VIETNAM EXPRESSWAY MANAGEMENT OFFICE
DIRECTORATE FOR ROADS OF VIETNAM
THE SOCIALIST REPUBLIC OF VIETNAM

THE PROJECT FOR STRENGTHENING OPERATION AND MAINTENANCE SYSTEM FOR EXPRESSWAY IN VIETNAM

PROJECT COMPLETION REPORT

JULY 2013

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

DAINICHI CONSULTANT INC.
CENTRAL NIPPON EXPRESSWAY COMPANY LTD.

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Abbreviations and Acronyms

BOT :	Build, Operate and Transfer
C/P :	Counterpart
Cuu Long CIPM :	Cuu Long Corporation for Investment, Development and Project Management of Infrastructure
CG :	Consultative Group Meeting
DRVN :	Directorate for Roads of Vietnam
ETC :	Electronic Toll Collection System
HPC :	Ha Noi People’s Committee
IRI :	International Roughness Index
ITST :	Institute of Transport Science and Technology
JCM :	Joint Coordination Meeting
JICA :	Japan International Cooperation Agency
LOS :	Level of Service
MOT :	Ministry of Transport
MOPS :	Ministry of Public Security
NEXCO Central :	Central Nippon Expressway Company Limited
O&M :	Operation and Maintenance
ODA :	Official Development Assistance
OJT :	On-the-Job Training
PPP :	Public Private Partnership
R/D :	Record of Discussion
PMUTA :	Technical Assistance Project Management Unit
RRMU :	Regional Road Management Unit
TG :	Technical Group
TECOTEC :	Technical Instrument and Consultant Technology JSC
TOC :	Table of Contents
TSG :	Technical Specification Guidelines
UTC :	University of Transport and Communication
UTT :	University of Transport Technology
VEA :	Vietnam Expressway Authority
VEC :	Vietnam Expressway Corporation
VEMO :	Vietnam Expressway Management Office
VMS :	Variable Message Signboard
WT :	Working Team

1 Background and Purpose of the Project

Expressway network development in Vietnam is implemented using several budgetary schemes such as state budget, ODA and private funds in the form of BOT, PPP and other private funds. Expressways' O&M works are to be undertaken by O&M executing bodies deployed by respective project owners in conformity with the standards and manuals designated and mandated by MOT. On the other hand, potentiality of contracting out of expressway O&M works to private entities is currently under review. Under these circumstances, it is expected that a diverse public / private business entities are engaged in expressway O&M works.

With the successive opening of expressway routes to traffic to be seen shortly, it is urgently required that MOT establish O&M standards and manuals, so that a variety of entities are able to provide expressways with a consistent level of service (LOS) that satisfies the necessary performance and social needs. In response to the request of the Government of the Socialist Republic of Vietnam (Vietnam), JICA has implemented the "Project for Strengthening Operation and Maintenance System for Expressway (hereafter "the Project") in order to transfer Japan's experienced and advanced expressway O&M technology to the Vietnamese counterpart. The Project's Overall Goal, Objective, Expected Output are given in Table 1.1.

Table 1.1 Project Overall Goal, Objective and Expected Outputs

Items	Details
Overall Goal	Expressway network is operated and maintained with effective & sustainable way.
Project Objective	Effective and safety framework for O&M of Expressways is established.
Expected Output	- Overall scheme for O&M of Expressways is established.
	- Trial O&M works is executed at some Expressway based on the above scheme.

2 Project Organization

2.1 Outline of Project Organization

The project is managed and implemented by the following set up in Figure 2.1.

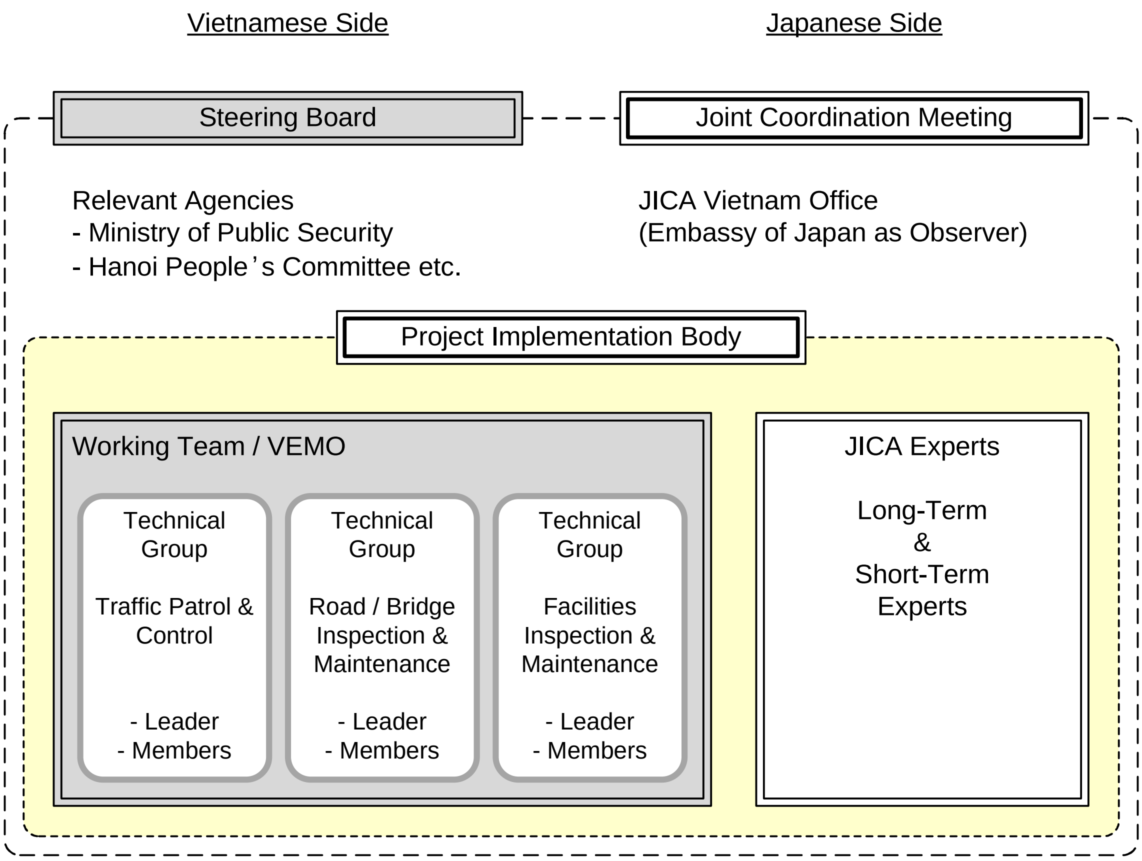


Figure 2.1 Organization for Project Implementation and Management

2.2 Counterparts

Vietnamese side, MOT has changed project implementing setup by "Decision on Transference of Project Owner and consolidation of the organization and implementation of the JICA funded Technical Assistance Project "Strengthening the O&M system for expressway""[1], July 30th, 2012. In response, Vietnamese side's participating members have undergone changes. Accordingly, project implementing agency has been transferred from MOT to DRVN, resulting in transfer of the Head of the Working Team, from Deputy Director of MOT's Planning Investment to Deputy Director of DRVN. Project's counterparts have been transferred. On technical matters, VEMO under DRVN has taken responsibility and, on administrative matters, PMUTA under DRVN has taken responsibility. No government decision is made on VEA to be established within MOT.

[1] MINISTRY OF TRANSPORT, No 1783: / QD-BGTVT, July 30, 2012, DECISION, On "Transference of Project Owner and consolidation of the organization and implementation of the JICA funded Technical Assistance Project" "Strengthening the O&M system for expressway" (see ANNEX-4)

2.3 Steering Board for the Project

Steering Board's functions are as follows:

- To coordinate with other government agencies and relevant bodies concerned.
- To review the Project outputs, such as proposed policy, standards and manuals, and to give concurrence to draft official documents.

2.4 Joint Coordination Meeting (JCM)

The JCM is co-chaired by the Vice Minister of MOT and the Representative of JICA Vietnam Office. The JCM's functions are as follows:

- To discuss and approve the annual work plan of the Project to be formulated under the framework of the R/D,
- To evaluate the achievement of the annual work plan and overall progress of the Project,
- To review and exchange opinions on major issues that have arisen during implementation of the Project.

In the meantime, the JCM Vietnamese-side members have been reshuffled as given in Table 2.1.

Table 2.1 JCM Members

Category	Name of the Organization
Initial setup	MOT, VEC, Relevant Authorities including MOPS and HPC
After reshuffle	MOT, DRVN, Relevant Authorities including VEC, MOPS, and HPC

2.5 Working Team

Working Team's functions are as follows:

- To conduct the Project activities in coordination with JICA experts.
- To report the progress of the Project activities to the Steering Board.

2.6 Technical Groups (TG)

The three Technical Groups (TGs) are set up in order to facilitate an efficient implementation of the Project, in particular, VEMO's human resources development, and earliest completion of the draft TSG. Accordingly, i) Road / Bridge Inspection and Maintenance, ii) Facilities Inspection and Maintenance, and iii) Traffic Patrol and Control are set up.

2.7 Japanese Experts

Japanese experts are tasked with the following professional assignments as given in Table 2.2. They gave advice and technical assistance to the Vietnamese Counterparts. They are assisted by Local Consultants (4 persons), Interpreters (1 person for Vietnamese / English, a maximum of 3 persons for Japanese / Vietnamese), and a secretary.

Table 2.2 Japanese Experts versus Assigned Professional Disciplines

Assigned Professional Disciplines	Experts' Name
Team Leader / Civil Works Maintenance Plan	ORIKASA, Mikio
Pavement Inspection and Maintenance	KIJIMA, Terutake
Bridge Inspection and Maintenance	YOKOYAMA, Hiroshi (SAKAIDA, Minoru)
Facility Inspection and Maintenance	IIMURA, Hideki
Communication Facility	YOSHIZAWA, Toshiyuki
Traffic Management (Patrol)	MATSUSHITA, Yasuhiko
Traffic Control	ISHIDUKA, Yoshihiro
Procurement Specialist	KAMIHASHI, Nobuyuki
Coordinator / Civil Works Maintenance Plan	URANO, Kazuya

3 Subjects Delivered by the Project

3.1 Consulting Services Undertaken by the Japanese Experts

The Japanese experts delivered the following consulting services, which include procurement of necessary equipment and tools as listed in Table 3.1.

Table 3.1 Consulting Services Delivered by the Project

Activity Code	Consulting Services	Period Engaged
1	Diagnosis of Current Standards and Regulations	July 2012 to August2012
	Production of the Draft TSG	July 2012 to January 2013
2-1	Preparation of Plan for On-the-Job Training (OJT)	December 2012 to March 2013
2-2	Preparation of Plan for Pilot Implementation	
3	Procurement of Equipment, Tools and Materials for OJT	December 2012 to March 2013
4-1	Execution of OJT	April 2013
4-2	Execution of Pilot Implementation	April 2013 to June 2013
5	Finalizing the TSG, and assistance in standardizing TSG	June 2013 to July 2013
6	Organizing and holding Workshops	June 2013
7	Conducting a Training Program in Japan	November 2012

3.2 Schedule

The above consulting services (broken down to 7 activities) are delivered during July 2012 – July 2013 (within scheduled 12.5 months) as given in Table 3.2.

Table 3.2 Project Schedule

Activities	Items	2012						2013						
		7	8	9	10	11	12	1	2	3	4	5	6	7
Activity 1	Diagnosis of Current Standards and Regulations	■	■											
	Preparation of the Draft of TSG			■	■	■	■	■			[Field Assignment-5]			
Activity 2	Preparation of the plan for the On-the-Job Training (OJT) and Pilot Implementation						■	■	■	■		[Field Assignment-6]		
Activity 3	Procurement of Equipment, Tools and Materials for OJT	[Field Assignment-1]					■	■	■	■		[Field Assignment-7]		
Activity 4	Execution of OJT		[Field Assignment-2]								■			
	Execution of the Pilot Implementation						[Field Assignment-3]				■	■	■	
Activity 5	Finalizing the TSG, and Supporting to standardize the TSG							[Field Assignment-4]				■	■	■
Activity 6	Work Shop (additional activity)												■	
Activity 7	Training in Japan					■								

Note-1: Parentheses [ ] in the table show the Field Assignment.

Note-2: Activity 7 was undertaken by JICA Long-Term Expert.

3.3 Japanese Experts' Detailed Field Assignments and Terms

The Japanese experts were dispatched to Vietnam seven (7) times during the Project term. They delivered the following consulting services as given in Table 3.3. Production of the draft TSG, formulation of OJT execution plan and pilot implementation plan, and procurement of equipment and a vehicle were delivered in the former period (up to February 2013) and execution of OJT and pilot implementation, finalization of the Draft TSG, and facilitation of TSG standardization were delivered in the latter period (March 2013 – June 2013). In particular, it is worth mention that the Japanese experts have advised and assisted the Vietnamese Counterparts in producing the Draft TSG and executing OJT to facilitate technology transfer.

Table 3.3 Japanese Experts' Field Assignments

Filed Assignment	Timing	Period	Japanese Team's Activities
Field Assignment -1	22 July – 4 August, 2012	14 days	- Preparatory Work - (Diagnosis of Current Standards and Regulations)
Field Assignment -2	26 August – 8 September, 2012	14 days	- Preparation of TSG (Draft)
Field Assignment -3	2 December – 15 December, 2012	14 days	- Preparation of TSG (Draft) - Preparation of Plan for OJT - Procurement of Equipment, Tools and Materials for OJT
Field Assignment -4	20 January – 2 February, 2013	14 days	- Finalizing TSG (Draft) - Preparation of the Detailed Plan for OJT - Confirmation of the Process of the Procurement of Equipment, Tools and Materials for OJT
Field Assignment -5	31 March – 20 April, 2013	21 days	- Execution of OJT by using the Draft TSG prepared by this project.
Field Assignment -6	26 May – 8 June, 2013	14 days	- Finalizing TSG based on the Results of OJT and Pilot Implementation
Field Assignment -7	19 June – 25 July, 2013	7 days	- Supporting to standardize TSG - Holding Workshop

3.4 Types of Meetings Organized

In this project, three types of meetings were held regularly for coordination among Vietnamese counterparts and JICA Experts.

3.4.1 Joint Coordination Meeting (JCM)

Joint Coordination Meeting was held on May 7, 2013 to report the project activities given and to discuss the standardization of TSG prepared by the Project. Minutes of Meeting for JCM is given in ANNEX-3.

3.4.2 Consultative Group Meeting (CGM)

Consultative Group Meetings were held at the time when Japanese experts were dispatched to Vietnam. In particular, at major milestones of producing the Draft TSG, CGM was convened to confirm the policy of VEMO and TG. In addition, in formulating the OJT plan, the Japanese experts have confirmed the basic strategy with the counterparts from VEMO and PMUTA, which helped both sides to be prepared to formulate the OJT planning. In the meetings, the project team and Vietnamese counterparts, VEMO and PMU have discussed and decided the policy how to prepare TSG (Draft) and OJT plan.

3.4.3 Regular Meetings

Regular meetings were held with the counterparts of the project -VEMO as technical side and PMUTA as administration side at appropriate timings in order to facilitate the project implementation.

3.5 Reporting and Deliverables

3.5.1 Reporting

Reports produced and submitted are given in Table 3.4 and Table 3.5.

Table 3.4 Reports Produced by the Project (As stipulated by the Contract with JICA)

No.	Reports Produced	Language	Timing of Submission
1	Inception Report (Text version)	JP	July 2012
2	Work Plan	EN	September 2012
3	Project Progress Report	JP EN	Late April 2013
4	Project Completion Report	JP EN	Early July 2013

Table 3.5 Reports Produced by the Project (Not bound by the Contract with JICA)

No.	Report Title	Languages	Purpose	Submission date
5	Inception Report	English Vietnamese	Briefing for relevant authorities	July 2012
6	Report	English Vietnamese	Kick-off meeting at MOT	August 2012
7	Kick-off Meeting Between Member of the Technical Groups and JICA Experts	English Vietnamese	Kick-off meeting at DRVN	August 2012
8	On-the-job Training (OJT) and Pilot Implementation Plan (Outline)	English Vietnamese	Briefing for PMUTA and VEMO	February 2013
9	On-the-job Training (OJT) Participants List	English Vietnamese	Ditto	March 2013
10	On-the-job Training (OJT) and Pilot Implementation Plan (Details)	English Vietnamese	Orientation meeting on OJT program	April 2013
11	Supplementary Teaching Material	Japanese Vietnamese	Teaching materials which supplement TSG in OJT	April 2013
12	Report of the OJT	English Vietnamese	At closing OJT program	April 2013
13	Comments and Answers to TSG from MOT & DRVN	Japanese English Vietnamese	TG Meeting (Finalizing TSG)	April 2013
14	Report	English Vietnamese	JCM	May 2013
15	Comments and Responses to TSG from Cuu Long CIPM, VEC and VEC O&M	Japanese English Vietnamese	TG Meetings (Discussed TSG Finalization based on pilot implementation results)	June 2013
16	Workshop Documents	Japanese English Vietnamese	Presentation materials for workshops	June 2013

3.5.2 Deliverables of Technical Cooperation Program

The Draft TSG document has been completed in production by January 2013, as it was intended to be used as OJT lecture material. The Draft TSG was finalized in April 2013, through the process of contents review by soliciting comments from the Vietnamese Authorities and relevant institutions. The documents of Draft TSG were ring-bound published in four separate volumes, each containing respective professional disciplines, with distinct colored covers.

Further, TSG Documents were finalized in June 2013. They reflect amendments due to responses from OJT execution, the Pilot Implementation and from relevant authorities. They are book bound with case binding in a compact form of A5-sized hardcover, accommodating Vietnam side's request for compactness and portability. TSG full texts are given in ANNEX-5.

4 Project Activities

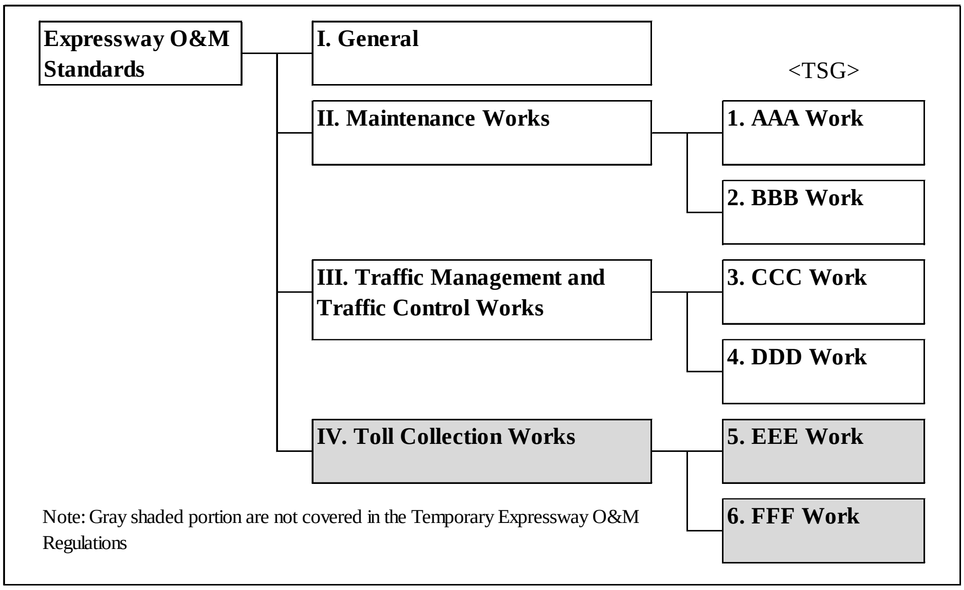
4.1 Outline

The Project has delivered 7 times of field assignments as given in Table 3.2. The subsections 4.2 – 4.10 below describe consulting services delivered.

4.2 Diagnosis of Current Standards and Regulations, and Production of TSG (Draft) (Activity 1)

4.2.1 Definition of O&M Standard and TSG (Draft)

Several Temporary Expressway O&M Regulations (hereafter referred to as "the Temporary Regulations") have been promulgated in Vietnam, and so far these are used as the Expressway O&M Regulations. The Expressway O&M Regulations are largely divided into three major areas, - maintenance, traffic management and control, and the toll collection systems. Furthermore, three major areas are subdivided into several work fields. The relationships among them are given in Figure 4.1. TSG represents an independent document that supplements the Regulation, providing details on O&M works such as damage inspection, criteria on the repair works to be conducted in accordance with the extent of the damage etc.

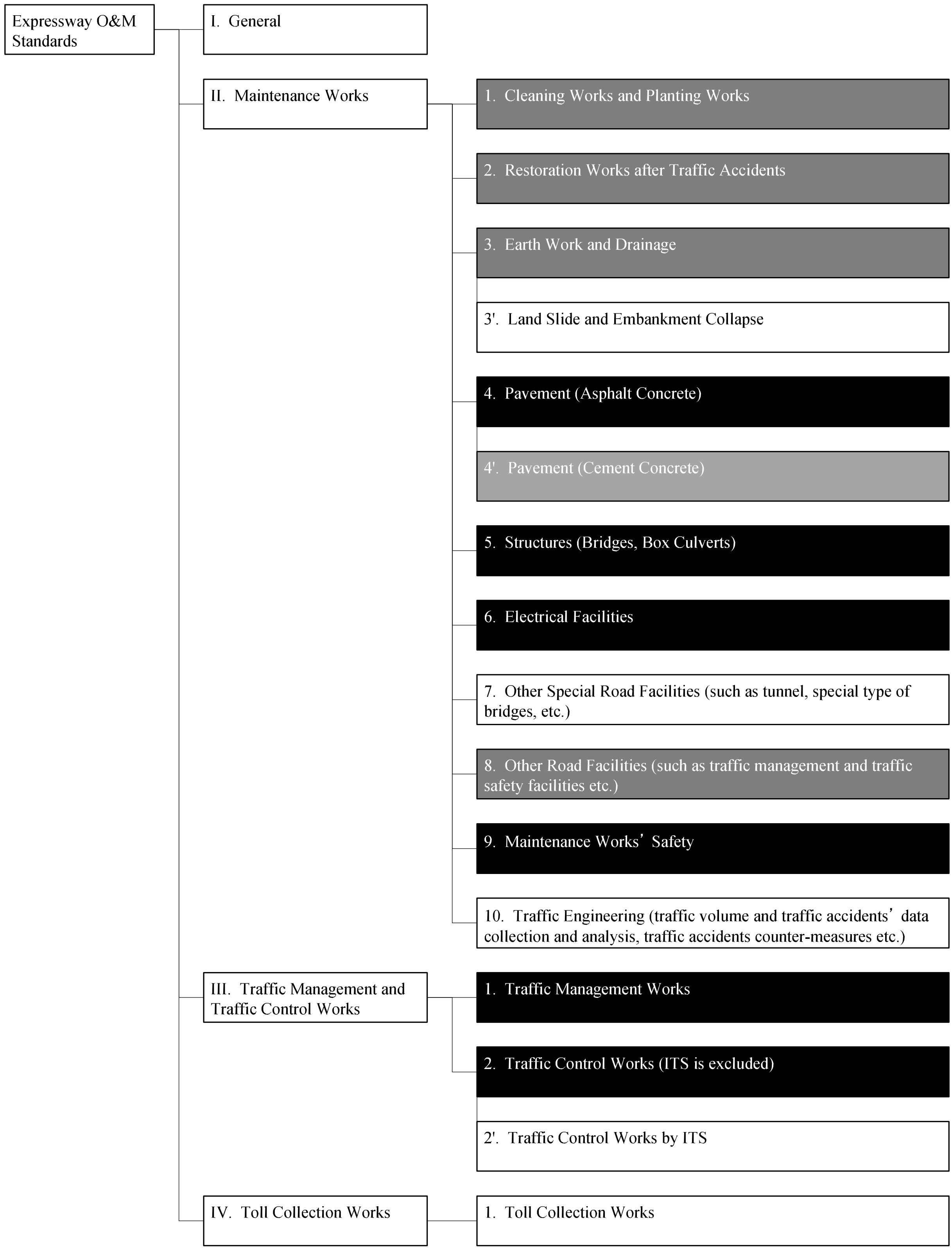


Source: JICA Experts Team

Figure 4.1 Relationships among O&M Standard and TSG

4.2.2 Configuration of O&M Standard and TSG

Subjects and topics to be covered by the Expressway O&M standards are given in Figure 4.2. Works of Expressway O&M are classified into three major areas and each area is subdivided into several works. The gray shaded items are already described in the Temporary Regulations and the black shaded items are to be prepared under the Project.



Source: JICA Experts Team
Note: The gray shaded items are already described in the Temporary Regulations.
Note: The black shaded items are to be prepared under the Project.

Figure 4.2 Configurations of Improved O&M Standard

4.2.3 Table of Contents of TSG

Table of Contents for each TSG area produced by the Project is given in Table 4.1.

Table 4.1 Table of Contents for TSG

Chapter 1 Pavement (Asphalt Concrete)
1.1 Outline
1.1.1 Functional Requirements for Pavements
1.1.2 Damage to Pavements and Its Causes
1.1.3 Need (Lifecycle Costs) for and Objectives of Pavement Protection
1.1.4 Definition of Maintenance and Repair
1.1.5 Workflow of Maintenance and Repair
1.2 Inspections and Surveys
1.2.1 Types and Frequencies
1.2.2 Daily Inspections
1.2.3 Routine Inspections
1.2.4 Emergency Inspections
1.2.5 Detailed Surveys (Surface Conditions, Structures and Mixtures)
1.2.6 Road Surface Survey Methods by Damage Type
1.2.7 Methods of Surveying Pavement Structure
1.3 Diagnosis and Maintenance and Repair Plans
1.3.1 Evaluation and Determination
1.3.2 Maintenance or Repair Plans
1.4 Maintenance and Repair Work
1.4.1 Major Daily Maintenance and Repair Work
1.4.2 Regular Maintenance and Repair Work
1.4.3 History of Maintenance and Repair
1.4.4 Recommendations for Construction
1.5 Traffic Safety Measures
1.5.1 Traffic Safety Measures
1.5.2 Installations for Traffic Safety Measures
1.6 An Addendum: Maintenance or Repair of Concrete Pavements
1.6.1 Types of Damage to Concrete Pavements
1.6.2 Main Causes and Mechanism of Damage (Concrete Pavements)
1.6.3 Major Survey Methods by Type of Damage (Concrete Pavements)
1.6.4 Evaluation and Determination and Repair Planning (Concrete Pavements)
1.6.5 Maintenance and Repair Methods (Concrete Pavements)

Chapter 2 Road Structures (Bridges, Box Culverts)
2.1 General
2.1.1 Performance Requirements for Road Structures
2.1.2 Evaluation on Soundness of Road Structures
2.1.3 Causes of Damage to Structures
2.1.4 Necessity and Purposes of Maintenance Work for Road Structures
2.1.5 Maintenance Work Flow for Road Structures
2.2 Inspection
2.2.1 Daily Inspection
2.2.2 Routine Inspection on Concrete Structures
2.2.3 In-Depth Inspection on Concrete Structures
2.2.4 Emergency and Special Inspections
2.2.5 Record-Keeping System
2.3 Assessment and Maintenance Program
2.3.1 Assessment based on Inspection Results
2.3.2 Maintenance Program
2.4 Maintenance Works
2.4.1 Daily Maintenance Work
2.4.2 Routine Maintenance Work

4.2.4 Methods in Drafting TSG

(1) Basic Principles in Drafting TSG

Basic principles of the preparation of TSG are as follows;

- TSG shall be based on existing Temporary Expressways O&M Regulations.
- Portions not described in the above Regulations shall refer to the Vietnam Roads O&M Standards.
- Further voids not filled by the above references shall refer to manuals for Expressways O&M by the Central NEXCO and other highway authorities, whichever is available and applicable to the Vietnamese Expressways operation situation.

(2) Drafting Process

TSG drafting process has taken the following steps in Table 4.2.

Table 4.2 Process of Drafting TSG

Step	Descriptions	Remarks
Step-1	Draft a table of contents (TOC) for TSG.	
Step-2	Selected from the TOC are subject items with more occasions of use in responding to daily operational demands.	
Step-3	Orders appearing in the TOC shall also reflect urgency.	
Step-4	TSG shall be prepared in the order of priority, by revising existing Temporary Regulations and newly drafting.	

4.2.5 Drafting Schedule

Drafting schedule of TSG is mentioned in Section "3.5.2 Deliverables of Technical Cooperation Program".

4.3 Preparation of Plan for On-the-Job Training (OJT) (Activity 2-1)

4.3.1 Training Items

Prepared TSG (Draft) will, after being standardized as Expressway O&M Standard in Vietnam, be used for practical O&M works in expressways as the sole standard. It is considered important to explain the contents of TSG and to guide working procedures and methods at site in accordance with TSG to the engineers who presently engage in O&M works for ordinary roads and expressways and will engage in the future. On-the-Job training is therefore planned including both classroom learning and on-site training.

OJT is executed for all the contents described in TSG (Draft): a series of required works in maintenance and management cycle for pavement, bridge and box culvert, electrical facilities fields, and traffic patrol, traffic management and countermeasures against unusual incidents for traffic management field. Training items of OJT planned are given in Table 4.3.

Table 4.3 Training Items of OJT

No.	Fields	Training items	Remarks
1	Pavement	O&M Inspection, diagnosis methods, and repair works	
2	Bridges and Culverts		
3	Electrical Facilities		
4	Traffic Management	Patrol method, on-road works, urgent actions for traffic accidents, and removal of obstacles on the road	

4.3.2 Schedule

Summarized schedule of OJT is given in Table 4.4.

Table 4.4 Schedule of OJT

No.	Schedule	Duration	Activities	Remarks
	2 April		Orientation	
1	3– 5 April /1st week	3 days	Classroom Learning	Conducted by JICA Experts' Team
2	8 – 12 April /2nd week	5 days	On-site Training	-ditto-
3	15 – 17 April /3rd week	3 days	On-site Training	-ditto-
	18 April		Closing Ceremony	

4.3.3 Participants

(1) Target Person of OJT

In selecting trainees by PMU and VEMO, the Japanese Experts Team advised them to consider the followings;

- Trainees must be technician staff who can attend the entire period of OJT.
- Prepared TSG (Draft) are used as the training material. Therefore, target persons for OJT shall be selected from technical staffs, who presently engage in the actual O&M works or will engage in the future.
- After OJT, pilot implementation will be done by some trainees. Therefore, some technical staff from VEC (VEC O&M) and Cuu Long CIPM (Company 715) should participate in OJT.

(2) Number of Trainees

The number of trainees is determined in each field as given in Table 4.5. Six (6) lecturers of UTT (University of Transport Technology) has also participated, who also constitute participating counterparts of the Project.

Table 4.5 Planned Number of Trainees

No.	Subjects	Type of Training	No. of Trainees	Remarks
1	Pavement	Classroom Learning On-site Training	10	
2	Bridge	Classroom Learning On-site Training	10	
3	Electrical Facilities	Classroom Learning On-site Training	10	
4	Traffic Management	Classroom Learning	10	
		On-site Training (Group A)	5	Trainees, which count as many as 10, are divided into two groups. Trainees from HCMC should be included in Group A to be able to pursue continued Classroom Learning and On-Site Training.
		On-site Training (Group B)	5	

4.3.4 Training Outline

Outlines of training in each field are given in Table 4.6, Table 4.7, Table 4.8 and Table 4.9 respectively.

Table 4.6 Training Outline of Pavement

No.	Schedule	Duration	Activities	Place
1	3 – 5 April	3 days	- Classroom Learning	- Meeting room in Hanoi
2	8 – 12 April	5 days	- On-site Training	- Meeting room of VEC O&M, Vuc Vong - Cau Gie – Ninh Binh Expressway
3	15 – 17 April	3 days	- On-site Training (JICA Experts guide trainees to learn the method to conduct OJT) - Supplementary lecture, wrapping up the training	-ditto-

Table 4.7 Training Outline of Bridge and Box Culvert

No.	Schedule	Duration	Activities	Place
1	3 – 5 April	3 days	- Classroom Learning	- Meeting room in Hanoi
2	8 – 12 April	5 days	- On-site Training - (Bridge Inspection / Bridge Repairing Works)	- Meeting room of VEC O&M, Vuc Vong - Vuc Vong and Liem Tuyen Viaducts (Cau Gie – Ninh Binh Expressway)
3	15 – 17 April	3 days	- On-site Training - (Bridge Repairing Works)	- Meeting room of VEC O&M, Vuc Vong - Parking area of VEC O&M Office

Table 4.8 Training Outline of Electrical Facilities

No.	Schedule	Duration	Activities	Place
1	3 – 5 April	3 days	- Classroom Learning	- Meeting room in Hanoi
2	9 – 12 April	4 days	- On-site Training - (Electrical Facilities Inspection)	- Meeting room of VEC O&M, Vuc Vong - Vicinity of Vuc Vong IC (Cau Gie – Ninh Binh Expressway)
3	15 – 17 April	3 days	- Classroom Learning - (Evaluation of the inspection results and way of repairing)	- Meeting room of VEC O&M, Vuc Vong

Table 4.9 Training Outline of Traffic Management

No.	Schedule	Duration	Activities	Place
1	3 – 5 April	3 days	- Classroom Learning	- Meeting room in Hanoi
2	8 – 11 April (Group A)	4 days	- On-site Training - (Patrolling etc.)	- Meeting room and Parking area of VEC O&M, Vuc Vong - Cau Gie – Ninh Binh Expressway
3	12, 15 – 17 April (Group B)	4 days	- On-site Training - (Patrolling etc.)	-ditto-

4.3.5 Cost Sharing for OJT Activities

The cost incurred by conducting OJT activities is shared by the Vietnamese side and the Japanese side as given in Table 4.10.

