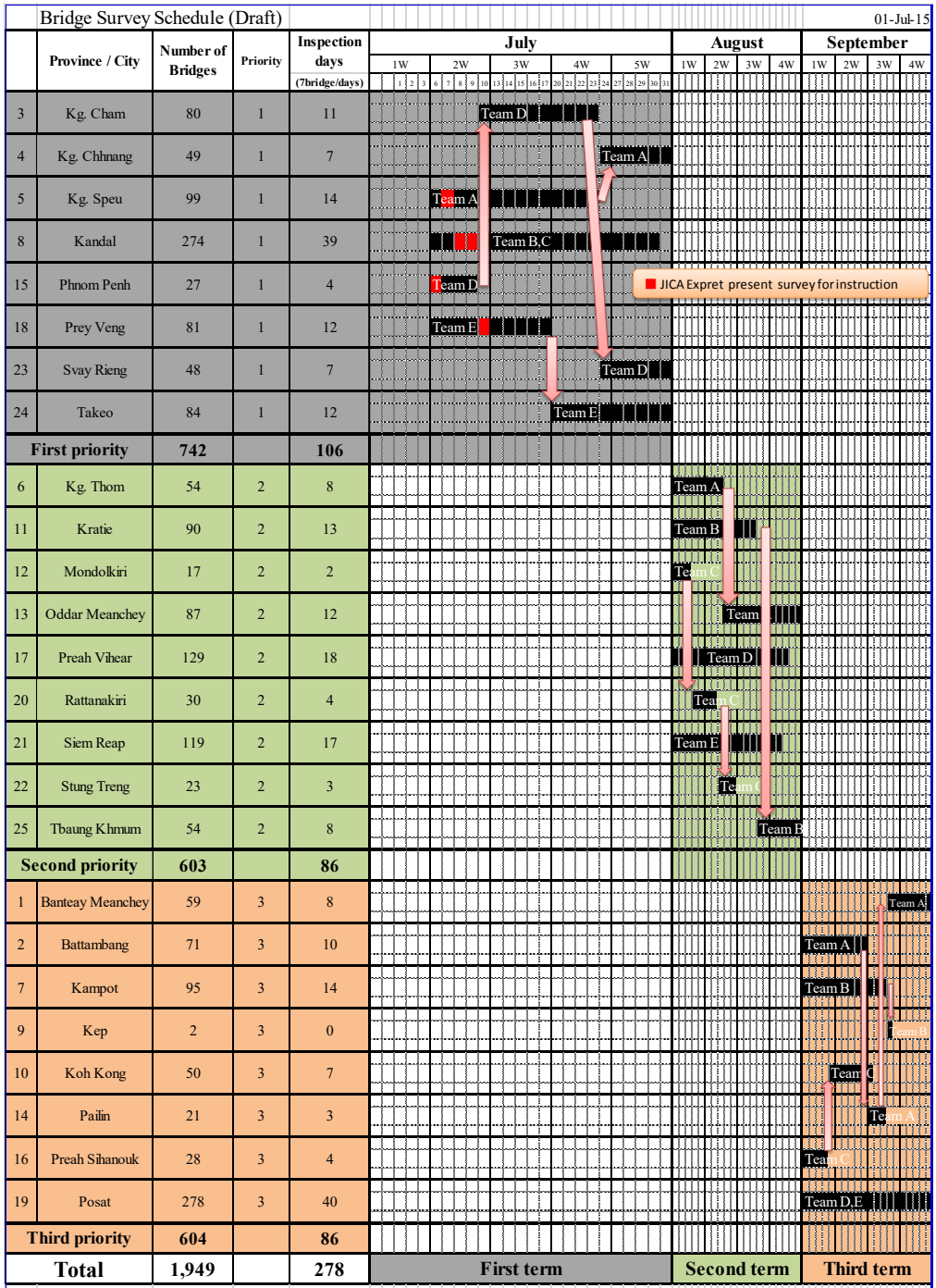
6.4.2 Inspection of Bridges

(1) Plan of 2000 bridges inspection

2000 Bridge Inspection was conducted in 2015. Figure 6-12 below shows the schedule chart for the inspection. It took approximately 3 months to complete the inspection of a majority of the bridges.

Bridge Survey Schedule (Draft) 01-Jul-15

	Province / City	Number of Bridges	Priority	Inspection days (7bridge/days)
3	Kg. Cham	80	1	11
4	Kg. Chhnang	49	1	7
5	Kg. Speu	99	1	14
8	Kandal	274	1	39
15	Phnom Penh	27	1	4
18	Prey Veng	81	1	12
23	Svay Rieng	48	1	7
24	Takeo	84	1	12
First priority		**742**		**106**
6	Kg. Thom	54	2	8
11	Kratie	90	2	13
12	Mondolkiri	17	2	2
13	Oddar Meanchey	87	2	12
17	Preah Vihear	129	2	18
20	Rattanakiri	30	2	4
21	Siem Reap	119	2	17
22	Stung Treng	23	2	3
25	Tbaung Khmum	54	2	8
Second priority		**603**		**86**
1	Banteay Meanchey	59	3	8
2	Battambang	71	3	10
7	Kampot	95	3	14
9	Kep	2	3	0
10	Koh Kong	50	3	7
14	Pailin	21	3	3
16	Preah Sihanouk	28	3	4
19	Posat	278	3	40
Third priority		**604**		**86**
Total		**1,949**		**278**



		Inspection Days	Required persons RID 2 preson/day	DPWT 2 preson/day	Student 2 preson/day	Total
Capital region	First priority province (8 provinces)	106	212	212	212	636
Northeast of Cambodia	Second priority province (9 provinces)	86	172	172	172	516
Southwest of Cambodia	Third priority province (8 provinces)	86	172	172	172	516
	Total	278	556	556	556	1,668

Figure 6-12 Schedule of 2000 bridges survey

(2) Inspection Result of Bridges at Target DPWTs

The 2000 bridges survey was completed by nominated RID groups and DPWT supporters. The inspection team structure is as shown in Figure 6-13. Sample of SD bridges are shown in Attachment 3.

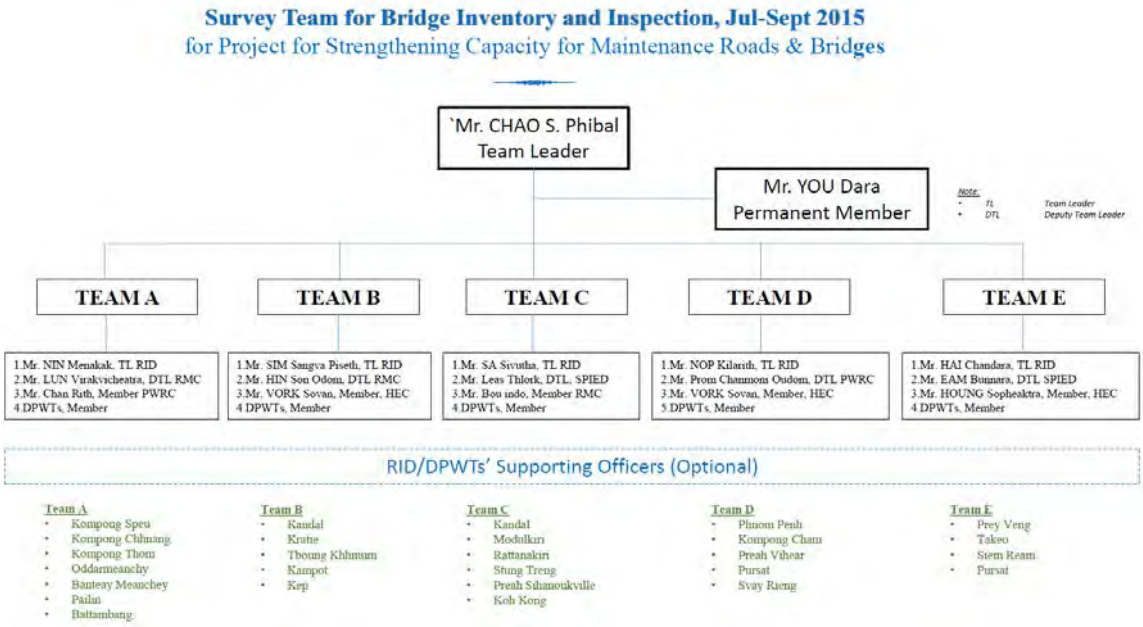


Figure 6-13 2000 Bridge Inspection Team Structure

Table 6-38 Summary of 2000 survey result (2017)

Condition	Number of bridges
SD bridges	59
D bridges	167
O bridges (to be under Observation)	429
N bridges (No defects found)	1734
Total	2,389

The condition of Bridges in Cambodia is analyzed and illustrated as shown in Figure 6-15 and Figure 6-16 using the bridge database.

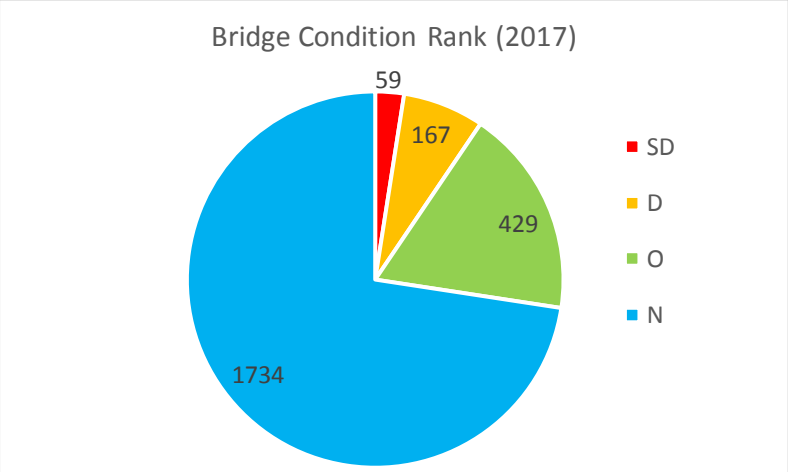


Figure 6-14 Number of bridges by condition

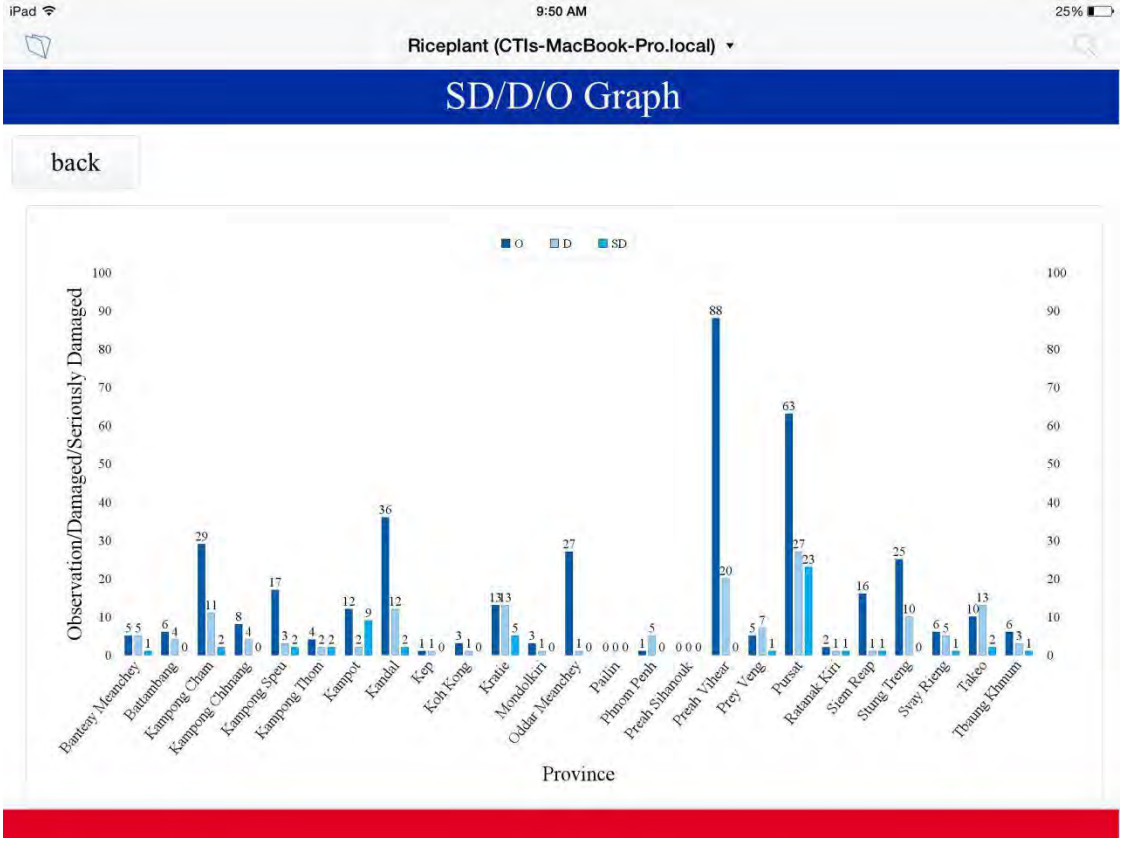
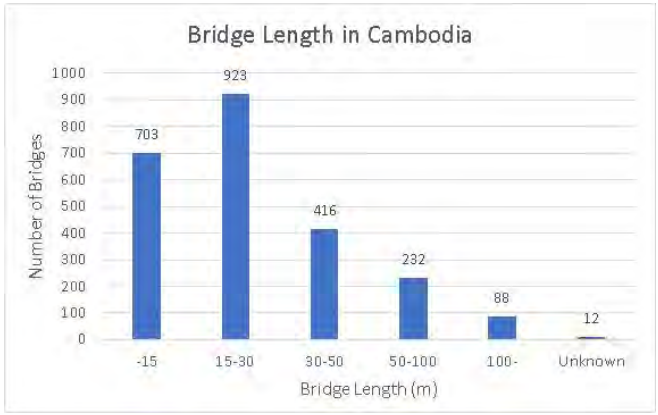
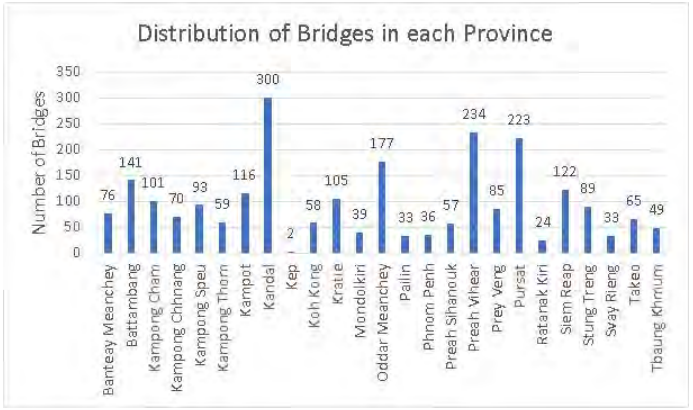


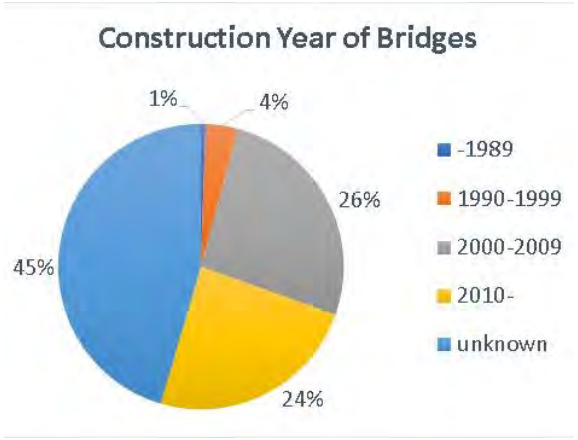
Figure 6-15 Bridge condition by province