Table 4.10 Sharing Costs Incurred by Executing OJT Activities

No.	Items	Category	Details	Cost Sharing	
				Vietnamese side	Japanese side
1	Venue	Orientation and Closing Ceremonies	Meeting room of DRVN	●	---
		Classroom Learning	Meeting rooms of DRVN	---	●
		On-site Training	Meeting rooms of VEC O&M	---	●
			Parking area of VEC O&M	---	●
			Lane control works of Phap Van – Cau Gie Highway	---	●
2	Transportation	On-site Training	Between Hanoi and VEC O&M Office	---	●
			Between VEC O&M Office and training site	---	●
			A road patrol car	---	●
3	Teaching Equipment, Tools and Materials	Teaching Materials	Technical Specification Guidelines	---	●
			Supplementary Teaching Materials	---	●
		Teaching Tools	PC, Projector etc.	---	●
4	On-site Training Equipment, Tools and Materials	Equipment etc.	Donated by JICA	---	●
		Tools etc.	Prepared by JICA Experts' Team	---	●
			Prepared by Trainees	●	---

No.	Items	Category	Details	Cost Sharing	
				Vietnamese side	**Japanese side**
5	Traveling Expenses for Trainees	Per-diem	JICA Experts' Team pay to trainees **[see Note-1]**	---	●
		Accommodation Fee	Borne by each trainee	●	---
		Lunch Fee	Borne by each trainee **[see Note-2]**	●	---
		Transportation Fee	Borne by each trainee **[see Note-3]**	●	---
6	Expenses for Orientation and Closing Ceremonies (Equipment, Meals etc.)	Coffee Serving	Opening and closing Ceremonies	---	●
		Equipment	Opening and closing Ceremonies	●	●

Note-1: The amount of Per-Diem will be determined based on the JICA Office Rule.

Note-2: During the training period, trainees take lunch by their own expense. During on-site training, the canteen of VEC O&M office was available.

Note-3: Transportation fee shall be borne by each trainee, otherwise transportation vehicle was made available provided by JICA Experts' Team.

4.4 Formulating the Plan for Pilot Implementation (Activity 2-2)

In finalizing TSG (Draft), it is necessary to confirm the suitability of TSG (Draft) in the situations of expressways in Vietnam and inconveniences in practical expressway O&M works. Pilot Implementation of TSG was therefore organized so that participated trainees are to execute at their home offices.

Pilot Implementation is conducted for all four (4) fields of prepared TSG (Draft): pavement, bridge and box culvert, electrical facilities and traffic management. Trainees should carry out all the works described in TSG (Draft) as much as possible and extract the issues to be improved in TSG (Draft).

It was conducted for duration of 7 weeks, starting from 22 April 2013 to 7 June 2013. Schedule of Pilot Implementation after OJT planned is given in Table 4.11.

Table 4.11 Summarized Schedule of Pilot Implementation

No.	Schedule	Duration	Activities	Remarks
1	22 April/4th week - 24 May/8th week	5 weeks	- Pilot Implementation	Conducted by trainees themselves at each office
2	27 May - 7 June /9th week & 10th week	2 weeks	- Review by JICA Experts' Team the manner of OJT conducted by trainees. - Revise and finalize TSG (Draft)	Conducted by JICA Experts' Team and trainees

4.5 Procurement of Equipment, Tools and Materials for OJT (Activity 3)

4.5.1 Donated Equipment by JICA

Equipment needed to conduct OJT and O&M works, as dictated by the draft TSG, is donated by JICA. They are used in the real situation of the on-site equipment usage in the OJT training. A list of equipment procured is mentioned in A4 Form as given in ANNEX-6.

4.5.2 Tools and Materials for On-Site Training

(1) Prepared by JICA Experts Team

Necessary tools and materials for on-site training were provided by JICA Experts' Team as given in Table 4.12.

Table 4.12 Tools and Materials Prepared by JICA Experts' Team

No.	Name of Tools and Materials	Quantity	Unit
Medicine			
1	Thinner for cleaning equipment	1	Piece
Scale			
2	Digital Scale	1	Piece
Stationery			
3	Name Plate	83	Piece
4	Cutter for shaping urethane foam	1	Piece
5	Whiteboard (for photography)	5	Piece
6	Whiteboard marker	16	Piece
7	Eraser for whiteboard	8	Piece
8	Magnets	8	Piece
9	Clipboard (A3)	20	Piece
10	Choke for on-site training	20	Piece
11	Tape for imitation lane marking (600m) 100mm×25m (white color)	24	Piece
Tool			
12	Helmet + Safety Vest	10	Piece
13	Gloves	20	Piece
14	Measuring tape (50m)	3	Piece
15	Extension power cable for indoor use	4	Piece
16	Cord reel (20m)	1	Piece
17	Red flag 70x70cm	6	Piece
Miscellaneous goods			
18	Buckets	6	Piece
19	Water tanks	1	Piece
20	Blue sheet for field curing (4 × 4m)	1	Piece
21	Trash bags	11	Piece
22	Plate	2	Piece
23	Spoon	7	Piece
24	Waste for equipment maintenance	1	Kg
25	Broom for cleaning	2	Piece

(2) Prepared by Trainees

Table 4.13 gives the necessary tools for on-site training provided by the trainees.

Table 4.13 Tools for On-Site Training Prepared by Trainees

No.	Name of Tools	Purpose	Quantity	Remarks
1	Helmet	Occupational Safety & Health (OSH)	by each trainee	
2	Safety vest	-ditto-	-ditto-	
3	Work clothes	-ditto-	-ditto-	
4	Work shoes	-ditto-	-ditto-	
5	Writing instruments	-ditto-	-ditto-	

(3) Equipment and Tools Rented from VEC O&M

In addition, some equipment, tools, meeting rooms and personnel of VEC O&M for lane control works during on-site training period are rented from VEC O&M, which is paid by JICA Experts' Team. According to Table 4.14, JICA Experts' Team has signed a rental contract with VEC O&M.

Table 4.14 Equipment and Tools Rented from VEC O&M

No.	Name of Tools	Quantity	Unit	Remarks
Renting Rooms / Equipment				
1	Warehouse (included a warden)	1	month	
2	Meeting rooms (included desks and chairs)	32	rooms days	
3	Projectors	32	projectors days	
4	Beam lifter (10m ~ 12m) and operator (included fuel)	1	day	
5	Pickup truck (1.0 t) and driver (including fuel)	8	days	
6	Generator (2.4 KVA) (including fuel)	8	days	
7	Ladder (7m, 2 stage)	8	days	
Lane Control Works				
8	Lane control (one carriageway close, L=200m) between Vuc Vong IC and Cao Bo IC	5	days	
9	Lane control (one toll gate close) at Vuc Vong IC (1day) and Cao Bo IC	3	days	
Technical Personnel Support				
10	Technician (Bridge)	5	men days	
11	Technician (Electric Facilities)	4	men days	
12	Technician (Traffic Control)	2	men days	
13	Electrician	4	men days	
14	Worker	2	men days	
15	Operators (Driver)	2	men days	

4.5.3 Warehouse for Storing Equipment for OJT

A warehouse for storing equipment, tools and materials for OJT is leased at VEC O&M as given in Table 4.14. Procured equipment, tools and materials will be delivered to the warehouse by the vendor (TECOTEC Company) from 20 – 27 March, 2013. JICA Experts' Team will carry out the acceptance inspection to equipment, tools and materials that have been delivered.

Table 4.15 Storage Room of Equipment for OJT

Location of Warehouse	Duration	Number of days	Activities
VEC O&M, Vuc Vong	20 – 27 March, 2013	8 days	Delivery
	28 – 29 March, 2013	2 days	Acceptance inspection
	30 March – 18 April	20 days	OJT (Classroom learning, on-site training)

4.5.4 Specifications for Procurement of a Patrol Vehicle

The procurement of a patrol vehicle to be used in OJT exercise was budgeted in the project. At first, the patrol vehicles presently deployed for expressway traffic management by VEC and Cuu Long CIPM were surveyed. Based on the fact findings, the project team proposed to the JICA Vietnam Office the specifications of the vehicle which might be used as a Vietnamese patrol vehicle in the future. Based on this proposal, it was determined that a patrol vehicle be purchased from Japan. During the procurement process, as it took a lot of time for the Vietnamese side to examine the required specification of a patrol vehicle in detail, it was almost certain that it was difficult to make the imported vehicle available by the commencement time of OJT exercise. Therefore, the project team has decided to rent a similar type of the Japanese expressway patrol vehicle. Eventually the act of procurement of a vehicle wasn’t performed in the project.

4.5.5 Delivery of the Procured Equipment

Procured Equipment of the project was delivered to DRVN in strict accordance with the “JICA Guideline for the Equipment Procurement and Management in the Entrustment Contract etc., April 2012”. Results of the delivery of the procured equipment are given in Table 4.16.

Table 4.16 Results of Delivery of Procured Equipment

No.	Items	Date	No. of Equipment	Confirmer
1	Delivery of the donated equipment	5 April, 2013	11 items	PMUTA of DRVN
2	Delivery of the consumable goods	17 April, 2013	72 items	PMUTA of DRVN

Note: The donated equipment is used in OJT exercise which was carried out for 17 days from 8th April to 17th April of 2013. Therefore the project team used it during OJT period, making it available, through a borrowing procedure from DRVN.

4.6 Execution of OJT (Activity-4-1)

4.6.1 Outline

OJT was carried out based on the OJT plan mentioned in Section 4.3. Summary of the OJT and the implementation results in each course are given below.

(1) Schedule

OJT was carried out for three weeks, the first week was conducted by the classroom learning style and the second / third weeks conducted on-site training, as given in Table 4.17.

Table 4.17 Actual Schedule of OJT

No.	Schedule	Duration	Activities	Remarks
1	2 April		Orientation	
2	The First week/ 3 April – 5 April	3 days	Classroom learning	Done by the Japanese experts
3	The Second week/ 8 April – 12 April	5 days	On-site training	-ditto-
4	The Third week/ 15 April – 17 April	3 days	On-site training	-ditto-
5	18 April		Closing ceremony	

(2) Number of Trainees

1) Number of Trainees in Each Field

Number of trainees was selected in each field as Table 4.18. Six (6) lecturers of UTT (University of Transport Technology) participated.

Table 4.18 Actual Number of Trainees

No.	Subjects	Type of Training	No. of Trainees	Remarks
1	Pavement	Classroom Learning On-site Training	15	
2	Bridge	Classroom Learning On-site Training	15	
3	Electrical Facilities	Classroom Learning On-site Training	8	
4	Traffic Management	Classroom Learning	11	
		On-site Training (Group A)	6	11 trainees are divided into two groups.
		On-site Training (Group B)	5	Trainees from HCMC participated in the Group A, making them available for continuing Classroom Learning and On-site training.

2) Total Number of Participants

Altogether, participated are a total of 67 people for the classroom learning and a total of 70 people for on-site training. They include trainees, Japanese experts, interpreters and local consultants. The breakdown of the participants of every field is given in Table 4.19.

Table 4.19 Actual Total Number of Participants

Subjects	Type of Training		Number of Participants				
			Trainees	PMU	Japanese Experts	Interp. & Local Consultant	Total
Classroom Learning	Pavement		15	1	1	2	19
	Bridge		15	1	1	2	19
	Electrical Facilities		8	1	2	2	13
	Traffic Management		11	1	2	2	16
	Total						**67**
On-Site Training	Pavement		15	1	3	2	21
	Bridge		15	1	1	2	19
	Electrical Facilities		8	1	6	2	17
	Traffic Management	(Group A)	6	1	4	2	13
		(Group B)	5	1	4	2	12
	Total						**70（69）**

Note: The number of Japanese experts for on-site training includes the training supporters from NEXCO Central and affiliated companies in Japan.

(3) Training Places

1) Classroom Learning

It is necessary to have four lecture rooms that can accommodate about 20 people of each field for three days as given in Table 4.20. Therefore, the project team rented four lecture rooms of Apollo English Center in Hanoi.

Table 4.20 Lecture Room for Classroom Learning

Schedule	Duration	Field	No. of Rooms	No. of Participants	Place	Lecture Room
In the mornings of 10:00 – 16:00, 3 – 5 April	3days	Pavement	1	19	Hanoi	Apollo English Center in Hanoi
		Bridge	1	19		
		Electrical Facilities	1	13		
		Traffic	1	16		
Total			**4**	**67**	**---**	**---**

2) On-Site Training

It is necessary to have four meeting rooms that can accommodate 15 people each for eight days as given in Table 4.21. Meeting Rooms of VEC O&M at Vuc Vong are used as the lecture rooms for on-site training. Therefore, the project team has made the agreement with VEC O&M for rented four meeting rooms[2].

[2] This rental expense was included in rental contracts mentioned in Section 4.5.2, (3) "Tools and Materials for On-Site Training".

Table 4.21 Lecture Room for On-Site Training

Schedule	Duration	Field	No. of Rooms	No. of Participants	Place	Lecture Room
8 – 12 April	5 days	Pavement	1	21	Vuc Vong	To use four meeting rooms as lecture rooms in VEC O&M Office
		Bridge	1	19		
		Electrical Facilities	1	17		
		Traffic	1	13		
Total			**4**	**70**		
15 – 17 April	3 days	Pavement	1	21	Vuc Vong	To use four meeting rooms as lecture rooms in VEC O&M Office
		Bridge	1	19		
		Electrical Facilities	1	17		
		Traffic	1	12		
Total			**4**	**69**		

Furthermore, training yards for on-site training of each field were used as given in Table 4.22.

Table 4.22 Training Yards for On-Site Training

Schedule	Duration	Field	Lecture Room	Training Yards	Remarks
8 – 12 April	5 days	Pavement	- Meeting room of VEC O&M	- Vuc Vong IC – Cao Bo IC (Cau Gie – Ninh Binh Expressway)	Lane control works are needed.
		Bridge	- Meeting room of VEC O&M	- Around VEC O&M office - Vuc Vong IC – Cao Bo IC (Cau Gie – Ninh Binh Expressway)	-----
		Electrical Facilities	- Meeting room of VEC O&M	- Vicinity of Vuc Vong IC	-----
		Traffic	- Meeting room of VEC O&M	- Parking area of VEC O&M - Cau Gie IC - Ninh Binh IC (Cau Gie – Ninh Binh Expressway)	Lane control works are needed.
15 – 17 April	3 days	Pavement	- Meeting room of VEC O&M	- Vuc Vong IC – Cao Bo IC (Cau Gie – Ninh Binh Expressway)	Lane control works are needed.
		Bridge	- Meeting room of VEC O&M	- Around VEC O&M office	-----
		Electrical Facilities	- Meeting room of VEC O&M	-----	-----
		Traffic	- Meeting room of VEC O&M	- Parking area of VEC O&M - Cau Gie IC - Ninh Binh IC (Cau Gie – Ninh Binh Expressway)	Lane control works are needed.

(4) Lane Control of Carriageway for On-Site Training

In conducting pavement and traffic management on-site training, both of the lane control for the practice of pavement inspection / repairing works and traffic management works need to be done at the same time. The project team requested that VEC O&M carry out the lane control (one carriageway, length = about 200m) in Cau Gie - Ninh Binh Expressway. Detailed schedule of lane control is given in Table 4.23[3].

Table 4.23 Lane Control of Carriageway for On-Site Training

Schedule	Field	Duration		Lane Control Section	Road Operator
		AM	PM		
9 April (Tuesday)	Pavement	10:30-12:00 (1hr 30min)	13:30-16:00 (2hr 30min)	TBD	VEC O&M
10 April (Wednesday)	Pavement	-ditto-	-ditto-	-ditto-	-ditto-
11 April (Thursday)	Pavement	-ditto-	-ditto-	-ditto-	-ditto-
15 April (Monday)	Pavement	-ditto-	-ditto-	-ditto-	-ditto-
16 April (Tuesday)	Pavement	-ditto-	-ditto-	-ditto-	-ditto-
17 April (Tuesday)	Traffic	-ditto-	-----	-ditto-	-ditto-

(5) Transportation for On-Site Training

On-site training in OJT was done around the VEC O&M office near Vuc Vong IC. Therefore, below mentioned transportation for moving the participants of training was prepared by the project team.

- Transportation between Hanoi and Vuc Vong (VECO&M Office)
- Transportation between VECO&M Office and on-site training places
- Transportation for on-site training of Traffic Management (Road patrol training)

(6) Teaching Curriculum and Teaching Materials

Details of OJT such as teaching curriculum and teaching materials were prepared by the project team. OJT curriculum was composed by the prepared TSG (Draft) and the supplementary documents that have been prepared by the project team in order to complement the contents of TSG (Draft).

(7) Opening and Closing

Orientation was held on the first day for explaining the implementation method of OJT. And the closing ceremony was held on the last day for presenting the OJT results and to confer a certificate of achievement[4] to the trainees who attended OJT for the entire training period. Outlines of orientation and closing ceremony are given in Table 4.24 and Table 4.25 respectively.

3 This lane control works' expense was included in rental contracts mentioned in Section 4.5.2, (3) "Tools and Materials for On-Site Training".

4 The certificate of achievement which the project team confers to the trainees and the trainee list are attached to ANNEX-7.

Table 4.24 Opening (2nd April (Tuesday))

No.	Time Table	Duration (Min.)	Activities	Presenter
1	10:00-10:30	30	Explanation of OJT Outline	JICA Experts
2	10:30-11:30	60	Orientation in each field	JICA Experts

Table 4.25 Closing (18th April (Thursday))

No.	Time Table	Duration (Min.)	Activities	Presenter
1	10:00-10:05	5	Opening Speech	Chief of VEMO, PMU
2	10:05-10:15	10	Speech by DRVN	Deputy Director of DRVN
3	10:15-10:25	10	Speech by JICA	JICA Representative
4	10:25-10:40	15	Report of the OJT Results	JICA Expert
5	10:40-10:55	15	Handing the Certificate of OJT Attendance	Deputy Director of DRVN
6	10:55-11:00	5	Closing Speech	Chief of VEMO, PMU
			Coffee Break	

4.6.2 Each Course of OJT

(1) Pavement Course

1) Outline

Outline of pavement course is given in Table 4.26. Detailed activities of the course are given in ANNEX-8 (1).

Table 4.26 Outline of Pavement Course

Kind of Training	Date	Details
Classroom Learning	3 April (Wed.)	Lecture of TSG 1.1, TSG 1.2
	4 April (Thu.)	Lecture of TSG 1.3, TSG 1.4
	5 April (Fri.)	Lecture of TSG 1.5, TSG 1.6
On-Site Training	8 April (Mon.)	Instruction regarding operation of measuring equipment / Explanation of repairing works
	9 April (Tue.)	Survey and evaluation method for pavement damage such as rutting, pothole and difference in level
	10 April (Wed.)	Survey and evaluation method for pavement damage such as cracking
	11 April (Thu.)	Small repair works using cold asphalt mixture, and crack repair works by heat sealing materials.
	12 April (Fri.)	Evaluation of road surface condition by visual inspection in the patrol vehicle
	15 April (Mon.)	Confirmation of survey and evaluation methods for pavement damage
	16 April (Tue.)	Confirmation of small repair works
	17 April (Wed.)	Summary of inspection and repair works for pavement Explanation of pilot implementation after OJT

2) Unique Points Devised in the Training Implementation

Unique points of the pavement course are given in Table 4.27.

Table 4.27 Unique Points of Pavement Course

Items	No.	Details
Lecture documents	1	- The Japanese experts prepared the teaching documents written by Vietnamese and Japanese together for facilitation of the simultaneous interpretation.
Teaching method	2	- In order to be understood easily, the Japanese experts prepared the documents in such a way and adopted the plain explanation methods.
	3	- The trainees participated in classroom learning positively. They understood early and did the resourceful responses in the class.
Instruction on how-to use equipment	4	- Since trainees did not have prior experiences in using equipment and materials for OJT, the Japanese experts have combined explanation with documents and how-to-do basic operation in the lecture.
Safety measures in the training	5	- Safety measures are put highest priority in the on-site training in the lane control exercises. Emphasized are the security-first for the passing traffic of the expressway and for the OJT participants.

3) Incorporating Feedbacks in Finalizing TSG based on the OJT Exercises

So far, no crucial opinions are raised that TSG has to incorporate during OJT exercises. Though the OJT period was time-constrained, it is important that the trainees are expected to continue to identify problem areas by practicing the draft TSG.

(2) Bridge Course

1) Outline

Outline of the bridge course is given in Table 4.28. Detailed activities of the course are given in ANNEX-8 (2).

Table 4.28 Outline of Bridge Course

Kind of Training	Date	Details
Classroom Learning	3 April (Wed.)	Lecture of TSG 2.1
	4 April (Thu.)	Lecture of TSG 2.2
	5 April (Fri.)	Lecture of TSG 2.3-TSG 2.6
On-Site Training	8 April (Mon.)	Inspection works (routine)
	9 April (Tue.)	Inspection works (periodic)
	10 April (Wed.)	Inspection works (detailed)
	11 April (Thu.)	-ditto-
	12 April (Fri.)	Repair works (joint sealing)
	15 April (Mon.)	Repair works (resin mortar injection to cracks of concrete)
	16 April (Tue.)	Repair works (damage restoration by resin concrete)
	17 April (Wed.)	Summary of inspection and repair works for bridges Explanation of pilot implementation after OJT

2) Unique Points Devised in the Training Implementation

Unique points of the bridge course are given in Table 4.29.

Table 4.29 Unique Points of Bridge Course

Items	No.	Details
Producing contents of lecture documents	1	- In the classroom learning, the Japanese expert developed the PowerPoint documents, containing a lot of figures and photos so that trainees were able to understand TSG easier.
Lecture method	2	- Japanese expert produced the documents, rich with photos, videos, charts so that trainees can understand the contents of TSG easily. ▫ Prior to the on-site training of inspection and repair works, above mentioned documents were briefed. ▫ To wrap up everyday training, above mentioned documents were introduced and discussed for reviewing the training.
	3	- Japanese expert has tried to take a lot of time of discussion with trainees and the introduction of examples from trainees in both classroom learning and on-site training. ▫ Presenting participants' experiences of bridge damage incident and showing the damaged examples raised by participating trainees in the classroom training ▫ To discuss how to assess the damage detected in the inspection and repair works in on-site training.
Lecture and on-site training method	4	- Trainees questioned and discussed actively, and were totally cooperative with the Japanese expert. ▫ To discuss all of trainees by the introduction of their experiences in the classroom learning. ▫ To carry equipment and tools before / after the on-site training by all of trainees, and to progress the training program smoothly.
On-site training method	5	- The training for the concrete repair works were carried out at the concrete walls of the VEC O&M office to ensure the safety and to complete the training on schedule.
	6	- In the on-site training, opportunity of actual work training for all trainees was increased.
	7	- The training was carried out by good teamwork among Japanese expert, trainees and Vietnamese's supporting staffs. - By the trainees' active attitude, good training was accomplished.
Safety measures during the on-site training	8	- In the on-site training, the Japanese expert kept in mind for safe works such as; ▫ To bring the attention to trainees before the work starts. ▫ To confirm the safety of equipment and tools before the work starts. ▫ To take the break appropriately during the on-site training. ▫ To use the break time for the communication between Japanese expert and trainees.

3) Incorporating Feedbacks in Finalizing TSG based on the OJT Exercises

So far, no crucial comments are raised that TSG has to incorporate during OJT exercise. As Japanese experts took the time to discuss with trainees and always kept repetition of training contents during OJT exercises, understanding of TSG by the trainees was deepened.

(3) Electrical Facilities Course

1) Outline

Outline of electrical facilities course is given in Table 4.30. Detailed activities of the course are given in ANNEX-8 (3).

Table 4.30 Outline of Electrical Facilities Course

Kind of Training	Date	Details
Classroom Learning	3 April (Wed.)	Lecture of TSG
	4 April (Thu.)	-ditto-
	5 April (Fri.)	-ditto-
	8 April (Mon.)	Preparation of on-site training
On-Site Training	9 April (Tue.)	Inspection works (power receiving and distribution facilities)
	10 April (Wed.)	Inspection works (private power generation equipment)
	11 April (Thu.)	Inspection works (road lighting facilities) Traffic control for inspection works
	12 April (Fri.)	Inspection works (road lighting facilities)
Classroom Learning	15 April (Mon.)	Lecture of inspection data utilization method
	16 April (Tue.)	-ditto-
	17 April (Wed.)	-ditto-

2) Unique Points in the Training Implementation

Unique points of the electrical facilities course are given in Table 4.31.

Table 4.31 Unique Points of Electrical Facilities Course

Items	No.	Details
On-site training method	1	- To carry out the training to find small damage with the use of the measuring instrument. - To carry out how to use the measuring tools by trainees themselves after the Japanese expert explained it.
	2	- To prepare the check list and the recording sheet in the inspection prior to commencing the training, - To explain the importance of the data management and utilization method to the trainees in the classroom learning. - To explain repeatedly how to fill in the data obtained from the measuring tools by the trainees, who were organized in three groups.
On-site training method and safety measures during the on-site training	3	- Though trainees were unfamiliar with the inspection methods at the beginning, they have been able to carry out the inspection effectively after acquiring the knowledge. - Trainees had understood the importance of the safety, they did the inspection by taking into account the safety without the Japanese pointed out.
Safety measures during the on-site training	4	- Since the mental attitude of trainees for "the safety" was not enough, the Japanese experts ordered to the trainees to wear a helmet and safety vest during the on-site training.
	5	- To carry out the inspection of the power distribution equipment with the voltage detector, gloves and boots because there is a risk of electric shock.

Items	No.	Details
	6	- During the traffic control work, arrow boards and rubber cones were installed by taking into account the traffic safety. - Trainees stayed on the outside of the guardrail in order to avoid the danger from the traffic on the expressway.

3) Incorporating Feedbacks in Finalizing TSG based on the OJT Exercises

So far, no crucial comments are raised that TSG has to incorporate during OJT exercise. It is not known to what extent the contents of TSG have trainees understood because the lecture period of three days was limited and the contents of TSG were totally new for trainees. If there were chances of comments from the staff engaged in the actual on-site O&M works were available, it is assumed that the contents of TSG become more practical.

(4) Traffic Management Course

1) Outline

Outline of traffic management course is given in Table 4.32. Detailed activities of the course are given in ANNEX-8 (4).

Table 4.32 Outline of Traffic Management Course

Kind of Training	Date	Details
Classroom Learning	3 April (Wed.)	Lecture of TSG
	4 April (Thu.)	-ditto-
	5 April (Fri.)	-ditto-
On-Site Training (Group A)	8 April (Mon.)	Basic traffic control works
	9 April (Tue.)	Method of traffic control
	10 April (Wed.)	Method of traffic control
	11 April (Thu.)	Practical training on the expressway
On-Site Training (Group B)	12 April (Fri.)	Basic traffic control works
	15 April (Mon.)	Method of traffic control
	16 April (Tue.)	Method of traffic control
	17 April (Wed.)	Practical training on the expressway

2) Unique Points in the Training Implementation

Unique points of the traffic management course are given in Table 4.33.

Table 4.33 Unique Points of Traffic Management Course

Items	No.	Details
On-site Training Method (safety awareness)	1	- Since the volume of traffic in the Vietnamese expressway is generally low, the trainees are only conscious of the ordinary roads, and unaware of severity of expressways. - Therefore, the Japanese experts always endeavored to raise awareness of trainees regarding "expressway is dangerous, it is important that workers to behave conscious of expressway safety.
On-site Training Method	2	- To help trainees understand the traffic management easily, teaching materials with video and photos were prepared in Japan. - NEXCO traffic management experts have explained TSG with their practice.
	3	- It was intended that Experts and trainees to share maximum time in order to understand TSG sufficiently. - In the on-site training, trainees were organized in two groups, and detailed guidance was given in small group.
	4	- At the on-site training in Japan, a traffic management specialist engaged in the actual traffic management works at the Yokohama base of the Tomei Expressway was added to the tutorial cadre for the training course. - The above specialist could demonstrate the actual activities of traffic control works at one of the most heavy traffic sections in Japan.
	5	- On-site training of the traffic management was carried out at the premises of VEC O&M parking area. It was intended to avoid a risk of conducting on-site training on the expressways. - At that time, white color tapes were used for installing the imitation lane marking.
	6	- On the last days of each group, on-site training on the expressway was executed for reviewing the performance of the training conducted at the premises at VEC O&M parking. - Also, the evacuation training by all trainees was carried out to acquire skills to prevent injury accidents on the expressway.
	7	- Though trainees were unfamiliar with the traffic management works at the beginning, they could carry out the works well after doing the basic action repeatedly. - Trainees were observed to attend the training course seriously. It was also observed that they even volunteered to shoot a video shown by the Japanese experts explaining TSG
	8	- Traffic management personnel of VEC O&M cadre, who were not registered as the OJT participants, were admitted to the on-site training of Group B. - On the last day of training conducted at the actual expressway, they exercised the training actively, such as installation and removal of traffic control tools, in strict accordance to what are dictated by TSG.

3) Incorporating Feedbacks in Finalizing TSG based on the OJT Exercises

So far, no crucial opinions are raised that TSG has to incorporate during OJT exercises. In order that field O&M workers are able to understand TSG more precisely, it is recommended to train them rather than O&M staff of the O&M companies. As a matter of fact, the VEC O&M traffic management workers have participated in the on-site training.

4.6.3 Overall Evaluation of OJT Results

(1) Understanding Level of Trainees in OJT

As the trainees for OJT were selected with the conditions that they can attend for entire OJT period of three (3) weeks, almost all the trainees participated in all the training programs with the average attendance ratio of 76 % in all the four (4) fields. In addition, OJT curriculum was developed with such two (2) steps as classroom learning for understanding the contents in TSG (Draft) at the first step and on-site training for practicing the works at the second step. With the above devices, it was believed that trainees achieved high level of understanding.

In the fields of pavement and bridge / box culvert, as almost all of the trainees presently engage in O&M works of ordinary roads, they had a certain level of experience and knowledge and actively worked in OJT. It was believed that trainees sufficiently understand TSG (Draft).

For electrical facilities and traffic management fields, the trainees did not have any experience and knowledge and the contents of TSG were totally new for trainees. In order to enhance the understanding level of trainees, continued training is essential.

(2) Results of Questionnaire Survey to Trainees

In order to confirm the understanding level of trainees, questionnaire survey was carried out to all trainees participated after completion of all OJT exercises. It was summarized as follows. Some responses are given in Table 4.34 and Table 4.35 respectively. In addition, all responses are attached to ANNEX-9.

- Question-1: How to utilize the results of OJT exercises in your O&M works in the future?
- Question-2: Comments and opinions about OJT

It is understood that the majority of trainees considered OJT very helpful and would like to utilize the results in their future O&M works. On the other hand, some comments and opinions were raised that TSG (Draft) does not fully suit to the situation of expressways in Vietnam. In standardizing TSG, some revisions will be needed by MOT through the practical use of TSG and O&M works.

Table 4.34 Results of Questionnaire Survey (Question-1)

Course	No.	Category	Answers
Pavement	1	Application to the O&M works	- To apply TSG to the repair work of Ha Noi – Hai Phong Expressway in order to secure the safety and smooth traffic.
Bridge	2	Preparation of standards	- In drafting the standards and manuals of the expressway O&M works, reference will be made to TSG.
	3	Preparation of Inspection Plan	- In drafting bridges and box culverts inspection plan, reference will be made to the knowledge a trainee acquired during the course.
	4	Use of TSG in the organization	- Use the acquired knowledge for the education in the University as follows; ▫ To add “the bridge inspection and maintenance course” to the academic curriculum of the land transport faculty. ▫ To implement the course in the University in the future.
	5	Application to the O&M works	- To apply TSG to the repair and maintenance works of expressways in Vietnam. - To use the knowledge acquired from OJT for the inspection and repair works of old bridges between Thanh Hoa and Thua Thien Hue. - When a trainee finds any damage in the bridges within the operation area, he can judge the damage and determine the repair method.
Electrical Facilities	6	Preparation of standards	- TSG will be a manual to inspect and monitor the electrical system in Vietnam. - To establish the working process for the electrical facilities inspection and maintenance in Vietnam.
	7	Preparation of O&M plan	- To develop the repair and maintenance plan. - To develop quarter and annual plans for periodical inspections and repairs on electrical facilities.
	8	Application to the O&M works	- To correct the inadequacies in the existing working processes. - To apply the road lighting maintenance of highways and expressways in Vietnam. - To improve the ability to inspect and maintain the electrical infrastructure. - To use the knowledge acquired from the training to the expressway O&M works in Vietnam.
Traffic Management	9	Utilization of TSG in the Organization	- Trainee who participated to OJT improves his ability on his own and educates to other staff in the organization. - Trainee who participated to OJT educates and trains to other staff in the organization. - To utilize the knowledge acquired from OJT to the lectures of the class at the University. - In the future, if there is a class of expressway O&M in the university, a trainee will instruct to other lectures.
	10	Application to the O&M works	- To utilize the knowledge acquired from OJT to the O&M works as follows; ▫ Activities and behaviors in the traffic management works. ▫ Communication between the related organizations for the information exchanges. ▫ Communication between traffic administrators. ▫ Communication between traffic polices and traffic administrators.

Table 4.35 Results of Questionnaire Survey (Question-2)

Course	No.	Category	Answers
Pavement	1	Compatibility of TSG	- A course was very effective and practical; but some points are not suited to the expressways in Vietnam. . - TSG will not be applied by some organizations.
	2	Contents Learned	- We learned the followings: ▫ Safety during the work. ▫ Knowledge of the road inspection. - To acquire the skills of repair and maintenance planning for the expressway O&M.
Bridge	3	Compatibility of TSG	- TSG includes a lot of knowledge and was prepared practically. But it is necessary to examine some items to suite to the situations in Vietnam. - The Japanese experts worked hard, and they have a lot of technical knowledge. - The atmosphere of the class was fun. - There should be more on-site training courses.
	4	Request to the contents of TSG	- Since we learned the inspection procedures and items to be inspected, repair measures can be taken in advance through determination of locations to be inspected regularly and evaluation of degree of damage. - We could study useful things for our works because there were both the class room learning and on-site training in OJT. - Though TSG includes the general forms for bridges, specific forms by structure types, such as expansion joint, abutment, pier, beam, are needed in order to collect and use the data with ease.
	5	Contents Learned	- We studied a lot of new repair works and management of the expressway O&M.
Electrical Facilities	6	Contents Learned	- The contents of OJT are very practical, and the work safety was always reminded in the training. - We could use the advanced equipment and tools for the effective work and work safety. - We could learn a lot of knowledge about repair and management of the expressway O&M and the working manner. - Contents of the Japanese O&M manuals are detailed and unified. - This OJT course is needed for Vietnamese. - We studied a lot of good things in various ways. - We have a good impression about the working way of the Japanese experts. - We have learned closely a technique of repair and management of the expressway O&M in Japan, and utilize them in the Vietnamese expressway O&M works.
Traffic Management	7	Compatibility of TSG	- Japanese experts have a high degree of specialization in each field and explained kindly. - It is difficult to apply TSG in Vietnam because the roles of each organization are not clear in Vietnam. - Japanese experts gave us the instruction kindly and carefully. - Equipment is easy to use, and it's good for the works, but it is difficult to use in severe weather conditions such as typhoons.
	8	Contents Learned	- Japanese expert gave the knowledge, which was useful to us, in this course kindly.

4.7 Execution of the Pilot Implementation (Activity-4-2)

4.7.1 Outline

(1) Schedule

The schedule and the detailed activities of the pilot implementation are given in Table 4.36.

Table 4.36 Outline of Pilot Implementation

Phase	Date	Duration	Activities	Remarks
Phase-1	22 April - 24 May, 2013	5 weeks	- Based on the results of OJT, each trainee will use TSG in the actual expressway O&M works. - Trainees will review and check the contents of each TSG by themselves based on the implementation of O&M works.	
Phase-2	27 May – 7 June, 2013	2 weeks	- Japanese experts and trainees will review the contents of each TSG based on the results of pilot implementation. - Japanese experts will visit again VEC O&M and Cuu Long CIPM presently conducting expressway O&M. - Japanese experts will survey how TGSs are being used. - Japanese experts' team is going to finalize TSG.	

(2) Results of Pilot Implementation

Results obtained from the practical use of TSG (Draft) in the actual O&M works by each trainee during the pilot implementation period should be archived as the project data. Data will be filled in the recording sheets, which are prepared by the project team, for each trainee, and submitted them during the Phase-2 period of pilot implementation. The project team will finalize TSG with reference to the recording sheets after they are submitted. The summary of the pilot implementation results are given in Table 4.37.

Table 4.37 Summary of Pilot Implementation Results

Phase	Summary of the Pilot Implementation
Phase-1	- The trainees who participated in OJT exercises came back to their workplace and used TSG (Draft) in their actual Expressway O&M works. - The results obtained from the practical expressway O&M works were collected and archived as the project documents.
Phase-2	- The collected data were input to the forms of TSG and submitted to the Japanese experts. - The Japanese experts have examined the data sheet produced by the trainees. Those trainees' responses that need to be incorporated to TSG were reflected in finalizing TSG with the Japanese experts' evaluation.

4.7.2 Results of Pilot Implementation in Each Field and Overall Evaluation

(1) Pavement Field

The results of pilot implementation for pavement conducted on expressways managed by VEC O&M and Cuu Long CIPM are as attached in ANNEX-10 (1).

It was confirmed that daily and routine inspections were conducted in accordance with TSG (Draft) and the results were recorded properly in the specified forms. On the other hand, some routine inspection items were not carried out as they do not have necessary equipment. As to the repair works, though potholes detected in the inspection were repaired, cracks were not repaired due to no necessary machinery and equipment. It is concluded that presently possible pilot implementation was sufficiently conducted except for the works which need special machinery and equipment.

Comments, opinions and suggestions to TSG were collected during the pilot implementation, and some of them related to the finalization of TSG and responses to them from the Japanese experts are given in Table 4.38. As the result, there was no crucial opinion that TSG has to be revised during the pilot implementation period. However, it is necessary to use TSG and to extract the problem areas continuously in the future because the operation period of the expressway is limited until now.

Table 4.38 Results of Pilot Implementation in Pavement Field

Category	No.	Opinions and Suggestions	Replies
Relation between repair works and budget	P1	- Since the sources of budget for pothole repairs are different by the causes of pothole, potholes should be classified by types of causes.	- Causes of the pothole cannot be clearly identified, as a variety of causes regulate potholes individually or combinedly.
Repair work cycle	P2	- Advise the optimal repair cycle of potholes, because the cycle depends on the number and density of potholes in Vietnam.	- Optimum repair cycle cannot be determined as it depends on available budget and level of service of each expressway. - The level of service is determined by respective administrative entity of state or region.

The following comments, opinions and suggestions were also raised. In order to solve these issues, it is recommended MOT standardize TSG as early as possible as well as secure the sufficient budget for O&M works, procure necessary machinery and equipment and revise TSG through continued use of TSG and actual O&M works to suit to the situation of expressways in Vietnam.

- In Vietnam, without standardizing the procedures of inspection and repair works, such works cannot be implemented.
- We understand the necessity to repair the cracks; but we cannot carry it out because there is no budget.
- Some items of inspection and repair works could not be implemented as we do not have necessary equipment and tools.
- We do not know where there are any problems in TSG, because the service time has been very short since it is open to traffic and consequently the practical work experience is limited.

(2) Bridges

The results of pilot implementation for bridge and box culvert conducted on expressways managed by VEC O&M and Cuu Long CIPM are as attached in ANNEX-10 (2).

It was confirmed that daily and routine inspections were conducted in accordance with TSG

(Draft) and the results were recorded properly in the specified forms. Pilot implementation detected exposure of steel reinforcements on concrete deck slab, dropping the bolts off, clogging with soils and rubbish, and conducted evaluation of defects / damage and subsequent urgent measures / repair works in accordance with TSG (Draft). It is concluded that pilot implementation was successfully carried out.

Comments, opinions and suggestions to TSG were collected during the pilot implementation, and some of them related to the finalization of TSG and responses to them from the Japanese experts are given in Table 4.39. As the result, the form for the periodic inspections in TSG (Draft) was revised with reference to the form prepared by the JICA Project "Transport Sector Loan for National Road Network Development" as well as main texts of TSG (Draft) related to this review were revised.

Table 4.39 Outline of Pilot Implementation in Bridge Field

Category	No.	Opinions and Suggestions	Replies
Form for inspection	B1	- The form of periodic inspections in TSG should refer to the inspection forms for ordinary roads used in Vietnam.	- The form of periodic inspection follows the form of the ordinary road manual presented by VEMO.
	B2	- The legend in Form 2-4 should be modified for easy understanding to Vietnamese engineers / workers.	- The legend is excerpted from the manuals in Japan. It will be changed with reference to the Vietnamese standard.
	B3	- Form for the abutment should be added to Form 2-4.	- There is the Form for the pier, and it can be used as the Form for the abutment. Therefore the Form of the abutment is not added.
Evaluation of inspection	B4	- A comparative statement indicating the damage with its degree assessed versus examples is needed.	- It should be produced in the future through continued inspection works. It is out of scope of the project.
Contents of TSG	B5	- In Form 2-2, expression of “abnormal vibration” should be replaced by the word “excessive vibration” as a Vietnamese description.	- It will be changed accordingly.
Style of printing TSG	B6	- TSG should be printed by A5 size for portability.	- At the TG meeting, it was decided that TSG document is to be produced 50 copies by A5 size.

It is recommended in the future that MOT standardize TSG as early as possible as well as revise TSG through continued use of TSG and actual O&M works to suit to the situation of expressways in Vietnam.

(3) Electrical Facilities

The results of pilot implementation for electrical facilities conducted on expressways managed by VEC O&M and Cuu Long CIPM are as attached in ANNEX-10 (3).

It was confirmed that visual inspection and daily / routine inspections using the measuring equipment were conducted for power receiving / distribution facilities and private power generation facilities in accordance with TSG (Draft), and the results were recorded properly in the specified forms. For defects / damage detected, urgent measures were properly implemented. It is concluded that pilot implementation was properly conducted.

Comments, opinions and suggestions to TSG were collected during the pilot implementation, and some of them related to the finalization of TSG and responses to them from the Japanese experts are given in Table 4.40. As the result, no inconsistency was found.

Table 4.40 Outline of Pilot Implementation in Electrical Facilities

Category	No.	Opinions and Suggestions	Replies
Inspection Equipment	F1	- None of inspection work can be done because there is no instrument (grounding resistance measuring equipment, insulation resistance measuring instrument).	- Since it is necessary to grasp functional degradation beforehand and to do preventive maintenance, the measuring instruments are needed. - It is advised to request necessary budget for procurement of measuring instruments to the competent institute / organization after TSG is standardized.
	F2	- Without platform / scaffolding for inspection of power receiving leading-in poles, detail inspections cannot be implemented. - Currently, only appearance check of dirt / damage around top of leading-in pole can be done from the ground.	- The inspection of power receiving leading-in poles on transformer, attachment and low-pressure switchboard is necessary to grasp functional degradation beforehand, and to do preventive maintenance. - It is advised to request necessary budget for installation of platform / scaffolding on the poles to the competent institute / organization after TSG is standardized. - It is advised to proceed with TSG standardization.
Others	F3	- We have conducted inspections using the inspection record forms in TSG. - Photographs are taken with whiteboard indicating inspection items and judgment (evaluation) results.	- Continued implementation is required.

The following comments, opinions and suggestions were also raised. In order to solve these issues, it is recommended MOT standardize TSG as early as possible as well as secure the sufficient budget for O&M works, procure necessary machinery and equipment, continue OJT and revise TSG through continued use of TSG and actual O&M works to suit to the situation of expressways in Vietnam.

- Further defects / damage are found on inspection items newly specified in TSG. Though such defects / damage are reported to relevant authorities, no budget is allocated for repair works.
- No repair work can be conducted for defects / damage detected by inspections because sufficient budget is not allocated.
- Due to small number of skilled staff members, it needs a lot of time for inspection.
- Trained staff members gave education and training to other staff members related to TSG and OJT.

(4) Traffic Management

The results of pilot implementation for traffic management conducted on expressways managed by VEC O&M and Cuu Long CIPM are as attached in ANNEX-10 (4).

It was confirmed that traffic patrols were conducted in accordance with TSG (Draft) and the results were recorded properly in the specified forms. Measures such as i) rescue of disabled vehicles, ii) rescue of vehicles with flat tires and iii) removal of road obstacles were properly conducted and recorded. Traffic accidents were also satisfactorily handled and recorded on details of accidents and measures taken. It is concluded that pilot implementation was satisfactorily conducted.

Comments, opinions and suggestions to TSG were collected during the pilot implementation, and some of them related to the finalization of TSG and responses to them from the Japanese experts are given in Table 4.41. As the result, "Status of cooperation organizations" was added in the TSG Form of "abnormal event corresponding records". No other inconsistency was found.

Table 4.41 Outline of Pilot Implementation in Traffic Management Field

Category	No.	Opinions and Suggestions	Replies
Traffic Patrol System	T1	- According to TSG, at least two (2) crews shall conduct traffic patrol. However, for Cau Gie - Ninh Binh Expressway, just one (1) crew can conduct traffic patrol due to its small number of traffic volume.	- To ensure safe on-road works, it shall be necessary to conduct traffic patrol with at least two (2) crews.
Traffic Control Tools	T2	- Since traffic regulation equipment presently used in Vietnam is heavy, it is difficult to install required number of equipment specified in TSG.	- With the increased number of traffic volume, it is safe to install required number of traffic regulation equipment as specified in TSG. - It is advised to request necessary budget for renewal of traffic control equipment to the competent organization.
Use of Flag	T3	- We used batons commonly used in Vietnam for traffic regulation, since we do not have flags and/or the drivers cannot be aware of instructions by flags newly introduced.	- Use of "the baton" is accepted in TSG. - It is advised to gradually shift to "a flag" with the traffic increase, because "a flag" is superior in visibility and safety.
Recording Form	T4	- Pilot Implementation was carried out by the addition of "Status of cooperation organizations" to the TSG Form of "countermeasures taken against abnormal event records".	- "Status of cooperation organizations" is added in the TSG Form of "abnormal event corresponding records".

The following comments, opinions and suggestions were also raised. In order to solve these issues, it is recommended MOT standardize TSG as early as possible as well as make decision on establishment of traffic control center and revise TSG through continued use of TSG and actual O&M works to suit to the situation of expressways in Vietnam.

- Since TSG is not yet standardized officially by MOT, patrolling record as dictated in TSG could not be used during the pilot implementation.
- There is no traffic control center for HCMC - Trung Luong Expressway. (Wrecker management section holds responsible for the role of the traffic control.)

4.8 Finalization of TSG (Draft) and Assistance in Standardizing the TSG (Activity-5)

4.8.1 Finalization of TSG (Draft)

(1) Comment to TSG (Draft)

A Draft version of TSG, hereunder termed as "TSG (Draft)", was used as a tutorial text for the classroom learning in the OJT exercise. Trainees who participated in the OJT exercises have carried out the pilot implementation at their expressway O&M works in the fields. With the completion of OJT exercises coupled with their pilot implementation, comments about TSG (Draft) from the trainees were collected and mentioned in Section 4.8.2. Furthermore, comments about TSG (Draft) were submitted separately by Cuu Long CIPM (Company 715) and by VEC (VEC O&M), both of which entities are carrying out the expressway O&M works at present. (see ANNEX-11 (1))

(2) Method of Finalization of TSG (Draft)

The following comments were considered in the revision of TSG (Draft). Revised TSG was approved and finalized in the TG meetings held on 18 April and 5 June, 2013. Finalized TSG has been printed after checking the contents several times by VEMO.

- Comments from Cuu Long CIPM (Company 715) and VEC (VEC O&M)
- Comments from MOT and DRVN submitted (see ANNEX-11 (2))
- Comments made during OJT exercises and the pilot implementation

4.8.2 Assistance in Standardizing the TSG

(1) Overview

The finalized version of TSG, produced through this Project, is intended to be used as the sole reference to the "Expressway O&M standards" in Vietnam in the future. However, the Expressway O&M standards have to cover the whole fields of Expressway O&M works as given in Figure 4.2, "Configurations of Improved O&M Standard".

Therefore the project team took avail of all opportunities to mention the perspective of the "Expressway O&M Standards and Manuals" in the Project meetings. In addition, the prepared four fields of TSG which are applicable in the expressway O&M works directly should be used in the actual O&M works, immediately after they are established as standards. And it is important to use the standardized TSG in the practical expressway O&M works, and confirm the suitability in the Vietnamese expressway conditions. It is expected that the Vietnamese side continue to revise TSG and finalize TSG that meet the Vietnamese situations.

(2) Way of Standardization and Schedule

At the JCM on 7 May, 2013, Mr. Nguyen Hong Truong, Vice Minister of MOT, has instructed the personnel from MOT/DRVN to standardize the prepared four fields of TSG as early as possible. Pursuant to the Vice Minister's directive, DRVN is in a move to standardize it by the middle of 2014. Table 4.42 gives the direction of how to standardize it.

Table 4.42 A Roadmap for Establishing TSG Standards

Steps	Timing	Details
Step 1	June 2013	- Preparation of the four fields of TSG by the Project
Step 2	December 2013	- Whole fields of TSG will be prepared by the WG established within DRVN. - The WG members are to be composed by DRVN and UTC. - TSG is divided into "Maintenance Works" and "Traffic Management". - Maintenance Works of TSG make avail of those produced by the Project – pavement / bridge / electrical facilities. The remaining TSG areas so far not yet produced - tunnel, metal bridge, slope protection, etc. will be prepared by making avail of the temporary regulations and other countries' manuals. - TSG of Traffic Management will be prepared based on the prepared TSG (traffic management).
Step 3	Middle of 2014	- The TSG, thus produced as above, covers the whole fields of Expressway O&M. It will be circulated among concerned authorities and agencies to invite opinions / comments. - Afterwards, TSG will take effect as a standard of DRVN.
Step 4	Middle of 2016	- Expressway O&M companies such as VEC and Cuu Long CIPM apply the standard of DRVN. - The standard will be standardized, after extracting problems of TSG from the result of the application.
Step 5	After 2016	- DRVN reports it to MOT so that the standard becomes the national standard. - Afterwards, MOT will take them effect as a national standard.

Source: Above mentioned details are clarified in the meeting with the attendance of the Director of the Science and Technology in DRVN on June 18, 2013.

On the other hand, preparation of "ITS Standards and Manuals" is being undertaken independently by MOT. At present, MOT has established WGs to produce the standards and manuals for the following five sub-systems of ITS.

- Variable Message Signs: VMS
- Electronic Toll Collection System: ETC
- Traffic Management Center
- Communication System
- Weigh Station

With the initiatives of MOT, the Vietnamese IT companies participate. Contents of standards and manuals being produced target not only design standard of ITS equipment but also operations manual. In particular, the JICA study reports on ITS serve as the basic reference for these preparation of ITS standards now.

4.9 Workshop (Activity 6)

The preparation of whole fields' of standards and manuals are needed in order to establish the expressway O&M system in future. In addition, personnel training in the area of expressway O&M works are essential. In order to establish the expressway O&M system by Vietnamese themselves, a workshop was held on 21 June, 2013 at DRVN, at which occasion the Japanese experts provided the useful information regarding expressway O&M technology,.

In the workshop both sides of the Japanese and the Vietnamese gave four presentations under the main theme "Establishing the expressway O&M system in Vietnam" as follows;

- Vietnamese side: i) The present situation and plan of the expressway O&M in Vietnam
- Japanese side: i) Method of financing for expressways development, ii) Necessity for the establishment of data base systems for expressway maintenance works, and iii) Present status of ITS operation in Japanese expressways

By the way, presentation topics of Japanese side were selected from the requesting items from Vietnam, which were described by Mr. Nguyen Hong Truong, Vice Minister of MOT, at JCM.

The summary of the workshop is attached to ANNEX-12.

4.10 Training in Japan (Activity 7)

Technical Training in Japan has been done in order to understand the actual expressway O&M system in Japan, and help Vietnamese side to prepare TSG (Draft) efficiently. This training was planned to be conducted from November 2012 for 10 days. Number of trainees are 10, and most of trainees were selected from main members of TGs. Moreover, many project members from NEXCO became the lecturers for the each training program.

5 Subjects, Creativity, Lessons Learned on Implementation of the Project (way of project implementation and management system of the project)

5.1 Subjects

Subjects that have been arisen in the project implementation are given in Table 5.1.

Table 5.1 Subjects

No.	Category	Descriptions
1	Counterpart of the project	- The counterparts of the project are divided into two organizations, PMUTA and VEMO of DRVN, held responsible, respectively for administrative and Technical matters. However, sometimes the project team doesn't know which organization is to be engaged in the works related to both administrative and technical matters. It is recommended that the two bodies to establish a single contact point to be dedicated to the project coordination.
2	Preparation method of TSG	- Since DRVN doesn't manage any expressways so far, there are no engineers familiar with the expressway O&M technique. Then, practical matters in the prepared TSG (Draft) are hardly understood by DRVN. Therefore, some organizations and engineers familiar with these practices should be included in the project implementation.
3	Standardization of TSG	- At present, Cuu Long CIPM and VEC are affiliated organizations of MOT, and are not under DRVN. Therefore, in order to utilize the prepared TSG in the expressway O&M works, it is mandated that TSG come into effect as the MOT Standards.

5.2 Creativity

Creativities during the TSG preparation in the project are given in Table 5.2.

Table 5.2 Creativity

No.	Category	Descriptions
1	Preparation method of TSG and revision of TSG in the future	- Basically, TSG (Draft) were prepared based on the contents of "the Temporary Expressway O&M Regulations of Vietnam". Moreover, "Ordinary Roads' O&M Standard of Vietnam" and other countries' expressway O&M standards were referred to compensate for the lack of those parts in the Vietnamese regulation. - However, there is not enough description of the Vietnamese standard criteria regarding electrical facilities and traffic management at present. Therefore, many parts of these fields shall be applied from the standards and manuals of Japanese expressways. - Therefore, it is mandated to revise them in accordance with Vietnamese expressway condition in the future if there are any unsuitable parts in TSG, exemplified by its practical use in the actual expressway O&M works.
2	Preparation method of TSG	- Revision of them will be carried out by the Vietnam government itself in the future. Therefore the project team always worked in cooperation with TGs for the preparation of TSG, and did the technology transfer at major milestones of how to prepare TSG. Then, TGs members can understand the flow of revision, and does the preparation of TSG by themselves.
3	Contents of TSG	- The project team tried to describe more easily and more specifically the contents of TSG in order to be understood by the Vietnamese working staffs of the expressway O&M works.

In addition, points given in Table 5.3 were considered in the OJT Implementation Plan.

Table 5.3 Points to be Considered

No.	Category	Descriptions
1	Selection of OJT trainees	- OJT members were selected from the field staff engaged in the highways and expressways O&M works presently and those who will be engaged in the future because the prepared TSG (Draft) can be utilized practically by the staff of the highways and expressways O&M works. - In particular, the project team requested many engineers from Cuu Long CIPM and VEC, which are presently carrying out the expressway O&M works, to participate.
2	Selection of OJT equipment	- Since expressway O&M companies in Vietnam must be able to procure equipment for O&M works easily in the future, equipment for OJT was basically procured in Vietnam as much as possible. Eventually, 16 out of 87 items for OJT equipment were only imported from Japan and other countries.

5.3 Lessons

Lessons learned through the project are given in Table 5.4.

Table 5.4 Lessons

No.	Category	Descriptions
1	Need of the reflection to TSG about experience and knowledge	- At present, there are only two expressways in service, Cau Gie - Ninh Binh and HCMC - Trung expressways, and operated by VEC and Cuu Long CIPM respectively. In addition, the companies have experiences in operation for a shorter period only, and their expressway O&M works' experiences are very limited. Therefore, information from these expressways' O&M works is not reflected in the contents of TSG.
2	Need of the experience and knowledge accumulation	- Accumulation of the expressway O&M works' know-how in the O&M companies is essential. In addition, it is necessary to train many technical staff in the future.
3	Need of the personnel training	- For training the technical staff, it should be done cooperatively with the ongoing JICA project, "Project for Enhancing Training Capacity of Transport College (currently University of Transport Technology) ".
4	Need of the establishment of the expressway O&M system and the personnel training method	- In order to revise standards / regulations / manuals and human resources development in the future, it is important to establish the cooperation system among Public (MOT, DRVN) and Private (expressway O&M companies) and Research Institutes (UTC, UTT, ITST etc.). Thus, VEA (advance organization of VEMO) should be established as a subordinate organization of MOT rather than DRVN as soon as possible. And VEA should be given overall jurisdictional power over all expressway O&M companies.

6 Achievement of the Project Objectives

6.1 Achievement of the Project Objectives

Project Objective is as follows.

- Effective & safety framework for O&M of Expressway is established

In order to achieve this objective, the outputs mentioned below are expected in this project.

- Overall scheme for O&M of Expressway is established.
- Trial O&M works is executed at some Expressway based on the above scheme.

The project team presented the perspective of standards and manuals which are needed to carry out the expressway O&M works. Continuously, four fields were selected as the important and urgent fields among them, and four fields of TSG have been prepared.

Furthermore, OJT and pilot implementation were executed to train the personnel engaged in the expressway O&M works based on the prepared TSG. Then the objectives of the project were accomplished. Since the scope of the prepared TSG is limited and the number of participated trainees in OJT and pilot implementation were limited, it is necessary to extend such training programs in the future.

6.2 Activities Necessary for Achievement of the Project Objective

The Project outputs will help MOT to establish a roadmap for the expressway O&M system in the future. Based on the result of the project, activities that are needed to be done in Vietnam are considered as follows;

- To standardize the four fields of TSG that were prepared by the project team, and they should be used at the actual expressway O&M works.
- After applying and practicing TSG to the actual expressway O&M works, four fields of TSG should be revised to adapt to the actual expressway O&M works condition in Vietnam.
- In revising TSG process, it is important to listen to the opinions from the expressway O&M workers.
- Produce a comprehensive TSG, integrated with the four fields of TGS.
- The comprehensive TSG thus produced shall be used in all expressway O&M companies of Vietnam.
- Expressway O&M workers should be trained based on the above comprehensive TSG.

In carrying out the above mentioned items, expressway O&M works will be able to be performed by several expressway companies that will operate the several expressways in Vietnam in the near future with the unified level of service responding to social needs. Expressway O&M standards and manuals should be prepared based on the accumulation of the daily O&M work experience, and they should be revised by their experiences. In addition, it is necessary to establish a dedicated unit held responsible for the preparation of the expressway O&M standards and manuals in the administrative organization. The dedicated unit is tasked to grasp field’s actual situation of the expressway O&M works, and to revise the standards and manuals to conform to the actual situation.

7 Recommendations on Achieving the Overall Goal

At present, each expressway is operated by applying respective temporary regulations enacted for each expressway. However, what are stipulated by respective temporary regulations are rather conceptual and do not necessarily cover all fields of expressway O&M works. Therefore, it is not satisfactory to execute all aspects of the O&M works by the existing temporary regulations.

Therefore, in this project, only the four principal fields of TSG, that are deemed critical and essential, are prepared. In the future, it is required to produce standards and manuals encompassing all fields of O&M, based on these four fields of TSG as reference. Therefore the JICA Experts Team recommends below how to prepare the expressway O&M standards and manuals in the future.

7.1 Types of Standards, Specifications and Manuals

7.1.1 General Standards, Specifications and Manuals in Japan

Table 7.1 collates General Standards, Specifications and Manuals generally seen in various sectors of Japan.

Table 7.1 General Standards, Specifications and Manuals Practiced in Japan

Hierarchy	Contents	Competent Institution	Remarks
Act	Legal instrument enacted through The National Diet Resolution	The National Diet	
Cabinet Order Ordinance of the Ministry Rule	Administrative Order, Directives	Respective Administrative Organ	
National Standard	Competent Minister's Decision	Respective Administrative Organ	JIS (Japanese Industrial Standards) etc.
Sector Standards	Stipulated by Sector Administration	Respective Administrative Organ	
Specifications	Privately specified	Concerned Institution	
Manuals / Guidelines	Privately specified	Concerned Institution	

Source: JICA Experts Team

7.1.2 Types of Standards and Manuals in the Japanese Highway Sector

Table 7.2 collates General Standards, Specifications and Manuals seen in the highway sector of Japan.

Table 7.2 Types of Standards and Manuals Practiced in Japanese Highway Sector

Hierarchy	Standards, Specifications and Manuals	Contents	Competent Institution
Act	Road Act	Stipulates Road Principles and General Rules	The National Diet
Ordinance of the Ministry	Road Structure Ordinance, Road O&M Standard [Note]	• Designates Standard Specifications • Designates Standard Specifications of Road O&M	Ministry of Land, Infrastructure, Transport and Tourism
Rules for Operation	Rules for Operation attached to the Road Structure Ordinance, etc.	Gives interpretations of the above standard specifications	Ministry of Land, Infrastructure, Transport and Tourism
Sector Standards	Specifications for Highway Bridges, Standard Specifications for Concrete Structures	Specifies standards in road construction	
Specifications	General Specifications for Civil Works	Specifies conditions for implementing various construction works	Expressway operating body
Manuals / Guidelines	Design and construction manuals / guidelines	Guidelines/Manuals for Construction work's implementation methods	Expressway operating body
Norm	Norms applicable for civil work cost estimate	Standard methods employed in cost estimating respective civil works	Ministry of Land, Infrastructure, Transport and Tourism / Expressway operating body
Supplementary Provisions, Schedule	Unit cost for estimating civil work costs	Gives reference unit prices and reference amount multipliers	Ministry of Land, Infrastructure, Transport and Tourism / Expressway operating body

Source: JICA Experts Team

[Note]: At present, highway O&M operational references are set by respective highway administration. The Ministry of Land Infrastructure, Transport and Tourism in Japan has decided to designate them by establishing a legal instrument. (http://www.kensetsunews.com/?p=12362, 2013/05/13)

7.1.3 A Hierarchical List of Vietnamese Specifications, Operational Procedures and Supporting Manuals in the Road and Highways Sector

A Hierarchical List of Vietnamese Specifications, Operational Procedures and Supporting Manuals in the Road and Highways Sector is given in Table 7.3.

Table 7.3 List of Vietnamese Specifications, Operational Procedures and Supporting Manuals in Road and Highways Sector

No	Category/ Class	Effective Date	Category of Documents	Institution	Document ID	Title
1	[C] [III]	16/8/1997	Circular	MOF	53/TC/TCT	Guiding the procedure for collection, payment and management of the fee for ensuring inland waterway traffic order and safety
2	[B] [IV]	20/12/2001	Decision	MOT	4393/2001/ QĐ-BGTVT	Promulgating 22TCN237-01 Standard of rules and road signs Regulations of Road Signs: Traffic regulation of traffic lane management for maintenance works on opened traffic road etc.
3	[B] [IV]	28/5/2003	Decision	MOT	1527/2003/ QD-BGTVT	Promulgating 22TCVN306-03 on Technical Standards for Road Routine Maintenance
4	[C] [II]	3/6/2002	Decree	GOV	57/2002/ ND-CP	Detailing the implementation of the ordinance on charges and fees
5	[C] [III]	19/7/2004	Circular	MOF	76/2004/ TT-BTC	Instruction for collection, remittance, management and usage of fees, charges in road transportation
6	[C] [III]	21/5/2007	Circular	MOF	53/2007/ TT-BTC	Instructions for collection, payment and usage of fees levied on driving test
7	[I]	13/11/2008	Law		23/2008/QH2	Road Traffic Law
8	[A] [III]	4/1/2010	Report	PMU My Thuan	15/PMUMY-TCB	Approval of the Plan for Temporary Management of HCMC- Trung Luong Expressway (Phase 1) (adjusted, supplemented to Report 5196/PMUMT-TCB dated December 25th 2009)
9	[A] [III]	20/1/2010	Decision	MOT	181/ QD-BGTVT	Approving the Plan for Management Organization, Temporary Operation of HCMC- Trung Luong Expressway
10	[A] [III]	21/1/2010	Decision	MOT	195/ QD-BGTVT	Temporary Regulation on Management & Operation over Ho Chi Minh City – Trung Luong Expressway
11	[B] [IV]	19/4/2010	Circular	MOT	10/2010/ TT-BGTVT	Road Maintenance Routine Standards
12	[C] [III]	28/7/2010	Ministerial Decision	DRVN	1270/QD'-TCDBVN	On the promulgation of “Regulations for authorization of power and responsibility of DRVN in the management of investment into repairs conducted in the National Highway system, with the usage of economic road fund and revenues collectible from ferry fee
3	[A] [III]	24/12/2010	Decision	MOT	3641/QD-BGTVT	Temporary Regulation on Organization, Management, and Operation of Thang Long Boulevard
13	[A] [III]	17/2/2011	Decision	MOT	266/QD-BGTVT	Temporary Regulation on the Maintenance of Ho Chi Minh City- Trung Luong Expressway
14	[C] [III]	28/4/2011	Resolution	HCMCPC	03/2011/ NQ-HDND	Adjustment of road charges at toll gate of Binh Trieu 2 Bridge
15	[A] [III]	28/10/2011	Decision	MOT	2451/QD-BGTVT	Temporary Regulation on Management and Operation over Cau Gie – NH21 Section of Cau Gie – Ninh Binh Expressway
16	[A] [III]	28/10/2011	Decision	MOT	2452/QD-BGTVT	Management and Operation Plan over Cau Gie – NH21 Section of Cau Gie – Ninh Binh Expressway

Source: JICA Experts Team

Category: [A] Expressway O&M, [B] O&M of Roads, [C] Funds for road construction and O&M.

Classification: [I] Act, [II] Ordinance of the Ministry, [III] Rules for Operations, [IV] Sector Standards, [V] Specifications, [VI] Manuals / Guidelines, [VI] Norm, [VII] Supplementary Provisions and Schedule

Source: “Technical Standard on Road Maintenance Issued Pursuant to Decision No. 1527/2003/QD-BGTVT, May 28, 2003” (Vietnam Transport Sector Study Task 5 Proposal for National Road Maintenance Program, JICA Feb. 2010 (P3-18))

7.2 Principles Employed in Producing Expressways' O&M Standards and Manuals

7.2.1 Comparison of the Reference Specifications by Both Countries

Though Vietnam has already established a substantial number of reference specifications and guiding manuals in the Road and Highways sector, yet they are not satisfactory in their coverage as given in Table 7.3. In order to elucidate those areas lacking in the Vietnamese side, a comparison is made in Table 7.4.

Table 7.4 A Comparison of Reference Specifications Available by Both Countries

Hierarchy	Reference Specifications Available		Present Availability of Vietnamese Reference Specifications
	Japanese Reference Specifications	Vietnamese Reference Specifications (In accordance with the MOT's document Classification of Table 7.3)	
Act	The Road Act	[I] Law	Lack of an Act that govern the whole road sector
Ordinance of the Ministry	Road Structure Ordinance Road O&M Standards	[II] Decree	Lack of an Ordinance that systematically designate the road sector
Rules for Operations	Rules for Operations attached to Road Structure Ordinance	[III] Circular / Decision	Ditto
Sector Standards	Specifications for Highway Bridges, Standard Specifications for Concrete Structures		
Specifications	General specifications for civil works	[IV] Circular / Decision	Ditto
Manuals / Guidelines	Manuals and Guidelines		
Norm	Reference unit prices for civil works	Norms and schedules are designated.	Reference specifications are not subjected to continual update. No applicable specifications for the Expressways.
Schedule	Reference unit prices for civil works		

Source: JICA Experts Team

7.2.2 What Remains to be Done

The uniqueness of the Vietnamese way of organizing a Decision, Directive, Ordinance, or a Regulation, whichever are above-mentioned, is that it embraces all relevant reference standards, standard operating procedures, and schedules as attached to the main body, unconscious of their hierarchical order. In the short-term future, it is imperative to establish a coherent and harmonized system of reference standards and regulation applicable to the Vietnamese Expressways, thus making it clear whichever type and contents of reference standards are lacking as given in Table 7.4 and what contents are needed to fill the voids, which are given in Table 7.5.

Table 7.5 Contents remain to be filled - Reference Specifications and Manuals for Expressways O&M

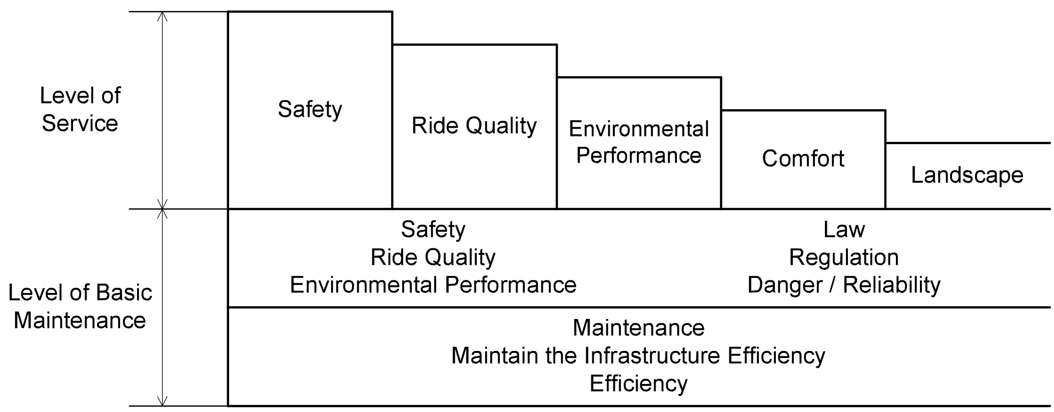
Category	Reference Specifications and Manuals	Contents to be Included	Competent Authority	Remarks
Ministry Directive	Expressway O&M Reference Specifications	Contents to be produced by designating "Level of Service" suited to the situations of expressways in Vietnam	Competent Administration (MOT)	
Manuals / Guidelines	Expressway O&M Manual (Technical Guidance)	All aspects of Expressway O&M works, including checkpoints, standard operation procedure, schedule and methods, need to be dealt with.	Respective Bodies (Expressway Operating Companies)	The target contents to be produced correspond to what the project drafted.