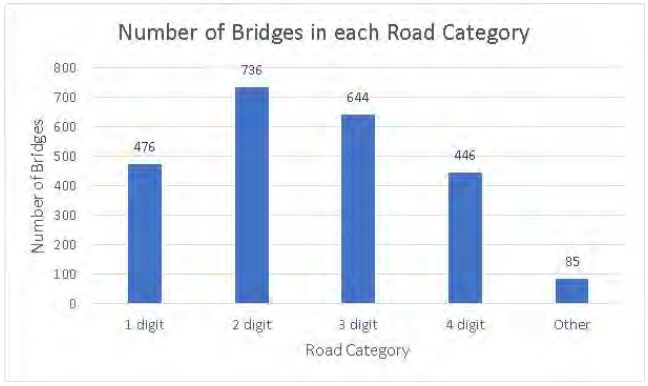
Bridge Length



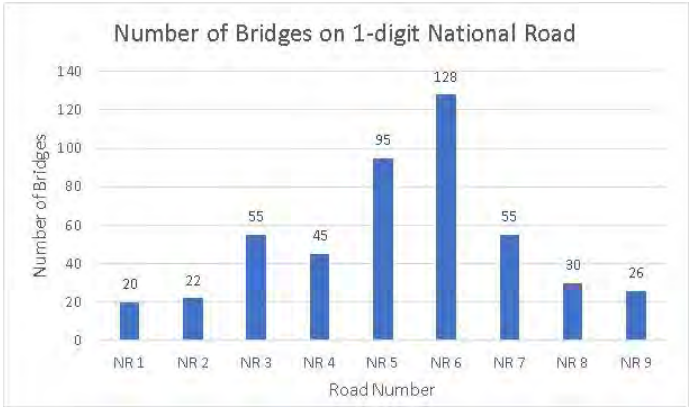
By Province



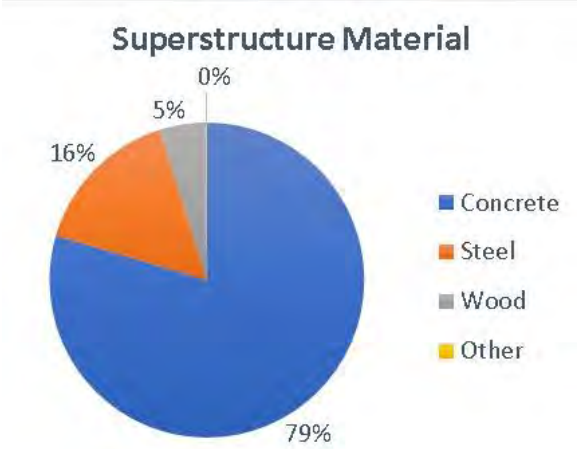
By construction year



By Road Category



Number of bridge in 1st digit Road



Superstructure material type

Figure 6-16 Bridge Condition Analysis using bridge database

Table 6-39 Bridges list (SD Bridges) as of 21 July 2016

No	Bridge Name	Province	Road Name	PK	PK_meter	SS_Material	SS_Type	DamageLevel
1	Hak nouk man	Takeo	2	36	150	Steel	Truss	SD
2	Prek leng	Kandal	110	79	400	Concrete	Others	SD
3	Sammaky	Kandal	42	7	0	Concrete	Slab girder	SD
4	O Kondour	Kampong Cham	70	7	55	Steel	Truss	SD
5	Tropan srorng	Takeo	125	1	307	Concrete	Girder	SD
6	O Nimol	Kampong Speu	46	7	600	Steel	Truss	SD
7	O Som Chort	Kampong Speu	46	10	100	Steel	Truss	SD
8	Kam Pi	Kratie	377	20	640	Wooden	Girder	SD
9	Prek son dain	Kampong Cham	31	32	440	Steel	Truss	SD
10	Tadav	Svay Rieng	314	23	300	Steel	Truss	SD
11	Ror leang4	Prey Veng	385	16	210	Concrete	Girder	SD
12	Au Daung	Kampong Thom				Wooden	Others	SD
13	Prek chik	Kampong Thom				Wooden	Others	SD
14	Koh Sla 1	Kampot	43	74	50	Steel	Truss	SD
15	Steung Thom	Kampot	43	82	300	Steel	Truss	SD
16	O dong touk	Kampot	43	86	880	Steel	Truss	SD
17	O chhnang hors	Kampot	43	89	50	Steel	Truss	SD
18	O Kreang	Kampot	43	98	310	Steel	Truss	SD
19	In Tha Nou 1	Kampot	700	0	740	Concrete	Arch	SD
20		Kampot	133	3	300	Concrete	Girder	SD
21	In Tha Nou 2	Kampot	700	0	740	Steel	Slab girder	SD
22	In Tha Nou 3	Kampot	700	0	740	Concrete	Slab girder	SD
23	Kom bot	Kratie	279	144	700	Wooden	Others	SD
24		Kratie	375	31	360	Wooden	Others	SD
25	O Ju	Kratie	375	32	980	Wooden	Others	SD
26	Kilometer 7	Kratie	375	40	650	Wooden	Others	SD
27	Beoung Kranh	Pursat	154	19	780	Wooden	Truss	SD
28	Kompong Rokar	Pursat	11	3	770	Wooden	Truss	SD
29	Thnol Dach 1	Pursat	11	4	290	Wooden	Slab girder	SD
30	Thnort Dach 3	Pursat	11	4	570	Wooden	Slab girder	SD
31	Joung Thlong	Pursat	152	4	980	Wooden	Girder	SD
32	Ta Prok	Pursat	152	6	830	Wooden	Girder	SD
33	Sor Svay	Pursat	155	4	880	Wooden	Slab girder	SD
34	Ta Kot	Pursat	155	5	680	Wooden	Slab girder	SD
35	Prous Krochab	Pursat	155	5	720	Wooden	Slab girder	SD
36	Doth Bat	Pursat	155	9	670	Wooden	Slab girder	SD
37	Beoung Ressey	Pursat	154	12	180	Wooden	Slab girder	SD
38	Chher Ty 2	Pursat	155	20	230	Wooden	Girder	SD
39	Chher Ty 3	Pursat	155	20	910	Wooden	Girder	SD
40	Kbal O	Pursat	155	27	310	Wooden	Girder	SD
41	Stok Klok 1	Pursat	154	12	790	Wooden	Slab girder	SD
42	Stok Klok 2	Pursat	154	13	420	Wooden	Slab girder	SD
43	Ka pot Ang	Pursat	154	4	915	Wooden	Slab girder	SD
44	Pjek Chrom	Pursat	1551	9	80	Wooden	Girder	SD
45	Pjek chrom	Pursat	1551	11	650	Wooden	Girder	SD
46	Olan Plok	Pursat	1551	12	980	Wooden	Girder	SD
47	Ta Than	Pursat	1551	14	660	Wooden	Girder	SD
48	O kbey Ngob 2	Pursat	1551	29	910	Wooden	Girder	SD
49	Kach changkes	Ratanak Kiri	3785	20	500	Wooden	Girder	SD
50	Dom Nak Cha Krom	Pursat	55	33	0	Steel	Truss	SD
51	Reach Dom nek	Siem Reap	6	307	900	Concrete	Girder	SD
52	Kro Bao	Banteay Meanchey	156	27	400	Wooden	Arch	SD
53	Toul Por	Tbaung Khmum	7	161	700	Concrete	Slab girder	SD

Table 6-40 Bridges list (D Bridges) as of 21 July 2016

No	Bridge Name	Province	Road Name	PK	PK_meter	Bridge Length	SS_Material	SS_Type	DamageLevel
1	O Ron	Kampong Chhnang	153	6	20	25	Concrete	Girder	D
2	120	Kampong Chhnang	1534	42	950	30	Steel	Others	D
3	Derm thkov	Kampong Chhnang	1534	25	410	18	Steel	Others	D
4	Ou than	Takeo	2	55	500	15.3	Steel	Truss	D
5	Phum sla	Takeo	2	63	300	35	Steel	Truss	D
6	Prey San deak	Takeo	2	85	695	15	Concrete	Girder	D
7	Chres	Takeo	2	95	334	15	Concrete	Girder	D
8	Prek rom deang5	Takeo	128	28	213	51	Steel	Truss	D
9	Krang leav	Takeo	3	56	700	15	Concrete	Girder	D
10	Thnong	Takeo	129	4	610	80	Concrete	Others	D
11	Prek Sleng	Kandal	2	28	180	18	Steel	Truss	D
12	Spean Siemreab	Kandal	2	24	453	12	Steel	Truss	D
13	Thmor kor	Kandal	380	41	0	30	Concrete	Girder	D
14	Prek cher teal 1	Kandal	381	6	528	50	Concrete	Girder	D
15	Prek jrey	Phnom Penh	0	8	905	105.15	Concrete	Slab girder	D
16	Baku	Phnom Penh	0	8	314	30	Concrete	Slab girder	D
17	Rolous	Phnom Penh	0	7	614	10.4	Concrete	Slab girder	D
18	Sak sompov	Phnom Penh	0	6	200	36	Concrete	Girder	D
19	Areak	Phnom Penh	42	7	700	16	Concrete	Slab girder	D
20	Thnol Keng-Japan	Kampong Cham	6	44	700	53.7	Concrete	Girder	D
21	Toul Tamar	Kampong Cham	277	31	740	26.6	Steel	Truss	D
22	Tropeang Veng 1	Kampong Cham	6	50	926	54	Concrete	Girder	D
23	Tros 1	Kampong Cham	6	51	912	160	Concrete	Girder	D
24	Beoung Trav 3	Kampong Cham	270	6	5	11.8	Concrete	Slab girder	D
25	Prak Thmey	Kampong Cham	270	40	810	36	Steel	Truss	D
26	Peak Leav Thom	Kampong Cham	270	47	100	21	Steel	Truss	D
27	Chhroy chon Luos lech	Kampong Cham	2714	28	450	12	Concrete	Slab girder	D
28	Tek chom	Kampong Chhnang	11	9	330	12	Concrete	Slab girder	D
29	Spean Bak	Kampong Speu	43	3	0	36	Steel	Truss	D
30	Sbeak Preal 3	Kampong Speu	43	7	0	10	Concrete	Slab girder	D
31	Song long	Takeo	126	7	677	40	Concrete	Girder	D
32	Chom res	Takeo	13	8	712	10	Concrete	Slab girder	D
33	Tonle Bati	Takeo	120	1	360	15	Steel	Truss	D
34	Tropan srorng	Takeo	125	0	908	5.3	Concrete	Girder	D
35	Border som roung prey kabas	Takeo	129	10	0	40	Concrete	Girder	D
36	Tro yerng	Takeo	129	10	99	10	Concrete	Girder	D
37	Peam Te (concrete)	Kratie	73	86	310	30	Steel	Girder	D
38	Ah Ha	Kratie	377	36	320	36	Steel	Truss	D
39	Ta Lia	Kratie	377	31	840	32	Steel	Truss	D
40	Somrong	Kratie	377	30	720	18	Steel	Truss	D
41	O Preas	Kratie	7	412	750	125	Concrete	Slab girder	D
42	Hannchey	Kampong Cham	279	17	590	129	Steel	Truss	D
43	Phum Ty 6	Kampong Cham	31	20	300	32	Concrete	Slab girder	D
44	Gy li	Kampong Cham	31	32	700	57	Steel	Truss	D
45	Khset	Svay Rieng	314	38	600	12	Steel	Truss	D
46	Krang Loa	Svay Rieng	312	21	0	12	Concrete	Slab girder	D
47	Pro Sot	Svay Rieng	1	135	179	60.3	Steel	Girder	D
48	Prey Beng	Kampong Speu	110	2	140	25	Concrete	Girder	D
49	Chork	Svay Rieng	13	7	700	27	Steel	Truss	D
50	Hun Sen Somrong	Svay Rieng	13	23	450	36	Steel	Truss	D
51	O Rum deng	Stung Treng	2648	15	300	36	Wooden	Others	D
52	Kompong por pil	Prey Veng	8	46	800	130	Concrete	Slab girder	D
53	Raka3	Prey Veng	8	62	500	85	Concrete	Slab girder	D
54	Sameki	Prey Veng	385	5	380	9	Concrete	Girder	D
55	Ror leang 1	Prey Veng	385	15	470	15	Concrete	Girder	D
56	Ror leang2	Prey Veng	385	15	810	15	Concrete	Girder	D
57	Stoeng Slot	Prey Veng	1	66	400	148	Concrete	Girder	D
58	Prek hon	Prey Veng	310	16	150	60	Concrete	Girder	D
59	Kom Pongchin	Kampong Thom				60	Wooden	Others	D
60	Au Wy	Kampong Thom	0			30	Concrete	Girder	D
61	Dong son Touch	Kampot	43	88	250	9	Steel	Truss	D
62		Kampot	1311	12	900	50	Steel	Truss	D
63	Spean Thmor 1	Kep	1332	11	920	48	Concrete	Girder	D
64	Prek Chhloung	Kratie	7	274	750	136	Concrete	Slab girder	D
65	Jreav	Kratie	373	17	300	45	Concrete	Girder	D
66	Sonday rong	Kratie	279			35	Wooden	Others	D
67	Kreang	Kratie	279	145	900	45	Wooden	Others	D
68	O khroch	Kratie	375	31	190	24	Wooden	Others	D

No	Bridge Name	Province	Road Name	PK	PK_meter	Bridge Length	SS_Material	SS_Type	DamageLevel
69	Kilometer 9	Kratie	375	38	930	7	Wooden	Others	D
70	Kon ork	Kratie	375	43	90	8	Wooden		D
71	Pong Ro	Kratie	371	85	660	126	Steel	Truss	D
72	Svay Doun Keo	Pursat	5	219	500	92	Steel	Girder	D
73	Ro leab3	Pursat	155	2	737	30	Concrete	Girder	D
74	Yous	Pursat	154	9	570	6	Wooden	Others	D
75	Banteay Youn	Pursat	154	18	360	45	Steel	Slab girder	D
76	Svay Sor Ler 2	Pursat	153	22	210	12.4	Steel	Girder	D
77	Svay Sor Ler 1	Pursat	153	20	390	12.5	Steel	Girder	D
78	Wat Taphy	Pursat	152	2	180	9.5	Concrete	Frame	D
79	Dorng Rong	Pursat	154	1	920	14.9	Concrete	Slab girder	D
80	Wat Balang	Pursat	155	7	990	18.3	Wooden	Slab girder	D
81	Santipeab	Pursat	154	8	300	12	Wooden	Slab girder	D
82	Pro Moy	Pursat	1551	0	763	90	Steel	Truss	D
83	Pro moy2	Pursat	1551	1	520	7.4	Wooden	Girder	D
84	Chherteal Chrom	Pursat	1551	17	880	12.5	Wooden	Girder	D
85	Tek veal	Pursat	1551	21	680	10	Wooden	Girder	D
86	O kbey Ngob	Pursat	1551	23	540	8.5	Wooden	Girder	D
87		Pursat	1551	39	930	14	Wooden	Girder	D
88	Chhay Luk	Pursat	1551	49	530	83	Wooden	Girder	D
89	Krang Dong	Preah Vihear	62	104	488	78	Concrete	Slab girder	D
90	Ta keing 1	Preah Vihear	62	155	464	24	Concrete	Girder	D
91	Sra Aem	Preah Vihear	62	211	813	80	Concrete	Slab girder	D
92	Spean 1	Preah Vihear	23	4	650	12	Steel	Truss	D
93	Spean 7	Preah Vihear	23	13	50	12	Steel	Truss	D
94	Ta Seim	Preah Vihear	23	4	0	9	Steel	Truss	D
95	Spean Ty 3	Preah Vihear	2627	3	480	15	Concrete	Girder	D
96	Kor2	Preah Vihear	22	10	710	12	Concrete	Girder	D
97	Kor1	Preah Vihear	22	7	0	12	Concrete	Girder	D
98	O Sneat	Preah Vihear	95	17	730	30	Steel	Truss	D
99	Pot Drea	Preah Vihear	95	40	0	120	Steel	Truss	D
100	O chonh	Preah Vihear	2626	15	0	45	Concrete	Girder	D
101	Spean 23	Preah Vihear	2625	11	700	24	Concrete	Girder	D
102	O Sor	Preah Vihear	2626	15	130	15	Steel	Truss	D
103	Steung kdol	Preah Vihear	64	102	640	60	Concrete	Slab girder	D
104	Rolom Trobek	Preah Vihear	64	101	914	39	Concrete	Slab girder	D
105	O Sho Pol	Preah Vihear	64	72	500	15	Concrete	Girder	D
106	Oh jar	Stung Treng	376	15	40	36.5	Steel	Truss	D
107	Oh ksach phum	Stung Treng	376	17	85	40	Wooden	Girder	D
108	Oh pong teuk	Stung Treng	279	271	550	12	Wooden	Girder	D
109	Ma jong	Stung Treng	379	0	0	24.5	Wooden	Girder	D
110	O rom dang	Stung Treng	379	10	900	30.8	Wooden	Girder	D
111	Oh banh kla	Stung Treng	379	22	287	21.6	Wooden	Girder	D
112	Oh ta Len pen	Stung Treng	379	29	970	28	Wooden	Girder	D
113	Oh Dom bong	Stung Treng	379	30	560	28	Wooden	Girder	D
114	Oh bhacha	Stung Treng	43	0	525	20	Wooden	Girder	D
115	O ta ngy	Ratanak Kiri	3789	19	800	22	Wooden	Girder	D
116	Bridge 2	Koh Kong	5	0	211	10	Concrete	Slab girder	D
117	Prek Thei Ka khpos	Kandal	21	12	76	36	Steel	Girder	D
118	Wat kbal khos	Kandal	21	22	166	6.8	Concrete	Girder	D
119	Prek Ta Hing	Kandal	21	46	79	8.3	Concrete	Girder	D
120	Prek Nu	Kandal	21	50	698	36	Steel	Truss	D
121	Prek chan	Kandal	21	52	780	18	Steel	Truss	D
122	Prek krounh	Kandal	21	62	0	27	Steel	Truss	D
123	Perk Me srok	Kandal	21	16	917	12	Concrete	Girder	D
124	Prek TaVa	Kandal	21	21	821	18	Steel	Girder	D
125	Teuk Chenh	Battambang	1577	52	560	9.5	Wooden	Arch	D
126	O 400	Battambang	1577	53	290	12	Steel	Truss	D
127	O Ponlok	Battambang	0	40	310	6.5	Wooden	Girder	D
128	O Jiom	Battambang	1552	14	520	18	Concrete	Girder	D
129	Prek Mouy	Pursat	55	34	700	9	Wooden	Girder	D
130	Spung	Pursat	55	39	600	16	Steel	Truss	D
131	O Leak Meas	Pursat	55	58	250	36	Wooden	Arch	D
132	Toul Krous	Pursat	55	79	100	15	Steel	Truss	D
133	Tang Yor	Pursat	55	90	650	15	Steel	Truss	D
134	Ta kry	Pursat	55	98	200	15	Steel	Truss	D
135	Dey kro hom No.4	Pursat	55	129	328	12	Steel	Truss	D
136	1500 No.2	Pursat	55	153	920	9.5	Steel	Truss	D
137	A4 No.1	Pursat	55	166	420	8	Wooden	Slab girder	D
138	A4 No.6	Pursat	55	172	970	9	Steel	Truss	D
139	Ta mom	Siem Reap	265	10	300	20	Concrete	Girder	D
140	Kor-Sang	Banteay Meanchey	156	10	800	8	Concrete	Slab girder	D
141	Kong Va	Banteay Meanchey	56	7	0	20	Concrete	Slab girder	D
142	Bridge 16	Banteay Meanchey	6	381	935	20	Concrete	Slab girder	D
143	Bridge 7 Sa-Krav	Banteay Meanchey	6	406	690	26	Concrete	Slab girder	D

No	Bridge Name	Province	Road Name	PK	PK_meter	Bridge Length	SS_Material	SS_Type	DamageLevel
144	Bridge Preah Ponlea	Banteay Meanchey				84.7	Wooden	Arch	D
145	Prek Jrang	Tbaung Khmum	372	12	700	24	Steel	Truss	D
146	Dong Hit	Tbaung Khmum	372	14	0	12	Steel	Truss	D
147	Prek Kray	Tbaung Khmum	372	17	700	31	Steel	Truss	D
148	O tron	Mondolkiri	3761	12	150	21	Steel	Truss	D
149	Au Romdeng	Oddar Meanchey	2647	43	150	12	Concrete	Girder	D
150	O Ta Chhor	Preah Vihear	2623	10	82	18	Concrete	Girder	D
151	O Da	Preah Vihear	2623	16	570	24	Concrete	Girder	D
152	Stung Sen	Preah Vihear	0	1	790	90	Concrete	Girder	D

Serious Damaged Bridges in 2015 **(No.1-1)**

Bridge Name : Ror leang 4	Province : Prey Veng	Location Road Name : 385 GPS : Latitude: 11.764402 Longitude: 105.356771 PK: 16 +210
Type : Deck : Concrete Girder : Concrete Substructure :Concrete	Dimension: Length 12.5m, Width 6.5m Span : 3	Opening Date : yyyy /mm / dd
Location Map 		
Inspection (2015/9/18) Mr. Menakak and JICA expert   	Evaluation Mr. Menakak and JICA expert Damages: Superstructure(Concrete) *Deck slab concrete broken and fallen down *Rebar exposed *Rebar rusted *Some vehicles are passing on the sidewalk	Counter measure **This bridge is desirable to replacement** *Deck slab broken and fallen down . (Vehicles run through the sidewalk, but the health of it has not been guaranteed.) *It can`t be ensured traffic safety

Figure 6-17 Bridge Damage Record Sheet (Sample)

(3) 1st Maintenance Operation Meeting (MOM)

Among 2,389 bridges, 173 bridges were selected for the detailed inspection considering the urgency of the inspection. The inspection was completed and the result was shared in the 1st MOM on 26 May 2017. In the meeting, a schedule by next MOM for detailed inspection was planned. The material used in the MOM (Maintenance Operation Meeting) is attached as Appendix 4,5,6.