Source: JICA Experts Team

7.2.3 Basic Principles of Producing Expressway O&M Standards and Manuals

(1) Required Functions and Social Needs to be Delivered by the Expressways

"The Level of Basic Maintenance" and "The Level of Service" are the two aspects of O&M Works, measured by the Expressway Administrators. The "Basic Maintenance Level" dictates the fundamental function level to be delivered by the Expressway Companies, to meet the social needs. On the other hand, "The Level of Service" is the target pursued by respective Expressway Administrators to maintain the performance suited to respective expressways. The relationships between "The Level of Basic Maintenance" and "The Level of Service" are given diagrammatically in Figure 7.1. However, these two levels are sometimes generally termed as "The Level of Service", as there is no expressed boundary between the two.



Source: "Expressway Maintenance and Management Technique" Central Nippon Highway Engineering Tokyo Company Limited, Dec. 2008, P11

Figure 7.1 Expressways' Social Needs versus Level of Service

(2) Reference Standards versus Standard Operating Procedure

In general, the State Administration sets the reference standards applicable to respective field to be observed by the Expressway Operating Companies, so that Expressways can be maintained at the “Level of Basic Maintenance”. On the other hand, respective Operating Companies establish their own detail standard reference coupled with standard operating procedures, made to suite their own Expressway characteristics, to maintain their own “Level of Service”. They are mandated to be approved by the State Authority, so that they can satisfy both “Level of Basic Maintenance” and “Level of Service”.

7.2.4 The State Designated O&M Standards

(1) Expressways’ Functional Performance Norms

“Level of Basic Maintenance” and “Level of Service” are largely defined by road structure and road surface conditions, which are largely influenced by inspection frequency, traffic volume, traffic quality and the occurrence of traffic accidents. Therefore, they are classified into five performance categories such as safety, ride quality, environmental performance, comfort and landscape of the expressway. Performance indicators in each category are given in Table 7.6.

Table 7.6 Performance Categories and Indicators

Performance Categories	Performance Indicators	Example of Setting Indicators
Safety	Driving at the specified range of the speed, and safe arrival to the destination.	- Number of traffic accidents, Traffic accident rate
		- Pavement evaluation criteria: Rutting depth (25mm),Skid resistance (0.25), Longitudinal profile (8mprofile 90(PrI)), Cracking ratio (20%), and Size of pothole (D=20cm)
Ride Quality	Saving the traveling time, and ensuring the convenience for road users	- Vehicle speed is secured at 80 km/h during normal hours - Vehicle speed is secured at 60 km/h during peak hours
		- Reducing the hours of congestion
Environmental Performance	Mitigating harmful impacts caused by operating the expressway.	- Impacts of noise, vibration, light, and odor (Impacts on air, the soil, and water) shall be mitigated.
		- Reduction of pollutant emissions by the road traffic
		- Reduction of noise from the road traffic.
Comfort	Extent of driving comfort	- Reducing the stress perceived by the road users - Reducing negative impacts on the drivers and passengers.
		- IRI as the indicator
Landscape Amenity	Enjoying the convenience and pleasure of the expressway by the residents around the expressway and the expressway users	- Evaluation by the road users
		- Perception by residents adjacent to the expressway

Source: “Expressway Maintenance and Management Technique” Central Nippon Highway Engineering Tokyo Company Limited, Dec. 2008, P 12 - P 13

(2) Required Contents of the Expressway O&M Standard

In principle, the State produces the “Expressway O&M Standards” with reference to the “Level of Service”, suited to the Vietnamese situation, in accordance with that given in Table 7.6. Each Expressway Operating Company regularly reports O&M performance to the State Authority. The State Authority confirms their O&M deliver satisfactory services and quality.

7.2.5 The O&M Company Designated O&M Manuals

(1) Temporary Expressway O&M Regulation in Vietnam

The kind of regulations applied in these fields is stipulated in "The Temporary Regulation" as given in Table 7.7.

Table 7.7 Contents of "The Temporary Regulation"

Category	Items	Descriptions	Work Field
Technical Direction for O&M	1) Traffic Management	Expressway inspection and patrol / Traffic count	Traffic Management
	2) Cleaning	Cleaning median strip, traffic signs and guard rails / Plant trimming and grass cutting / Cleaning the accident sites / Cleaning and removing the obstacles	Road Maintenance
Guidelines of Maintenance for Embankment and Bridge	1) Technical Criteria for the Evaluation of the Drainage System, Embankment and Pavement	Inspection and evaluation of the condition of embankment, pavement and drainage / Inspection and evaluation of the condition of auxiliary construction works / Technical criteria employed in evaluating the auxiliary construction works	Road Maintenance
	2) Inspection and evaluation of the condition of culverts, bridges and other construction works	Inspection and evaluation of the condition of bridge and other construction works / Technical criteria employed in evaluating the quality of bridges and other works	Road Maintenance
	3) Maintenance works for embankment and drainage system	Damages on embankment and drainage system / Routine, periodic and emergency maintenance for embankment and drainage system	Road Maintenance
	4) Maintenance works for asphalt concrete pavement	Damages on asphalt concrete pavement / Routine, periodic and emergency maintenance for asphalt concrete pavement	Road Maintenance
	5) Maintenance of cement concrete pavement	Damages on cement concrete pavement / Routine, periodic and emergency maintenance for cement concrete pavement	Road Maintenance
	6) Maintenance of the auxiliary works	Damages on auxiliary construction works / Routine, periodic and emergency maintenance for auxiliary construction works	Road Maintenance
	7) Maintenance and repair for the structural parts	Damages on structure works / Routine, periodic and emergency maintenance for structure works	Road Maintenance
	8) Technical guidelines for maintenance and repair of other technical infrastructure works	Damages on technical infrastructure works / Routine, periodic and emergency maintenance for technical infrastructure works / Maintenance of lighting system	Road Maintenance
	9) Repair of damages to accessories caused by vehicles:		Traffic Management
	10) Work safety and traffic management during the maintenance	Work safety in expressway management / Traffic safety assurance in expressway maintenance	Traffic Management
	11) Labor safety and traffic safety assurance during maintenance works	Labor safety in maintenance works / Assurance of traffic safety in the maintenance works	Traffic Management
Technical Norms for O&M	1) Basis for the development of norms for O&M	—	—

Category	Items	Descriptions	Work Field
	2) Some applicable regulations	—	—
	3) Norm for management and inspection works	Technical Norm for management and inspection works / Composition of the management and inspection works	—
	4) Norm for maintenance and repair of road, bridges and the other Works	General provisions / Contents of the Technical Norm	—

Source: "Temporary Regulation on the Maintenance of HCMC - Trung Luong Expressway, Decision, Minister of Transport, 17 February 2011"

(2) Required Contents of the Expressway O&M Manual

"The Temporary Regulation" is supposed to cover all aspects of inspection, repair, cleaning and traffic management engaged in O&M works as are given in Table 7.2. However frequency and organizational setup necessary for each work item are scarcely mentioned, nor there concrete description about the contents of works[5]. "The New O&M Regulation", while it is developed on existing "The Temporary O&M Regulation", is assumed to supplement the contents of roads/facilities maintenance and traffic control and management, inclusive of emergency countermeasures. A description on toll fee collection system shall also be added. Contents needed to be dealt with by the proposed "The New O&M Regulation" are given in Table 7.8. Those are comparatively shown with the standards and manuals prepared by one of the Japanese expressway companies. Consequently, the whole set of technical manuals, to be prepared by "The Project for Strengthening Operation and Maintenance System for Expressway in Vietnam, which was mentioned in Section 6.3.1.1 will, eventually cover all of items described in Table 7.8.

5 "Project Formation Study on the Operation and Maintenance of Expressway in Vietnam" The Ministry of Economy, Trade and Industry of Japan, March, 2010, P3-38"

Table 7.8 Contents to be Dictated by "The New O&M Regulation"

Work Field	Items	Standards / Manuals Presently Practiced by a Japanese Expressway Company	Required Descriptions By O&M Regulation
Road Maintenance	Inspection	Road Inspection Manual	Frequency, system, and content of inspection
		Bridge and Structure Inspection Manual	-ditto-
	Maintenance Plan	Road Maintenance and Repair Manual	Concrete measures of maintenance
		Bridge and Structure Maintenance and Repair Manual	-ditto-
	Supervision	Construction Supervision Manual	Concrete measure of supervision
Traffic Management	Traffic Regulation	Traffic Patrolling Manual	Concrete measure of patrol
		Traffic Regulation Procedure Manual	Traffic management and control on, regulating the lanes
	Wireless	Wireless Communication Manual	Maintenance and operation method of equipment
Toll Collection	Toll Collection Works	Toll Collection Works Manual	Concrete means of toll collection
	Toll Collection Equipment	Toll Collection Equipment Maintenance Manual	Maintenance and operation method of equipment
Emergency Countermeasures	Traffic Accident	Traffic Accident Countermeasure Manual	Role and content of work of each organization
		Traffic Accident Countermeasure Manual during Maintenance Works	-ditto-
	Emergency	Traffic Regulation for Natural Disaster, Abnormal weather etc.	Traffic regulation standard value and content of work
Standards and Manuals to be established (Besides the above O&M Regulation)			
Specification of Works	—	Specification for Road Maintenance Works	Specifications based on contract standard
		Specification for Facilities Maintenance Works	-ditto-
Design Standards	Design Manual	Expressway, Pavement, Drainage etc.	Design manual for the entire expressway
		Bridge, Culvert, Tunnel etc.	-ditto-
		Auxiliary Facilities (Traffic Safety, Traffic Management)	-ditto-
		Facilities (Building, Electrical Facility, Communication System)	-ditto-
		Planting	-ditto-

Source: JICA Experts Team

7.3 Recommended Means to Draft and Establish O&M Standards and Manuals

In the immediate future, Vietnam needs to establish a comprehensive Expressway O&M standards and guidelines (TSG) as given in Figure 4.2. It should be drafted with references to Vietnamese road O&M standards and similar Expressway O&M standards practiced in other countries, based on existing "Temporary Regulations in Vietnam" as piloted by this Project. Their contents shall be drafted as clear and easy to be understood by on-site field technicians and workers as well.

In this Project, our original attempt was to maximally exploit those contents available from "The Temporary Regulations"; however, their relevant portions are not directly excerpted nor extracted for use in the Project's draft O&M, as excerpts indicate an extent of conceptual rather than practical, and are not-well defined than concrete. As a result, major contents of the Project O&M standards are produced with reference to those of Central NEXCO's O&M manual.

Moreover, the Draft TSG was finalized through the review and revise process, incorporating feedbacks from 3-weeks of OJT, held April – May, 2013, followed by 5-weeks of pilot implementation.

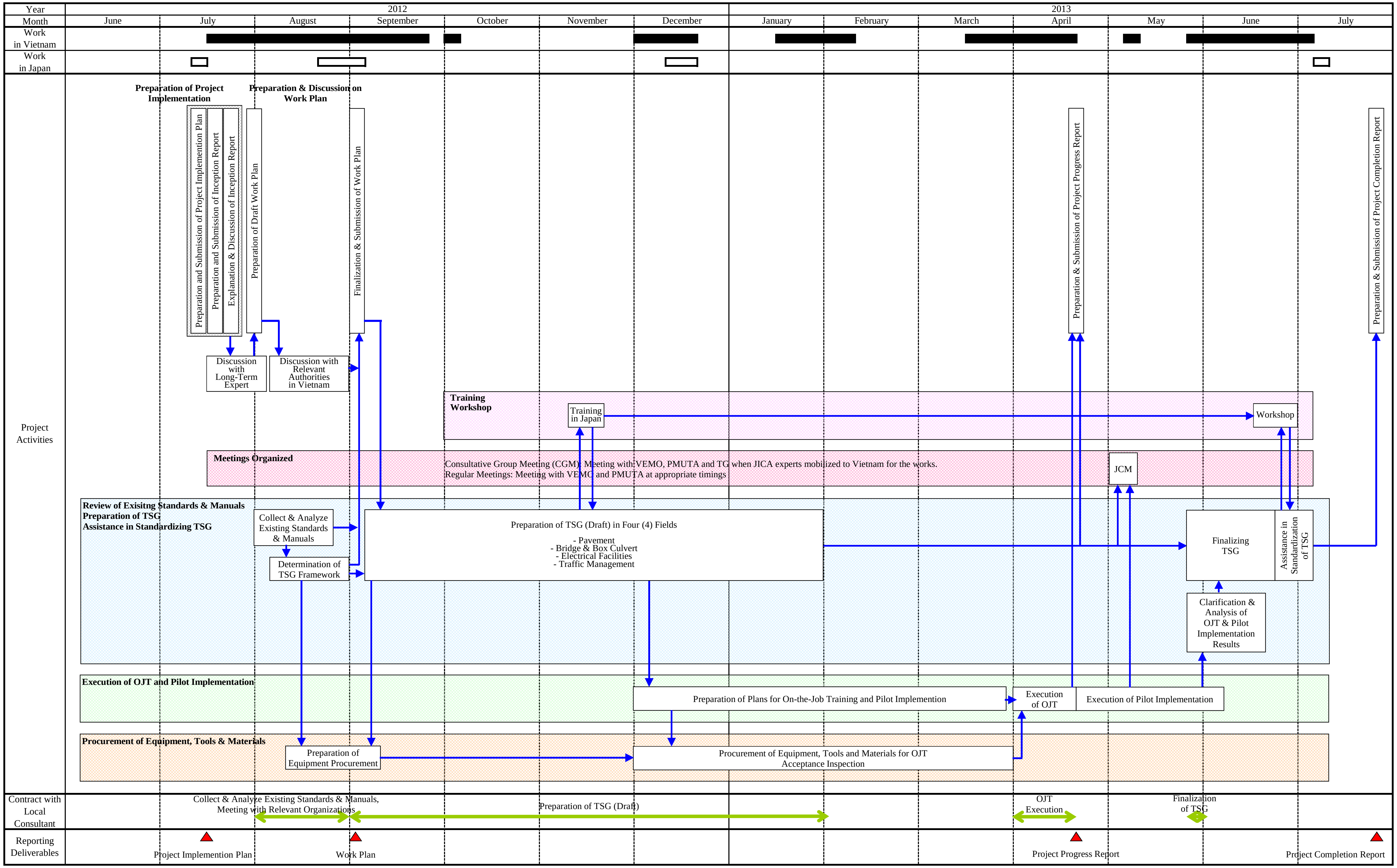
It is recommended that DRVN / MOT to oversee and check the relevancy and appropriateness of the comprehensive TSG and accompanying manuals to be produced, harmonized among them, through pilot execution process. DRVN / MOT are recommended to establish them as Vietnamese "Expressway O&M Standards".

Drafting and producing "Expressways' O&M Standards and accompanying manuals" is not yet completed, though the Project has produced the four critical areas' TSG. Drafting and producing "Expressways' O&M Standards and accompanying manuals" applicable throughout the general fields of Expressways' O&M works is yet to be done. It is desired that the Vietnamese engineers to sincerely execute the O&M standards in their daily expressway operation and maintenance work.

ANNEX

ANNEX-1

Work Flow


Year
2012
2013
Month
June
July
August
September
October
November
December
January
February
March
April
May
June
July
Work in Vietnam
Work in Japan
Project Activities
Preparation of Project Implementation
Preparation & Discussion on Work Plan
Preparation and Submission of Project Implemention Plan
Preparation and Submission of Inception Report
Explanation & Discussion of Inception Report
Preparation of Draft Work Plan
Finalization & Submission of Work Plan
Preparation & Submission of Project Progress Report
Preparation & Submission of Project Completion Report
Discussion with Long-Term Expert
Discussion with Relevant Authorities in Vietnam
Training Workshop
Training in Japan
Workshop
Meetings Organized
Consultative Group Meeting (CGM): Meeting with VEMO, PMUTA and TG when JICA experts mobilized to Vietnam for the works.
Regular Meetings: Meeting with VEMO and PMUTA at appropriate timings
JCM
Review of Exisitng Standards & Manuals
Preparation of TSG
Assistance in Standardizing TSG
Collect & Analyze Existing Standards & Manuals
Determination of TSG Framework
Preparation of TSG (Draft) in Four (4) Fields
- Pavement
- Bridge & Box Culvert
- Electrical Facilities
- Traffic Management
Finalizing TSG
Assistance in Standardization of TSG
Clarification & Analysis of OJT & Pilot Implementation Results
Execution of OJT and Pilot Implementation
Preparation of Plans for On-the-Job Training and Pilot Implemention
Execution of OJT
Execution of Pilot Implementation
Procurement of Equipment, Tools & Materials
Preparation of Equipment Procurement
Procurement of Equipment, Tools and Materials for OJT
Acceptance Inspection
Contract with Local Consultant
Collect & Analyze Existing Standards & Manuals, Meeting with Relevant Organizations
Preparation of TSG (Draft)
OJT Execution
Finalization of TSG
Reporting Deliverables
Project Implemention Plan
Work Plan
Project Progress Report
Project Completion Report

ANNEX-2

Assignments of JICA Experts Provided

A02-01

Assignment Schedule Provided

	Assignment	Name (Sex)	Company	Grade	Year / Month	2012 7	8	9	10	11	12	2013 1	2	3	4	5	6	7	Total (days)	Person / Month Vietnam	Person / Month Japan
Work in Vietnam	Team Leader / Civil Works Maintenance Plan	ORIKASA Mikio (Male)	Dainichi Consultant Inc.	2	Actual	15	(69)	21 2 (1) 2			2 (21) 22	13 (28)	9	17 (35)	20	5 (7) 11	26 (42)	6	203	6.77	
	Pavement Inspection & Maintenance	KIJIMA Terutake (Male)	Dainichi Consultant Inc. (Supporting Staff)	3	Actual	22 (14) 4	26 (14) 8				2 (14) 15	(14) 2		31	(21) 20		26 (14) 8		91	3.03	
	Bridge Inspection & Maintenance	SAKAIDA Minoru YOKOYAMA Hiroshi (Male)	Dainichi Consultant Inc.	3	Actual	22 (14) 4	19 (14) 1				2 (14) 15	20 (14) 2		31	(21) 20		26 (14) 8		91	3.03	
	Facility Inspection & Maintenance	IIMURA Hideki (Male)	NEXCO Central	4	Actual	22 (14) 4	26 (14) 8				2 (14) 15	20 (14) 2		31	(21) 20		26 19 (14) 8	25(7)	98	3.27	
	Electricity / Communication Facility	YOSHIZAWA Toshiyuki (Male)	NEXCO Central (Supporting Staff)	4	Actual	22 (14) 4	26 (14) 8					20 (7) 26		31	(21) 20		26 (14) 8		70	2.33	
	Traffic Management (Patrol)	MATSUSHITA Yasuhiko (Male)	NEXCO Central	4	Actual	22 (14) 4	26 (14) 8				2 (11) 12	17 (17) 2		31	(21) 20		26 19 (14) 8	25(7)	98	3.27	
	Traffic Control	ISHIDUKA Toshihiro (Male)	NEXCO Central (Supporting Staff)	4	Actual		26 (14) 8				2 (7) 8	20 (14) 2		31	(21) 20		26 (14) 8		70	2.33	
	Procurement Specialist	KAMIHASHI Nobuyuki (Male)	Dainichi Consultant Inc. (Supporting Staff)	4	Actual		12 (7) 18				2 (7) 8			25 (14) 7					28	0.93	
	Coordinator / Civil Works Maintenance Plan (Assistant)	URANO Kazuya (Male)	Dainichi Consultant Inc.	5	Actual	15 (21) 4													21	0.70	
					Subtotal (in Vietnam)													Actual		25.66	
Work in Japan	Team Leader / Civil Works Maintenance Plan	ORIKASA Mikio (Male)	Dainichi Consultant Inc.	2	Actual	11 (3) 13												8 (2) 9	5		0.17
	Procurement Specialist	KAMIHASHI Nobuyuki (Male)	Dainichi Consultant Inc. (Supporting Staff)	4	Actual	8/20-8/24 (5) 8/27-8/31 (5)		9/3-9/7 (5) 12/10-12/14 (5) 12/17-12/19 (3)											23		0.77
					Subtotal (in Japan)													Actual			0.94
					Total													Actual		26.60	

▲ Project Implemention Plan ▲ Draft Work Plan ▲ Work Plan ▲ ▲ Project Progress Report ▲ ▲ Draft Project Progress Report ▲ ▲ Draft Project Completion Report; Project Completion Report

Legend: Work in Vietnam; Work in Japan; Work paid by the Company

ANNEX-3

Minutes of Meeting for JCM

Form-1

"The Project for Strengthening Operation and Maintenance System for Expressway in Vietnam"

Joint Coordination Meeting (JCM)

Minutes of Meeting

Date and Time	May 7th, 2013. 14.05 ~16:00
Organization	JCM of the Project
Venue	Meeting room, Block A (MOT) , 80 Tran Hung Dao, Hanoi
Attendee	(Vietnamese side) MOT/DRVN etc. 1) Mr. Nguyen Hong Truong, vice minister of MOT 2) Mr. Pham Quang Vinh, vice director general DRVN 3) Mr. Nguyen Anh Tuan, VEMO, DRVN 4) Mr. Nguyen Trong Phu, PMU TA, DRVN 5) Mr. Tran Quang Uyen (VEC) 6) Mr. Tuan (VEC O&M) 7) Representative of Department of International Cooperation (MOT) 8) Representative of Department of Science & Technology, (MOT) 9) Representative of Department of Finance (MOT), 10) Representative of Department of Appraisal (MOT) 11) and other related person
	(JICA side) JICA Vietnam Office, JICA Experts Team 1) Mr. Nagase (JICA Office, Senior Representative) 2) Ms. Tomuro (JICA Office, Representative) 3) Ms. Ha (JICA Office) 4) Ms. Hang (Japanese interpreter) 5) Mr. Murata Shigeo (JICA expert: expressway management institution adviser) 6) Mr. Orikasa Mikio (Team leader) (O&M specialist) 7) Ms. Quách Thị Thu Trang (secretary) 8) Ms. Nguyen thi Thuy Linh (Japanese interpreter) 9) Mr. Đỗ Trọng Tân (English translator)
Document used in the discussion	- Aattachment1: Outcomes of Strengthening Operation and Maintenance for Expressway In Vietnam by April 2013 (dated 5-5-2013) prepared and distributed by VEMO - Aattachment2: Progress Report on Strengthening Operation and Maintenance for Expressway In Vietnam prepared and distributed by JICA experts (Vietnamese version)
Main Topic	- Report on the implementation of the project
Issue & Commentary	
Items	**Contents**
Speech by Mr. Nguyen Hong Truong,	- Vice minister of MOT welcomes the JICA team and briefly introduces the participants on MOT side in the meeting. - Among others, he quotes the Representatives of

	Department of International Cooperation Department of Science & Technology, (MOT) Department of Finance (MOT), Department of Appraisal (MOT) He says he would like to listen to the reports on outcomes.
Speech by Mr. Nagase	- Appreciates the cooperation of MOT and the attendance of the meeting - Reviews the Japan – Vietnam cooperation, emphasizing the 2013 the Year of Japan – Vietnam cooperation Anniversary - Reviews the Project and encourages the continuous cooperation.
Report by Mr. Vinh DRVN reports:	- The overall implementation of the Project (see attachment 1) - Regarding the Draft of Decree on standardization of Expressway O&M, three institutions (VEC, Cuu Long, and VIDIFI) are consulted for technical comment until May 25, 2013 - Technically, on the proposed installation of 2 cameras, DRVN thinks that it is unnecessary; the reason is that if one is installed in Phap Van- Cau Gie route, there must be an unit for operation and management, meanwhile Cau Gie – Ninh Binh Expressway is equipped with a whole ITS with cameras under commissioning now. - The Technical Standards now have 11 areas in the list, only 4 have been covered. - In this year (2013), it is expected to have 6 standards. - Standards for Road Signs and Right of Way are in question.
Report by Mr. Murata	- Reports on the overall project implementation (ref. Progress Report Attachment 2- part 1). He focusses on the overseas training of technical experts in Japan , · illustrated with pictures and methods. Power point Presentation.
Report by Mr. Orikasa	- Reports on the actual implementation of OJT and the plan for taking the data from pilot implementation to finalize TSGs (ref. Progress Report Attachment 2-part 2). Power point Presentation.
Comments and discussions	- Representative of the Department of Science & Technology, (MOT) · It is a very useful and necessary project. Now Vietnam is in need of Japanese technology and techniques. · Application of what have been prepared like TSGs can be accepted in practice. Even if we need a legal framework of applicable standards . · A long list of items still needs specifications for maintenance (e.g. Novachip surface) i.e different materials need different methods of maintenance . · Phap Van – Cau Gie is not yet classified as expressway - Representative of VEC · It is highlighted and proposed that the project donated equipment (List of 43 items prepared by VEC) should be sent to VEC for actual Expressway O&M - DRVN (Mr. Vinh)

	・ Re-confirmation on the fruitful cooperation with the Japanese JICA experts in: ・ Institutional support in term of O&M with Standards to be endorsed by MOT ・ The development of TSGs for O&M ・ Effective Japan and Vietnam cooperation ・ Good method of training in which theory is linked to practice demonstrated through OJT. - Representative, (OJT trainee from MOT) ・ Representing the OJT trainees , he finds OJT a professional training , putting O&M into a systematic practice ・ In his opinion, the Project has just covered only 10% of the actual demands : how about large steel bridge? ITS? Mobile devices with mandatory frequency for use? And many others ? - Ms Tomuro (JICA Office) ・ This Project is not designed to cover ITS O&M. ・ O&M for ITS (and possibly others) will be included in a Loan Agreement to be signed later.
Conclusions by vice minister of MOT	- the vice minster of MOT: ・ highly values the Study for TSGs drafting ・ appreciates the adequate and full reports presented by JICA long and short term experts. ・ By 2015 there are hundreds of km of expressway put into operation ・ A drastic need of O&M instruction for expressway ・ DRVN is requested to communicate closely with the representative of the donor. ・ Concentrating on the finalization of TSGs. ・ And the overall technical instructions for expressway O&M, to be included in the Bidding document for expressway O&M planned to be apply in the job of O&M. ・ DRVN should reach consensus with the consultants on the outcomes. ・ Vice minister emphasizes one thing that the 4 mentioned areas of O&M should be highlighted to reach standards for these activities to be carried out. ・ Should there be a link between O&M and ITS. We take it for granted that JICA is now supporting to set up a ITS center for the Northern part of Việt Nam . Because this center, once it is in operation, will be a great sources of data to support the O&M and repairs. ・ Human resource for O&M should be in question, DRVN can propose to have more training ・ JICA experts (from actual practice in Japan) should consider the support to us in term of data and information on how to make a cost estimate for O&M (3-5 years) and repair cost (after a duration of operation). Taking it

	proportionally against investment amount, length of the route and vehicle counts. · It is critically important for DRVN and JICA consultants to meet and agree on the followings (to reach the common shared conclusions): if the objectives of the project are hit? What should be raised up for further discussion? (Service Station? Coordination with traffic safety wardens?) After the project, what should be done next? Funding mechanism? · DRVN should develop the standards for qualification and capacity of the O&M unit: it needs specific parameters. · A telephone number, an on-line number to get feedback from public on the quality of Expressway operator service. · And others like: along the road buffer wall (net), fencing – lining trees? · We expect these regulations created and applicable immediately for O&M in VEC, HCM Trung Luong, and Hanoi – Thang Long. · The signaling system should also be studied ? Now is it workable and useful ? · Vice minister of MOT thanks the attendants - JICA Office · Urges the support from MOT for the remaining time of the project and further communication for cooperation.
Contact details	n/a
Others	n/a

The meeting ends at 16.00 of the day Recorded by Mr. Tan

MINISTRY OF TRANSPORT
DIRECTORATE FOR ROADS OF VIETNAM
Address: D20 Ton That Thuyet – Cau Giay – Hanoi

Url: http://www.drvn.gov.vn
Tel: (84) 4 38571444
Fax: (84) 4 38571440

Hanoi, May , 2013

IMPLEMENTATION REPORT ON PROJECT FOR STRENGTHENING OPERATION AND MAINTENANCE SYSTEM FOR EXPRESSWAY

(up to April 2013)

I. PROJECT INFORMATION:

Project Owner: DRVN (referring to the Decision 1366/QD-BGTVT dated June 13th 2012, VEMO under MOT was former project owner)

Duration: Estimated from 8/2011 to 7/2013 (24 months)

Total capital: USD 2.394.000.

Main objectives: (according to R&D between MOT and JICA dated May 25th 2011)

+ Establishment of an effective and safety framework for expressway operation and maintenance.

+ Personel training and capacity building for Vietnam expressway management organizations for the effective expressway management, operation and maintenance.

The project outputs include:

a. Output 1: Preparation of master plan, principal scheme for expressway operation and maintenance.

b. Output 2: To prepare the expressway operation and maintenance manual

c. Output 3: To execute trial maintenance works at some expressway sections

d. Output 4: Personnel training for expressway operation and maintenance; Capacity building for VEMO

Besides, MOT issued Decision 271/QD-BGTVT dated February 13th approving this investment project with 04 outputs.

II. PROJECT IMPLEMENTATION:

- On June 13th 2010, MOT issued Decision 1366/QD-BGTVT on transferring the Technical Assistance "Project for Strengthening Operation and Maintenance System for Expressway" funded by JICA, on July 13th 2010, MOT issued Decision 1783/QD-BGTVT on changing the Project owner and strengthening organization of Technical Assistance "Project for Strengthening Operation and Maintenance System for Expressway" funded by JICA;

- On June 29th 2012, DRVN issued Decision 1079/QD-TCDBVN on assigning tasks on the management of Technical Assistance "Project for Strengthening Operation and Maintenance System for Expressway".

- On August 15th 2012, DRVN issued Decision 1355/QD-TCDBVN on establishment of Working Groups of Technical Assistance "Project for Strengthening Operation and Maintenance System for Expressway".

By the end of April 2013, the outcomes are as follows:

- **Output 1:** Preparation of master plan, principal scheme for expressway operation and maintenance:

In September, 2012, VEMO requested to clarify and JICA Expert replied that this content was not in the scope of this project. During the implementation, JICA Expert was twice requested and sumitted the comments for Draft of New Decree on Expressway Management, Operation and Maintenance. Until now, JICA Expert considers this as one project activities.

- **Output 2:** Preparation of 04 draft of manuals on expressway O&M:
  - Manual for inspection/ maintenance of asphalt concrete pavement;
  - Manual for inspection/ maintenance of bridge;
  - Manual for inspection/ maintenance of facilities (lighting system, power system for other electrical equipment, radio communication);
  - Manual for traffic management, patrol and control (no ITS) and incident handling.

Outcome:

- The first draft of 04 manual was completed by the end of January 2013.
- 09 units have commented and the Consultant organized a meeting to explain for those comments and summarize the result of OJT (output 2) in the afternoon of April 18th 2013.
- Final draft: as planned, will be prepared after the pilot implementation (after June 7th 2013 to the end of the project).

- **Output 3:** Execution of OJT and trial O&M on some expressway sections, which includes 2 steps:
  - Step 1: Lessons on the content of 4 manuals (in the class) and training on site on Cau Gie-Ninh Binh: 02/4/2013 - 18/4/2013 (about 3 weeks): completed.

There are 42/40 trainees from 12 organizations, units.

- Step 2: Execution of pilot implementation on 2 expressways under management (Ho Chi Minh-Trung Luong and Cau Gie-Ninh Binh from 22/4 to 25/5/2013); review and evaluation by Japanese expert (from 27/5 to 7/6/2013): will be conducted.

+ DRVN issued an official letter No.1543/TCDBVN-VPDCT dated April 17th 2013 to instruct VEC O&M and Company 715 to execute the pilot implementation on Cau Gie-Ninh Binh and HCM-Trung Luong; VEC and RRMU VII are requested to supervise the execution.

- **Output 4:** Human resource training for expressway operation and maintenance; Capacity building for VEMO.

- Training in Japan: completed, from 11/11/2012 to 23/11/2012, there are 9 attendences which are officials from DRVN and MOT.

- In June 2013: Project plans to install 02 cameras for traffic monitoring at Phap Van interchange (01 camera on Phap Van-Cau Gie, 01 camera on Ring Road 3). This system will be maintained for 01 month. The purpose of this system is to bring to VEMO the basic knowledge of traffic condition on expressway and how to handle the incidents: will be conducted.

III. PROPOSAL – RECOMMENDATION

1, Outcome 4- Regarding the installation of 02 cameras for for traffic monitoring at Phap Van interchange (01 camera on Phap Van-Cau Gie, 01 camera on Ring Road 3)

Because Ring Road 3 and the lighting system of Phap Van-Cau Gie have been handed over to Hanoi People's Committee, if cameras are installed on these sections, we must request for the approval of Hanoi Transportation Department, and it may be difficult to maintain the system. Moreover, on Phap Van-Cau Gie-NH1, there is one camera system of Hai Chau Corporation in cooperation with Road and Railway Traffic Police Bureau; and on Cau Gie-Ninh Binh, VEC's camera mornitoring system is now under construction and will be used for pilot implementation.

Recommend to revise as follows:

- To use the data of Cau Gie-Ninh Binh from May 15th to June 15th for training, and it is not necessary to install 2 cameras as planned. JICA Expert has the same opinion.
- Target trainees: the purpose of this system is to give the basic knowledge of traffic condition on expressway and how to handle the incidents so the target trainees should be organizations, units which will be responsible for expressway/road management, namely: Transport Infrastructure and Safety Department (DRVN), RRMU II (Traffic Management Department, Safety Department), VEC, VEC O&M.

2, The content of Draft of TSG is qualified to be upgrade to Standard. We would like to propose that upgrading the Draft to Standard, which can be issued officially and applied in actual management and operation, should be added as one task of this project. Implementation method: using Project capital for Editorial Board, Check and Acceptance Boar d, meeting, printing (this proposal is in accordance with MOT's Notice No.516/TB-BGTVT dated September 05th 2012).

However, according to JICA Expert, it is difficult to use ODA fund for these activities.

The end of report

ANNEX-4

Official Letter for Changing the Counterpart of the Project

MINISTRY OF TRANSPORT

SOCIALIST REPUBLIC OF VIETNAM
Independence -Freedom - Happiness

N° 1783: / QD-BGTVT

Hanoi, July 30, 2012

DECISION

On "Transference of Project Owner and consolidation of the organization and implementation of the JICA funded Technical Assistance Project "Strengthening the O&M system for expressway"

THE MINISTER OF TRANSPORT

- Pursuant to the Decree 51 /2008/ND-CP on 22.4.2008 issued by the Government, regulating the functions, tasks, powers and organizational structure of the MOT;
- Pursuant to the Decree 131/2006/ND-CP on 9.11.2006 issued by the Government, regulating the management and usage of Official Development Assistance fund ;
- Pursuant to the Circular 04/2007/TT-BKH on 30.7.2007 issued by the MPI, providing the instructions for the management and usage of Official Development Assistance fund ;
- Pursuant to a Memorandum of Understanding signed on 25/5/2011 between JICA Chief Representative of Vietnam and the Ministry of Transport;
- Pursuant to Official Letter dated 17.11.2011 from JICA on the statement about the implementation of the TA project "Strengthening the O&M system for expressway";
- Pursuant to the Decision 271/QD-BGTVT on 13.02.2012 of MOT on approving technical assistance project "Strengthening of O&M system for the expressway funded by JICA "; and 892/QD-BGTVT dated 24.4.2012 on transference of the VEMO to DRVN and the Decision 1366/QD-BGTVT dated 13.6.2012 on the transference of TA project "Strengthening the O&M system for expressway" funded by JICA.
- Having reviewed the request of the DRVN specified in the Document 1950/TCDBVN-VPDCT dated 29.5.2012 on the transference of the Project to DRVN, and the 2743/TCDBVN-TCCB dated 16.7.2012 on the establishment, and consolidation of the working groups for JICA funded Project "Strengthening the O&M system for expressway";
- Upon the request of the Planning & Investment Division (DRVN)

Hereby DECIDES

Article 1. To transfer the Project Owner of the JICA funded Technical Assistance Project "Strengthening the operation and maintenance system for the expressway" with VEMO to DRVN. Other actions will follow the Decision 271/QD-BGTVT dated 13.2.2012 issued by MOT.

Article 2. Adjustment is made in the technical Working Group for "Strengthening the O&M system for expressway" which was established after Decision 265/QD-BGTVT issued on 17.2.2012 by MOT to be relevant to Decision on the Project transference 1366/QD-BGTVT issued by MOT, in which Mr. PHAM QUANG VINH, the vice Director General of DRVN will to be the Group Leader in replacement for Mr. LE ANH TUAN, the vice Director of Planning & Investment Division. The other actions will follow the Decision No. 265/QD-BGTVT issued by MOT on 17.2.1012.

DRVN, therefore, is assigned to establish working groups to work in partnership with the Project consultants and to implement the Project as required by Memorandum of Understanding signed on 25/5/2011 between JICA Chief Representative of Vietnam and the Ministry of Transport.

Article 3. This Decision shall take effect from the date of signing.

Article 4. The Heads of Divisions, Planning & Investment, Infrastructure, Finance, Science & Technology, DRVN and heads of agencies and concerned units are responsible for the implementation of this Decision ■

Recipients :
- As specified in Article 4;
- Minister of Transport (reporting);
- MPI; MOF; State Bank of Việt Nam;
- Treasury, central and local banks
- Archives in Clerk Office, Planning & Investment

signed by
VICE MINISTER
on behalf of
MINISTER

NGUYEN NGOC DONG

ANNEX-5

Technical Specification Guidelines (TSG)

ANNEX-5 (1)

TSG (English)

Directorate for Roads of Vietnam Japan International Cooperation Agency

The Project for Strengthening Operation and Maintenance System for Expressway in Vietnam

TECHNICAL SPECIFICATION GUIDELINES FOR OPERATION AND MAINTENANCE OF EXPRESSWAYS

Vietnam Expressway Management Office

JICA Experts Team

JUNE 2013

Preface

The expressway network is a key constituent in the national road system. The Decision 356/QD-TTg dated 02/25/2013 of the Prime Minister approving the adjustment of Vietnam road development master planning for duration 2020 - 2030 determines the rapid development of expressway network, expected to reach 2,018 km in length by 2020.

The organization, management, operation and maintenance of expressways, in accordance with the objectives set out in the Law on Road Traffic, are to ensure constant traffic, safety, and shortening of travelling time. This is a heavy responsibility, but perceived as the honor by the Directorate for Roads of Vietnam.

Understanding the importance and significance of the management, operation and maintenance of expressways, the Ministry of Transport of Vietnam and the Japan International Cooperation Agency (JICA) have discussed and agreed on the realistic actions. Accordingly, the two-year technical cooperation Project "Strengthening of Operation and Maintenance of the Expressway" has been successfully implemented in the Directorate for Roads of Vietnam (July 2011- July 2013). An important outcome of the project is to develop "the Technical Specification Guidelines" for Operation and Maintenance of the expressway with the 4 main sections as in the followings;

- Technical Specification Guidelines for inspection and maintenance of pavement.
- Technical Specification Guidelines for inspection and maintenance of bridge & culvert.
- Technical Specification Guidelines for inspection and maintenance of electrical facilities (lighting system, power supply for other equipment, and radio system for communication).
- Technical Specification Guidelines for traffic magement (excluding ITS).

The groups of Japanese and Vietnamese authors would like to thank the leadership, the efficient coordination of the Vietnam Ministry of Transport, the Japan International Cooperation Agency (JICA), the Directorate for Roads of Vietnam and other related organizations and individuals, who have prepared all the best favorable conditions for this Guidelines to be compiled with quality, and timely accomplishment.

Regards,

Mr. Vu Anh Tuan,
Chief Officer of Vietnam Expressway Management Office

Directorate for Roads of Vietnam Japan International Cooperation Agency

The Project for Strengthening Operation and Maintenance System for Expressway in Vietnam

SECTION 1

TECHNICAL SPECIFICATION GUIDELINES FOR INSPECTION AND MAINTENANCE OF PAVEMENT

Vietnam Expressway Management Office
JICA Experts Team

JUNE 2013

Table of Contents

1 Pavement (Asphalt Concrete)

1.1 Outline

1.1.1 Functional Requirements for Pavements

Pavements need to satisfy such major functional requirements as safety, comfort and economy. The performance needs meeting the respective functional requirements. To achieve safety, high skid resistance and visibility of pavement markings are required. Comfort is greatly affected by smoothness. Besides, smoothness also affects safety and economy that is represented by the vehicle mileage.

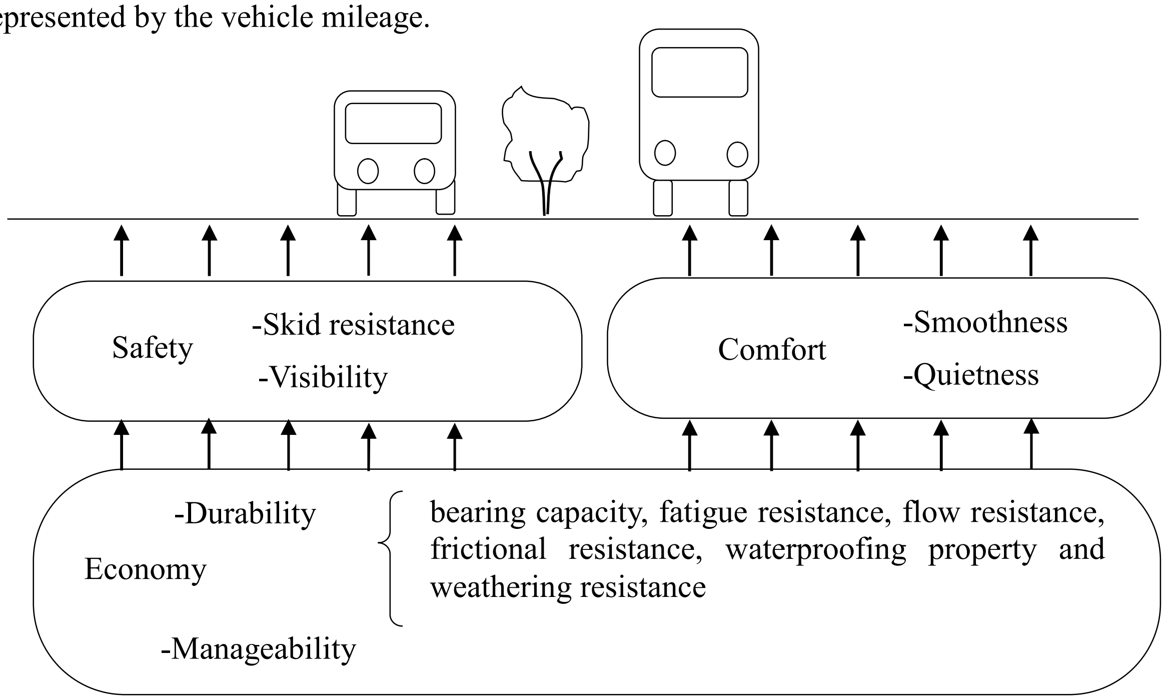


Figure 1.1-1 Functional Requirements for Pavements

1.1.1.1 Safety

Major performance requirements for pavements for safe travel on expressways are skid resistance and visibility. Skid resistance is required in the transverse and longitudinal directions. Transverse skid resistance affects the maneuverability of vehicles that is affected by lateral wind forces and transverse slope. Longitudinal skid resistance on the other hand governs the braking and stopping of vehicles. Skid resistance varies according to the pavement material used and road roughness. Selecting appropriate materials is therefore necessary.

Visibility function ensures drivers of good recognition on lane markings and vehicles ahead. Loss of visibility greatly deteriorates safety. The visibility of lane markings is important particularly at night and at the time of a rain. In order to prevent the deterioration of visibility, it is necessary to provide pavements with appropriate surface drainage systems.

1.1.1.2 Comfort

Among the performance functions required for comfortable travel on expressways, smoothness and quietness provided by pavements are important.

Smoothness affects the comfort of vehicle occupants and governs the comfort and fatigue of the driver. The results of existing studies show that there is a close correlation between the comfort of vehicle occupants and road smoothness. Smoothness offered by road pavement is also related to economy in terms of vehicle mileage and the length of time to repair. In order to achieve a high level of smoothness, it is necessary to select homogeneous materials with sufficient bearing capacity, flow resistance and frictional resistance, and appropriate method for construction work.

Quietness is evaluated in terms of the noise to which the driver and roadside residents are subjected to. The noise of a vehicle is composed of the mechanical noise released from the engine and exhaust system, vehicular noise produced by the body and driving systems and tire noise made at the interface between the tire and road surface. Pavement smoothness (longitudinal roughness) is related to vehicular noise and surface roughness is related to tire noise.

1.1.1.3 Economy

Pavements are civil engineering structures, which get damaged while they are in service, and if they are repaired from time to time, their life cycle can be more prolonged. When considering the economy of pavement, therefore, it is important not only to minimize the costs required at the initial construction or during maintenance and repair but also to consider the costs required over a long period of time. It is necessary to make the most economical decision through taking into account all the costs accruable to the construction work over time.

From an economic viewpoint, durability and maintainability (ease of management) count as important performance requirements for pavements.

Durability is required to ensure the serviceability of pavements that is designated in the initial stage. The performance factors of pavements related to durability are bearing capacity, fatigue resistance, flow resistance, frictional resistance, waterproofing property and weathering resistance.

Maintainability is meant to be a function that facilitates the management of pavements including maintenance and repair. As more expressways are constructed and more pavements become ready for service, the percentage of maintenance and repair cost increases in proportion to overall expressway improvement cost. It is therefore necessary to develop efficient maintenance and repair plans and to minimize maintenance and repair work.

1.1.2 Damage to Pavements and Its Causes

Asphalt pavements suffer fatigue failure due to repeated traffic loading and to the deterioration or aging of the asphalt mixture, or serviceability deterioration owing to the flow of mixtures or friction. Damage to asphalt pavements is largely classified into functional and structural types of damage.

1.1.2.1 Functional Damage

Functional damage is not attributable to the reduction of strength of pavement structure and includes rutting and surface cracking. The damage stays at the surface layer in most of the cases. Unless appropriate repair is made immediately, the damage frequently penetrate the base course and below under certain local and traffic conditions.

The major types of functional damage to pavements include rutting, cracking and the deterioration of skid resistance. The progression of those damages induce the deterioration of traveling performance of vehicle in terms of safety and comfort.

1.1.2.2 Structural Damage

Structural damage is attributable to the reduction of structural strength of the pavement body like cracking due to the deterioration of bearing capacity of the base or sub grade. It is necessary to consider the repair even of the base and sub grade.

Damage related to pavement structure is caused by strength deterioration under repeated loading, insufficient pavement thickness and material strength, strength deterioration in the base or sub grade due to frost heave, etc. Rutting and cracking, which are functional types of damage in the initial stage, may also cause structural damage if they are left unattended for a long period of time.

Structural damage is frequently induced by strength reduction in lower layers such as the base and sub grade and by the penetration of damage to lower layers. It is necessary to select the optimal repair method based on the results of structural surveys of pavements.

1.1.2.3 Types of Damage to Asphalt Pavements

Typical types of damage to asphalt pavements are described below.

1.1.2.3.1 Rutting

Rutting means uneven and rough surface in the transverse direction caused by the heavy repetitive traffic loads. Rutting is caused either by the flow of asphalt mixture or friction.

Rutting due to the flow of asphalt mixture cracking

1.1.2.3.2 Cracking

Cracking is caused by the deterioration or aging of mixture or by structural factors. Both factors affect the durability of pavements. If it is left unattended, cracking expands and develops. Infiltration of storm water promotes cracking and is likely to lead to structural damage.

1.1.2.3.3 Deterioration of Smoothness

Smoothness is deteriorated by the local settlement of road surface due to cracking or the development of potholes, insufficient roller compaction in the backfill of the structure during construction, or residual settlement in soft-ground areas. Smoothness greatly affects the driver’s comfort.

Deterioration of smoothness due to settlement in the front and rear of the structure

Pothole

1.1.2.3.4 Potholes

Potholes are small holes created on the road surface. The causes of potholes include the leakage of oil from vehicles and poor mixing of asphalt mixture. If potholes are left unattended, damage develops because of the infiltration of storm water or other factors and structural damage may be induced.

1.1.2.3.5 Bumps

Bumps are created by vertical displacement of road surface at the connection between the bridge joint and pavement surface or along a buried object, and affect the comfort of vehicle occupants.

A bump at a bridge joint.

The types and states of damage to asphalt pavements, the area or location of damage and damage classifications are listed in Table 1.1-1.

Table 1.1-1 Types of damage to asphalt pavements 1

(damage state, area or location, damage classification)

Type of damage		State of damage	Area or location damage occurred	Damage classification	
				Functional	Structural
Rutting	Rutting due to the flow of asphalt mixture	Consolidation and lateral movement of asphalt mixture or settlement at lower layers	Mainly on vehicle swept paths along heavy traffic routes in warm areas	○	○
	Rutting due to friction	Abrasion on vehicle swept paths	In snowy and cold areas	◎	
Cracking	Cracking due to the deterioration of bearing capacity of the base and sub grade	Linear cracks developing to hexagonal	Mainly on vehicle swept paths		◎
	Cracking due to the deterioration or aging of asphalt mixture	Hexagonal	Cracking occurring on vehicle swept paths progressing to the entire pavement.	○	○
	Cracking due to uneven settlement	Linear (longitudinal, transverse or irregular)	Around the structure, at joints made as a result of the widening of lanes, at cut/fill boundaries, etc.		◎
	Cracking due to thermal stress cracking	Linear (transverse). At nearly regular intervals.	In cold areas and in the areas with large variations of temperature	○	○
	Cracking at construction joints	Linear (longitudinal or transverse)	At construction joints	◎	
	Reflective cracking	Liner (longitudinal or transverse)	On concrete slabs and in cases where cement stabilization is applied		◎
	Top-down cracking	Linear (longitudinal) to reticular	On vehicle swept paths	○	○
Deterioration of smoothness	Longitudinal irregularities and settlement	Longitudinal irregularities with a relatively long wavelength	In soft grounds, in the backfill of the structure and near a buried object		◎
	Corrugations	Ripple-like folds on the surface	Near the toll gate and in congested sections	○	○
	Depressions and swells	Local depressions and swells	In parking areas and in congested sections	○	○
Others	Potholes	Holes created on pavement surface. Occurrences of abrasion of aggregates and hexagonal cracking	In cracked sections, poor-drainage sections and sections subjected to raveling by tire chains	○	○
	Deterioration of skid resistance coefficient	freezing and polishing		◎	
	Bump	Vertical surface displacement or irregularities	At expansion joints on bridges and in the backfill of a structure	○	○
	Pumping	Outflow of water and fine particles of sub grade materials., often accompanied by cracking.	At spots with cracking or abrasion on the base layer or below		◎
	Raveling	Separation of surface mortar	Mainly on vehicle swept paths	◎	
	Cutback due to oil leakage	Scattered aggregates. Potholes.	At accident sites and in parking areas	◎	

Legend Damage classifications ◎: Highly likely incidence.
○: Potential .incidence

1.1.2.4 Main Causes and Mechanisms of Damage

The causes and mechanisms of typical damage to asphalt pavements are described below.

1.1.2.4.1 Rutting

Rutting is a transverse surface irregularity created by wheels. Rutting is caused either by the flow of asphalt mixture or by friction.

Conceivable external causes of rutting due to the flow of asphalt mixtures are the rise of pavement surface temperature in the summer and the concentration of heavy vehicles on specific lanes. The mechanical properties of asphalt mixtures are greatly affected by binder properties. Asphalt mixtures behave like an elastic body at low temperature but they behave like a viscos-elastic body at high temperature. At high temperature, asphalt mixtures are vulnerable to deformation under heavy vehicles. Deformation mostly remains permanently. Permanent deformations are accumulated further as wheels pass the same position. One of the internal factors of the rutting attributable to the flow of asphalt mixtures is the flow resistance of asphalt mixtures. Flow resistance is affected by the amount of asphalt, asphalt penetration and the grain size of the mixture. Measures to increase flow resistance are listed below.

- Minimize the amount of asphalt as long as an optimum amount is secured.
- Use hard asphalt.
- Use coarse graded materials for mixtures and increase the amount of coarse aggregate.

Rutting caused by the flow of asphalt mixture Rutting caused by friction

The external cause of rutting by friction is the travel of vehicles equipped with tire chains or spike tires. A conceivable internal factor is the frictional resistance of asphalt mixtures. Frictional resistance is reduced by the following factors.

- Inadequate density due to insufficient compaction
- Inadequate amount of asphalt
- Low hardness of aggregate

1.1.2.4.2 Cracking

Cracking occurs in a varying manner according to the cause or pavement structure. Cracking is roughly divided into linear and planar types. Linear cracking is generally considered to occur in the initial stages and mostly belongs to functional damage. Planar cracking usually occurs as linear cracking and develops with the lapse of time into structural damage.

The most important external cause of cracking is traffic loading. Cracks are caused by the tensile stress created by traffic loading (an external force).

If the asphalt mixture is assumed to be an elastic body, it is deformed by an external force as shown in Figure 1.1-2, and compressive and tensile stresses occur at the top and bottom edges of the mixture respectively. Asphalt mixtures with the tensile strength approximately one-tenth of compressive strength have extremely low resistance to tension. Excessive loads cause the tensile strain on the bottom surface of the asphalt layer to exceed the limit resulting in cracking. Pavements are designed to maintain a mechanical balance. Once the balance is lost, an excessive-deflection induced deformation causes cracking, due to a rapid increase in traffic volume, overloaded heavy-duty vehicles and uneven bearing capacity of roadbed;

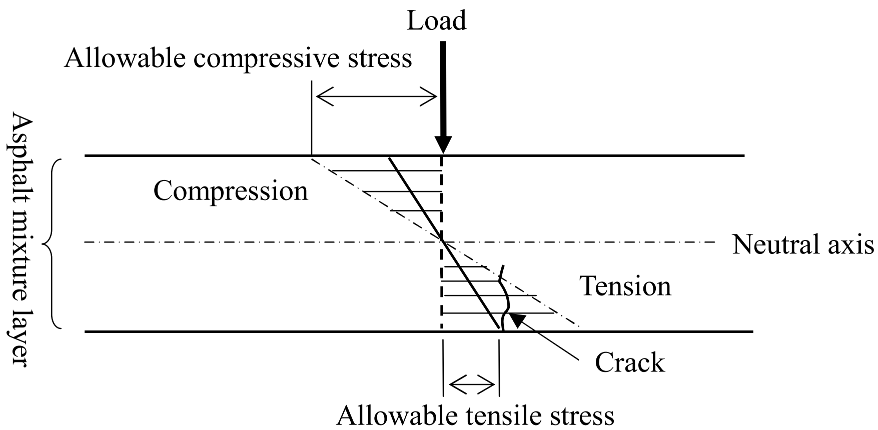


Figure 1.1-2 Tensile Stress of Asphalt Mixture

The internal causes of cracking include the amount and hardness of asphalt. Mixtures with a large amount of asphalt and of fine-graded type are highly resistant to cracking. Mixtures with a small amount of asphalt and of course-graded type are vulnerable to cracking. The hardness of asphalt is affected by thermal degradation during the manufacturing of mixtures. Temperature should therefore be controlled appropriately.

Planar cracking Reflective cracking
(develops into a structural failure) (at the end of an approach slab)

1.1.2.4.3 Deterioration of Smoothness

The deterioration of smoothness, in the broad sense, refers to the longitudinal and transverse directions, however, it generally means longitudinal irregularities. For smoothness, a standard value is defined at the completion of construction. Smoothness remains satisfactory in the initial stages of service but deteriorates with the lapse of time. The deterioration frequently occurs with other types of damage such as cracking and surface settlement due to the development of potholes. Bumps and corrugations also lead to the deterioration of smoothness. These phenomena cause the deterioration of smoothness of a short wavelength.

The deterioration of smoothness in soft grounds or in the backfill of a structure induces poor smoothness of a relatively long wavelength in numerous cases. The phenomenon is attributable to the slow progress of residual settlement, which is caused mainly by poor soil stabilization during construction or insufficient compaction of backfill materials.

Deterioration of smoothness due to surface settlement with the development of cracking

Deterioration of smoothness due to differential settlement near a transverse structure

The types of damage to asphalt pavements, the area or location of damage and main causes are listed in Table 1.1-2.

Table 1.1-2 Types of damage to asphalt pavements 2

(area or location of damage and main causes)

Type of damage		Area or location damage occurred	Main causes
Rutting	Rutting due to the flow of asphalt mixture	Mainly on vehicle swept paths along heavy traffic routes in warm areas	Travel of heavy-loaded vehicles, congestion and inappropriate mixtures
	Rutting due to friction	In snowy and cold areas	Abrasion by tire chains or other materials
Cracking	Cracking due to the deterioration of bearing capacity of the base and sub grade	Mainly on vehicle swept paths	Strength deterioration in the base or sub grade
	Cracking due to the deterioration or aging of asphalt mixture	Cracks occurring at vehicle swept paths, progressing to the entire pavement.	Thermal degradation during the manufacturing of mixtures and aging by ultraviolet rays
	Cracking due to differential settlement	Around the structure, at joints made as a result of the widening of lanes, at cut/fill boundaries, etc.	Differential settlement due to the consolidation of a fill
	Cracking due to thermal stress cracking	In cold areas and in the areas with large variations of temperature	Shrinkage due to temperature decrease
	Cracking at construction joints	At construction joints	Poor spreading and compaction
	Reflective cracking	On concrete slabs and in cases where cement stabilization is applied	Cracks in the base and sub grade
	Rutting	At wheel tracks	Tensile strain on the pavement surface created by heavy vehicles
Deterioration of smoothness	Longitudinal unevenness and settlement	In soft grounds, in the backfill of the structure and near a buried object	Differential settlement due to the consolidation of a fill, difference in residual settlement rate and insufficient compaction
	Corrugations	Near the toll gate and in congested sections	Uneven bearing capacities of the base and sub grade and loading at vehicle start-up and stopping.
	Depressions and swells	In parking areas and in congested sections	Poor application of prime coat or tack coat
Other	Potholes	At cracked sections, poor-drainage sections, sections subjected to raveling by tire chains	Developing cracks, poor quality of mixtures and insufficient compaction
	Deterioration of skid resistance coefficient		Leaks of asphalt constituent and polished aggregate
	Bump	At expansion joints on bridges and in the backfill of a structure	Settlement due to insufficient compaction of base, sub grade and mixtures and differential ground settlement
	Pumping	In sections with cracking or spalling on the base layer or below	Cracking or spalling on the base layer or below
	Raveling	Mainly on vehicle swept paths	Shortage or hardening of asphalt
	Cutback due to oil leakage	At accident sites and in parking areas	Cutback due to oil leakage

1.1.3 Need (Lifecycle Costs) for and Objectives of Pavement Protection

1.1.3.1 Maintenance and Repair and Serviceability

For economical and efficient maintenance and repair, it is important to appropriately and systematically comprehend the driving performance in such terms as safety and comfort, and the serviceability of pavements.

Serviceability means the bearing capacity and surface properties of pavements at a given point of time. The serviceability of pavements declines with the development of damage due to the accumulation of traffic volumes. Serviceability declines gradually, while necessary maintenance work (e.g. sealing the cracks and patching) is carried out to keep the serviceability of pavement at a certain level. Then, repair (overlaying by cutting or partial replacement) work is done at a certain point of time to restore serviceability greatly. Serviceability is restored upon pavements repair. Serviceability, however, starts declining due to the accumulation of vehicle traffic load at the point when the repaired pavement commence service. When the pavement fails, all the layers are replaced and serviceability is restored to the level at the time when it was initially constructed. Thus, the life cycle of pavements is restarted with cyclic repairs. A concept of the life cycle of a pavement from a viewpoint of maintenance and repair is shown in Figure 1.1-3.

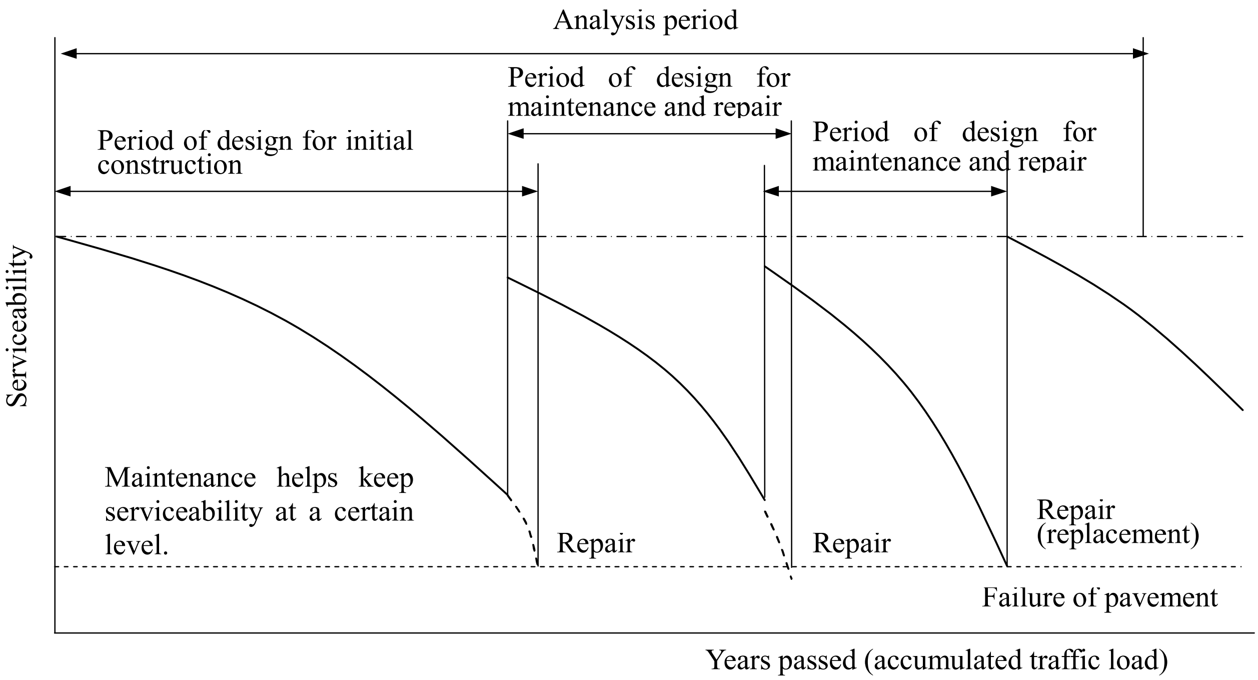


Figure 1.1-3 Concept of Life Cycle of Pavement and Maintenance and Repair

1.1.3.2 Need for and Objectives of Preventive Maintenance

The economy of maintenance and repair should be evaluated not only counting the costs required for maintenance and repair but also the subsequent costs of maintenance and repair incurred continuously and the benefit and cost of road users (such as the travel time reduction and the period of congestion). The concept of lifecycle cost counts the combined sum total of initial construction, maintenance and repair costs, in order to manage pavements most economically.

Potholes and cracks, which are functional damage in the initial stages of occurrence, develop into structural damage if they are left unattended. Structural damage requires much higher costs of surveys and repair than those of functional damage. Daily protective maintenance activities including inspections, investigations, maintenance and repair constitute an important effort for minimizing the lifecycle cost.

It is therefore important to accumulate and analyze the records of inspections, investigations, maintenance and repair to develop repair plans for minimizing the lifecycle cost.

1.1.4 Definition of Maintenance and Repair

Maintenance and repair are appropriate treatments applied for specific damage to pavements to achieve the following goals.

- To secure the durability of pavements and keep the pavement structure functional
- To ensure vehicular maneuverability on the road surface and provide safety and comfort
- To prevent roadside environmental degradation ascribable to pavements

Pavements are subjected to external forces such as the traffic loads and weather conditions. They suffer from aging to yield degraded serviceability. The smooth vehicular travel is gradually affected adversely. In order to prevent such problems, it is important to constantly grasp the surface condition and take appropriate maintenance and repair measures at appropriate time.

Pavements are maintained and repaired to keep their serviceability at a certain level. Maintenance aims at keeping or slightly upgrading the serviceability of pavements, however, structural enhancement is not intended. Examples include the filling the cracks in pavements with sealing materials and the patching of potholes and partially settled spots.

On the other hand, repair is made to improve the structural strength of pavements, thus restoring serviceability to a large extent, such as, overlaying, surface cutting and overlaying and partial replacement are conceivable.

Maintenance or repair is conducted at an appropriate timing in view of the development of damage. Maintenance and repair are classified as described below based on the timing.

- At each time damage is discovered during a patrol, measures should be taken urgently.
- In cases where damage develops gradually but no structural enhancement is required, measures may be taken on a timely basis when the damage reaches a certain limit.
- In cases where damage develops gradually and cross-sectional design is required, long-term measures should be applied based on a plan.

Conducting maintenance or repair work at a wrong timing may cause the damage to pavements to develop, resulting in a great increase in maintenance or repair costs. It is therefore important to control the development of damage (extending the service life by maintenance) in the initial stages of damage to minimize the progress of damage. In order to implement maintenance or repair method based on a plan, an appropriate timing of maintenance or repair should be determined based on the results of cost performance analysis in view of the lifecycle cost.

1.1.5 Workflow of Maintenance and Repair

Workflow from surface inspection to maintenance and repair is shown in Figure 1.1-4. Pavements maintenance and repair works are conducted in that sequence. Inspections are conducted daily and regularly. Emergency measures are taken immediately for the damage that requires urgent or temporary work. Whenever maintenance or repair is required, the scale and causes of the damage is evaluated through investigations, and appropriate maintenance or repair methods are selected, designed and implemented. The results are recorded. In conducting maintenance and repair work, the workflow is followed.

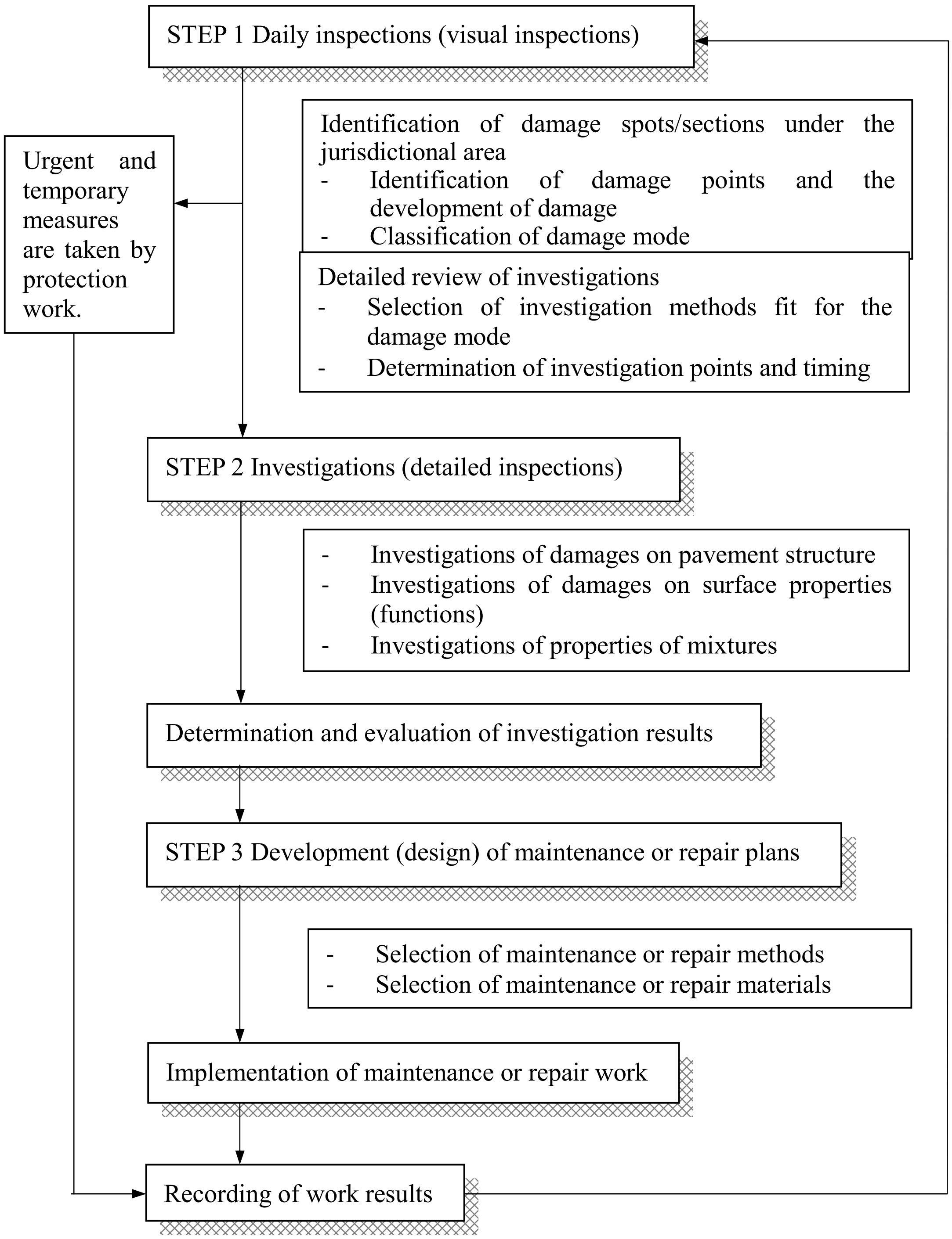


Figure 1.1-4 Workflow of maintenance and repair

Maintenance or repair is composed of three phases - planning maintenance or repair throughout the road, developing plans for implementation in selected sections and implementing the plans.