In the MOM, bridge condition was verified one by one by the ME. The MOM identified the actual number of bridges with damages as illustrated below. The bridge inspection system gives preliminary evaluation to bridges while the MEs give the final evaluation.

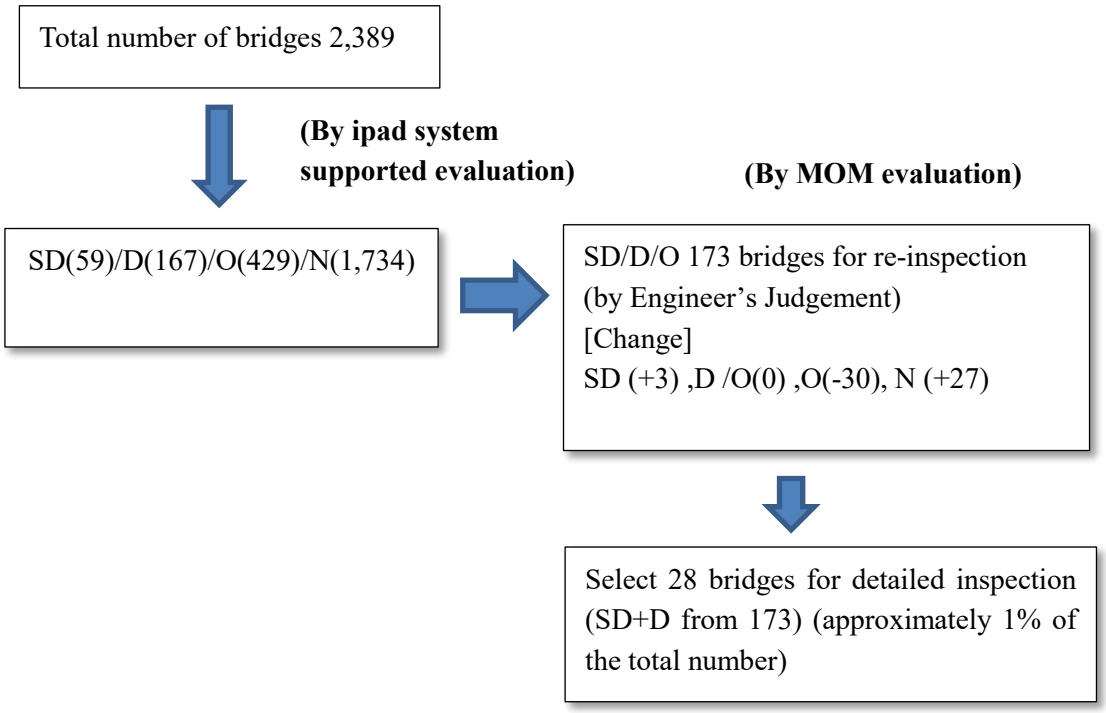


Table 6-41 Bridge Condition after Evaluation in MOM (2017)

Condition	Number of bridges
SD bridges	62 (59)
D bridges	167 (167)
O bridges (to be under Observation)	399 (429)
N bridges (No defects found)	1,761(1,734)
Total	2,389

( ) is the number before MOM

Number of all Inspection Bridges:	173
Already replaced or under replacing Bridges:	8
Number of net Inspection Bridges:	165
Judged as Detailed Inspection Bridges*:	28

* Judged as SD/D/DorO by JICA Expert

		JICA Expert Judgement					
		SD	D	D or O	O	N	Total
MPWT Judgement	SD	5			1		6
	D	1	2	1	6	9	19
	O	3	3	3	18	32	59
	N		7	3	4	67	81
	Total	9	12	7	29	108	165

Same Judgement Between MPWT and JICA Expert	96	58%
Safty Judgement by MPWT more than JICA Expert	48	29%
Risky widely Judgement by MPWT more than JICA	10	6%
Risky Judgement by MPWT more than JICA Expert	11	7%
Bridges should be detailed inspected by August	28	17%

Figure 6-18 Result of the MOM (Engineer's Judgement)

(4) 2nd Maintenance Operation Meeting

The 2nd maintenance operation meeting was held in December 2017 in order to set the inspection plan for FY2018. Attachment 7.

(5) Cost Estimation for Bridges Repair

The JICA TCP team proposed that at least all bridges in Cambodia be inspected once in every five years (1 Time / 5 years) using the afar method, that is, by use of binoculars. (In the last progress report, the JICA TCP team suggested that all bridges be inspected by close (=touching) method. However, inspection of all bridges by closed method would need a huge budget which would be difficult of RID. For that reason, in this progress report, Cost Estimation was modified. A detailed Inspection cost estimate is as shown in Table 6-42 below.

Table 6-42 Estimated Cost for Bridge Inspection

Cost Estimation of Inspection								
				Price	Unit		Initial price	Remark
Initial Cost	Inspection Equipments			4,297	US$/Province		107,425	25 Province
	Total						**107,425**	
	Classification of Inspection	Inspection Method	Frequency	Price	Unit	Frequency	Annual price	Remark
Running Cost	Routine Inspection	Checking in car	Once/Month	2,026	US$/Once	Once / Month	24,312	With road inspection
	Periodic Inspection	Afer inspection	Once/5Year	47,170	US$/Once	Twice / Year	94,340	
	Detailed Inspection	Close touching	Once/5Year	1,424,797	US$/Once	Once / 5 Years	284,959	
	Initial Inspection	Distance view	Befor service			Whenever neccesary	3,793	1% of Inspection A&B
	Emergency Inspection	Close touching	Whenever neccesary			Whenever neccesary		
	Total						**407,404**	

6.5. To Register the Inspection Results in the Database at the Target DPWTs (2000 Bridge Survey)

6.5.1 Development of Bridge Database System

The bridge database system introduced in the project has the following functions:

1) Data collection for bridge inventory;
2) Brief bridge inspection system;
3) Browsing bridge inventory data and inspection data;
4) Indication of basic bridge condition in Cambodia by Graph;
5) Extraction of bridge inventory data;
6) Extraction of brief bridge inspection data;
7) Data output for mapping to GIS software;
8) Data output of the data in database system by Excel format (.xls) for analysis.

The Expert Team is requesting to connect the database to the MPWT LAN so as to make it accessible by authorized staff. In this regard, the bridge database server requires a global IP address in order to enable access from outside (for example, by DPWTs).

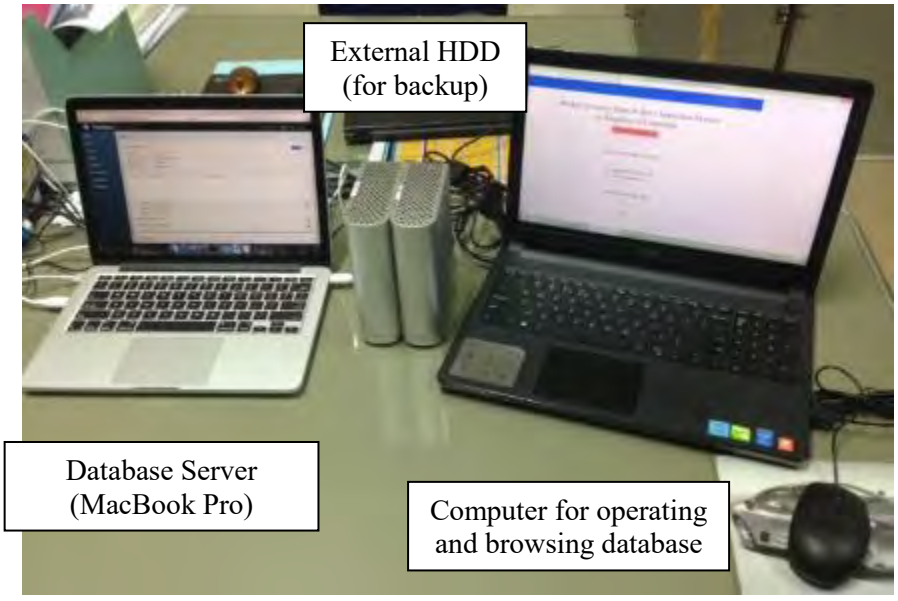


Photo 6-1 Bridge Database (Hardware)

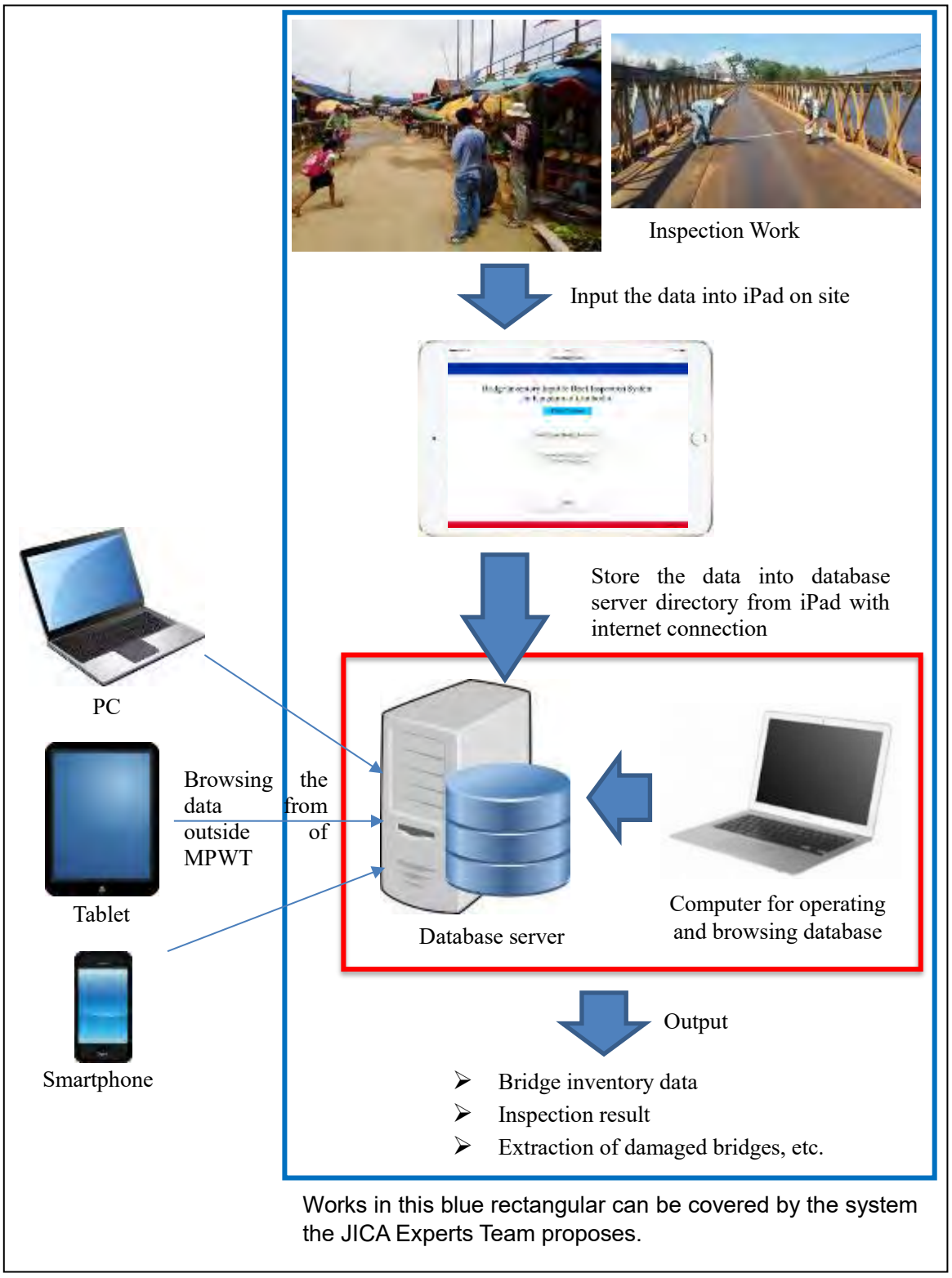
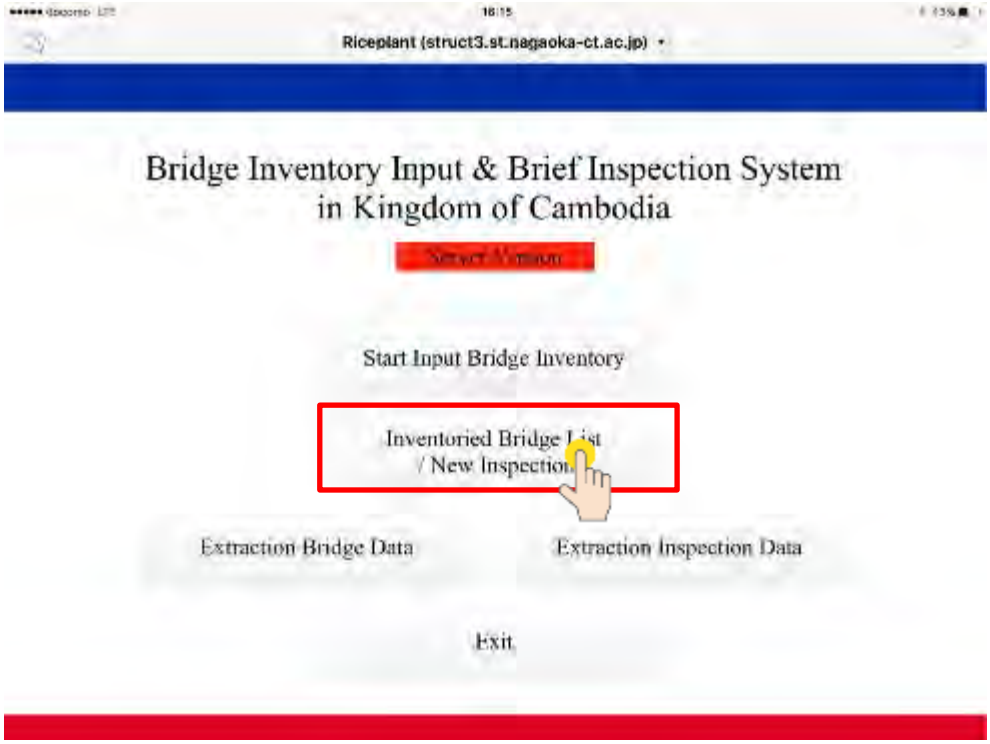