For maintaining or repairing the entire road network, plans are developed for the entire road network by dividing all the routes in the sections under control into units of sections, comparatively evaluating serviceability of each unit and prioritizing the units accordingly. For the damage that is found to require urgent measures during regular or daily inspections, however, suitable construction methods should empirically be determined and maintenance or repair works should be implemented immediately.

For performing maintenance or repair work, rational implementation plans are to be established by conducting necessary investigations, targeting the sections prioritized to be maintained or repaired in planning the entire road network plan. When determining suitable sections of maintenance or repair, an appropriate length should be established in view of the traffic conditions and other factors.

Visual inspections are conducted first in the investigations in individual sections. If implementing maintenance or repair methods is considered adequate as a result of visual inspections, it is possible to dispense with detailed identification of the state of damage or the identification of design conditions. In the case where repair is required, however, it is desirable to grasp the state of damage in detail or to grasp design needs.

For appropriate maintenance and repair of pavements, records should be made available on a successive basis including pavement inventory and database to explicitly present the history of maintenance and repair.

1.2 Inspections and Surveys

1.2.1 Types and Frequencies

Inspections are classified into daily inspections conducted daily, Routine inspections done periodically and emergency inspections that are made in emergency as during an abnormal weather. Detailed surveys are conducted as required based on the results of inspections. The desirable frequencies and methods of respective inspections are listed in Table 1.2-1.

Table 1.2-1 Guidelines for Frequencies and Methods of Inspections

Type	Frequency of inspection	Method of inspection
Daily inspections	Daily	Visual inspection
Routine inspections	Monthly or once in several months	Visual inspection
	Yearly or once in several years	Detailed surveys using instruments
Emergency inspections	In emergency like during an abnormal weather	Visual inspection

1.2.2 Daily Inspections

Daily inspections are required for managing the pavements appropriately and in a systematically well-planned manner. In daily inspections, surface conditions are visually observed in inspection vehicles. In cases where detailed confirmation is required, the condition is confirmed while the inspection vehicle is parked on the shoulder. The results of daily inspections serve as a basis for conducting appropriate detailed surveys and for establishing appropriate maintenance or repair plans. It is therefore important in daily inspections to record the conditions in the locations where an incidence of abnormality is detected.

Response to pavement damage in the initial stages of occurrence greatly affects subsequent damage progression. Therefore, daily inspections play an important role to discover pavement damage in early stages. In the case where temporary repair is made in particular, subsequent progress of damage should closely be monitored. In daily inspections, records of time-based changes and the mode of damage are to be organized.

It is important to make use of the results of daily inspections to establish survey and construction plans for fundamental repair.

Table 1.2-2 shows a reference table in determining the damages versus the criteria employed in daily inspections. Potholes, voids, stripping and cracks causing serious damage require immediate repair work for the purpose of extending the service life at the damage spot.

Table 1.2-2 Criteria for Assessment of Damages

Type of deformation	Criteria for Assessment	Remarks
Potholes, voids and stripping	Surface stripping exceeds the surface layer thickness and is wider than a 20-cm-diameter area on the surface.	The deformation occurs suddenly after a rainfall.
Upheaval (Bumps)	Great bumps at the connections on a structure cause the loss of control of steering wheel and considerable bouncing of the vehicle. The bump exceeds 20 mm at the connection on a bridge, or 30 mm at the connection on a transverse structure or at the cut/fill boundary.	Bumps at the joints of concrete pavements are included.
Rutting	Ruts of more than 25 mm on the road surface cause the loss of control of steering wheel and considerable bouncing of the vehicle.	Large quantities of water splash during a rainfall.
Cracking	Cracks on the surface are likely to lead to potholes and stripping. Large cracks with a cracking ratio of more than 20% occur that lead to the deformation in the pavement.	
Longitudinal irregularities and subsidence	Large longitudinal irregularities and settlements adversely affect the comfort of vehicle occupants.	
Local deformations and voids	Local deformations and voids on the surface cause the loss of control of steering wheel and considerable bouncing of the vehicle.	
Depression	Local surface poodle is observed each time rain falls.	
Raveling	The ejection of fine particles is found on the surface. Hexagonal cracks also occur.	This is highly likely to be structural damage.
Corrugations	Ripple-like folds with a depth of more than 30 mm exist on the surface.	
Breakage at joints	Breakage at joints and projections on the surface are found.	Concrete pavements

Reference: NEXCO - Inspection Procedure for Protection (Structures)

Table 1.2-3 Daily Inspection Form for road patrol (reference)

Affiliated Unit：

Patroller：

Range of road patrol： ～

Date of performance：

Date and time of inspection	Location, chain age, place where damages and/or violations are spotted	Climate condition (sunny, rainy, cloudy, foggy, stormy), sudden incidents, nature of newly detected incidents and/or violations (attached drawing shows location and sizes)	Solution, on-site measures taken and results	Comments and notes by senior officer who receives the report. His /her Signature	Comments by Patroller

※ Instructions

The purpose and requirements

1) Road patrol diary aims at recording to promptly detect damages, violations for quick fixing. This document is kept in files at the affiliated agencies.
2) The road patroller while on duty must record the condition of roads, bridges, buildings and safety corridors.
3) Leadership will check the contents of logbook/ dairy and provide instructions for solutions / processes, and undersign his/her authorization.

   Inspector checks the daily journal entry and directs the counter measures.

   Leadership of departments of RRMUs or the provincial Transportation Department checks on a monthly basis and provides instructions.
4) Every month, every quarter logbooks /diary of road patrol must be submitted to Commission of Acceptance.
5) Road Patrol Diary is the product of the patroller. The dairy is the foundation to assess partially the quality, performances and management practices of management unit. And from the results, it is to make a rational maintenance and repair plan.

Content for inspection and records

1) Pavement: Check for potholes, mud sink ... or not. If so, record the location and percentage (%, m2 ...).
2) Curb: Check to ensure whether the location is not flat, filled with rocks ... or not
3) Longitude trench: Check if it is backfilled with stone, or damaged affecting the drainage ... or not
4) The clearance of wild trees, and weeds
5) Traffic Safety System: Check for damaged, lost or stolen parts.
6) The road: Check for damage or subsidence ... or not
7) Check for violating road safety or
8) Traffic safety: When traffic accidents happen, write in road diary of patrol and recommendations for fixing and road rehabilitation, and to report to the agency within the day.
9) To monitor the implementation of the road works, if there is a problem, immediately notify the inspector/patroller.
10) Description of road cleanliness condition

1.2.3 Routine inspections

By Routine inspections, the general surface damage or changes thereof identified by daily inspections are evaluated regularly and quantitatively. Routine inspections are conducted at intervals of several months or years according to the conditions at the site. Routine inspections include inspections by repeated implementation of simple manual methods and detailed surveys using measurement equipment.

1.2.3.1 Routine inspections by Repeated Implementation of Simple Methods

This type of survey is positioned at the midpoint between daily inspections and detailed surveys. It is difficult to quantitatively grasp the changes in damage by daily inspections. In selecting the locations where detailed surveys are required, identifying the time-based changes at damage points is important. In order to supplement daily inspections, therefore, visual inspections are made regularly by inspectors aboard an inspection vehicle and how the vehicle occupants feel is inspected every month or once in several months.

Heavy vehicles generally run on nearside lanes where vehicles travel at relatively low speed. The damage to pavement is therefore more outstanding on nearside lanes than on passing lanes. Routine inspections are therefore limited to the evaluation made on a vehicle running on the nearside lane. Inspections are to detect the rutting and cracking, and the smoothness is accessed if driving is free from bumps. The rating is defined as good (no entry in the table), poor (represented by a triangle) or very poor (represented by an “x”). Inspections are made at every passage of 1 km. If possible, however, inspections should be conducted at passage of 100 m (Figure 1.2-1). A vehicle running at a speed of 60 km/hr. takes approximately six seconds to pass a distance of 100 m, which is sufficient to determine and enter the rating. To assist recording, markings are required in the field at intervals of 100 m.

Simplified items and methods as described above enable easy quantitative identification of changes. Accumulated survey results provide information for determining the location and timing of detailed surveys.

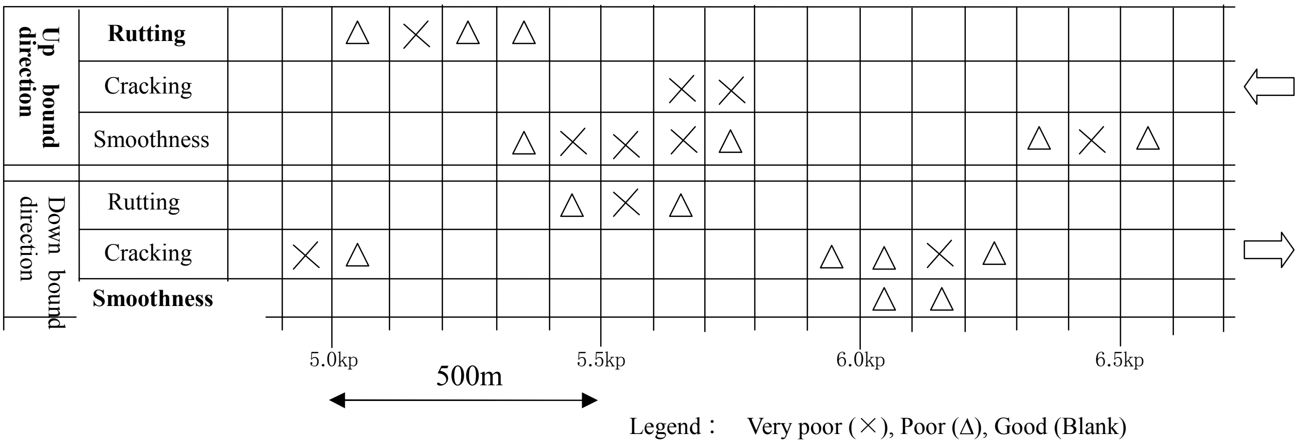


Figure 1.2-1 Examples of records of Routine inspections by simple methods

1.2.3.2 Routine inspections Using Measurement Equipment

In the case where the spots are found with a heavy damage that develops quickly as a result of daily inspections and of 1.2.3.1 above, the degree of damage is identified more accurately by detailed surveys using measurement equipment. The spots that are preliminarily considered important should be selected roughly once a year for detailed surveys using measurement equipment. The items for which Routine inspections are desirable and the frequencies of surveys are listed in Table 1.2-3.

Table 1.2-3 Items and Frequencies of Routine inspections

Inspection item	Frequency of inspections		Remarks
	Routine inspections by simple methods	Routine inspections using measurement equipment	
Rutting	Monthly	Annually	
Cracking	Monthly	Annually	
Deterioration of smoothness	Monthly	Annually	Bumps are included

Routine inspections using measurement equipment should be conducted on all the lanes throughout the route on a regular basis. In the case where measurement takes much time, however, the range of detailed surveys should be narrowed down by repeatedly implementing simple methods, and detailed Routine inspections should be conducted using measurement equipment.

1.2.4 Emergency Inspections

Emergency inspections are conducted to identify the extent and severity of adverse impacts on pavements whenever there are incidences of an abnormal weather occurs or a chemical substance spillovers. It is important to conduct emergency inspections at the occurrence of incidence, while securing the safety of inspection engineers. Otherwise, the possibility of secondary damage to inspection engineers increases.

In emergency inspections, surface conditions are visually monitored by inspectors aboard an inspection vehicle. If detailed verification is required, the conditions should be verified while the inspection vehicle is parked on the shoulder. Whenever an abnormal condition is discovered, the responsible organizations should be notified, followed by dispatched specialized inspection organization's conduct of detailed surveys for corrective actions.

The severity of the emergency incidence that require emergency inspections should be identified in advance. For predicting incidence of abnormal weather, the installation of observation equipment such as rain gauges and seismographs is a prerequisite. For surveying the wash-out of chemicals, the chemical substances that are distributed in Vietnam should be identified in advance. For reference, some of the reference values for conducting emergency inspections on Japanese expressways are listed in Table 1.2-4.

Table 1.2-4 Some of the reference values for emergency inspections in Japan (for reference)

Event requiring inspections	Reference values for emergency inspections	Remarks
Abnormal rainfall	A continuous rainfall of 220 mm or more and an hourly rainfall of 50 mm or more	Rain gauges installed at fixed points are used.
Earthquake	A measured seismic intensity of 4.5 or higher	Seismographs installed at fixed points are used.

Reference: NEXCO Central - Disaster Inspection Guidelines

1.2.5 Detailed Surveys (Surface Conditions, Structures and Mixtures)

1.2.5.1 Survey Methods for Respective Purposes

The methods of surveys that are required to evaluate different types of performance of asphalt pavements are shown in Table 1.2-5. Visual surveys are regarded as simple surveys in daily, regular and emergency inspections. Other surveys than visual surveys correspond to detailed surveys.

Table 1.2-5 Major asphalt pavement survey methods for respective purposes

Survey item		Survey method
Load bearing capacity	Capacities of base and sub grade	Measurement of settlement and deflection
	Fatigue-induced cracks on bottom surface	Visual surveys, sketches and photography
	Low-temperature cracks	Visual surveys, sketches and photography
	Fatigue-induced cracks on the surface	Visual surveys, sketches and photography
	Frost heave	Visual surveys, sketches and photography
	Seismic capacity	Visual surveys, sketches and photography
	Traffic volume	Measurement of daily and accumulated traffic volumes
Safety of travel	Skidding	Measurement of the depth of texture and skid resistance coefficient
	Texture	Visual surveys and surface roughness
	Abrasion (wear and rutting)	Visual surveys and measurement of transverse profile
	Bumps	Visual surveys and measurement of bumps
Comfort of vehicle occupants	Longitudinal irregularities and roughness	Visual surveys and measurement of smoothness and longitudinal profile
	Bumps	Visual surveys and measurement of bumps
Durability of surface layer	Durability of asphalt	Visual surveys, core sampling and cut and cover surveys
	Spalling	Visual surveys, core sampling and cut and cover surveys
	Scattering of aggregate	Visual surveys, core sampling and cut and cover surveys
Strength of asphalt mixtures		FWD (falling weight deflect meter) surveys, core sampling and cut and cover surveys
Bearing capacities of base and sub grade		FWD surveys, plate loading tests and in-situ CBR(California bearing ratio) tests

Reference: Japan Society of Civil Engineers - Standard Specifications for Pavements

1.2.5.2 Survey Methods for Respective Types of Damage

In the surveys of pavement damage, it is necessary to identify the causes by analogy based on the mode of damage, and to select survey methods fit for the damage. Surveys include the surveys to obtain the bearing capacity of the pavement body, surface property surveys for identifying the reduction of functional damage and the surveys to obtain the properties of mixtures. The typical survey and test methods for evaluating the damage to asphalt pavements are listed in Table 1.2-6.

Table 1.2-6 Major asphalt pavement survey methods by type of damage

Type of damage		Type of survey: Structural	Type of survey: Road surface	Type of survey: Mixtures	Major survey methods fit for evaluation
Rutting	Rutting due to the flow of asphalt mixture		○	◎	Measurement of rutting and core sampling (properties of mixtures, spalling in lower layers and waterproofing property)
	Rutting due to friction		◎		Measurement of rutting
Cracking	Cracking due to the deterioration of bearing capacities of base and sub grade	◎	○	○	Measurement of cracking, measurement of deflection (FWD) and load bearing tests (in-situ CBR tests)
	Cracking due to the deterioration of asphalt mixtures		○	◎	Measurement of cracking ratio and check of properties of collected asphalt (penetration and softening point)
	Cracking due to differential settlement	○	○		Visual measurement of cracks and load bearing tests (in-situ CBR tests)
	Cracking due to thermal cracking		○	◎	Measurement of cracking ratio and check of properties of collected asphalt (ductility and brittle point)
	Cracking at construction joints		○		Visual measurement of cracks
	Reflective cracking	○	○	○	Measurement of cracking ratio, measurement of deflection (FWD) and properties tests (collected asphalt and mixtures)
	Top－down cracking		○	◎	Measurement of cracking ratio, measurement of deflection (FWD, core sampling and measurement of properties of collected asphalt (penetration and softening point)
Deterioration of smoothness	Longitudinal irregularities and settlements	◎	○	○	Measurement of IRI (International Roughness Index), measurement of deflection (FWD) and load bearing tests (in-situ CBR tests)
	Corrugations, depressions and swells		○	◎	Measurement of IRI and core sampling (amount of asphalt)
Other	Potholes		○	○	Measurement of diameter and depth, visual observation (material segregation and spalling of mixtures) and core sampling (density)
	Deterioration of skid resistance coefficient		◎	○	Measurement using British pendulum testers, dynamic friction testers or skid measurement vehicles.
	Bumps		◎		Measurement of bumps using leveling cords
	Pumping	◎	○	○	Partial cutting (cracks at lower layers), measurement of deflection (FWD) and core sampling (spalling at lower layers)
	Raveling		○	◎	Visual observation (stripping) and core sampling (density)
	Cutback due to oil leakage		○	○	Confirmation of the range and property tests (collected asphalt and mixtures)

Legend) Survey methods ◎ : Surveys required for detailed identification

○ : Surveys required to generally grasp pavement damage conditions

Reference: NEXCO - Design Guidelines (pavements)

1.2.5.3 Survey Levels

The levels of surveys are listed in Table 1.2-7. Detailed surveys should be made appropriately to identify the damage to pavements in detail. Surveys are generally conducted at levels 1 through 4 in numerous cases. The higher the level of survey, the more detailed information is obtained. Level-1 basic surveys should be made in any case. In level-2 surveys, the degree of damage is evaluated quantitatively. Level 3 is conducted in the case where further investigations are required. Level-4 investigations are intended to investigate the causes in detail.

Table 1.2-7 Items and levels of surveys of damage

Survey item	Level of survey			
	Survey level 1	Survey level 2	Survey level 3	Survey level 4
Rutting	Visual observation	Rutting	Core sampling, Deflection, Extraction and property tests	Testing of dynamic stability of cut samples, Cut and cover tests
Cracking	Same as above	Cracking ratio, Crack width	Core sampling, Deflection, Extraction and property tests	Cut and cover tests
Smoothness	Same as above	Smoothness		
Potholes	Same as above			
Bumps	Same as above	Depth of bump		
Other	Same as above			

Reference: Japan Road Association, Manual for Asphalt Pavement

1.2.6 Road Surface Survey Methods by Damage Type

Road surface surveys cover such items as rutting, cracking, smoothness and bumps. The survey methods are described in detail below.

1.2.6.1 Rutting

1.2.6.1.1 Measurement of Rutting with Leveling Cords

A leveling cord was set as a reference (Figure 1.2-2). The line that links the inside ends of lane marks on both sides was defined as a reference height. In order to eliminate the margin of error due to a swell over the reference height, pieces of wood of several centimeters with the same thickness were placed. Measurements were taken at intervals of 20 cm or less. The transverse shape was measured in millimeters using a scale. The method is easy to use but may involve errors according to the person in charge of measurement. No mechanical records can be stored.

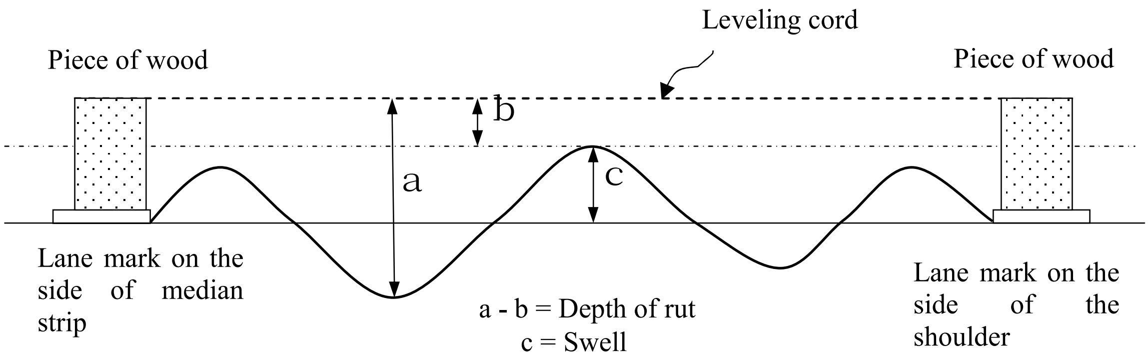


Figure 1.2-2Measurement of rutting with leveling cord

1.2.6.1.2 Method of Measurement Using Transverse Profile Meter

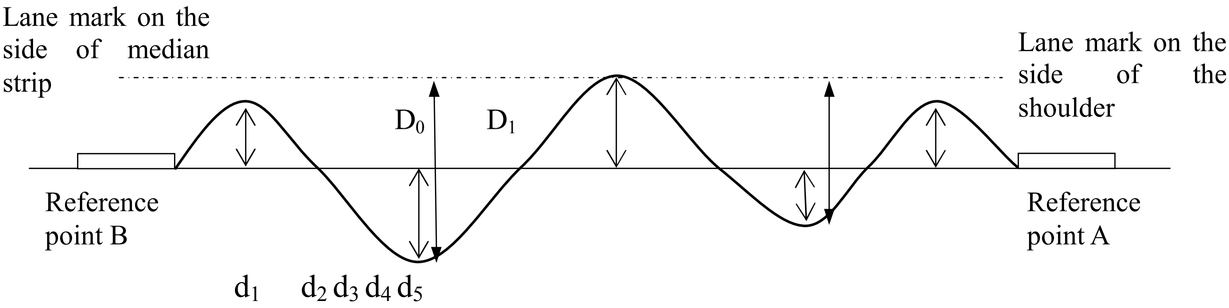
This method involves the mechanical recording of a transverse profile while moving along a beam (straight scale). The transverse profile meter is set so as to straddle the lane marks on both sides. Then, a scale is used to adjust the heights at both ends at the same level using adjustment screws. A waveform recorder is moved on the beam to record the transverse profile. The method requires much time for transport and assembly but enables mechanical recording of data.

Measuring rutting using a transverse profile meter

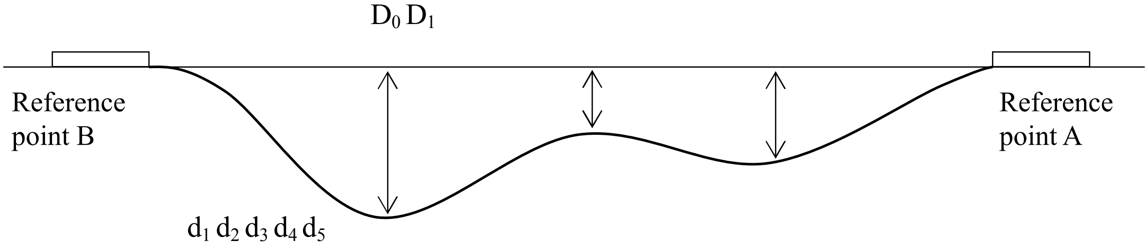
1.2.6.1.3 Calculation of the Results of Rutting Measurement

The results of measurement d1 through d5 are calculated in millimeters in each cross section Figure 1.2-3. The larger of D0 and D1 is defined as the depth of rut in the measurement cross section.

Example of rutting due to the flow of asphalt mixture



Example of rutting due to friction



Reference: NEXCO, NEXCO Testing Methods

Figure 1.2-3Definition of rut depth

1.2.6.2 Cracking

1.2.6.2.1 Methods for Measuring Cracks Using Sketches

Lanes are closed and plan views of areas where cracking occurred are developed using sketches. A two-dimensional diagram composed of meshes is prepared in advance. The lane width is divided into four and meshes are created at longitudinal intervals of 1 m. In order to make sure that cracks of 1 mm or larger are captured, cracks on the road surface are marked with a chalk before recording. Then, cracks are recorded on the preliminarily developed 2D diagram. At the same time, the locations of cracking are photographed. It is desirable that three to five people conduct surveys to minimize errors. The method enables accurate identification of the occurrence of cracks but requires much time. The method should therefore be used to a limited extent on roads that carry heavy traffic because there is a risk of traffic congestion.

1.2.6.2.2 Organization of the Results of Measurement of Cracks

Cracks are classified as described below when measurements are made using meshes.

Planar cracking means two or more cracks in a mesh. Linear cracking means only one crack in a mesh. Patching is applied in an area not wider than $100m^2$ at any point except in places where large-scale replacement is done or a bump is removed. The areas actually patched are recorded.

Cracks are measured on asphalt pavements. The mesh size is set at 1 m times a quarter of the lane width. The cracking ratio is calculated by the following equation.

Cracking ratio (%) = Area of meshes with planar cracking (m^2) + area of meshes with linear cracking (m^2) x 0.3 + area of patching (m^2) x 1/area of study section (m^2)

Cracking ratio is calculated by the above equation based on the results listed in Table 1.2-8 Surface Cracking Survey Sheet based on sketches. Cracking ratios are obtained every 100 meters of lane length in principle.

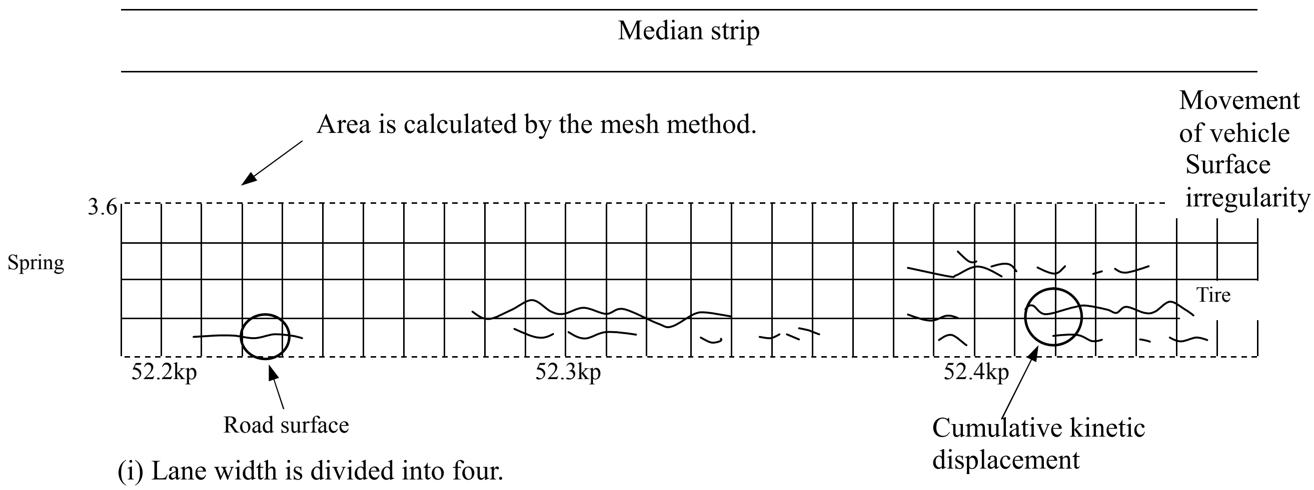
Table 1.2-8 Surface cracking survey sheet based on sketches (for reference)

<table>
<tr><td colspan="2">Name of administration office</td><td></td><td colspan="3">Date when the road is in service</td><td></td><td>Date of survey</td><td colspan="3"></td></tr>
<tr><td>Survey section</td><td>Up bound or down bound route</td><td colspan="2">Kp ～ kp</td><td colspan="2">Width</td><td>m</td><td>Site condition</td><td colspan="3">Fill, cut or bridge</td></tr>
<tr><td rowspan="2">Type of crack (check the applicable type)</td><td colspan="2">Linear cracking</td><td></td><td colspan="2">Maximum crack width</td><td>mm</td><td rowspan="2">Type of lane (check the applicable type)</td><td colspan="2">Nearside lane</td><td></td></tr>
<tr><td colspan="2">Planar cracking</td><td></td><td colspan="2">Maximum crack width</td><td>mm</td><td colspan="2">Passing lane</td><td></td></tr>
<tr><td colspan="11">Evaluation of cracked area</td></tr>
<tr><td>Person who made evaluation</td><td colspan="3">1</td><td>2</td><td>3</td><td>4</td><td>5</td><td colspan="3">Average (m^2)</td></tr>
<tr><td>Linear cracking (m^2)</td><td colspan="3">Mesh×1.0×0.9 *×0.3 * *</td><td></td><td></td><td></td><td></td><td colspan="3"></td></tr>
<tr><td>Planar cracking (m^2)</td><td colspan="3">Mesh×1.0×0.9</td><td></td><td></td><td></td><td></td><td colspan="3"></td></tr>
<tr><td>Total (m^2)</td><td colspan="3"></td><td></td><td></td><td></td><td></td><td colspan="3"></td></tr>
</table>

* A quarter of lane width

** Correction factor for linear cracking

Plan view of the points of cracking



(i) Lane width is divided into four.

(ii) Meshes are placed along the road alignment at intervals of 1 m from the 100-m kilopost.

Photographs are attached

Distance traveled

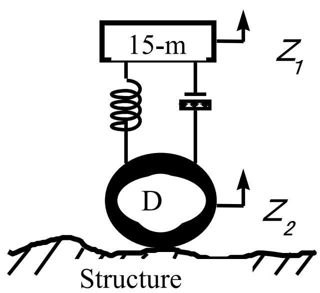
Reference: NEXCO, NEXCO Testing Methods

1.2.6.3 Method of Measuring Smoothness

The International Roughness Index (IRI) is generally used for evaluating smoothness. The IRI was first advocated in 1986 by the International Bank for Reconstruction and Development (World Bank), which then requested the University of Michigan Transportation Institute to build the evaluation index. The relatively new index enables the evaluation of a wide variety of surface from rough through smooth surfaces.

The longitudinal profile of surface is measured at intervals of 250 mm or less by any method and the collected data is analyzed by "Road Ruff", an IRI analysis program.

The IRI is expressed as the value (mm/m) obtained by dividing by the distance traveled the cumulative kinetic displacement due to the vertical vibration in the case where a quarter-car simulation model travels on the surface on which data was collected. The quarter-car simulation model is composed of tire and spring elements (Figure 1.2-4) and behaves like an actual vehicle. The evaluation method is beneficial as it quantitatively shows the behavior. Higher IRI indicates greater vertical movement of the vehicle and poorer smoothness (ride quality). There is no international standard for the length in which the IRI should be measured. The IRI is measured at intervals of 200 m on the expressways in Japan.



$IRI = \Sigma \Delta Z / L$

- $Z' = Z_1 - Z_2$
- $\Delta Z = |Z'_i - Z'_{i+1}|$

- $\Sigma \Delta Z$: Approach to the structure
- L: Ex-Joint
  Joint in a bridge
- Z_1: Two-meter leveling
- Z_2: Dm

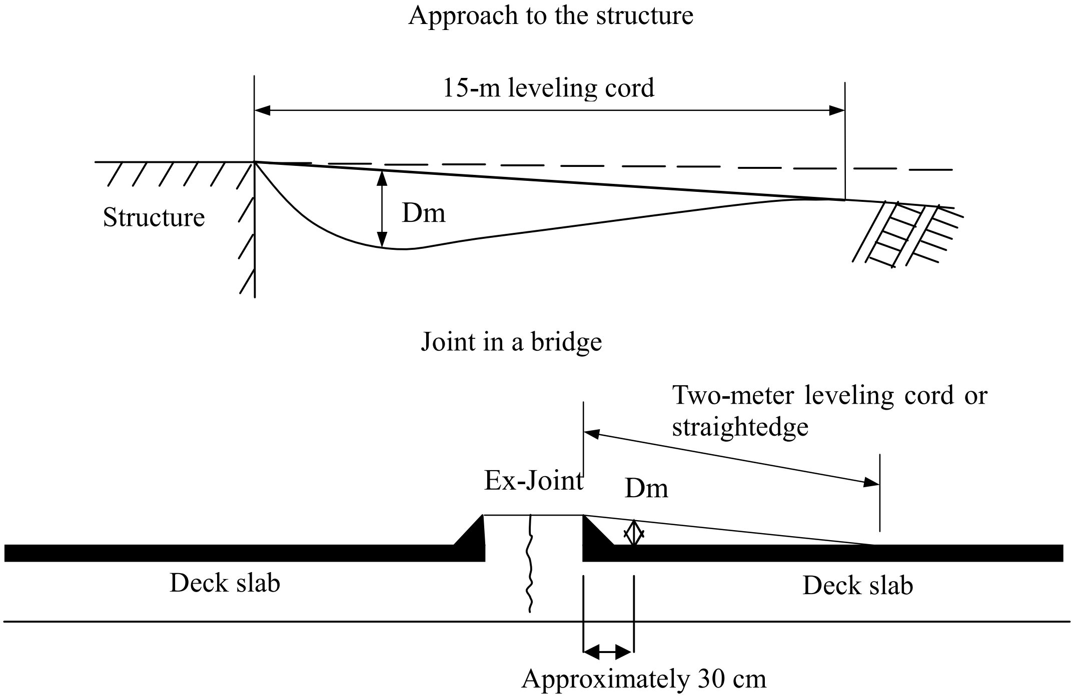
Figure 1.2-4Quarter-car simulation model for calculating IRI

Longitudinal profiles required for calculating the IRI can be measured most accurately by level surveys. The survey method, however, requires much labor. IRI measuring vehicles shown below are therefore generally used in numerous cases.

IRI measuring vehicle: Dainichi Consultant Inc.

1.2.6.4 Method of Measuring Bumps

Leveling cords are used to measure bumps at the approach to a structure or at the joints on a bridge. Bumps are generally measured in the outside wheel path (OWP) in principle. Measurements are made at the approach to a structure or at the joints on a bridge to obtain the difference in level (maximum depth of settlement) at the locations shown in Figure 1.2-5. Leveling is adopted in the case of settlement with the length of transition exceeding 15 m at the approach to a structure. The results of leveling are organized using the bump survey sheet shown in Table 1.2-9.



* Measurements are made using a 2-m leveling cord in the outer wheel path.

Figure 1.2-5 Method of measuring bumps

Table 1.2-9 Bump survey sheet (for reference)

Measurement point: approach to a structure ／ joint in a bridge Date of measurement ________ Measurement made by ________

Structure	KP Up bound/ Down bound route	Lane	Settlement measured (cm)																						Maximum settlement (cm)	Remarks
			Distance	m	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	m 15.0		
○○ bridge	KP Up/Down	Travel/ Passing	OWP		1.8	2.2	2.4	2.5	2.8	3.1	3.9	4.6	4.9	5.2	4.6	4.0	3.7	3.3	3.1	2.5	1.8	1.3	0.6		5.2	
	KP Up/Down	Travel/ Passing	OWP																							
	KP Up/Down	Travel/ Passing	OWP																							
	KP Up/Down	Travel/ Passing	OWP																							
	KP Up/Down	Travel/ Passing	OWP																							
	KP Up/Down	Travel/ Passing	OWP																							
	KP Up/Down	Travel/ Passing	OWP																							

OWP: outside wheel path

1.2.6.5 Other Survey Methods

1.2.6.5.1 Method of Measuring Skid Resistance Coefficient

Skid resistance may be measured using the British portable tester or dynamic friction tester. For high-speed measurement in a wide area, skid resistance measurement vehicles are used. Skid resistance deteriorates due to bleeding or polishing. Functions are seldom restored by repair work.

Skid resistance measurement vehicle
；Nippon Expressway Research Institute Co. Ltd.

1.2.6.5.2 Road Surface Measurement Vehicles

In the case where a limited number of roads are serviceable and carry a relatively small volume of traffic, road surface is surveyed manually while lanes are closed to traffic. With the increase of the road length to be administered and of the traffic volume, road surface measurement vehicles are used that enable high-speed measurement for greater safety of workers and higher work efficiency. The development of road surface measurement vehicles was launched in Japan around 1985 for use on expressways. At present, road surface conditions are measured throughout the routes on all expressways in Japan at intervals of two to three years.

A high-speed road surface measurement vehicle used by NEXCO Central is shown below. The vehicle can simultaneously measure rutting, cracking and the IRI at any speed up to 100 km/hr. It is also technically capable of making three-dimensional evaluation of road surface at high density (at longitudinal intervals of 0.5m and transverse intervals of 0.1 m) using GPS and inertial measurement unit (IMU).

High-speed road surface measurement vehicle「Road Tiger」
；Central Nippon Highway Engineering Tokyo Co. Ltd.

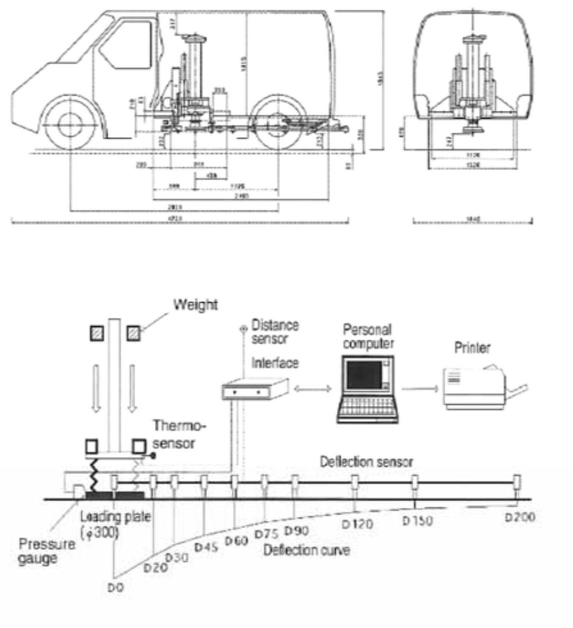
1.2.7 Methods of Surveying Pavement Structure

1.2.7.1 Surveys of Layers of Pavement

Structural damage frequently reaches the base course or sub grade. It is therefore important to start visual monitoring at the point when abnormal conditions are observed on the surface. The construction conditions for the base and sub grade should be identified based on the materials prepared in the initial stages of construction.

For evaluating the soundness of pavement structure, the degree of deflection is measured using a falling weight deflect meter (FWD). FWD measures the degree of deflection using multiple sensors that occurs on the surface when the surface is subjected to an impact produced by a falling weight. Dropping the weight at multiple points for measuring deflection causes the pavement to deflect around the points of loading. The shape and degree of deflection reflect the condition in the pavement. Evaluating the values of measurements enables the assessment of the soundness of the pavement.

In cases where no soundness of the pavement structure can be fully evaluated, core sampling or cut and cover surveys are adopted. Such a measure enables the verification of changes in thickness and material properties of layers constituting the pavement, load bearing capacity of the base, groundwater level and other parameters.



FWD（Falling Weight Deflect meter）
；Central Nippon Highway Engineering Nagoya Co. Ltd.

1.2.7.2 Surveys of Mixtures

Cores are sampled and the mixture materials and properties are surveyed in order to select the repair method or verify the degree of deterioration of mixtures. The tests fit for evaluation vary according to the mode of damage. Surveys should therefore be planned only after the state of damage to the pavement to be studied has been fully identified. Survey plans need to be developed that are suitable for the mode of damage based on Table 1.2-6.

1.2.7.3 Information Obtained in Surveys

Asphalt pavements are damaged by various factors such as the deterioration due to heavy traffic, aging with the lapse of time and changes in mixture property owing to water infiltration. It is therefore necessary to estimate the causes of damage based on the information obtained in various tests and to take necessary corrective measures. The types of surveys of pavement structures and mixtures, and the results of surveys are listed in Table 1.2-10.

Table 1.2-10 Methods of Surveying Pavement Structures and Survey Results

	Type of survey	Results of survey (information obtained)	Remarks
Pavement structure	In-situ CBR test	Load bearing capacity of base and sub grade	
	Measurement of the degree of deflection	Strength and load bearing capacity of layers of the pavement	FWD
	Core sampling	Deformation of layers, range of damage, properties of materials and mixtures, waterproofing property, density, bond between aggregate and asphalt, etc.	
	Cut and cover surveys	The same parameters as listed above, and load bearing capacity of base course, dynamic stability, moisture state of bed and sub grade, etc.	
Mixtures	Penetration and softening point	Deterioration and aging of asphalt	Asphalt extraction tests
	Ductility	Cracking resistance	Asphalt extraction tests
	Brittle point	Susceptibility to deformation at low temperature	Asphalt extraction tests
	Density (void ratio)	Susceptibility to flow of asphalt	
	Dynamic stability	Flow resistance	
	Grain size and amount of asphalt	Property as an asphalt mixture	
	Immersion tests	Waterproofing property of mixture	

1.3 Diagnosis and Maintenance and Repair Plans

1.3.1 Evaluation and Determination

Selecting sections or spots where maintenance or repair are required, prioritization, selecting methods of maintenance work, and the timing of implementation is determined based on the results of various surveys.

The targeted goals of maintenance and repair are defined as the status at which level the pavement conditions are recovered by maintenance or repair works. The target goals have been set as shown in Table 1.3-1 so as to maintain the road surface at a certain level, thus maintain road conditions satisfactory.

Table 1.3-1 Target Goals for Maintenance or Repair

Rut (mm)	Cracking ratio (%)	Difference in level including settlement (mm)		Smoothness (IRI) (mm/m)	Skid resistance coefficient (μV)
		Connection to the bridge	Connection to the transverse structure		
25	20	20	30	※(3.5)	※(0.25)

Reference: NEXCO, Design Procedure (pavement)

Operational guidance in using the above goals

- Smoothness index will not be evaluated in terms of IRI for the time being. Smoothness will be evaluated using the target level for the difference in level including settlement. Improvement works have yet reported to be implemented on expressways by the reason of the degraded skid resistance. For the time being, therefore, IRI and skid resistance coefficient will not be employed to trigger maintenance and repair.
- Potholes, depressions, twists and other local deformations on the surface should be repaired immediately based on the results of visual inspections rather than setting the target level for maintenance or repair because they usually demand urgent response.
- No target goals will be set for structural surveys or for the properties of mixtures because pavement damages are induced by multiple factors. Evaluation will be made in principle through comparison with those pavements of sound sate. It is therefore important to make evaluations based not only on the survey results but also observation of external conditions including the traffic and weather, road structure, spring water and geology, coupled with observations on the point of damage.

1.3.2 Maintenance or Repair Plans

Maintenance or repair ensures the performance of asphalt pavements during their service life and reduces pavements' life cycle costs. Appropriate maintenance or repair is therefore important. In planning maintenance or repair work, the areas that require corrective measures are prioritized based on the results of evaluation and rating of the pavement. Then, appropriate corrective work and implementation time are determined in high-priority areas. The above process is implemented for each road network and for respective projects. Compatibility should be achieved between the maintenance or repair plans in the network and in the project. Table 1.3-2 lists basic considerations in maintenance or repair planning.

Table 1.3-2 Basic Considerations in Maintenance or Repair Planning

Road network (maintenance or repair plans throughout the road network)	Project (maintenance or repair design in areas of implementation)
—	Initial design conditions
Pavement configuration (thickness)	Pavement configuration (thickness and material property)
Traffic volume	Traffic volume and axle load (wheel load)
History of maintenance and repair	History of maintenance and repair
Surface conditions	Surface property and mixture property
—	Load bearing capacity and strength of each layer

On asphalt pavements, their weaknesses are likely to surface during a rain in particular and the damage develops rapidly. When a damage is discovered, therefore, measures should be taken on a timely basis. Whether actions are taken in the initial stages of damage or not has a great bearing upon the rate of subsequent progression of damage. Repair such as patching and the application of crack seals should be made diligently in the early stages. Early repair is the key to the elimination of future large-scale repair.

1.3.2.1 Identification of Design Conditions

When selecting the repair method, designing the cross section to be repaired or selecting the material, design parameters such as load bearing capacity, pavement structure, property of pavement materials and traffic conditions should be identified quantitatively as required. It is also desirable to confirm the design conditions at the time of initial construction and the history of maintenance and repair. The objective is to help make appropriate decisions.

- Load bearing capacity and pavement structure

  Evaluating the load bearing capacity and pavement structure enables the determination of whether the damage is structural or functional. Estimating the value required for overlay sectional design also becomes possible. Whenever the degree of deflection is found to be extraordinarily higher than usual, it often turns out that the sub grade has insufficient load bearing capacity. In those instances, cut and cover surveys need to be implemented. The depth of layers in which damage prevails and the load bearing capacity of the sub grade are measured to collect data required for identifying the range of layers that requires repair and for designing the cross section.

- Properties of pavement materials

  For asphalt mixtures, the grain size, amount of asphalt and asphalt property are investigated. Water content and penetration are investigated in the base and sub grade. The material properties of asphalt mixtures are frequently investigated mainly in the case where the damage is determined to be of functional type. Then, identifying the asphalt mixture material properties enables appropriate selection of repair materials.

- Traffic loads

  Pavements are also damaged in numerous cases as cyclic loading exceeding the design traffic volume or excessive traffic loads act, breaking the equilibrium between the traffic load and the pavement structure. In the case of sectional design in the repair of structural damage in particular, it is desirable to identify not only the sub grade design conditions but also the traffic loads for appropriate sectional design. In the case of functional damage, grasping the extent of traffic load is also important.

- Design conditions at the time of initial construction and history of maintenance and repair

  The design conditions when the pavement was initially constructed are important at the time of sectional design during the repair of structural damage. The history of maintenance and repair is useful when selecting the repair method or the range of repair.

1.3.2.2 Selection of Repair Method

Major maintenance methods include the injection including patching, surface treatment and local replacement. The appropriate method is selected based on the survey results and repair plans. Major repair methods are replacement, local replacement, leveling, cutting and overlaying, and overlaying. Selection should be made carefully based on the survey results and repair plans. Major maintenance and repair methods for asphalt pavements are outlined in Figure 1.3-1 and Table 1.3-3.

The horizontal axis indicates the characteristics of functional and structural measures. The vertical axis indicates the range of layers with applicable measures. The maintenance or repair measures at the upper right are more of structural character and cover all the layers of the pavement. Those at the lower left on the other hand are functional measures and cover only the surface and base layers. Some of the functional measures are taken mainly under urgent conditions. The measures positioned in the left of the figure are more of urgent character.

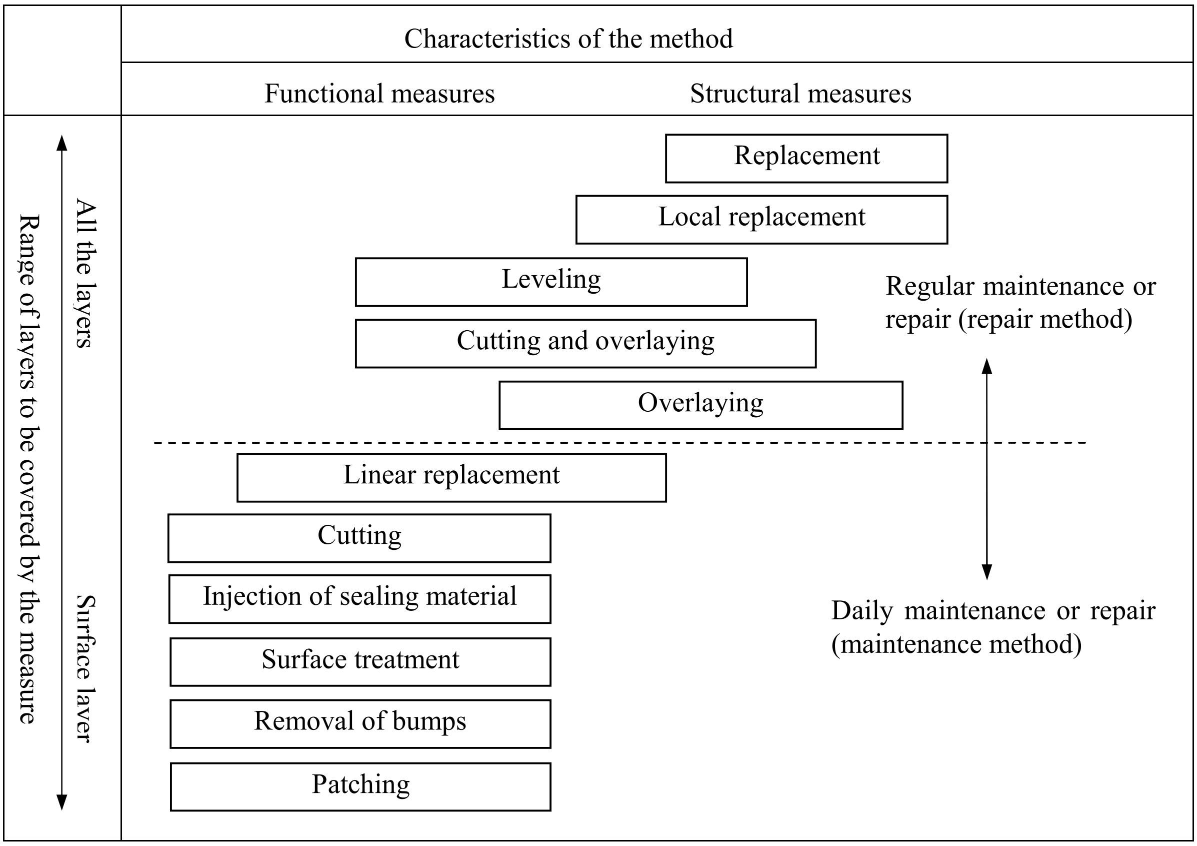


Figure 1.3-1 Major asphalt pavement maintenance and repair methods

Table 1.3-3 Outline of major maintenance and repair methods for asphalt pavements

Method	Outline
Replacement	The base course or part of the base course of an existing pavement is replaced. The sub grade may be replaced or the sub grade or base course may be stabilized in some cases.
Local replacement	In the case where the local damage to an existing pavement is determined to be great and no other method is expected to repair the damage, local replacement is done from the surface layer, base layer or base course. The method is frequently applied together with cutting and overlaying or overlaying in the areas where great cracking occurred locally.
Leveling	Modifications are made longitudinally by laying additional mixtures in longitudinal depressions on the surface produced by differential settlement. In planning, considerations should be given for guaranteeing the adequate height of safety fence, securing the drainage capacity and selecting appropriate regulation methods.
Cutting and overlaying	Existing asphalt mixture layers are removed by cutting, and the surface or base layer of the existing pavement is replaced.
Overlaying	Hot asphalt mixtures with a thickness of 3 cm or more are laid over an existing pavement. At locally faulty points, if any, replacement should be made first. If overlaying is adopted, the influences on the clearance gauge or the structures at the surface should be examined.
Linear replacement	The pavement is replaced along linear cracks. Only the hot asphalt mixture layers are replaced.

Method	Outline
Cutting	Bumps on the surface are removed by cutting to eliminate irregularities or the difference in level. The method is often implemented as a preliminary measure before overlaying or surface treatment.
Injection of sealing material	Joint fillers are injected into relatively wide cracks. Injection materials include emulsified, cutback and resin types. Various materials are used according to the width or depth of the crack.
Surface treatment	A sealing layer with a thickness of 3 cm or less is applied over the existing pavement using materials other than hot asphalt mixtures. The seal coat, slurry seal or resin-type seal method is available.
Patching and removal of the difference in level	Potholes, depressions and irregularities are temporarily filled. For filling, hot asphalt mixtures or cold mixtures using bituminous or resin binder are employed.

Considerations during the selection of the maintenance or repair method are described below.

- Types and causes of damage

  To which layer corrective measures are required is examined based on the results of inspections and detailed surveys. High degree of cracking or deflection needs particular attention because there is a high possibility of structural damage. In the case where serious rutting is found, caused by the flow of asphalt, removal of the layer is necessary that caused the rutting.

- Planar scale of damage

  It is necessary to determine whether the scale of damage is local or occurring at a wide area. Methods are chosen fitting to the scale of damage.

- Timing of maintenance or repair

  An appropriate timing should be determined considering the progression of the damage and the weather conditions.

- Roadside conditions

  The restrictions imposed by the roadside environment including the height of the existing pavement and houses in the vicinity should be examined.

- Traffic conditions

  It should be determined whether or not the cross section of the existing pavement is adequate under the present traffic conditions.

1.4 Maintenance and Repair Work

1.4.1 Major Daily Maintenance and Repair Work

Pavements are treated either by maintenance or repair. Maintenance is not intended for fundamental restoration from the damage to the pavement but only for the maintenance of serviceability of the pavement by temporary measures. The asphalt pavement maintenance measures include patching, injection of sealing materials, surface treatment, cutting and linear replacement. No discussions will be made here on surface treatment because there have been no cases of application of the method on expressways.

1.4.1.1 Patching (removal of the difference in level)

In patching, potholes, bumps, local cracks and depressions are temporarily filled with asphalt mixtures. The objective is to control the deterioration of load bearing capacity due to water infiltration and to improve ride quality on a temporary basis. A simple method is for embedding asphalt mixtures or other materials direct into the fault without applying any pre-treatment. In another method, faulty areas are removed by cutting and backfilled with asphalt mixtures. The former is adopted in the case where urgency is required. Patching is applied either by hot mixing or by colt mixing.

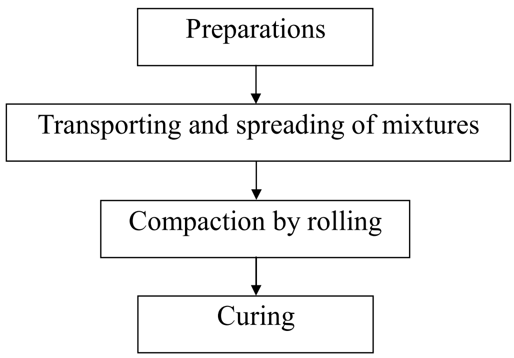


Figure 1.4-1 Flow of Patching Steps

1.4.1.1.1 Patching by Hot Mixing

In the patching by hot mixing, potholes, bumps and depressions are temporarily filled with hot asphalt mixtures. The method is fit for the maintenance or repair of roads that carry heavy traffic of large vehicles because it provides excellent bond with the existing pavement and high durability and stability. For the hot asphalt mixtures used by the method, materials similar to those used on the existing pavement should basically be adopted.

- Preparatory work

  Damaged and faulty sections are removed using a concrete cutter and their shape is trimmed. When repairing small areas such as potholes, no cutting is required. Then, dust and mud in or around the cut face are removed. Then, a tack coat is laid on the bottom and side surfaces. The excess tack coat staying in depressions are wiped off with a cloth or by other means.

- Transport and spreading of mixtures

  Only a small amount of mixture is generally used. The mixture is covered with membranes during the transport to prevent temperature drop. The mixture is spread so that the finished level may be approximately one centimeter higher than the road surface surrounding the faulty spot, taking into account of settlement after the commencement of service.

- Compaction by rolling

  Small road rollers or plate compactors are used for compaction.

- Curing

  The surface is cured until it becomes possible to touch with a hand.

- Matters to be taken care of

  In the above patch work, the point to be repaired needs to be cleaned and a wet surface needs to be completely dried. The work should be carried out quickly to obtain the designated compaction temperature. Heating by burners should be minimized even where necessary.

1.4.1.1.2 Patching by Cold Mixing

The method of patching by cold mixing can be implemented at the room temperature. It is easy to implement and is therefore adopted in emergency. The method is inferior to the hot mixing method in initial stability and durability, and moreover, it needs the period of curing.

- Preparatory work

  Similar pretreatment is done to that in the method by hot mixing.

- Spreading of mixture

  Aggregate mixture is wrapped in bags. The mixture is spread so that the finished level may be approximately one centimeter higher than the road surface surrounding the faulty spot, counting the magnitude of settlement after the commencement of service.

- Compaction by rolling

  Small road rollers or plate compactors are used for compaction.

- Curing

  The road should not be put into service until the moisture and solvent of the bituminous material vaporize.

- Considerations

  The method is temporarily applicable on roads that carry heavy traffic of large vehicles if urgency is demanding.

1.4.1.2 Injection of a Sealing Material

The sealing material injection method involves the injection of an asphalt-type sealing material or a resin-type sealing material into cracks, which is applicable at room temperature. The method is adopted to temporarily suppress the deterioration of load bearing capacity due to water infiltration. The objectives of the method are to extend the service life of the pavement and to reduce the cost of pavement maintenance and repair.

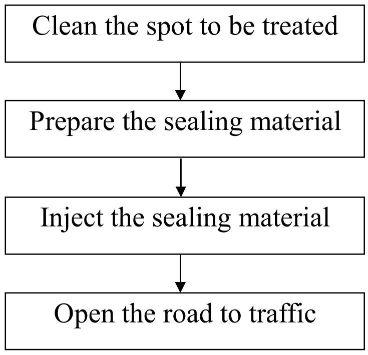


Figure 1.4-2 Flow of injection of a sealing material

1.4.1.2.1 Injection of an Asphalt-type Sealing Material

The method is used to treat the pavement by injecting a hot-mixed sealing material. Hot-mixed sealing materials are highly cohesive, adhesive and elastic, so they are well adaptive to swelling and shrinkage. Asphalt-type sealing materials are more cohesive than resin-type sealing materials that are described later. They are therefore suitable for cracks with a relatively large width of five to ten millimeters.

- Cleaning the spot to be treated

  The faulty spot is cleaned by blowing off the dust or mud in cracks using compressed air. The loosened areas around the crack are removed.

- Preparation of the sealing material

  The sealing material is melted by heating.

- Injection of the sealing material

  The sealing material is poured into the crack and made to penetrate into the crack using a U-shaped tool. Excess material is scraped off with a tool and the surface is cast. Sand is spread as required to prevent the adhesion to tires.

- Opening of the road to traffic

  The road is put into service after confirming that the sealing material has fully hardened.

- Considerations

  A wet surface is fully dried by heating with a burner before injection.

1.4.1.2.2 Injection of a Resin-type Sealing Material That Hardens at Room Temperature

The method is used to treat the pavement by injecting a resin-type sealing material that hardens at the room temperature. The sealing material hardens quickly and even at low temperature. Thus the material provides high workability including flexibility and traceability along the crack. The method is therefore applicable to narrow cracks of 5 mm or less.

- Method of patching

  The method similar to that for asphalt-type sealing materials is used. No preparation of a sealing material is, however, required.

- Considerations

  When the sealing material penetrates and cause settlement, additional volume of material is injected again according to the degree of settlement. Resin-type sealing materials are generally more costly than the asphalt type. They should be used within the designated working life. A wet surface should completely be dried by heating with a burner or other device before injection.

1.4.1.3 Cutting

Cutting is used to scrape off the projections on the uneven or irregular pavement surface. Bumps are scraped off using machines to restore the surface shape. The method is often adopted as a preparatory work before surface treatment or overlaying.

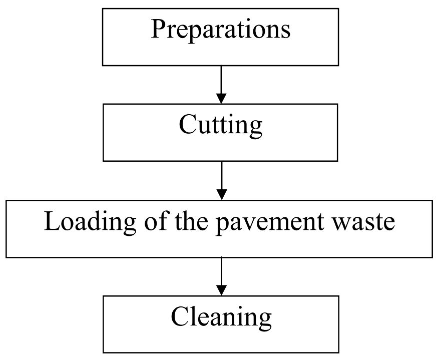


Figure 1.4-3 Flow of Cutting

- Preparations

Drainage basins are protected prior to surface cutting to prevent them from being clogged with the materials produced by cutting.

- Cutting

  Bumps are scraped for the designated thickness using surface cutters. Sufficient amount of water is sprinkled during cutting to control the production of dust during operation.

- Loading of the pavement waste

  The pavement waste produced by cutting is loaded on dump trucks using loading machines for transport to designated sites.

- Cleaning

  Road sweepers are used to completely clean the surface while sprinkling water to control the production of dust.

- Considerations

  The method is a temporary measure. On the surface where rutting due to the flow of asphalt or corrugations cause problems, therefore, irregularities are likely to recur early. The irregularities that developed in a short time in particular are highly likely to recur.

1.4.1.4 Linear Replacement

In linear replacement, the pavement is replaced along linear cracking. The method is generally applied only to asphalt mixture layers including the layers stabilized with bituminous materials.

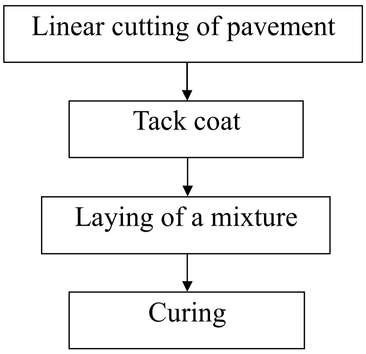


Figure 1.4-4 Flow of Linear Replacement

- Linear cutting of pavement

  The faulty sections with linear cracks are cut off. For cutting, a cutter is placed along the crack and the section is scraped off with a breaker or backhoe.

- Tack coat

  The cut spot is cleaned with a compressor and cured by evenly spreading emulsified asphalt using an engine sprayer. Then, the cut surface in the existing asphalt mixture layer is also fully coated with emulsified asphalt using a brush.

- Laying of a mixture

  A hot mixture is manually spread and compacted using a small vibratory roller or tire roller. Joints should be carefully compacted because the joints are likely to be compacted poorly, resulting in weak points.

- Curing

  The pavement is cured until the surface temperature drops below 50°C before opening the road to traffic.

1.4.2 Regular Maintenance and Repair Work

A type of regular maintenance or repair is the repair work. In the case where a pavement has been greatly damaged and keeping the surface under a structurally and functionally excellent condition is difficult, fundamental treatment is applied to the pavement through repair work.

Asphalt pavement repair methods include overlaying, cutting and overlaying, replacement and local replacement. All are more costly than maintenance.

The damage to pavements is caused by various factors. The repair method should therefore be adopted based on the materials including various survey results. The planar scope of the damage, timing of repair, and traffic and roadside conditions need to be examined carefully.

1.4.2.1 Overlaying (leveling)

In overlaying, an asphalt mixture layer is laid over the existing pavement. The method is applied in the case where the damage is expected to progress throughout the pavement in the near future or the pavement structure has become insufficient to carry ever increasing traffic. The method provides the following benefits.

- Increase in the load bearing capacity of the pavement or restoration of the load bearing capacity of a damaged pavement
- Functional restoration of surface smoothness or skid resistance
- Provision of additional functions

The thickness of the layer laid by the method is generally three to five centimeters unlike the thickness of carpet coat (applied by surface treatment) of 1.5 to 2.5 cm. Leveling is applied for restoring from functional damage in the areas subjected to differential settlement, however is not intended for structural reinforcement. In leveling, longitudinal modifications are made by laying new binders over depressions in the longitudinal direction.

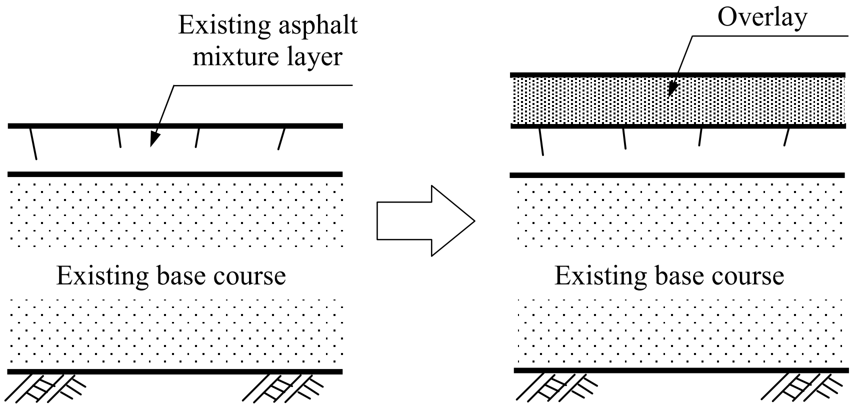


Figure 1.4-5 Conceptual View of Overlaying

The thickness of overlay is designed either by a method using the California Bearing Ratio (CBR) or by a method using deflection. Overlaying is a simple method for reinforcing the pavement structure that enables the improvement of layer equivalency factor by increasing pavement thickness. For adoption, it should be noted that the surface elevation increases and that the causes of damage have yet to be removed fundamentally.

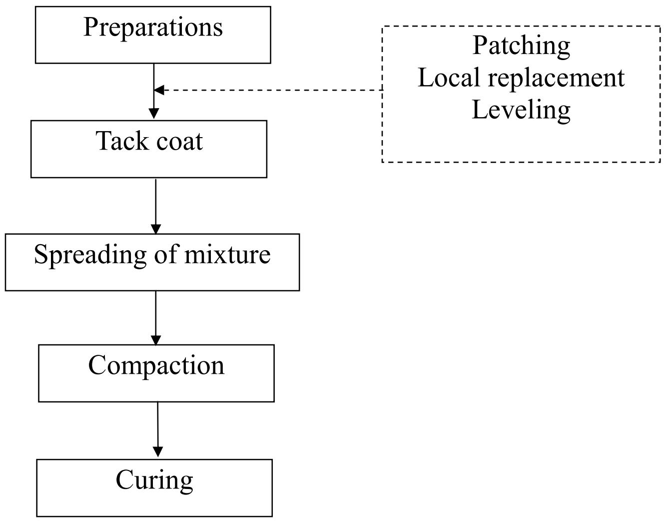


Figure 1.4-6 Flow of Overlaying

- Preparatory Work

  In the case where there are damaged areas or irregularities on an existing pavement, patching, leveling, local replacement or other measure is taken according to the condition before overlaying. For overlaying, the surface is cleaned, dust or mud is removed and a tack coat is applied. In leveling, cutting is required for a depth of approximately 20 mm for connection to secure the minimum pavement thickness at the end.

- Tack coat

  A designated amount of emulsified asphalt is evenly spread using distributors or other devices. At the end point of cutting, spreading is done manually or using simple pump spreaders. Care should be exercised to prevent emulsified asphalt from staying on the existing surface.

- Spreading of a mixture

  The mixture is usually spread using asphalt finishers, or manually in areas where no finishers can be used. The mixture is spread so as to achieve the designated thickness after compaction. If it starts raining while spreading the mixture, spreading should be suspended. The mixture that has been spread should be compacted quickly and finished.

- Compaction

  The mixture that has been spread is compacted so as to obtain the designated density. Compaction generally starts with joint compaction and proceeds to the primary and secondary compaction and ends with finishing.

  The primary compaction is done by two-time trips, or a back-and-forth trip, of a 10- to 12-ton roller. Compaction is carried out at the highest temperature possible as long as no hair crack occurs. The compaction temperature is generally 110 to 140°C. In order to prevent the mixture from adhering to the roller, a small amount of water may be sprayed thinly over the surface using an atomizer.

  For the secondary compaction, eight- to 20-ton tire rollers or six- to 10-ton vibratory rollers are generally used. Compacting the mixture by tire rollers improves the interlocking of aggregates owing to the force of compaction as under traffic loading, and is expected to achieve a uniform density in the depth direction. Using vibratory rollers with appropriate loading, frequency of vibration and amplitude produces the designated degree of compaction in smaller numbers of times of rolling than using tire rollers. The secondary compaction is generally carried out at 70 to 90°C.

  Finishing is done to correct irregularities or eliminate roller marks. Tire rollers or road rollers should travel back and forth once. In the case where vibratory rollers are used for secondary compaction, tire rollers should preferably be employed for finishing. No roller should stay for a long time on the just-finished pavement.

- Curing

  The pavement is cured until the surface temperature drops below 50°C before opening the road to traffic.

- Considerations

  Overlaying is suitable for controlling relatively moderate cracks that occur on the pavement surface. In the case of the occurrence of numerous cracks that are likely to reach the base course or sub grade, replacement is preferable. After the completion of the leveling work, it is necessary to secure the adequate height of safety fence and the drainage capacity.

1.4.2.2 Cutting and Overlaying

Cutting and overlaying work involves the cutting of part of the existing asphalt mixture layer followed by overlaying. The repair method - cutting and overlaying- has recently been implemented most because it eliminates the need of increasing the surface elevation and wide availability of high-performance cutters. In cutting and overlaying work, unlike overlaying work, surface cutters are adopted. Surface cutters are classified into wheeled-type and crawler-type devices according to the mode of travel. Surface cutters equipped with a loading machine are generally used.