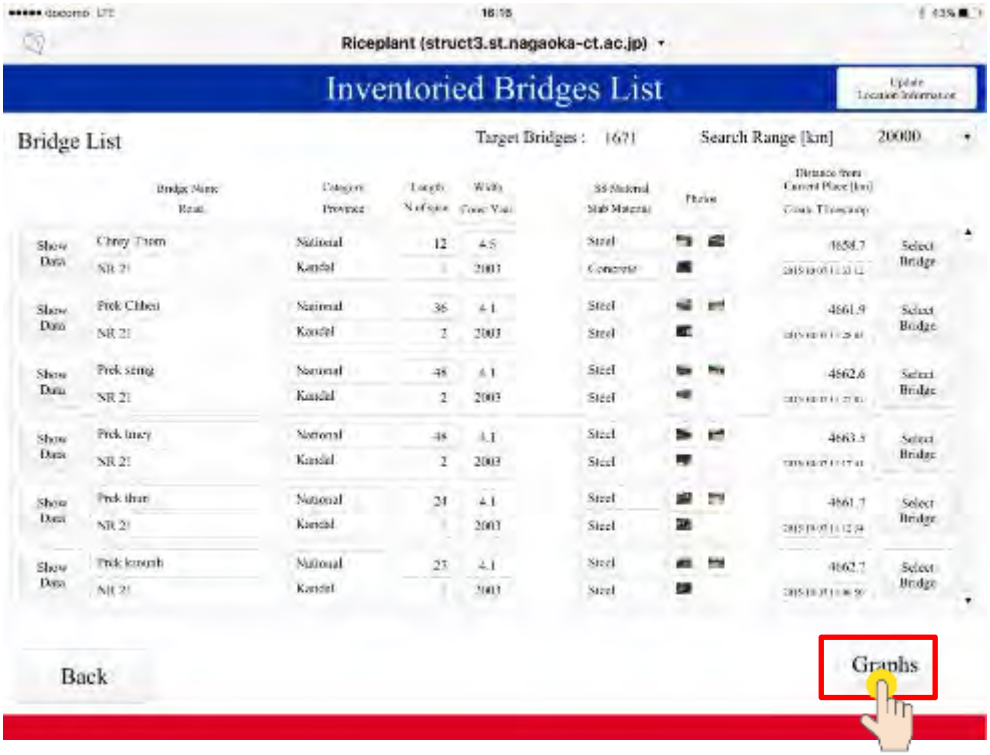
Figure 6-19 Bridge Database Framework

Description of the major functions of the system

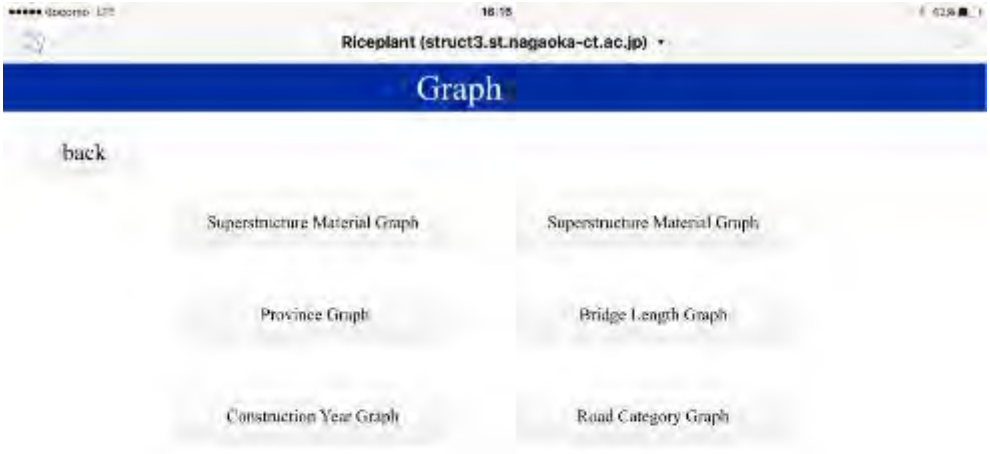
➢ How to show some information in graph



1. Tap the button “Inventoried bridge list / New Inspection”.

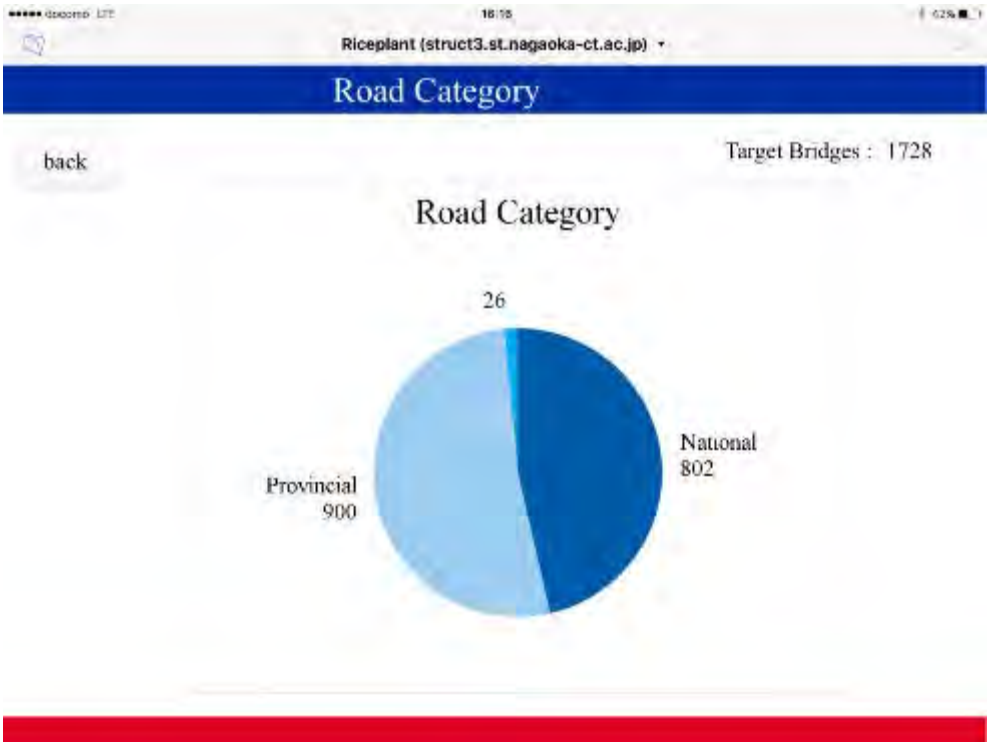


2. Tap the button “Graphs”.



About 10 contents will be prepared in the future.

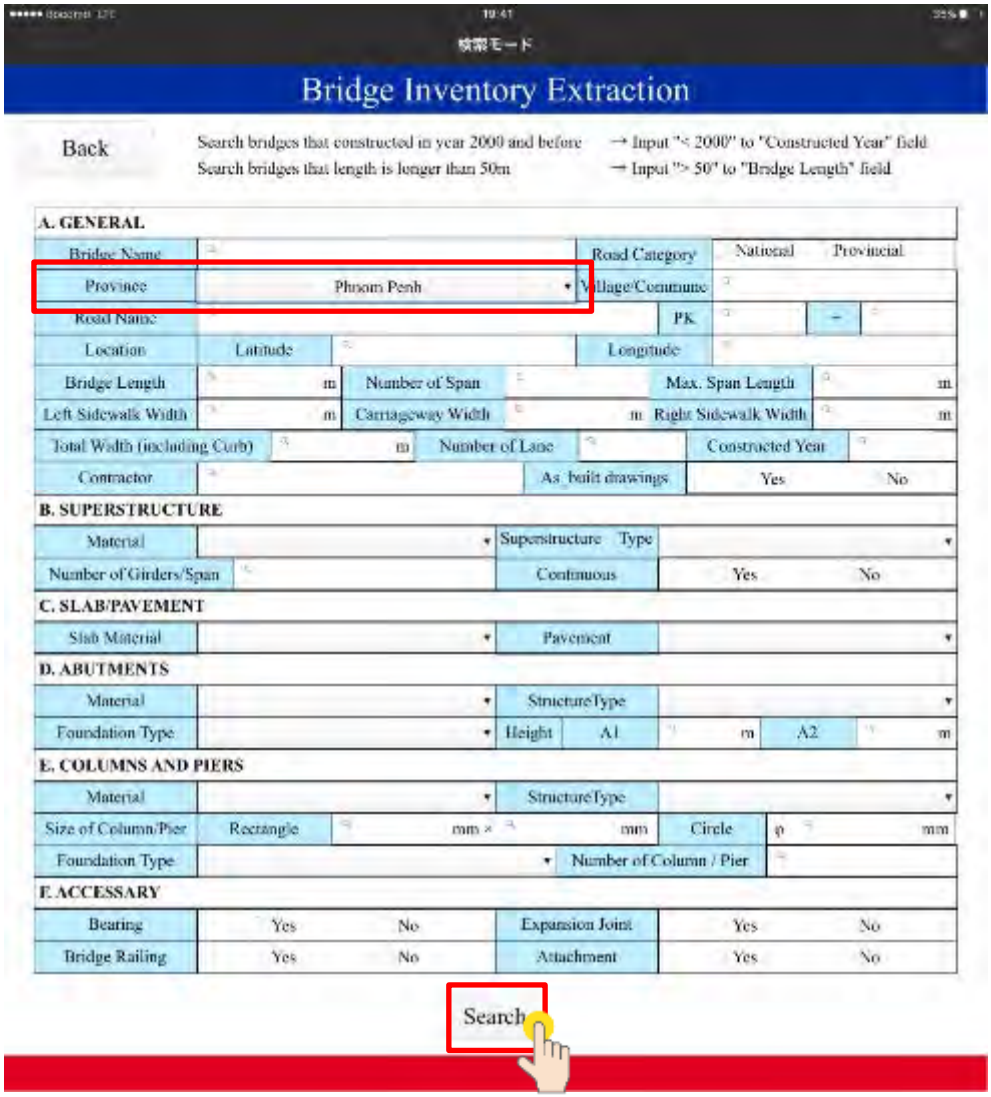
3. Select information to be seen in buttons indicated on the screen.



4. Sample graph (If select “Road Category”)

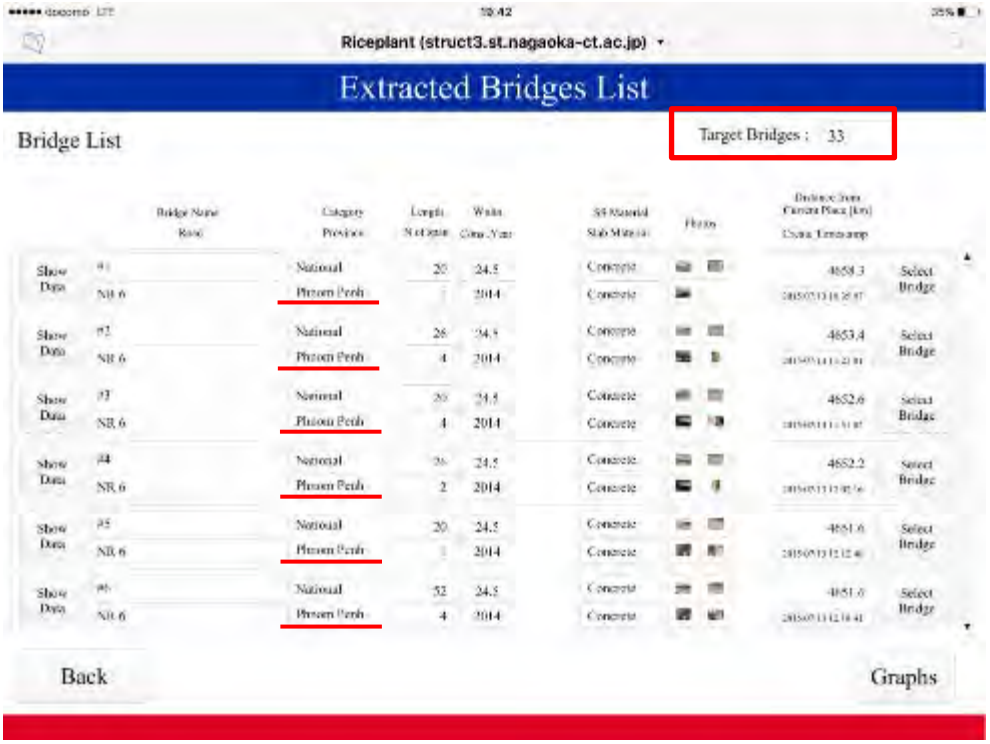
How to extract the bridge inventory data

Tap the button “Extraction Bridge Data”.



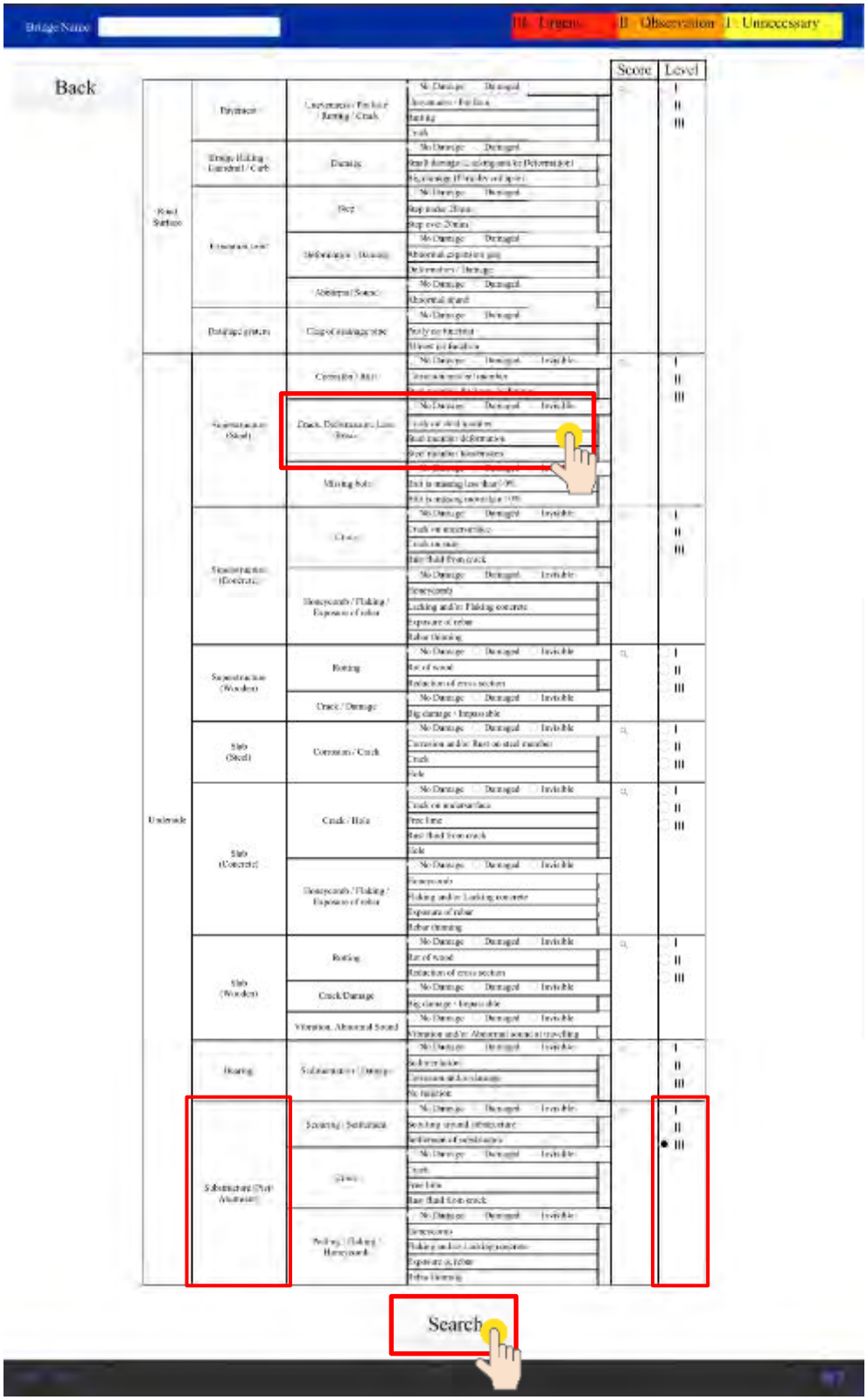
1. This screen will appear. If you would like to see the bridges in Phnom Penh, select “Phnom Penh” in the Province cell, then tap the search button.

✓ Multiple search criteria can be accepted in this system. But each cell can be accepted one term only.



2. The list of bridges located in Phnom Penh will appear.

➢ How to extract the bridge inspection data



1. This screen will appear. If you would like to see the bridges with level III damage to the substructure, select “Level III” in substructure, then tap the search button.

2. The list of bridges with level III damage in the substructure will appear.

6.5.2 Training on Bridge Database System

The training on bridge inspection and database system was conducted on 23 November, 2016.

1) Database operation

2) iPad System Inspection

Remark by Director of RID

Lecture by JICA Expert (AM)

Lecture by JICA Expert (PM)

Web accessible database

6.5.3 Manual for Bridge Inventory and Initial Inspection (2000 Bridge Inspection)

Using the Prototype database prepared in the Project, inspection data of 2000 bridges survey was served. The guideline for Bridge Inventory and Initial Inspection was also prepared for trainees.

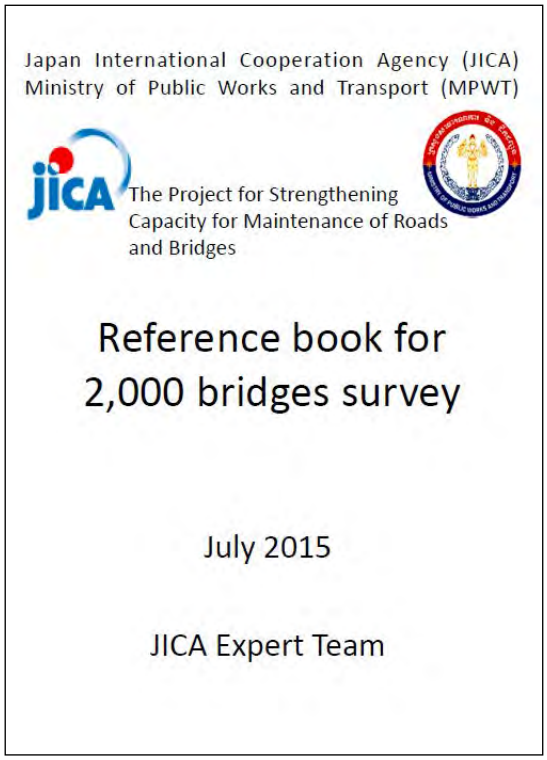
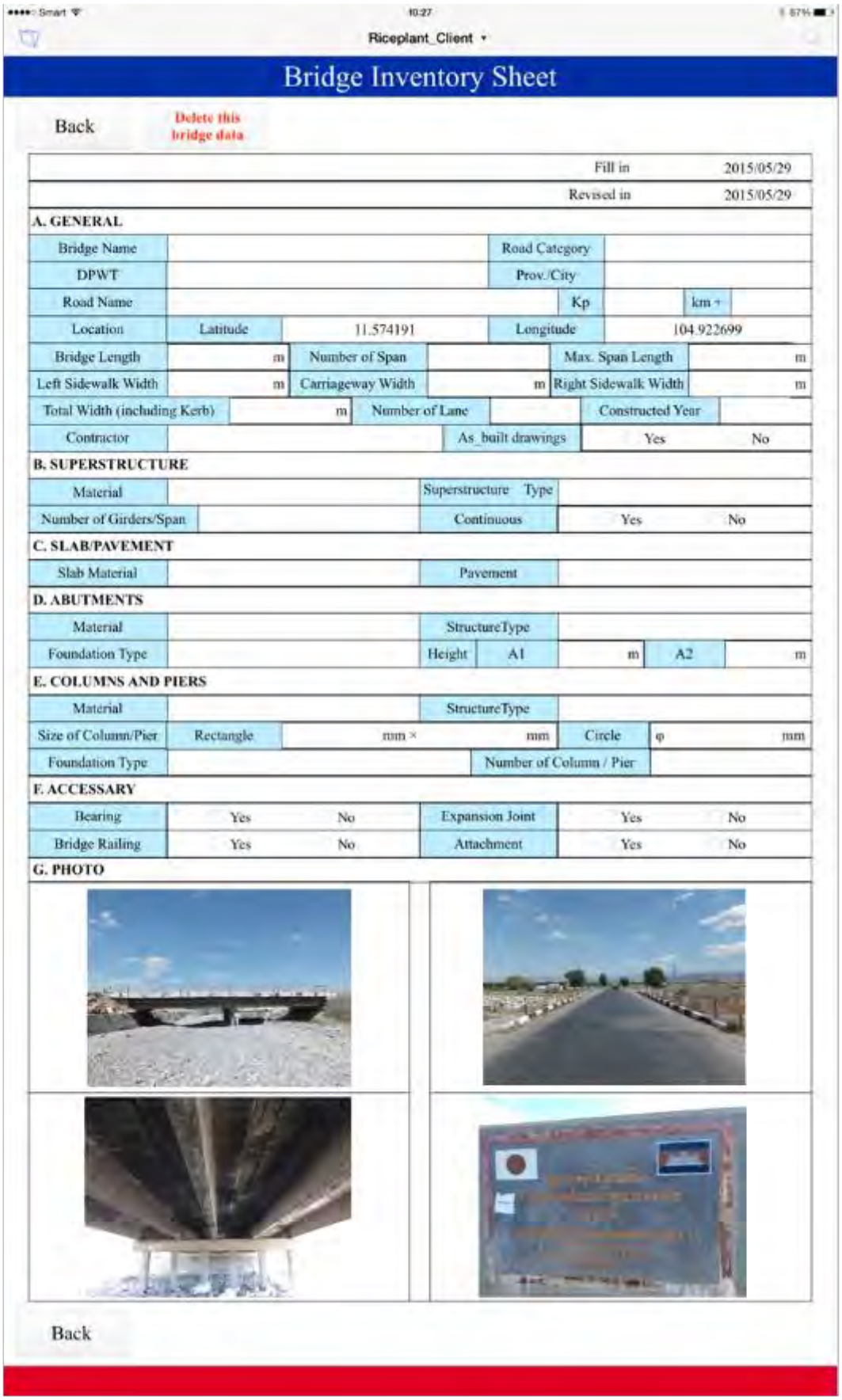


Figure 6-20 Bridge Inventory Manual



Riceplant_Client

Bridge Inventory Sheet

Back | Delete this bridge data

					Fill in	2015/05/29	
					Revised in	2015/05/29	
A. GENERAL							
Bridge Name				Road Category			
DPWT				Prov./City			
Road Name				Kp		km +	
Location	Latitude	11.574191		Longitude	104.922699		
Bridge Length	m	Number of Span		Max. Span Length	m		
Left Sidewalk Width	m	Carriageway Width	m	Right Sidewalk Width	m		
Total Width (including Kerb)	m	Number of Lane		Constructed Year			
Contractor				As_built drawings	Yes	No	
B. SUPERSTRUCTURE							
Material				Superstructure Type			
Number of Girders/Span				Continuous	Yes	No	
C. SLAB/PAVEMENT							
Slab Material				Pavement			
D. ABUTMENTS							
Material				StructureType			
Foundation Type				Height A1	m	A2	m
E. COLUMNS AND PIERS							
Material				StructureType			
Size of Column/Pier	Rectangle	mm ×	mm	Circle	φ	mm	
Foundation Type				Number of Column / Pier			
F. ACCESSARY							
Bearing	Yes	No		Expansion Joint	Yes	No	
Bridge Railing	Yes	No		Attachment	Yes	No	
G. PHOTO							

Back

Figure 6-21 Sample of Bridge Inventory and Inspection Output

6.6. To Revise the Road and Bridge Maintenance Manuals Incorporating Lessons Learned from the Above Activities by Organizing Review Workshops

In 2017, as described in the previous sections, ME trainings were conducted to all DPWTs. Through this activity, proposed manuals were reviewed and updated.

The Master Trainers took part in the translation of the manuals to Khmer for ease of use by DPWTs. The review and update of the manuals also took place during this period.

Attachment 1 Urgent Countermeasure to prevent third party accident

An urgent countermeasure to prevent accidents to third parties should be implemented whenever a dangerous defect which may cause the collapse of the bridge is detected.

Example of target defect

1. Serious structural damage on main parts
   (Shearing crack on girder, serious crack or hole on slab deck,)

Shearing crack on concrete girder

Fatigue crack and hole on steel deck

Example of countermeasures,

Traffic regulation

1. Traffic suspension (Closing bridge)
2. Stopping the passing of heavy vehicles
3. Deployment of security guards to decrease traffic speed

Additional measures

4. Warning signboard installation
5. Lighting pole installation

Follow-up inspection

6. Follow-up inspection every day (1 week or 1 month depending on the defect situation).

10th Oct 2016

Attachment 2: Important Points for Bridge Inspection

(1) Definition of words

<Damage level>

SD (Bridge): Seriously damaged (bridge)

D (Bridge): Damaged (bridge)

<Method of Inspection>

Afar Inspection: A bridge inspection involving the use of binoculars from a distance

Closed Inspection: A bridge inspection involving touch and hammering

<Type of Inspection>

Routine Inspection: Checking (Pavement, Railing, Drainage system) by car or on foot (Once / Month)

Periodic Inspection: Afar inspection by use of binoculars (as well as 2,000 Bridges Survey) (Once / Every 5 Years)

Detailed Inspection: Closed inspection to obtain detailed bridge information and damage by considering the result of periodic inspection

Follow-up Inspection: Follow-up inspection of the damage by considering the result of the periodic inspection (once/Year)

Emergency Inspection: Bridge inspection after an emergency occurrence (e.g. Traffic accident or disaster)

<Types of Countermeasures>

Replace: Reconstruction of the bridge after demolition

Repair works: Repair, Retrofit, Rehabilitation of the bridge

Urgent (Emergency) Repair Works: Repair works to prevent accidents to third party

(2) Periodic Inspection

- (Ideal) All bridges should be inspected through the closed inspection method (=Japanese legal standard)
- All bridges in Cambodia shall be inspected using the afar inspection method (Once / 5years)

(3) Target for Replace

The replacement of a bridge should be considered if it is Seriously damaged.

Situation of Damage (According to results of Inspection)

- SD bridge (It is important to define the nature of the bridge damage clearly (SD / D).

Consideration of Function

- Unsatisfactory width
- Inaptitude line
- Problem around river bank or quay

Consideration of Bridge Type

- Bailey bridge

- Wooden bridge

(4) Targets for a detailed bridge Inspection

Target

- Whole parts of bridge (Not only the damaged part)
- It is necessary to check by touching and hammering
- Crack width > about 0.3mm

Unnecessary target (shall Inspect 5 years later)

- Decision to be replaced
- Already confirmed allowable damage through afar inspection
- Already inspected by closed inspection at periodic inspection (e.g. low height bridge)

(5) Purpose of Detailed Inspection

- To get scale or degree of the damage
- To get information on damage progress
- To judge necessity for repair work
- To select repair method
- To estimate repair work cost for budgeting

(6) Checkpoint of Detailed Inspection

- Defect point of the bridge
- Defect size, degree
- Checking by touching and hammering
- Compare present result with past result
- Measuring crack length and width

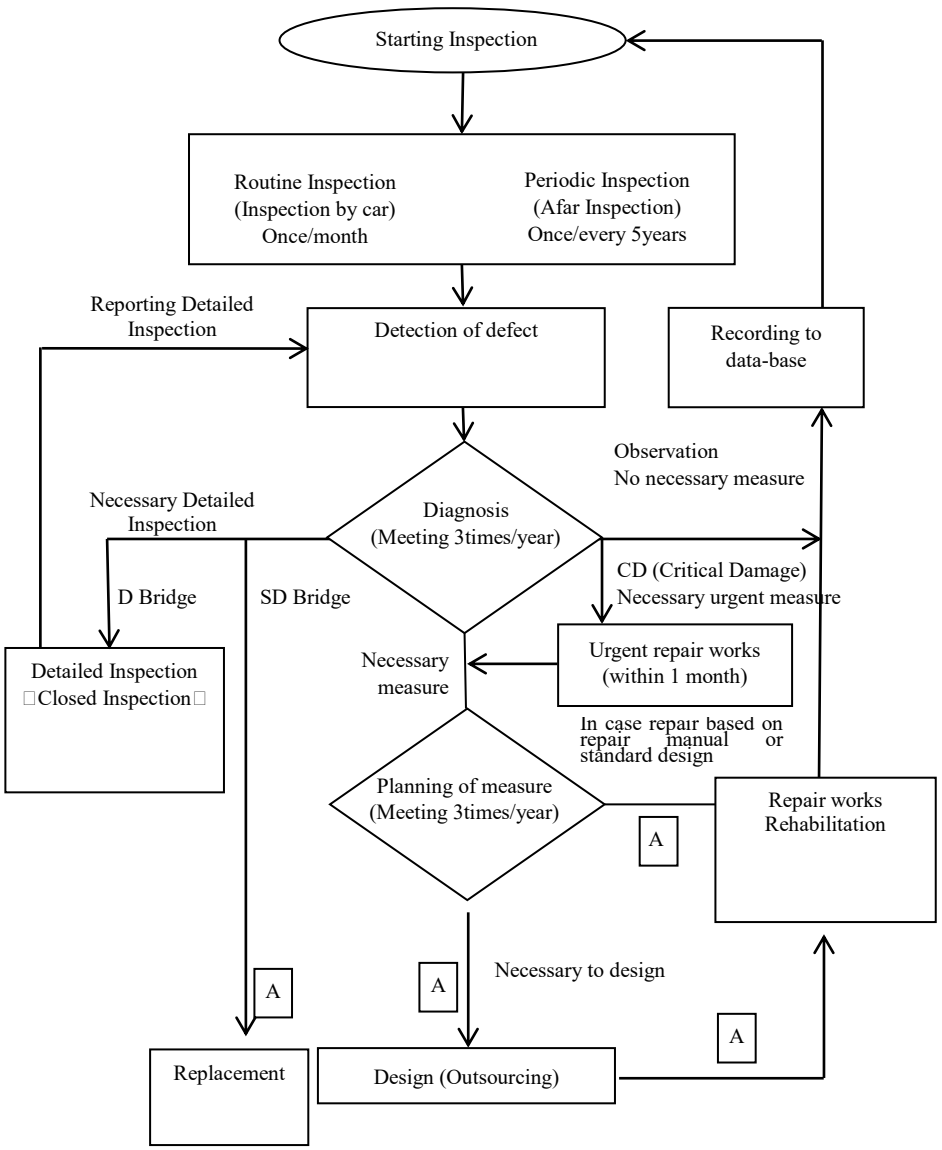
(7) Urgent (Emergency) Repair Works

- Damage influence to safety for third party or soundness of structure
  (Ex. Hole on slab deck, Broken steel member, etc)
- The damage should be repaired urgently within 1 month or another countermeasure taken
  (e.g. closing of the bridge)

(8) Follow-up Inspection

- Follow-up inspection shall be conducted until the bridge is fully repaired or replaced

Process of Bridge Inspection and Planning for Maintenance



In case impossible to repair early

A Method of Follow-up Inspection

Situation of Defect	Method of Inspection
If is possible to see progression of defect by afar inspection	Afar Inspection
If it is impossible to see te progression of defect by afar inspection	Closed Inspection

Situation of Defect	Frequency of Inspection
Damage influence to safety for third party	Once / month
Damage influence to soundness of structure	Once / 3 months
Others	Once / year

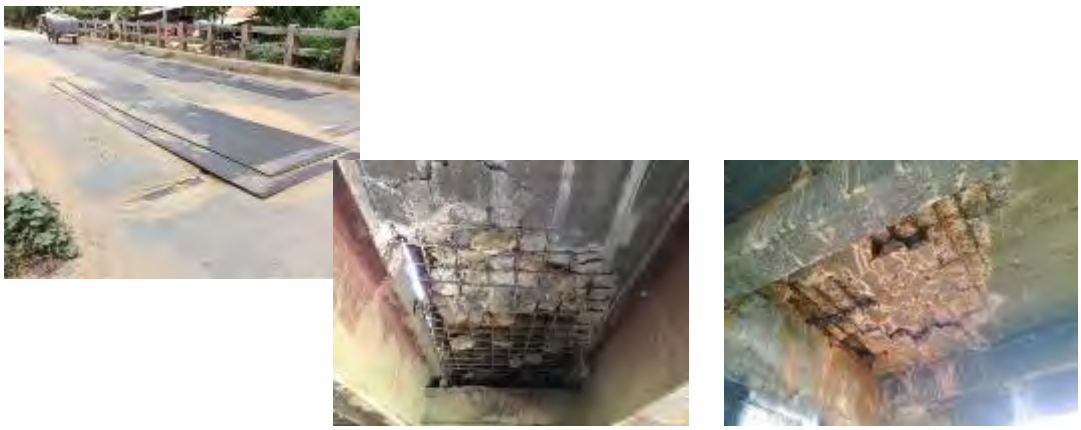
Figure: Procedure of bridge maintenance (DRAFT)

Attachment 3: Sample of SD (Seriously Damaged) Bridge

Seriously Damaged (SD) [hereinafter SD], Bridge can be defined using the following conditions:

- Impossible to pass
- Serious structural defect on slab deck
- Serious structural defect on main girder or truss girder
- Abutment or pier unstable by scouring
- Existence of many defects which is not SD.

(A) Impossible to pass



(B) Serious structural defect on concrete slab deck

Fig.1 Sample Photo of a Seriously Damaged Bridge (1)


(C) Serious structural defect on concrete girder (Shearing crack)


(D) Serious structural defect on steel slab deck (Fatigue crack)


(E) Serious structural defect on main girder or truss girder (Fatigue crack)

Fig.2 Sample Photo of Serious Damaged Bridge (2)

(F) Abutment or pier unstable by scouring
(Settled due to back filled soil washed out by scouring)

Fig.3 Sample Photo of Seriously Damaged Bridge (3)

Attachment 4: Inspection schedule for the 173 selected bridges

Inspection Schedule (Defects Inspection)

No	Province/City	Group	Defects Inspection					
			Number of Bridges	2016		2017		
				November	December	January	February	March
1	Banteay Meanchey	C	1				1	
2	Battambong	C	0					
3	Kandal	A	37	37				
4	Kep	C	1				1	
5	Koh Kong	C	0					
6	Kompong Cham	A	17		17			
7	Kompong Chhnang	A	0					
8	Kompong Speu	A	10		10			
9	Kompong Thom	B	1			1		
10	Kompot	C	6				6	
11	Kratie	B	2			2		
12	Mondul Kiri	B	0					
13	Otdor Meanchey	B	8			8		
14	Pailin	C	0					
15	Phnom Penh	A	4		4			
16	Preah Sihanouk	C	3				3	
17	Preah Vihear	B	35			35		
18	Prey Veng	A	5		5			
19	Pursat	C	25				25	
20	Ratanak Kiri	B	0					
21	Siem Reap	B	3			3		
22	Steung Treng	B	0					
23	Svay Rieng	A	2		2			
24	Takeo	A	10		10			
25	Tbaung Khmum	B	3			3		
Total			**173**	**37**	**48**	**52**	**36**	**0**
	Noted:	*	A = Middle Region					
		*	B = East Region					
		*	C = West Region					

Attachment 5: List of the 173 selected bridges for detailed inspection

No	Bridges Name	Province	Road Name	Bridges No.
1	Kor-Sang	Banteay Meanchey	PR 156 D	1
2	Troeung	Kampong Cham	7	17
3	Batheay 2	Kampong Cham	6	
4	Derm Chann	Kampong Cham	270	
5	Yay Ear	Kampong Cham	270	
6	Peak Cham	Kampong Cham	270	
7	Beoung Trav 1	Kampong Cham	270	
8	Beoung Trav 3	Kampong Cham	270	
9	Prak Leav Toch	Kampong Cham	270	
10	Tropeang kondal	Kampong Cham	2714	
11	Toul poul thy Kert	Kampong Cham	2714	
12	Thmor Koul	Kampong Cham	279	
13	Yay Penh	Kampong Cham	279	
14	Ro Angle	Kampong Cham	279	
15	Kizuna	Kampong Cham	7	
16	Phum Ty 8	Kampong Cham	3KC1	
17	Ta Tot	Kampong Cham	3KC1	
18	Prak Lveachey	Kampong Cham	3KC1	
19	Border kpc and kps	Kampong Speu	4	10
20	Phsar Kompong Speu	Kampong Speu	4	
21	Phsar Kompong Speu	Kampong Speu	4	
22	O Krang Omberl	Kampong Speu	4	
23	Sbeak Preal 3	Kampong Speu	43	
24	O Tapong	Kampong Speu	130	
25	Tropeong khjong	Kampong Speu	141	
26	Nop Bak	Kampong Speu	143	
27	Prey Beng	Kampong Speu	110	
28	Thnos Lung	Kampong Speu	NR 04	
29	Au Wy	Kampong Thom	Au kanthor	1
30	Mak Prang	Kampot	136	6
31	In Tha Nou 1	Kampot	700	
32		Kampot	1311A	
33		Kampot	133A	
34	Streung thlang	Kampot	133A	
35	In Tha Nou 3	Kampot	700	
36	Perk tateun	Kandal	110	37
37	Prek Klauk	Kandal	PR110	
38	Prek Ta Tern	Kandal	PR110	
39	Prek thmey	Kandal	110	
40	Prek phe	Kandal	110	
41	Prek kranh	Kandal	110	
42	Prek Ta Lot	Kandal	110	

No	Bridges Name	Province	Road Name	Bridges No.
43	Prek Ta prak	Kandal	110	
44	Prek tadol	Kandal	110	
45	Prek Svay	Kandal	110	
46	Prek Ta Inn	Kandal	110	
47	Prek voir	Kandal	110	
48	Prek leng	Kandal	110	
49	Prek horm	Kandal	110	
50	Prek leap	Kandal	14	
51	Prek Pak	Kandal	14	
52	Prek chnon	Kandal	14	
53	Prek Klang	Kandal	14	
54	Prek Tatho	Kandal	14	
55	Prek takeo	Kandal	1	
56	Prek treng	Kandal	1	
57	Preah ong Khmao	Kandal	380	
58	Spean mokvatsambour	Kandal	380	
59	Ta lok	Kandal	380	
60	Krom le	Kandal	380	
61	Spean chealon	Kandal	380	
62	Derm speur	Kandal	110	
63	Prek chev	Kandal	14	
64	Peam ta ek	Kandal	380	
65	Prek Cher teal 2	Kandal	381	
66	Prek cher teal 3	Kandal	381	
67	Tror pang rorka	Kandal	151A	
68	Sammaky	Kandal	42	
69	Preak Ta hab	Kandal	380	
70	Prek Kongvann	Kandal	380	
71	Prek Takong	Kandal	382	
72	Prek ong bang	Kandal	21	
73	Spean Thmor 1	Kep	1332	1
74	O Lvea	Kratie	7	2
75	Prek Chhloung	Kratie	7	
76	Au Ompil 1	Oddar Meanchey	2686	8
77	Au Somrang	Oddar Meanchey	2686	
78	Au Somrang 1	Oddar Meanchey	2686	
79	Torl brasart	Oddar Meanchey	2686	
80	Au Risei	Oddar Meanchey	2565 B	
81	Au Tram Paong1	Oddar Meanchey	PR2625	
82	Au Pkay 1	Oddar Meanchey	PR2678	
83	Au Romdeng	Oddar Meanchey	PR2647	
84	Baku	Phnom Penh	Prek jrey	4
85	Spean Phum kachoa	Phnom Penh	Bonteas Lang	
86	Spean Toul Svay	Phnom Penh	Banteas Lang	

No	Bridges Name	Province	Road Name	Bridges No.
87	Areak	Phnom Penh	42	
88	O Ta Pang	Preah Sihanouk	NR 4	3
89	Steung Prei Nob	Preah Sihanouk	NR4	
90	Sa Ray	Preah Sihanouk	NR4	
91	Rom Chak	Preah Vihear	NR62	35
92	O Trolok	Preah Vihear	NR62	
93	O Eang	Preah Vihear	NR62	
94	O Thnol 3	Preah Vihear	NR62	
95	Ojas 1	Preah Vihear	NR62	
96	Ojas2	Preah Vihear	NR62	
97	O Svay	Preah Vihear	NR62	
98	Kompol Neark	Preah Vihear	NR62	
99	Stung Sen	Preah Vihear	NR62	
100	Sra Aem	Preah Vihear	NR62	
101	O Chher Teal	Preah Vihear	NR62	
102	Kor1.A	Preah Vihear	NR62	
103	Kor1.C	Preah Vihear	NR62	
104	chor1	Preah Vihear	NR62	
105	Spean 2	Preah Vihear	PR2628	
106	Spean Ty 1	Preah Vihear	PR2627	
107	Spean Ty 4	Preah Vihear	PR2627	
108	Thnol Bek 3	Preah Vihear	NR64	
109	Thnol Bek 2	Preah Vihear	NR64	
110	Thnol Bek 1	Preah Vihear	NR64	
111	Phong Ror khang Kert	Preah Vihear	NR64	
112	O Phong Ror	Preah Vihear	NR64	
113	Phong Ror	Preah Vihear	NR64	
114	O kronhong	Preah Vihear	NR92	
115	O namsam	Preah Vihear	NR92	
116	O Trous	Preah Vihear	NR92	
117	Sre Pol	Preah Vihear	NR64	
118	Sre Pol	Preah Vihear	NR64	
119	O Sho Pol	Preah Vihear	NR64	
120	Phum Sras Malis	Preah Vihear	Tikrohorm	
121	Tompeng Vay	Preah Vihear	Phum Chek	
122	Stung Sen	Preah Vihear	Wat Prey Keng	
123	Dan 3	Preah Vihear	NR64	
124	Ta Hun	Preah Vihear	NR64	
125	Kondal phum	Preah Vihear	NR64	
126	Konpong por pil	Prey Veng	8	5
127	Raka3	Prey Veng	8	
128	Kompong lav	Prey Veng	11	
129	Ror leang4	Prey Veng	385	
130	Prek thmey	Prey Veng	310	

No	Bridges Name	Province	Road Name	Bridges No.
131	O Thom	Pursat	5	25
132	O Chon Los	Pursat	5	
133	Sala komrol1	Pursat	5	
134	Ra 1	Pursat	5	
135	O taporng	Pursat	5	
136	Khna	Pursat	5	
137	Sya	Pursat	Sya	
138	Wat Sya 1	Pursat	Sya	
139	O	Pursat	153B1	
140	Taing Ro veal	Pursat	153B1	
141	Veng	Pursat	153B1	
142	Wat Toul Tbeng	Pursat	153B1	
143	Bom Nok	Pursat	1534	
144	Kompong Prak	Pursat	152C	
145	Kompong Por	Pursat	152E	
146	keo Mony	Pursat	152G	
147	Srong	Pursat	152G	
148	Wat Taphy	Pursat	152G	
149	Poovong	Pursat	106A	
150	Wat Chas	Pursat	106A	
151	Dorng Rong	Pursat	154A	
152	Por Ronheang	Pursat	155C	
153	Domnak Konseng	Pursat	155C	
154	Rom Lech	Pursat	155D	
155	Kok romLor	Pursat	155D	
156	Peak sneng	Siem Reap	2SR3	3
157	East Ror Lous	Siem Reap	265E	
158	Sre noy	Siem Reap	67	
159	Krang Loa	Svay Rieng	312C	2
160	Tounle vai kol	Svay Rieng	1	
161	Thnong	Takeo	129A	10
162	Trojan leur	Takeo	129C	
163	Champei	Takeo	121	
164	Tropan srorng 2	Takeo	125	
165	Krang thong	Takeo	127	
166	Border som roung prey kabas	Takeo	129	
167	Toul sala	Takeo	41	
168	O kroch 1	Takeo	41	
169	Thoul koma	Takeo	41	
170	Tro yerng	Takeo	129D	
171	Toul Por	Tbaung Khmum	7	3
172	Salong No.3	Tbaung Khmum	PR373B	
173	O Sombor	Tbaung Khmum	PR370C	

Attachment 6: The Bridge Inspection Result by 1st MOM (26 May 2017)

The Project for Strengthening Capacity for Maintenance of Road and Bridges
Minutes Meeting

- **Agenda:**
  1. Summary of 173 bridges *(attached document)*
  2. Yearly Maintenance plan for Roads and bridges (*attached document*)
  3. Bridge inspection workshop (*attached document*)
  4. MOM (on the job)
  5. Correction of IPAD and database training

- **Date:** 26th May 2017, **Time:** 9:00am – 11:00am.
- **Venue:** RID Director meeting room.
- **Members:** **MPWT, RID:** Mr. You Dara, Mr. Chhouk Sochea, Mr. Nin Menakak, Mr. Long Davuth

  JICA: Mr. Koichi Ogawa, Mr. Masatoshi Watanabe, Mr. Kiry Nyvirak, Mr. Kumagai Takahiro, Mr. Shigeaki Tsukamoto, Mr. Nakajima Takashi, Mr. Dai Tamagawa

Summary of meeting:

1. **Summary of 173 bridges inspection result:**
   -173 bridges inspection result were shared to the members and then 28 bridges which should be conducted inspection again are selected because of their structural conditions were unclear.
   -Japanese experts mentioned that some bridges with defects on main members such as girder, slab are rated as D(Damaged) or O(Observation), they are rated as SD(Serious Damaged) because cracks on main members cannot be ignored.

		JICA Expert Judgement					
		SD	D	D or O	O	N	Total
MPWT Judgement	SD	5					6
	D	1	2	1			19
	O		3	3	18		59
	N			3	4	87	81
	Total	9	12	7	29	108	165

Same Judgement Between MPWT and JICA Expert	96	58%
Safty Judgement by MPWT more than JICA Expert	46	28%
Risky widely Judgement by MPWT more than JICA	10	6%
Risky Judgement by MPWT more than JICA Expert	11	7%

Fig.1 Comparison the bridge rating between JICA Experts and MPWT officials

2. **Yearly Maintenance plan for Roads and Bridges:**
   -JICA expert requested MPWT to input information to "Decision at MOM" of the table.
   -MPWT need to explain about the detail inspection to RID director.

3. **Bridge inspection workshop:**
   -The workshop will start from August to December(Draft).
   -The trainee will be gotten certificate from RID and JICA expert.

4. **MOM (on the job)**
   It was agreed to organize MOM with presence of director. Date and time will be fixed by today RID participants and inform to JICA team

5. **Correction of IPAD and database training**
   It was agreed to collect IPAD (10nos) and hold a training on database operation one day between 6 June.

CONFIRMED BY:

Mr. You Dara	**Mr. Koichi Ogawa**

Pictures of meeting activities

Attached of Meeting Attendance List

KINGDOM OF CAMBODIA
NATION RELIGION KING

26th May 2017

MINISTRY OF PUBLIC WORKS AND TRANSPORT
General Directorate of Public Works
Road Infrastructure Department

ATTENDANCE LIST

1St Maintenance Operation Meeting (MOM)
@ RID Meeting room

N°	Name	Position	Organization	Phone Number	Signature
01	You Dara	Deputy Director	RID		
02	Nin Menatak	Deputy chief office	RID		
03	Long Daruth	officer	RID		
04	Chhouk Sochea	Officer	RID		
05	Shigeaki Tsukamoto	Expert Team	JICA		
06	Kumago Takahiro	〃	〃		
07	Masataka WATANABE	〃	〃		
08	Dai Tanagawa	〃	〃		
09	TAKAHIRO NAKAJIMA	〃	〃		
10	Koichi OGAWA	〃	〃		
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25					

Summary of bridges crack on Superstructure (concrete)- 173 bridges

173 bridges have defects which were detected on structual parts (concrete girder or slab) at 2,000 bridges survey.

Number of all Inspection Bridges:	173
Already replaced or under replacing Bridges:	8
Number of net Inspection Bridges:	165
Judged as Detailed Inspection Bridges*:	28

* Judged as SD/D/DorO by JICA Expert

		JICA Expert Judgement					
		SD	D	D or O	O	N	Total
MPWT Judgement	SD	5			1		6
	D	1	2	1	6	9	19
	O	3	3	3	18	32	59
	N		7	3	4	67	81
	Total	9	12	7	29	108	165

	Same Judgement Between MPWT and JICA Expert	96	58%
	Safty Judgement by MPWT more than JICA Expert	48	29%
	Risky widely Judgement by MPWT more than JICA Exp	10	6%
	Risky Judgement by MPWT more than JICA Expert	11	7%
	Bridges should be detailed inspected by August	28	17%

Objective of dataied inspection

To reevaluate judgment.
To acquire information for mesuring, methodology of countermesure.

List of bridges crack on Superstructure (concrete)- 173 bridges

No	Bridges Name	Province	Road Name	Inspection Results and MPWT Judgement		JICA Expert Judgement			Decision at MOM
				Damage Level last inspection	Remarks	Damage Level	Detailed Inspection	Comments	
1	Kor-Sang	Banteay Meanchey	PR 156 D	D	The bridge is a new bridge (recently constructed)			Already replaced	
2	Troeung	Kampong Cham	7	N	This bridge is still good condition.	N		No damage or No need to repair	
3	Batheay 2	Kampong Cham	6	N	This bridge has a bit crack on super structure and other elements of this bridge is still good.	N		No damage or No need to repair	
4	Derm Chann	Kampong Cham	270	O	There are honeycombs on abutment and girder but super structure such as slab, handrails and pavement still good	O		Check progress of defect on next inspection	
5	Yay Ear	Kampong Cham	270	N	This Bridge is very old and serious damaged on underside such as cracks and honeycomb.	N		No damage or No need to repair	
6	Peak Cham	Kampong Cham	270	O	No comment	N		No damage or No need to repair	
7	Beoung Trav 1	Kampong Cham	270	O	No comment	N		No damage or No need to repair	
8	Beoung Trav 3	Kampong Cham	270	D	No comment	D or O	O	Need to detaied inspection at concrete slab crack. Crack need to be repaired by epoxy injection.	
9	Prak Leav Toch	Kampong Cham	270	N	No comment	D or O	O	Need to detaied inspection at concrete slab crack. Crack need to be repaired by epoxy injection.	
10	Tropeang kondal	Kampong Cham	2714	N	This bridge is still good condition and has a bit crack on pavement and abutment.	N	O	No damage or No need to repair	
11	Toul poul thy Kert	Kampong Cham	2714	O	This bridge has some crack on superstructure and need maintenance on expansion join.	N	O	No damage or No need to repair	
12	Thmor Koul	Kampong Cham	279	N	This bridge is still good condition but it's narrow for traffic.	N	O	No damage or No need to repair	
13	Yay Penh	Kampong Cham	279	O	This bridge has damaged on sub structure many cracks on wall columns both sides.	O	O	Check progress of defect on next inspection	
14	Ro Angle	Kampong Cham	279	O	This bridge has some crack on side of girder and few vertical cracks on wall column.	O	O	Check progress of defect on next inspection	
15	Kizuna	Kampong Cham	7	O	This bridge is damage small part of surface asphalt concrete.	O	O	Check progress of defect on next inspection	
16	Phum Ty 8	Kampong Cham	3KC1	O	This bridge is very old and have heavy damage on SS and slab as shown in photos and must be replace new elements of this	SD	O	Wide racks on main girder. Need to replace.	
17	Ta Tot	Kampong Cham	3KC1	O	This bridge has heavy damages on SS under sub deck or soffit and a bit crack around bearing and abutment, must Be rebuild	SD	O	Wide racks on main girder. Need to replace.	
18	Prak Lveachey	Kampong Cham	3KC1	O	This bridge has heavy damages on SS and under slab as shown in photo table, Need to recover of sub deck and under	N	O	It must be fracking along concrete form.	
19	Border kpc and kps	Kampong Speu	4	O	This bridge have a bit crack under slab and crack on pier.	O	O	Check progress of defect on next inspection	
20	Phsar Kompong Speu	Kampong Speu	4	O	This bridge is a bit crack and honeycomb on superstructure and slab.	N	O	No damage or No need to repair	
21	Phsar Kompong Speu	Kampong Speu	4	N	This bridge is serious damaged	D	O	Crack need to be repaired by epoxy injection.	
22	O Krang Omberl	Kampong Speu	4	N	This bridge has a bit damage on pavement and some damage on pier (corrosion)	N	O	No damage or No need to repair	
23	Sbeak Preal 3	Kampong Speu	43	D	This bridge has some small cracks underside and drainage no fuction.	N	O	No damage or No need to repair	
24	O Tapong	Kampong Speu	130	O	This bridge is damage.	N	O	No damage or No need to repair	
25	Tropeong khjong	Kampong Speu	141	N	This bridge is still good condition, but has some of exposure of rebar.	N	O	No damage or No need to repair	
26	Nop Bak	Kampong Speu	143	N	This bridge has damaged on handrial and some cracks on sub structure and column.	N	O	No damage or No need to repair	
27	Prey Beng	Kampong Speu	110	D	This bridge is serious damaged	N	O	No damage or No need to repair	
28	Thnos Lung	Kampong Speu	NR 04	N	This bridge is damaged crack and pot hole on AC pavement near joint of span and has any soil on side walk as shown in	N	O	No damage or No need to repair	
29	Au Wy	Kampong Thom	Au kanthor	D	The bridge is good. But retaining wall exposed some rebars. The slop protection is broken cause scouring by settlement	N	O	No damage or No need to repair	
30	Mak Prang	Kampot	136	N	This Bridge is good.	N	O	No damage or No need to repair	
31	In Tha Nou 1	Kampot	700	SD	This bridge is serious damage and very old. Sub structure are flaking and exposure of rebars and many cracks underside.	SD	O	Need mesure as heritage	
32		Kampot	1311A	O	This bridge is damaged on sub structure and bridge railing	D	O	Repair railng	
33		Kampot	133A	SD	This bridge is serious damaged. Hole on slab, exposure of rebar and cracks on girder and abutment scouring.	SD	O	Need to be replaced.	

List of bridges crack on Superstructure (concrete)- 173 bridges

No	Bridges Name	Province	Road Name	Inspection Results and MPWT Judgement		JICA Expert Judgement			Decision at MOM
				Damage Level last inspection	Remarks	Damage Level	Detailed Inspection	Comments	
34	Streung thlang	Kampot	133A	N	There are some cracks underside, girders and slab and exposure rebar. We can judge it as a damage bridge	N	O	No damage or No need to repair	
35	In Tha Nou 3	Kampot	700	SD	This bridge is serious damage and very old . There are many cracks, holes exposure rebars and flaking.	SD	O	Need mesure as heritage	
36	Perk tateun	Kandal	110	O	This bridge rebuilt the new one in 2015. No damage.		O	Already replaced	
37	Prek Klauk	Kandal	PR110	O	This bridge is under construction in 2017 by MPWT/HEC.		O	Under replacing	
38	Prek Ta Tern	Kandal	PR110	O			O	Already replaced	
39	Prek thmey	Kandal	110	O	This bridge is curing.	O	O	Check progress of defect on next inspection	
40	Prek phe	Kandal	110	N	This bridge was injection by epoxy last year for first pilot project but still has few small cracks undersidde of girder.	O	O	Check progress of defect on next inspection	
41	Prek kranh	Kandal	110	N	This bridge is good.	N	O	No damage or No need to repair	
42	Prek Ta Lot	Kandal	110	N	This bridge is still good condition.	N	O	No damage or No need to repair	
43	Prek Ta prak	Kandal	110	N	This bridge is repaird by expoxy materials. No need maintenance more.	N	O	No damage or No need to repair	
44	Prek tadol	Kandal	110	N	This birdge is still good condition.	N	O	No damage or No need to repair	
45	Prek Svay	Kandal	110	N	This bridge is too small and need maintance.	N	O	No damage or No need to repair	
46	Prek Ta Inn	Kandal	110	N	This bridge need maintenance of slope protection because it is scoring.	N	O	No damage or No need to repair	
47	Prek voir	Kandal	110	N	This bridge look so old and small carriage way, need maintenance super structure.	D	O	Crack need to be repaired by epoxy injection.	
48	Prek leng	Kandal	110	SD	The old bridge is removed structure now replace new structure is 2 cell culvert pipes.		O	Under replacing	
49	Prek horm	Kandal	110	N	The old bridge on this road is removed old structure bridge and now replace new bridge is under construction.		O	Under replacing	
50	Prek leap	Kandal	14	N	This bridge has a bit crack as shown in photo and other elements is normal conditions.	N	O	No damage or No need to repair	
51	Prek Pak	Kandal	14	N	This bridge has a bit crack on pavement and slab as shnow in photos and other elements is normal condition.	N	O	No damage or No need to repair	
52	Prek chnon	Kandal	14	N	This bridge has a bit crack on super structure.	N	O	No damage or No need to repair	
53	Prek Klang	Kandal	14	N	This bridge has many crack on super structure under slap.	D or O	O	Need to detaied inspection at concrete slab crack. Crack need to be repaired by epoxy injection.	
54	Prek Tatho	Kandal	14	N	This bridge is still good condition and have a bit of crack under slap.	N	O	No damage or No need to repair	
55	Prek takeo	Kandal	1	N	This structure is still condition but need some maintenance on pier because so many honeycomp, box culvert combine with	N	O	No damage or No need to repair	
56	Prek treng	Kandal	1	N	This structure is still good condition but have a bit crack on superstructure, box culvert combine with spillway.	N	O	No damage or No need to repair	
57	Preah ong Khmao	Kandal	380	O	No comment	O	O	Check progress of defect on next inspection	
58	Spean mokvatsambour	Kandal	380	N	This bridge is under construction.		O	Under replacing	
59	Ta lok	Kandal	380	N	Scouring	N	O	No damage or No need to repair	
60	Krom le	Kandal	380	N	No comment	N	O	No damage or No need to repair	
61	Spean chealon	Kandal	380	N	This bridge is big scuring.	O	O	Check progress of defect on next inspection	
62	Derm speur	Kandal	110	O	No comment	N	O	No damage or No need to repair	
63	Prek chev	Kandal	14	N	This bridge has many cracks on super structure and under slab as show in photos.	N	O	No damage or No need to repair	
64	Peam ta ek	Kandal	380	O	This old bridge was rebuilt as a new box curlvert 3 cell in 2016.	O	O	Check progress of defect on next inspection	
65	Prek Cher teal 2	Kandal	381	N	For under super structure of this bridge is invisible on this time, as shown in photo.	N	O	No damage or No need to repair	
66	Prek cher teal 3	Kandal	381	O	This bridge so small with width, need mainteenace on structure because have so many honeycomb.	O	O	Check progress of defect on next inspection	

List of bridges crack on Superstructure (concrete)- 173 bridges

No	Bridges Name	Province	Road Name	Inspection Results and MPWT Judgement		JICA Expert Judgement			Decision at MOM
				Damage Level last inspection	Remarks	Damage Level	Detailed Inspection	Comments	
67	Tror pang rorka	Kandal	151A	O	No comment	O	O	Check progress of defect on next inspection	
68	Sammaky	Kandal	42	SD	This bridge is serious damaged	SD	O	Need to be replaced.	
69	Preak Ta hab	Kandal	380	N	No comment	N	O	No damage or No need to repair	
70	Prek Kongvann	Kandal	380	N	No comment	N	O	No damage or No need to repair	
71	Prek Takong	Kandal	382	N	This bridge need repair of wing wall and have a bit of crack on pavement.	N	O	No damage or No need to repair	
72	Prek ong bang	Kandal	21	O	This bridge under construction by Dasan company.	N	O	No damage or No need to repair	
73	Spean Thmor 1	Kep	1332	D	This Bridge is have one Exterior Girder deflection and Free lime at Flange of slab.	N	O	No damage or No need to repair	
74	O Lvea	Kratie	7	N	This bridge is still good condition.	N	O	No damage or No need to repair	
75	Prek Chhloung	Kratie	7	D	Bridge is have big crack at wall of column.	N	O	No damage or No need to repair	
76	Au Ompil 1	Oddar Meanchey	2686	N	This bridge is still good condition but having damaged on slop protection, such as scoring and settlement	O	O	Check progress of defect on next inspection	
77	Au Somrang	Oddar Meanchey	2686	O	This bridge is still good condition	O	O	Check progress of defect on next inspection	
78	Au Somrang 1	Oddar Meanchey	2686	O	This bridge has some crack on underslab and girder . Has scouring around slope protection but this bridge is still good	O	O	Check progress of defect on next inspection	
79	Torl brasart	Oddar Meanchey	2686	N	This Bridge have Creak on side of girder (exterior).	N	O	No damage or No need to repair	
80	Au Risei	Oddar Meanchey	2565 B	O	This bridge is still good condition but having damaged on slop protection and lacking concrete on abutment	O	O	Check progress of defect on next inspection	
81	Au Tram Paong1	Oddar Meanchey	PR2625	N	This Bridge is have creak underside of slab (many).	D	O	Crack need to be repaired by epoxy injection.	
82	Au Pkay 1	Oddar Meanchey	PR2678	N	This Bridge is have creak underside of cantilever slab	N	O	No damage or No need to repair	
83	Au Romdeng	Oddar Meanchey	PR2647	D	This bridge is securing and settle Abutment A2.(big Scuring)	D	O	Need countermesure to scoring	
84	Baku	Phnom Penh	Prek jrey	D	This bridge is under construct widening.	N	O	No damage or No need to repair	
85	Spean Phum kachoa	Phnom Penh	Bonteas Lang	N	This birdge is still good condition.	N	O	No damage or No need to repair	
86	Spean Toul Svay	Phnom Penh	Banteas Lang	N	This birdge is still good condition.	N	O	No damage or No need to repair	
87	Areak	Phnom Penh	42	D	This bridge is damage.	D	O	This bridge is need to be replaced.	
88	O Ta Pang	Preah Sihanouk	NR 4	N	This bridge has a bit cracks on side of superstructure and under slab as show in photos	N	O	No damage or No need to repair	
89	Steung Prei Nob	Preah Sihanouk	NR4	N	This bridge is damaged on superstructure	D	O	Need to detaied inspection at concrete slab crack. Crack need to be repaired by epoxy injection.	
90	Sa Ray	Preah Sihanouk	NR4	N	This bridge is serious damage on slab and piers.	D	O	Need to detaied inspection at concrete slab crack. Crack need to be repaired by epoxy injection.	
91	Rom Chak	Preah Vihear	NR62	N	This bridge structure are still good but column underside is scouring.	N	O	No damage or No need to repair	
92	O Trolok	Preah Vihear	NR62	N	Sub structure columns is scouring around pier and exposure of rebar, underside of bridge there are so many rubbish and	N	O	No damage or No need to repair	
93	O Eang	Preah Vihear	NR62	N	This bridge has scouring around abutment.	N	O	No damage or No need to repair	
94	O Thnol 3	Preah Vihear	NR62	N	This bridge is settlement pavement Road abutment.	N	O	No damage or No need to repair	
95	Ojas 1	Preah Vihear	NR62	N	Have small creak on side superstructure.	N	O	No damage or No need to repair	
96	Ojas2	Preah Vihear	NR62	O	This bridge is good condition either super-structure and sub-structure. But the drainage system is no function.	N	O	No damage or No need to repair	
97	O Svay	Preah Vihear	NR62	N	This bridge is good condition either super-structure and sub-structure. But the drainage system is no function.	N	O	No damage or No need to repair	
98	Kompol Neark	Preah Vihear	NR62	O	This bridge is steel in good condition. Both approach slabs are settle about 3cm because maybe had no slab installed.	O	O	Check progress of defect on next inspection	
99	Stung Sen	Preah Vihear	NR62	O	This bridge is in good condition, the main concern is the scouring around the abutments when the high water level come	O	O	Check progress of defect on next inspection	

List of bridges crack on Superstructure (concrete)- 173 bridges

No	Bridges Name	Province	Road Name	Inspection Results and MPWT Judgement		JICA Expert Judgement			Decision at MOM
				Damage Level last inspection	Remarks	Damage Level	Detailed Inspection	Comments	
100	Sra Aem	Preah Vihear	NR62	D	This bridge is still in good condition. The most concern is drainage system is not work not only this bridge but also most	N	O	No damage or No need to repair	
101	O Chher Teal	Preah Vihear	NR62	N	This bridge is new no heavy load or much traffic in this area. Concerned is drainage system is NO FUNCTION	N	O	No damage or No need to repair	
102	Kor1.A	Preah Vihear	NR62	O	The bridge is good. Drainage and almost the bridges along NR62 have no approach slab installed	N	O	No damage or No need to repair	
103	Kor1.C	Preah Vihear	NR62	N	This Bridge is securing and Settlement at Approach Slab	N	O	No damage or No need to repair	
104	chor1	Preah Vihear	NR62	N	This Bridge is Securing .	N	O	No damage or No need to repair	
105	Spean 2	Preah Vihear	PR2628	N	This Bridge is creak on Underside of Slab.	D	O	Crack need to be repaired by epoxy injection.	
106	Spean Ty 1	Preah Vihear	PR2627	N	This Bridge is free Lim and Creak on under side of Slab.	N	O	No damage or No need to repair	
107	Spean Ty 4	Preah Vihear	PR2627	O	This Bridge is Creak On Underside of slab and Securing Abutment.	D	O	Damaged slab need to be replaced.	
108	Thnol Bek 3	Preah Vihear	NR64	O	This bridge is still good condition.	N	O	No damage or No need to repair	
109	Thnol Bek 2	Preah Vihear	NR64	O	This bridge is still good condition.	N	O	No damage or No need to repair	
110	Thnol Bek 1	Preah Vihear	NR64	O	This bridge is still good condition.	N	O	No damage or No need to repair	
111	Phong Ror khang Kert	Preah Vihear	NR64	O	This bridge is damaged on abutment but sub structure and super structure are still good condition.	N	O	No damage or No need to repair	
112	O Phong Ror	Preah Vihear	NR64	O	This bridge is still good condition.	N	O	No damage or No need to repair	
113	Phong Ror	Preah Vihear	NR64	N	This bridge is damaged on abutment but sub structure and super structure are still good condition.	N	O	No damage or No need to repair	
114	O kronhong	Preah Vihear	NR92	N	This bridge still good condition but has some small crack on superstructure.	N	O	No damage or No need to repair	
115	O namsam	Preah Vihear	NR92	N	This bridge has a bit crack on superstructure and slap, and structure is still good condition.	N	O	No damage or No need to repair	
116	O Trous	Preah Vihear	NR92	O	This bridge has a bit crack on superstructure and slap but still good condition.	N	O	No damage or No need to repair	
117	Sre Pol	Preah Vihear	NR64	O	Have clog drainage by DBST	N	O	No damage or No need to repair	
118	Sre Pol	Preah Vihear	NR64	O	Clog drainage by DBST .	N	O	No damage or No need to repair	
119	O Sho Pol	Preah Vihear	NR64	D	This bridge is newly constructed. The draining pipe is not attached cause the water flows on the structure. And many line	O	O	Check progress of defect on next inspection	
120	Phum Sras Malis	Preah Vihear	Tikrohorm	O	This bridge need maintenance on slab, because has many cracks on under surface.	N	O	No damage or No need to repair	
121	Tompeng Vay	Preah Vihear	Phum Chek	N	This bridge is newly construction, but seem to be not standard (slab crack by part) And drainage system is poor (lake of	D	O	Damaged slab need to be replaced urgently.	
122	Stung Sen	Preah Vihear	Wat Prey Keng	D	This bridge was settlement and flaking concrete on wing wall connect to abutment, and settlement on bridge railing.	O	O	Check progress of defect on next inspection	
123	Dan 3	Preah Vihear	NR64	O	Have creak on side of superstructure.	N	O	No damage or No need to repair	
124	Ta Hun	Preah Vihear	NR64	N	Have clog drainage .alittle	N	O	No damage or No need to repair	
125	Kondal phum	Preah Vihear	NR64	N	Have small honeycomb.	N	O	No damage or No need to repair	
126	Konpong por pil	Prey Veng	8	N	This bridge has a bit crack on girder and around slop protection and just build by China construction	N	O	No damage or No need to repair	
127	Raka3	Prey Veng	8	D	This bridge has a heavy damage of scouring around pier	O	O	Check progress of defect on next inspection	
128	Kompong lav	Prey Veng	11	N	This bridge has no problem	N	O	No damage or No need to repair	
129	Ror leang4	Prey Veng	385	SD	This bridge just has build in 2016 replaced by old bridge on this road 385 and has a bit honeycombs on girder		O	Already replaced	
130	Prek thmey	Prey Veng	310	O	This bridge is good condition and a little bit of crack on under slab and around the abutment ... Because it just built in 2011	O	O	Check progress of defect on next inspection	
131	O Thom	Pursat	5	N	This bridge has a little crack on girder and mortar on superstructure near abutment . This bridge is still good	N	O	No damage or No need to repair	
132	O Chon Los	Pursat	5	N	Crack occurred on bottom girder number 8 from the right side	N	O	No damage or No need to repair	

List of bridges crack on Superstructure (concrete)- 173 bridges

No	Bridges Name	Province	Road Name	Inspection Results and MPWT Judgement		JICA Expert Judgement			Decision at MOM
				Damage Level last inspection	Remarks	Damage Level	Detailed Inspection	Comments	
133	Sala komrol1	Pursat	5	N	This bridge is still good condition . Just has a little crack of mortar on superstructure near abutment	N	O	No damage or No need to repair	
134	Ra 1	Pursat	5	O	This bridge has damaged on superstructure and substructure	N	O	No damage or No need to repair	
135	O taporng	Pursat	5	N	Crack on superstructure near abutment effected from mortar	N	O	No damage or No need to repair	
136	Khna	Pursat	5	O	This bridge is still good condition	N	O	No damage or No need to repair	
137	Sya	Pursat	Sya	N	The bridge is in good conditions. However there is concerned points related to construction methodology such as pier	N	O	No damage or No need to repair	
138	Wat Sya 1	Pursat	Sya	O	Since the bridge is too old (built in 1974), the bridge is in serious damaged condition even though there was repairs work	D or O	O	Need to detaied inspection to judge necessaty of repairing.	
139	O	Pursat	153B1	N	This bridge cover thinner can see rebars on pavement and water drainage no function but sub structure still good condition	N	O	No damage or No need to repair	
140	Taing Ro veal	Pursat	153B1	N	This Bridge is good but have clog drainage	N	O	No damage or No need to repair	
141	Veng	Pursat	153B1	O	This Bridge is Scuring wing wall .	N	O	No damage or No need to repair	
142	Wat Toul Tbeng	Pursat	153B1	O	This Bridge is Change to New Construction Bridge 2016	N	O	No damage or No need to repair	
143	Bom Nok	Pursat	1534	N	This bridge is still good condition but have many honeycomb on superstructure and flaking under slab.	N	O	No damage or No need to repair	
144	Kompong Prak	Pursat	152C	O	This old bridge have many honeycomb and big crack under slab	D or O	O	Need to detaied inspection to judge necessaty of repairing.	
145	Kompong Por	Pursat	152E	N	This bridge is still good condition	N	O	No damage or No need to repair	
146	keo Mony	Pursat	152G	O	This bridge need maintenance on pier abutment	N	O	No damage or No need to repair	
147	Srong	Pursat	152G	O	This bridge need some maintenance on pier and abutment	D	O	2 dimensional crack on slab. Crack need to be repaired by epoxy injection.	
148	Wat Taphy	Pursat	152G	D	This bridge has no problems.	N	O	No damage or No need to repair	
149	Poovong	Pursat	106A	O	This bridge is still good conditionbut has many honeycomb and abutment.	N	O	No damage or No need to repair	
150	Wat Chas	Pursat	106A	O	This bridge has a crack onside of superstructure, and can not inspect more details because of high water level	N	O	No damage or No need to repair	
151	Dorng Rong	Pursat	154A	D	This bridge is look so old and has a lot of honeycomb on superstructure	N	O	No damage or No need to repair	
152	Por Ronheang	Pursat	155C	N	This bridge has many honeycombs on girder	N	O	No damage or No need to repair	
153	Domnak Konseng	Pursat	155C	O	This bridge is still good condition but just have a little crack on girder	N	O	No damage or No need to repair	
154	Rom Lech	Pursat	155D	N	The bridge is still in condition but only the cross beam over abutment exposes rebar	N	O	No damage or No need to repair	
155	Kok romLor	Pursat	155D	O	This Bridge is have creak on side of deck Sleb (5mm) bigger than creak allowable	O	O	Check progress of defect on next inspection	
156	Peak sneng	Siem Reap	2SR3	N	The bridge is in good condition. It is expected to serve in long term	N	O	No damage or No need to repair	
157	East Ror Lous	Siem Reap	265E	O	Currently, the bridge still can be usable, however, there are some cracks appeared on girder and column since it is too old (	SD	O	This bridge is need to be replaced.	
158	Sre noy	Siem Reap	67	N	This bridge is creak superstructure on side at girder at settlement at slop (Gabion)	N	O	No damage or No need to repair	
159	Krang Loa	Svay Rieng	312C	D	This bridge is serious damaged and too small for traffic flow, this bridge near the border of Cambodia Vietnam	O	O	Check progress of defect on next inspection	
160	Tounle vai kol	Svay Rieng	1	O	This bridge has good condition but has a little cracks under slab and has scouring around slop protection	N	O	No damage or No need to repair	
161	Thnong	Takeo	129A	D	This bridge has many cracks on superstructure and reposed of rebar on pier and one more it is old bridge because it built since	O	O	Check progress of defect on next inspection	
162	Trojan leur	Takeo	129C	N	This bridge is serious damaged.	O	O	Check progress of defect on next inspection	
163	Champei	Takeo	121	O	This bridge has some crack on super structure and exposed of rebar under girder and bridge railing	D or O	O	Need to detaied inspection to judge necessaty of repairing.	
164	Tropan sromg 2	Takeo	125	SD	This bridge has a lot of damages with super structure and sub-structure (crack , exposed of rebar , honeycomb)	SD	O	This bridge is need to be replaced.	
165	Krang thong	Takeo	127	N	This bridge has some crack on super structure and exposed of rebar on Girder	N	O	No damage or No need to repair	

List of bridges crack on Superstructure (concrete)- 173 bridges

No	Bridges Name	Province	Road Name	Inspection Results and MPWT Judgement		JICA Expert Judgement			Decision at MOM
				Damage Level last inspection	Remarks	Damage Level	Detailed Inspection	Comments	
166	Border som roung prey k	Takeo	129	D	This bridge has some crack on super structure and exposed of rebar on girder and erosion on pier	O	O	Check progress of defect on next inspection	
167	Toul sala	Takeo	41	O	This Bridge is good .	N	O	No damage or No need to repair	
168	O kroch 1	Takeo	41	O	This bridge is still good condition.	N	O	No damage or No need to repair	
169	Thoul koma	Takeo	41	O	This bridge is still good condition.	N	O	No damage or No need to repair	
170	Tro yemg	Takeo	129D	D	This bridge is serious damaged.	SD	O	This bridge is need to be replaced.	
171	Toul Por	Tbaung Khmum	7	SD	This bridge is damage big handrail and crack supper structure.	O	O	Not structual crack.	
172	Salong No.3	Tbaung Khmum	PR373B	O	This old bridge on road PR373B is removing structure by Ministry of Rural development.	O	O	Check progress of defect on next inspection	
173	O Sombor	Tbaung Khmum	PR370C	N	This bridge has heavy cracks on super structure and under slab as shown in photo, need to repair it.	D or O	O	Need to detaied inspection to judge necessaty of repairing.	

Different widely judgment between MPWT and JICA (MPWT: O JICA: SD)
Different judgment between MPWT and JICA (MPWT: D JICA: SD) or (MPWT: O/N JICA: D)
Already replaced or under replacing
Need to detaied inspection to judge necessaty of repairing or to acquire information of methodology of countermaesure
Need mesure as heritage

Attachment 7 The Bridge Inspection Result by 2nd MOM (11 December 2017)

The Project for Strengthening Capacity for Maintenance of Road and Bridges

Minutes Meeting

2nd Maintenance Operation Meeting

- **Agenda:**
  1. Target Activities for 2018
  2. For the introduction of the stable bridge maintenance to MPWT
  3. 5 year bridge inspection plan
  4. Repair/ replace work
  5. others
- **Date:** 11th December 2017, **Time:** 9:00am – 10:00am.
- **Venue:** RID Director meeting room.
- **Members:** **MPWT, RID:** Mr. You Dara, Mr.Em Sovisoth, Mr. Long Davuth, Mr.Panhavuth, Mr. Teara

  JICA: Mr. Koichi Ogawa, Mr.Yuzo Mizota, Mr.Takashi NAKAJIMA, Mr. Shigeaki Tsukamoto, Mr.Dai Tamagawa, Mr.Wang Jien

Summary of meeting:

1. Target Activities for 2018

1. Re-Detail Inspection for remaining bridges of 28 (19 remains).

-Some place need to wait until dry season.

-Not enough time to do.

2. Follow up the progress of defect of the Bridge (plan 2018, one and two-digit road) which cannot get budget for re-construction.

a. Re-detail inspection or study the progress of defect.

b. find some Countermeasures

c. do minor repair or make a warning signboard

3. Ranking all SD and D bridges from 2000 bridges survey for 3 years planning.
4. Selecting and ranking the SD and D bridges in to the list for 3rd year planning (year 2019).
5. Detail inspection for SD bridges (provincial road or 3 and 4-digit road) and when the dangerous defect which has possibility to collapse or fall down was found, the urgent countermeasure shall be decided to prevent accident of third party immediately until solution.
6. Do pilot project (Epoxy Injection) for all DPWTs (If they suggest).

-Because we already added to the repair code.

-They might not know how to do at site.

2. For the introduction of the stable bridge maintenance to MPWT

Mr.Ogawa explained concept of MOM and importance of continuous inspection.

It was noted that conduct of 5 year bridge inspection is important.

3. 5 year bridge inspection plan

Draft program of 5 year bridge inspection was explained.

In response to Mr.Ogawa's explanation, following action was explained for 5 year bridge inspection.

(1) All inventory work will be under "Inventory and Ferry Office" in RID, this office will be in charge of inventory and data updating

(2) RID will continue bridge inspection and road inspection following the "action plan" prepared in the project. This is also intention of MEF, and budget for periodic inspection was approved.

(3) Inspection of bridges will be mandate of DPWT after joint seminar on 20 December 2017. It is important to have mutual understanding of DPWTs for this activity
(4) 5 year plan will be presented in seminar on 20 December
(5) The draft 5 year periodic inspection group plan will be reviewed by RID for implementation

4. Repair/ replace work

For 2018, budget for replacement of 6 bridges on NR.43 is requesting to MEF. It is under negotiation with MEF. Actual number will be determined according to approved budget.

CONFIRMED BY:

Mr. You Dara	Mr. Koichi Ogawa

SECOND Maintenance Operation Meeting

-Date: 11. December, 2017
-Venue: Meeting room in RID building
-Member: RID officials, JICA experts
-Agenda:

1. Target Activities for 2018
2. For the introducing of the stable bridge maintenance to MPWT
3. 5 year bridge inspection plan
4. Repair/ replace work
- Target bridge list
5. Others

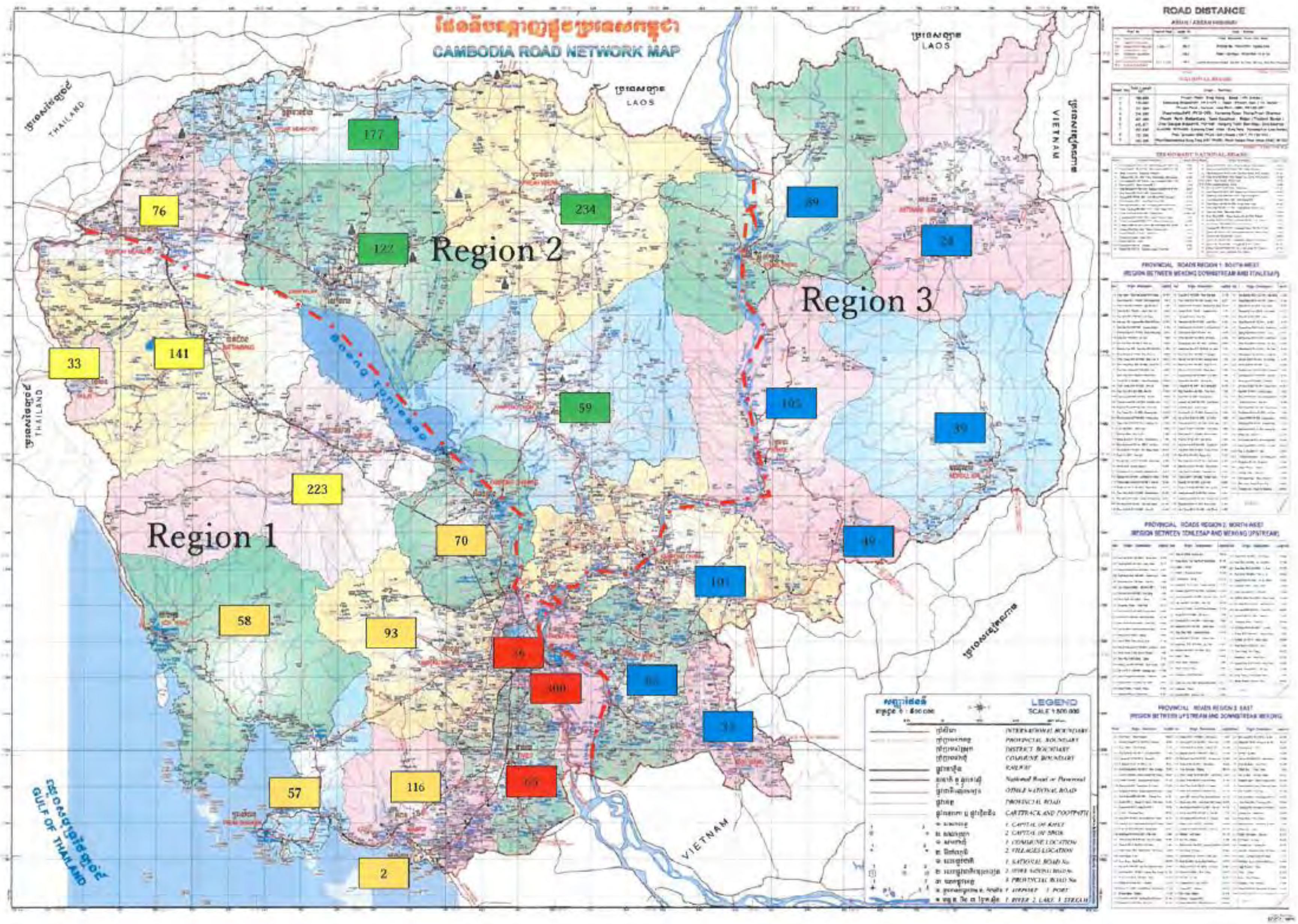
RID's Targets Activities for 2018

1. Re-Detail Inspection for remaining bridges of 28 (19 remains).
   -Some place need to wait until dry season.
   -Not enough time to do.
2. Follow up the progress of defect of the Bridge (plan 2018, one and two-digit road) which cannot get budget for re-construction.
   a. Re-detail inspection or study the progress of defect.
   b. find some Countermeasures
   c. do minor repair or make a warning signboard
3. Ranking all SD and D bridges from 2000 bridges survey for 3 years planning.
4. Selecting and ranking the SD and D bridges in to the list for 3rd year planning (year 2019).
5. Detail inspection for SD bridges (provincial road or 3 and 4-digit road) and when the dangerous defect which has possibility to collapse or fall down was found, the urgent countermeasure shall be decided to prevent accident of third party immediately until solution.
6. Do pilot project (Epoxy Injection) for all DPWTs (If they suggest).
   -Because we already added to the repair code.
   -They might not know how to do at site.

The importance of setting the Targets Activities:

1. At the beginning of each year, planning the targets activities is one way to achieve the long term goals because we can check if our annual activities match to the long term goals.

2. If we could not achieve the targets at the year end, we can improve our activity by analyzing the cause why the targets had not been achieved.


CAMBODIA ROAD NETWORK MAP
ROAD DISTANCE
Region 1
Region 2
Region 3
177
234
122
76
141
33
59
223
70
58
93
57
116
2
36
300
69
89
24
105
39
49
101
86
33
THAILAND
LAOS
VIETNAM
GULF OF THAILAND
LEGEND
PROVINCIAL ROADS REGION 1: SOUTH-WEST
PROVINCIAL ROADS REGION 2: NORTH-WEST
PROVINCIAL ROADS REGION 3: EAST

Priodic Bridge Inspection Grouping

Group	Region			Number of Bridges	SD	D	O	N
1	1	2	Battambang	141	0	4	5	132
4	1	1	Banteay Meanchey	76	1	4	4	67
1	1	14	Pailin	33	0	0	0	33
1	1	19	Pursat	223	24	26	64	109
				473	***25***	***34***	***73***	***341***
2	1	15	Phnom Penh	36	0	6	4	26
2	1	24	Takeo	65	2	12	10	41
2	1	8	Kandal	300	2	18	47	233
				401	***4***	***36***	***61***	***300***
3	1	4	Kampong Chhnang	70	0	4	8	58
3	1	5	Kampong Speu	93	6	6	20	61
3	1	7	Kampot	116	7	4	15	90
3	1	9	Kep	2	0	0	2	0
3	1	16	Preah Sihanouk	57	0	1	2	54
3	1	10	Koh Kong	58	0	1	3	54
				396	***13***	***16***	***50***	***317***
4	2	13	Oddar Meanchey	177	0	2	30	145
4	2	21	Siem Reap	122	1	1	18	102
4	2	6	Kampong Thom	59	2	1	5	51
4	2	17	Preah Vihear	234	0	22	102	110
				592	***3***	***26***	***155***	***408***
3	3	11	Kratie	105	5	12	14	74
3	3	3	Kampong Cham	101	5	17	27	52
3	3	12	Mondolkiri	39	0	1	2	36
3	3	18	Prey Veng	85	0	7	6	72
3	3	20	Ratanak Kiri	24	1	1	2	20
3	3	23	Svay Rieng	33	2	4	6	21
4	2	22	Stung Treng	89	0	10	25	54
3	3	25	Tboung Khmum	49	1	3	7	38
				525	***14***	***55***	***89***	***367***
			Total	***2387***	***59***	***167***	***428***	***1733***

bridges Planning 2018

No.	Bridge Name	Road Categor	Province	Road Name	PK	PK_meter	Latitude	Longitude	Bridge Length	Bridge Width	Material	Remarks	Damage Level
17	Reach Dom nek	National	Siem Reap	6	307	900	13.357124	103.878661	38	8	Concrete	Just do routine Maintenance	SD
21	Toul Poi	National	Thaung Khmum	7	161	700	11.83654	105.775326	8	8	Concrete	Just do routine Maintenance	SD
13	Koh Sla 1	National	Kampot	43	74	50	10.92528	104.250616	65	4	Steel	Just do routine Maintenance	SD
14	Steung Thom	National	Kampot	43	82	300	10.857655	104.236365	60	4	Steel		SD
15	O dong touk	National	Kampot	43	86	880	10.831757	104.25739	15	4	Steel		SD
16	O chhnang hors	National	Kampot	43	89	50	10.816817	104.276125	9	4	Steel		SD
18	O Kreang	National	Kampot	43	98	310	10.750141	104.222239	45	4	Steel	Just do routine Maintenance	SD
19	O Nimol	National	Kampong Speu	46	7	600	11.303327	104.152385	33	6.2	Steel		SD
20	O Som Chort	National	Kampong Speu	46	10	100	11.30924	104.132017	27	4.5	Steel		SD

Bridges Planning 2018

No.	Bridge Name	Road Categor	Province	Road Name	PK	PK_meter	Latitude	Longitude	Bridge Length	Bridge Width	Material	Remarks	Damage Level
1	Stoeng Slot	National	Prey Veng	1	66	400	11.247092	105.31984	148	10.5	Concrete	Studied by RAM Project	D
2	Pro Sot	National	Svay Rieng	1	135	179	11.069267	105.861421	60.3	12.5	Steel	Just do routine Maintenance	D
3	Spean Siemreab	National	Kandal	2	24	453	11.410554	104.867374	12	7	Steel	Do nothing	D
4	Prek Sleng	National	Kandal	2	28	180	11.378402	104.863601	18	7	Steel		D
8	Prey San deak	National	Takeo	2	85	695	10.911726	104.782342	15	10	Concrete	Just do routine Maintenance	D
9	Chres	National	Takeo	2	95	334	10.826747	104.798867	15	10	Concrete		D
10	Krang leav	National	Kampong Speu	3	56	700	11.173448	104.686724	15	10.5	Concrete		D
11	Border kpc and kps	National	Kampong Speu	4	106	850	11.193712	104.060675	19	10	Concrete		D
12	Steung Prei Nob	National	Preah Sihanouk	4	190	50	10.608964	103.772917	25.2	10	Concrete		D
13	Svay Doun Keo	National	Pursat	5	219	500	12.671939	103.640897	92	9.6	Steel		D
14	Thnol Keng-Japan	National	Kampong Cham	6	44	700	11.898103	104.923994	53.7	10.5	Concrete		D
15	Tropeang Veng 1	National	Kampong Cham	6	50	926	11.929367	104.936341	54	11	Concrete		D
16	Tros 1	National	Kampong Cham	6	51	912	11.937169	104.939547	160	11	Concrete		D
18	Bridge 16	National	Banteay Meanchey	6	381	935	13.582357	103.31007	20	10	Concrete		D
19	Bridge 7 Sa-Krav	National	Banteay Meanchey	6	406	690	13.625298	103.059094	26	10	Concrete	Just do routine Maintenance	D
20	Kizuna	National	Kampong Cham	7	121	400	11.987093	105.462231	1500	12.2	Concrete		D
23	Raka3	National	Prey Veng	8	62	500	11.670883	105.273672	85	11	Concrete	Just do routine Maintenance	D
12	Spean Bak	National	Kampong Speu	43	3	0	11.267769	104.232737	36	5.3	Steel	Just do routine Maintenance	D
17	Dong son Touch	National	Kampot	43	88	250	10.752162	104.302415	9	4	Steel	Just do routine Maintenance	D
32	Kong Va	National	Banteay Meanchey	56	7	0	13.649598	102.960084	20	10	Concrete	Just do routine Maintenance	D
33	Krang Dong	National	Preah Vihear	62	104	488	13.612698	105.032952	78	10	Concrete		D
34	Ta keing 1	National	Preah Vihear	62	155	464	13.861772	104.82262	24	10	Concrete		D
35	Sra Aem	National	Preah Vihear	62	211	813	14.236998	104.733375	80	10	Concrete		D
37	O Sho Poi	National	Preah Vihear	64	72	500	13.671744	104.52	15	11	Concrete		D
38	Rolom Trobek	National	Preah Vihear	64	101	914	13.8196	104.722618	39	10	Concrete		D
39	Steung kdol	National	Preah Vihear	64	102	640	13.819422	104.723239	60	10	Concrete	Just do routine Maintenance	D
41	O Sneat	National	Preah Vihear	95	17	730	13.686799	105.291153	30	5.8	Steel	Just do routine Maintenance	D
42	Pot Drea	National	Preah Vihear	95	40	0	13.512788	105.193564	120	5.3	Steel		D