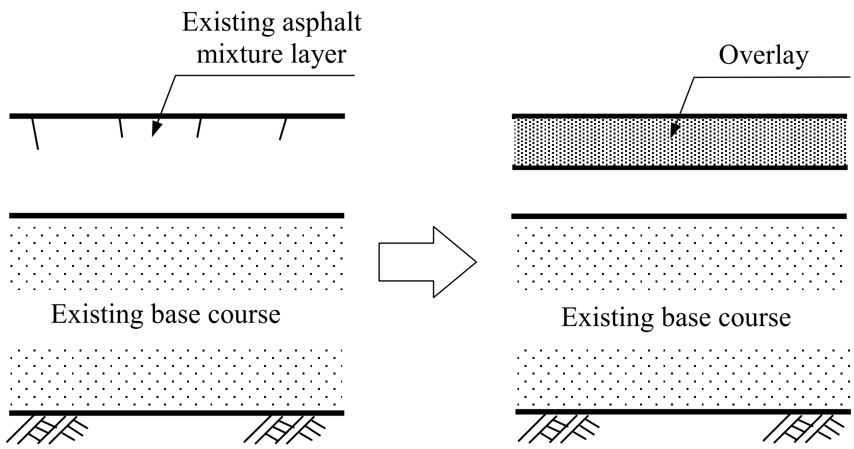


Figure 1.4-7 Conceptual View of Cutting and Overlaying

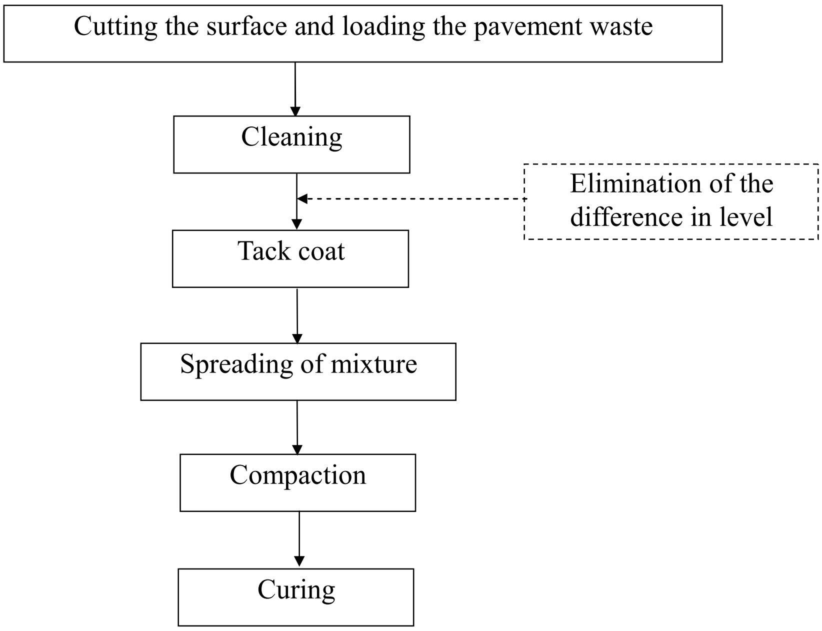


Figure 1.4-8 Flow of Cutting and Overlaying

- Cutting the surface and loading the pavement waste

  Cutting the existing surface is generally done by using surface cutters. The areas around cutting should be separated by cutting with concrete cutters. The pavement waste produced by cutting is transported to the designated places on trucks.

Cutting and loading of the pavement waste

Cleaning

- Cleaning

  The debris produced by cutting is completely removed while spraying water to prevent drifting. It should be make sure that no debris is left in the ditches created by cutting.

- Tack coat

  Construction is carried out as in overlaying. In cutting and overlaying, care should be exercised to prevent the emulsified asphalt that constitutes the tack coat from staying in the ditches created by cutting.

Tack coat

Tack coat (treatment at the edge)

- Spreading of mixture

  The spreading work is implemented as it is done in overlaying.

- Compaction

  The compaction work is implemented as it is done in overlaying.

- Curing

  The curing work is carried out as in overlaying.

Spreading

Primary compaction by a road roller

Secondary compaction by a tire roller

1.4.2.3 Replacement

In replacement, the existing pavement is partly or fully removed and a new pavement is constructed. The method is implemented in cases where the pavement has been seriously damaged and the damage has reached the sub grade or base course, or where the surface has a limited elevation. The types of damage to which the method is applied include the deterioration of the load bearing capacity of sub grade or base course and the rutting and cracking ascribable to settlement. The pavement is replaced from the surface to the layer with considerably deteriorated strength. In the case where the base course has suffered from the deterioration of load bearing capacity, the pavement is replaced using excellent materials or is stabilized.

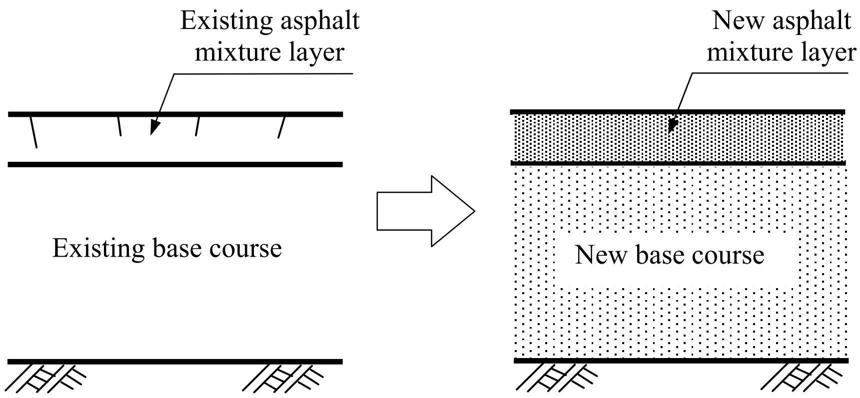


Figure 1.4-9 Conceptual View of Replacement

Demolishing an existing pavement and transporting the pavement waster using a shovel loader.

Laying a prime coat on a lower base course using an engine sprayer.

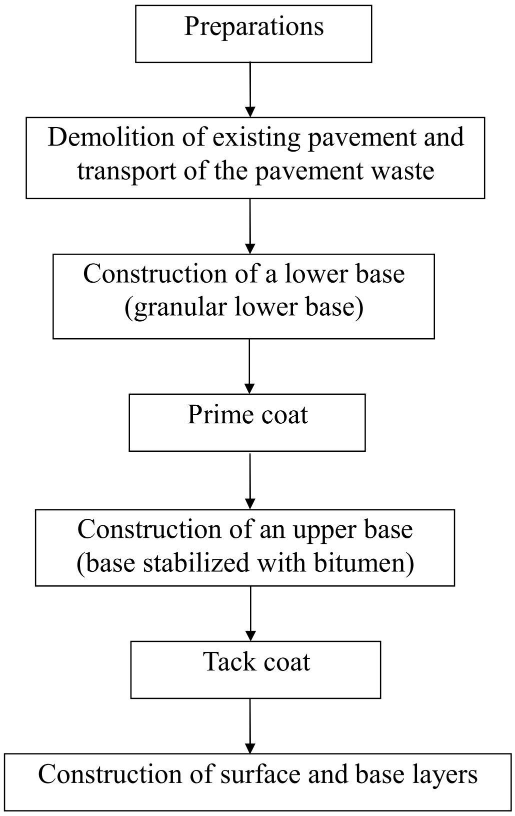


Figure 1.4-10 Flow of Replacement

- Preparations

  The points of replacement (e.g. start and end points and longitudinal joints) are specified explicitly.

- Demolition of the existing pavement and transport of the pavement waste

  The edge of the area to be replaced is cut to the designated depth by a cutter. The existing asphalt mixture is pulled up with a cutter or breaker and fragmented. The existing asphalt mixture that has been fragmented with a shovel loader or backhoe is loaded on dump trucks and transported to designated places. The sub grade is to be treated carefully so as to finish it as smooth as possible.

- Construction of a sub-base (granular sub-base)

  Irregularities on the cut surface are corrected using a bulldozer or grader while confirming the elevation of finished sub grade. The base course materials delivered by dump trucks are spread by bulldozers. Compaction is done using a road roller or a tire roller. The edge is corrected manually and carefully compacted with a rammer or other equipment.

- Prime coat

  A designated amount of emulsified asphalt is spread evenly with an engine sprayer and cured. When spreading, protection is provided using concrete panels or other materials to prevent the emulsion from drifting.

- Construction of a base course (base stabilized with bitumen)

  Construction is carried out as in overlaying.

- Tack coat work

  Emulsified asphalt is evenly spread with a distributor and is cured. When spraying the emulsion, protection is provided using concrete panels or other materials to prevent the emulsion from drifting.

- Construction of wearing course and binder course

  Construction is carried out by the same manner as is done in overlaying. When the binder course temperature drops to approximately 50°C, the tack coat works and the wearing course work are undertaken. The work is done as in overlaying. When the wearing course surface temperature drops to approximately 50°C, the pavement is opened to traffic. Then, pavement markings are placed using dedicated machines by a separate work.

1.4.2.4 Local Replacement

Local replacement of the wearing course, binder course or sub-base is one of the measures employed when the existing pavement is greatly damaged locally by cracking or other factors and suffered from structural damage as revealed by the preliminary survey... The method may sometimes be implemented in areas that suffered serious local damage before overlaying or “cutting and overlaying” is implemented.

Small cutter

Loading the pavement waste using a shovel loader

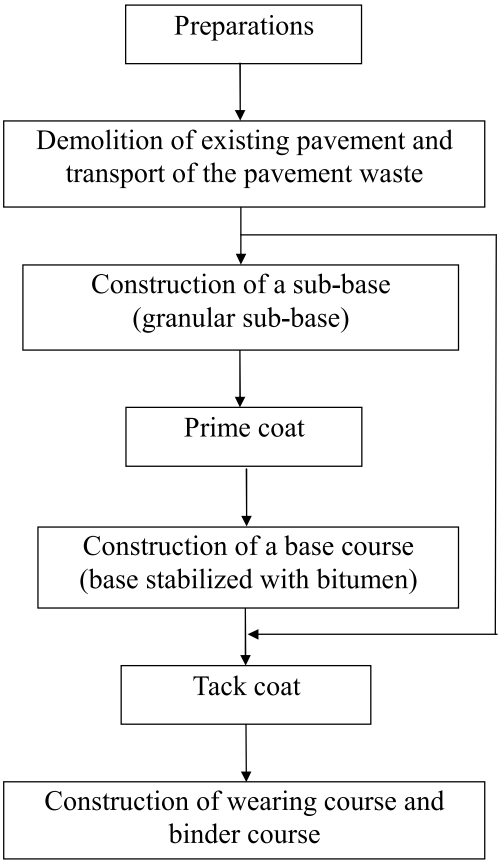


Figure 1.4-11 Flow of Local Replacement

- Preparatory work

  The points of replacement (e.g. start and end points and longitudinal joints) are to be marked.

- Demolition of existing pavement and transport of the pavement waste

  The edge of the area to be replaced is cut to the designated depth by a cutter. The existing asphalt mixture is pulled up with a small cutter or breaker and fragmented. The existing asphalt mixture that has been fragmented with a backhoe or shovel loader is loaded on dump trucks and transported to designated places.

- Construction of a sub-base

  Irregularities on the cut surface are corrected manually or using a backhoe while confirming the elevation of finished sub grade. The base course materials that are delivered by dump trucks are spread manually or using a backhoe. Compaction is done carefully with a rammer or plate compactor.

- Prime coat

  A designated amount of emulsified asphalt is spread evenly with an engine sprayer and is cured. When spreading, protection is provided using concrete panels or other materials to prevent the emulsion from drifting.

- Construction of a base course (base course stabilized with bitumen)

  The mixture is spread manually and compaction is done carefully using a rammer or plate compactor to construct the upper base.

- Tack coat work

  A designated amount of emulsified asphalt is spread evenly with an engine sprayer and cured. When spreading, protection is provided using concrete panels or other materials to prevent the emulsion from drifting.

- Construction of wearing course and binder course

  The binder course mixture is manually spread, and carefully compacted using a rammer or plate compactor to construct the binder course. Then, a tack coat is applied. The surface layer (wearing course) mixture is manually spread, and carefully compacted using a rammer or plate compactor to construct the surface layer. Pavement markings are placed with a line marker. When the pavement surface temperature drops to approximately 50°C, the pavement is opened to traffic.

- Considerations

  Local replacement is prone to cause settlement after the road is opened to traffic. Careful compaction is required in construction. Settlement is likely to occur at the edge in particular. It is therefore desirable to place the finished surface of the surface layer approximately 0.5 cm higher than the existing pavement. When two or more layers are constructed, the overlapping of joints should be avoided and the upper layers should be removed with a wider margin to facilitate compaction (Figure 1.4-12).

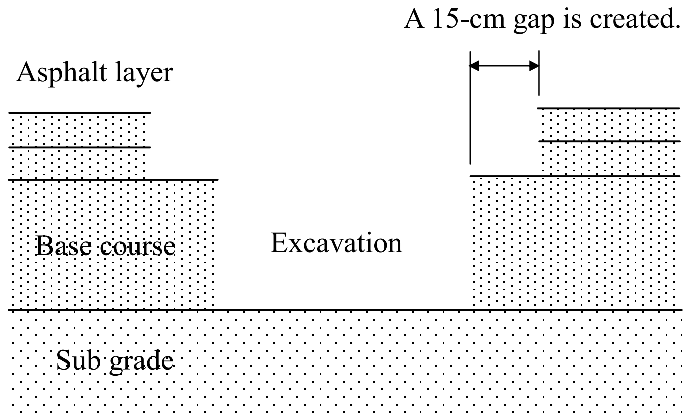


Figure 1.4-12 An indicative sample cross section of excavation in local replacement work

1.4.3 History of Maintenance and Repair

Keeping the records of maintenance or repair is important in assessing and establishing future maintenance or repair plans. Activities of surveys, planning, design, implementing maintenance and repair, evaluation, and research on pavements are interconnect each other. It is therefore desirable to make sure that valuable data is accumulated not only during construction but also during maintenance or repair. Table 1.4-1 gives a sample sheet for recording maintenance or repair work.

Table 1.4-1 Format for recording maintenance or repair work

Date of maintenance or repair			Route	
Site			Chainage/ Milestones	～ (up bound, down bound)
Type of damage			Severity of damage	Severe, medium, small
Method of maintenance or repair				
Load bearing capacity of sub grade			Design traffic volume	
Cross section and materials used	Status Before maintenance or repair		Status After maintenance or repair	
Special note	＊Enter particulars concerning the preliminary surveys, materials used, etc.			
General view of the site				

1.4.4 Recommendations for Construction

Asphalt pavements require timely and adequate provision of maintenance or repair after the commencement of service. Timely assessment on present status of structure, performance decline, safety and the applicability of new technologies is mandated to make a decision on implementing maintenance and repair. In the above assessment, consulted are records during construction and maintenance and repair. It is also necessary to continuously improve the technology for design, construction and maintenance or repair by analyzing life cycle costs. The records of maintenance and/or repair, together with inspection and survey records, are statistically processed for use to predict future performance of the pavement at the site. It is important to use the records so as to track them back to the design method at the time of construction.

1.5 Traffic Safety Measures

1.5.1 Traffic Safety Measures

Traffic safety measures are important during the inspection, survey or maintenance or repair work on expressways because other passenger vehicles travel in the vicinity at high speed during the work. Traffic safety measures on expressways under different conditions are described in this section.

1.5.1.1 Basic Matters Observed on Duty

1.5.1.1.1 Safe Driving

- The driver on duty should be fully aware that he or she is one of the road administrators and strictly observe rules of driving safely.
- Vehicle occupants should make sure to wear the seatbelt while traveling.
- The patrol or maintenance vehicles should have marked visible from other passenger vehicles.

1.5.1.1.2 Clothes, Equipment and Health Management

- Work clothes should be worn that enable easy movement.
- Specified protective equipment such as helmets, safety vests, safety shoes and whistles should be worn or carried.
- Health conditions should be checked before tasked to duty work and the work should be suspended in case of bad health.

1.5.1.1.3 Parking and Stopping

- Hazard lights should be turned on while parking or stopping the vehicle.
- Full attention should be paid to other passenger vehicles when accelerating or decelerating.
- The vehicle should park in an area with a wide shoulder that provides good visibility as much as possible.
- Front tires should be directed sidewards, away from the traffic flow to prevent the vehicle from entering the lane when it is bumped rear-ended.

1.5.1.1.4 Traffic Control

- Traffic is controlled to ensure the safety of the work yard and workers.
- Securing visibility by other passenger vehicles is important.
- The installation of traffic control equipment should be commenced at the upstream end.
- The removal of traffic control equipment should be commenced at the downstream end.

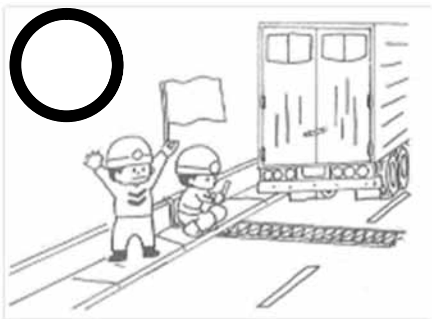
1.5.1.1.5 Work in Sections under Traffic Control

- It should be made sure that an inspector watches the behavior of other passenger vehicles.
- Workers should not work with their back turned to other passenger vehicles.
- Workers should not get out of the demarcated control area without due reasons while at work.

1.5.1.2 Traffic Safety Measures during Inspection or Survey

1.5.1.2.1 General

- Inspections and surveys should be conducted by at least two workers.
- One of the workers should command the attention of other passenger vehicles using a flag or other tool and secure the safety.
- The vehicle at work should be provided with markings and have its yellow revolving light turned on for differentiation from other vehicles.



One of the workers should be on the watch.

1.5.1.2.2 Considerations in Daily Inspections

- Visual inspections at a low speed should basically be conducted while traveling not on the passing lane but on the nearside lane.
- When an unusual spot is encountered, the vehicle should park on the shoulder after confirming safety, and an inspection should be made.
- In cases of emergency, safety should be secured at the site and the headquarters should be notified immediately for assistance.

1.5.1.2.3 Precautions to be taken in Routine inspections and Detailed Surveys

- Surveys using measurement equipment should be conducted while exercising due care to prevent the inspection/survey vehicle on duty from getting out of the lane closed to traffic.

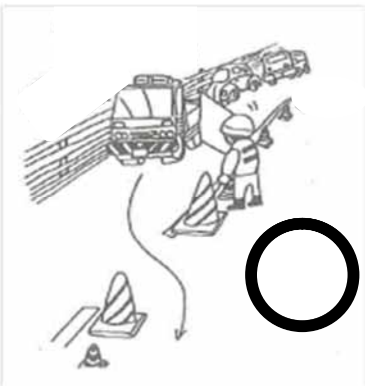
- It should be made sure that a separate inspector is deployed not to fail to confirm safety while others are preoccupied with inspection or survey.

1.5.1.2.4 Precautions to be taken in Emergency Inspections

- Emergency inspections should be conducted under the condition where the safety of the inspectors is fully guaranteed to prevent occurrence of secondary disasters.
- On-board visual verifications should be made at the lowest speed possible, so that serious damage is likely to be detected on the surface.
- When an unusual condition is detected, safety should be secured at the site and the headquarters should be notified immediately for help.

1.5.1.3 Traffic Control and Safety Measures during Maintenance or Repair Work

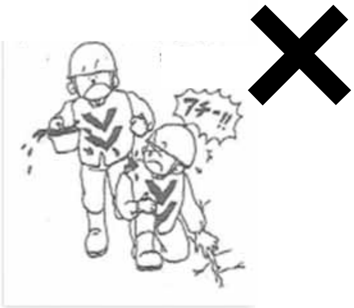
- An inspector should be assigned at the entrance/exit of the area closed to traffic to prevent the other vehicles from entering the area.
- Workers should work face to face with other passenger vehicles while working near an adjacent lane.

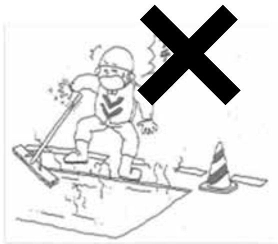
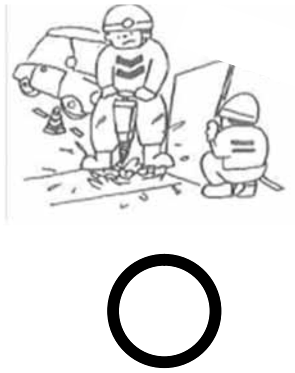


An inspector should be assigned at the entrance/exit to the area closed to traffic.

Worker should work face to face with other passenger vehicles.

- When handling hot crack sealing materials and pavement mixtures, protection should be provided against burn.
- When a cutter or breaker is used for cutting, concrete panels or other materials should be used to prevent broken pieces from spreading.



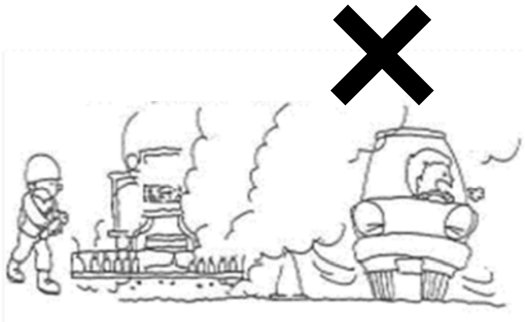



When handling hot materials, burn prevention measures should be taken.

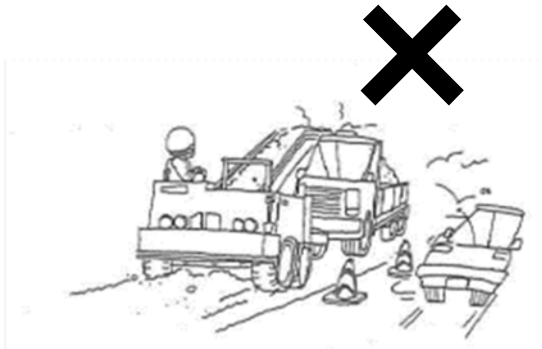
Protection should be applied to prevent the spreading of broken pieces.

When a heated cutter is used, the impacts of considerable smoke on other passenger vehicles should be minimized.

- When loading cutting waste, care should be paid to prevent the heavy machinery from getting out of the closed lane and to control the spreading of broken pieces.

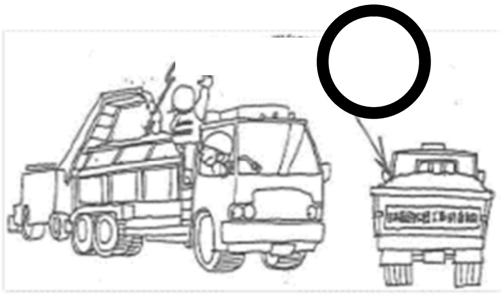


Considerable smoke causes accidents.



The spread of cutting waste should be strictly prohibited.

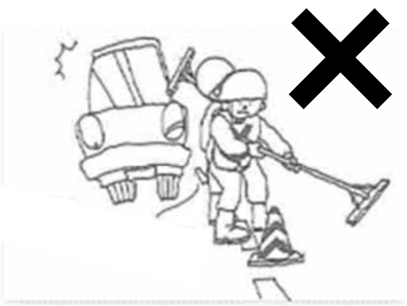
- The debris loaded on a dump truck for transport should be covered with a membrane to prevent spreading.
- When spreading bituminous materials, concrete panels should be installed to prevent the materials from spreading over other passenger vehicles.



Loaded debris is covered with a membrane to prevent spreading.

The spreading of materials is prevented with concrete panels.

- In laying pavement mixtures by manual labor, an inspector should be assigned to prevent workers from getting out of the closed lane.
- When multiple heavy machines are used for work, an inspector should be assigned to prevent their mutual accidental contact.



Care should be exercised to prevent the extrusion of equipment from the work yard.

Accidental contact of heavy machines should be prevented.

1.5.2 Installations for Traffic Safety Measures

Necessary installation required to secure safety for duty maintenance workers engaged in inspections, surveys and maintenance or repair on expressways, are described. Those installations are to assure workers' safety from while other passenger vehicles traveling at high speed in the vicinity and inviting passengers' attention to the work in progress.

1.5.2.1 Installations for Controlling Traffic

- Arrow board

  Arrow boards should be installed near the upstream end of the area closed to the traffic to construct a taper. Boards should basically be placed at an interval of 20 m and eleven boards should constitute a taper for a length of 200 m. Arrow boards should sufficiently be heavy enough not to be blown away and sufficiently light enough to be carried easily.

Arrow board

Rubber corn

- Rubber cones

  Rubber cones should be placed along lane markings at intervals of 10 to 20 m to separate the closed and controlled work area from the vehicle travel zone. The length of installation distance should be determined according to the range of work. Rubber cones, like arrow boards, should be sufficiently heavy enough not to be blown away and sufficiently light enough to be carried easily.
- Traffic control vehicles

  The traffic control vehicle should be located near the arrow board at the upstream end to identify the work site and protect the work space. The vehicle should preferably show arrows and be equipped with a rotating light to identify the work site.
- Regulatory markers

  Regulatory markers should be installed to notify passenger vehicles of traffic control. Specifics and the positions of installation should be determined through the consultation with the road administrator.

1.5.2.2 Equipment for Traffic Safety during Work

- Flags

  Inspectors wave flags to invite attention of passenger vehicles traveling in immediate adjacency of the closed lane.

- Work Clothes and equipment to be carried on

  Workers should dress themselves so that they can move easily. They should wear a helmet to protect their head from flying objects. They should wear a safety vest to make themselves highly visible at long range. They should work in feet protection safe shoes other than slippers to ensure alertness and protection from heavy objects. Workers should carry a whistle for announcing danger over a long distance.

1.6 An Addendum: Maintenance or Repair of Concrete Pavements

Concrete pavements are more durable but also more costly than asphalt pavements. Concrete pavements have another drawback as compared with asphalt pavements. They require much time and cost for repair. Concrete pavements are, therefore, generally constructed in a tunnel or near the toll gate where repair work involves difficulties.

1.6.1 Types of Damage to Concrete Pavements

Damage to concrete pavements, like that of asphalt pavements, is classified into functional and structural types of damage. The types and states of damage to concrete pavements, and the main causes of damage are listed in Table 1.6-1.

Table 1.6-1 Types of Damage to Concrete Pavements

Type of damage		State of damage	Major causes	Damage classification	
				Functional	Structural
Wear	Raveling	Wear by tire chains	Wear by tire chains	◎	
	Polishing and scaling	Scaled road surface	Abrasion of rough-finished surface, use of soft aggregate and freezing and thawing	◎	
Cracking	Cracks in corners and longitudinal and transverse cracks	Cracks in the corners of a slab, and longitudinal and transverse cracks	Inadequate structure or functions of joints, insufficient slab thickness, differential ground settlement and fatigue failure	○	○
	Cracks near a transverse structure	Cracks near a transverse structure	Differential settlement of the structure and base course, and stress concentration because of the structure	○	○
	Map cracks	Crack expansion in a grid pattern	Development of cracking		◎
Deterioration of smoothness	Deformation	Longitudinal irregularities	Differential ground settlement	◎	
Damage to joints	Damage to joint materials	Protrusion of joint materials	Aging of joint plates, extrusion of joint materials and pumping of base course materials	◎	
	Damage to the edge of joint	Cracking at joints	Inadequate structure or functions of joints	◎	
Other	Difference in level	Irregularities near a structure and difference in level on a slab	Differential ground settlement, and inadequate functions of dowel bars and tie bars.	◎	
	Blowup and crushing	Swelling of the slab at joints	Inadequate structure or functions of joints		◎
	Swelling of the slab		Insufficient thickness of the layer for controlling frost heave		◎

Legend Damage classifications ◎ : This classification is highly likely to be applicable.
○ : Either classification is likely to be applicable.

Reference: NEXCO, Design Protocol (pavement)

1.6.2 Main Causes and Mechanism of Damage (Concrete Pavements)

Main causes of concrete pavements are attributable to the concrete slab itself, to the base course or sub grade, or to such external factors as the traffic and the weather conditions after the commencement of service.

On concrete pavements, cyclic traffic loading, changes in pavement temperature or other factors cause fatigue failure, which then induces damage. The breakage at joints or expansion of cracks deteriorates serviceability and causes damage. The damage to concrete pavements similar to that of asphalt pavements include cracking, difference in level and wear. In contrast, breakage at joints and buckling occur only on concrete pavements. On continuous steel-reinforced concrete pavements, cracking is not treated as damage but is taken as a defect in structural design. The damage to concrete pavements should be assessed in terms of various work types designed for pavements.

1.6.3 Major Survey Methods by Type of Damage (Concrete Pavements)

The typical survey and test methods for evaluating the damage to concrete pavements are listed in Table 1.6-2.

Table 1.6-2 Major concrete pavement survey methods by type of damage

Type of damage		Major survey methods fit for evaluation
Wear	Raveling	Measurement of the extent of rutting
	Scaling	Visual verification of scaling Strength verification by sampling
Cracking	Cracks in corners Longitudinal and transverse cracks	Verification of cracking by visual inspections or other means Measurement of deflection by FWD (Falling Weight Deflect meter)
	Cracks near a transverse structure	Verification of cracking by visual inspections or other means Measurement of deflection by FWD
	Map cracks	Verification of cracking by visual inspections or other means
Deterioration of smoothness	Deformation	Measurement using IRI (International Roughness Index)
Damage to joints	Damage to joint materials	Verification of quality of joint materials
	Damage to the edge of joint	Visual verification of scaling Measurement of deflection by FWD
Other	Degradation of skid resistance coefficient	Measurement using BPT (British Pendulum Tester), DFT (Dynamic Friction Tester) or a slip measurement
	Difference in level	Measurement of deflection by FWD and cut and cover
	Blowup and crushing	Measurement of deflection by FWD and cut and cover
	Swelling of the slab	Measurement of deflection by FWD and cut and cover

Reference: NEXCO, Design Procedure (pavement)

Measuring deflection using FWD enables the evaluation shown in Table 1.6-3. The FWD method is effective for evaluating the damage to and the soundness of concrete pavements.

Table 1.6-3 Items of Structural Evaluation of Concrete Pavements Using FWD

Evaluation item	Survey area	Parameter	Remarks
Distribution of loads on the concrete slab	Center	Curvature and flexural stiffness	The lower the curvature or the higher the flexural stiffness, the better.
Bearing capacity of base course	Center and at the edge of joint	Total deflection	The lower the deflection, the better.
Load transfer at joints or in cracked areas	At joints and cracked areas	Transfer coefficient of deflection	The higher the transfer coefficient of deflection, the better.
Existence of voids	Center and cracked areas at joints	Comparison of relative deflection	Voids are suspected in cases where relative deflection of the concrete slab is large despite no cracks observable on the slab.

Reference: NEXCO, Design Protocol (pavement)

1.6.4 Evaluation and Determination and Repair Planning (Concrete Pavements)

Concrete pavements are evaluated and rated by the same manner as described in “1.3.1 Evaluation and Determination” and in “1.3 Diagnosis and Maintenance and Repair Plans”.

There have been fewer cases of maintenance or repair of concrete pavements than those of asphalt pavements. Owing to concrete pavements’ high durability, no methods have yet been established for design and construction for maintenance or repair of concrete pavements. In the repair planning for concrete pavements, therefore, materials and methods for maintenance or repair should be selected considering the state of damage and construction conditions at the site.

1.6.5 Maintenance and Repair Methods (Concrete Pavements)

The maintenance and repair methods that have been applied to concrete pavements versus the types of damage are listed in Table 1.6-4.

Table 1.6-4 Maintenance and Repair Methods for Concrete Pavements

Maintenance or repair method	Mode of failure	Breakage at joints		Cracking		Difference in level	Wear					Structural damage (in cases where slab removal is required)
		Joint materials	Near the joint	Cracks not reaching the bottom surface of slab	Cracks reaching the bottom surface of slab		Raveling (rutting)	Polishing (slipping)	Scaling	Pothole	Voids under the slab	
Sealing and filling		○	○	○	○							
Patching			○						○	○		
Local replacement			○		○							
Local replacement that creates new joints					○							
Stitching using bars					○							
Leveling						○						
Cutting						○	○					
Jacking up						○						
Surface treatment	Thin layer pavement							○				
Surface treatment	Chipping with a scribbler, or by shot blast or water jetting							○				
Surface treatment	Cutting							○				
Surface treatment	Longitudinal and transverse grooving							○				
Surface treatment	Chemical treatment and high-pressure jet							○				
Overlaying	Asphalt mixtures				○		○	○				
Overlaying	Cement concrete (SFRC)						○					
Cutting and overlaying	Cement concrete (SFRC)						○					
Injection											○	
Replacement	Asphalt pavements											○
Replacement	Concrete pavements											○
Replacement	Precast slabs											○

Reference: NEXCO, Design Protocol (pavement)

The concrete pavement maintenance and repair methods are outlined below.

- Sealing and filling

  Filling or injecting asphalt, cement or resin materials fill into cracks or joints.

- Patching

  The method involves the removal of existing pavement material in an area affected by cracking or other damage using a cutter, proper treatment of cut face and the repair with cement or resin materials.

- Local replacement

  Local replacement is applied in cases where cracks penetrated into the slab thickness near a joint or cracks occurred in corners.

- Local replacement creating new joints

  In cases where a crack fully crosses the lane at the center of the slab, a new joint is created in the cracked area and local replacement is applied.

- Stitching with bars

  The method is implemented in cracked areas or at joints with deteriorated load transfer capacity. Reinforcement is applied by installing connection materials that are cut in rectangular (e.g. D22 deformed reinforcing bars of 700 mm) and materials are also injected into the cracks.

- Leveling

  The method is used in the case where the lower layers of the slab are sound and suffer little deflection. The difference in level is removed using asphalt mixtures. Thin layers are applied, so care should be exercised to prevent the drop of mixture temperature and to apply adequate tack coating.

- Cutting

  An area where the difference in level occurred is cut to correct the difference. Care should be exercised to verify the soundness of the slab and when treating the area with defective edges created by cutting.

- Jacking up

  In the case where the difference in level accompanies voids under the slab, the voids are filled to remove the difference in level by jacking up.

- Surface treatment

  The method is employed to restore the skid resistance on the surface. Surface treatment includes re-grooving, thin film pavement, and cleaning by shot blast or water jetting.

- Overlaying

  The method uses either asphalt or cement mixtures. Asphalt mixtures are used more frequently because of the ease of construction and cost performance. Breakage is prevented and development of damage is preliminarily controlled by connecting slabs by stitching using bars or by injecting into moderate cracks.

- Cutting and overlaying

  The method is the same as cutting and overlaying on asphalt pavements. Full attention should be paid to varying capacity of cutting machinery according to the difference in material strength and also to the effects of cutting on wire mesh.

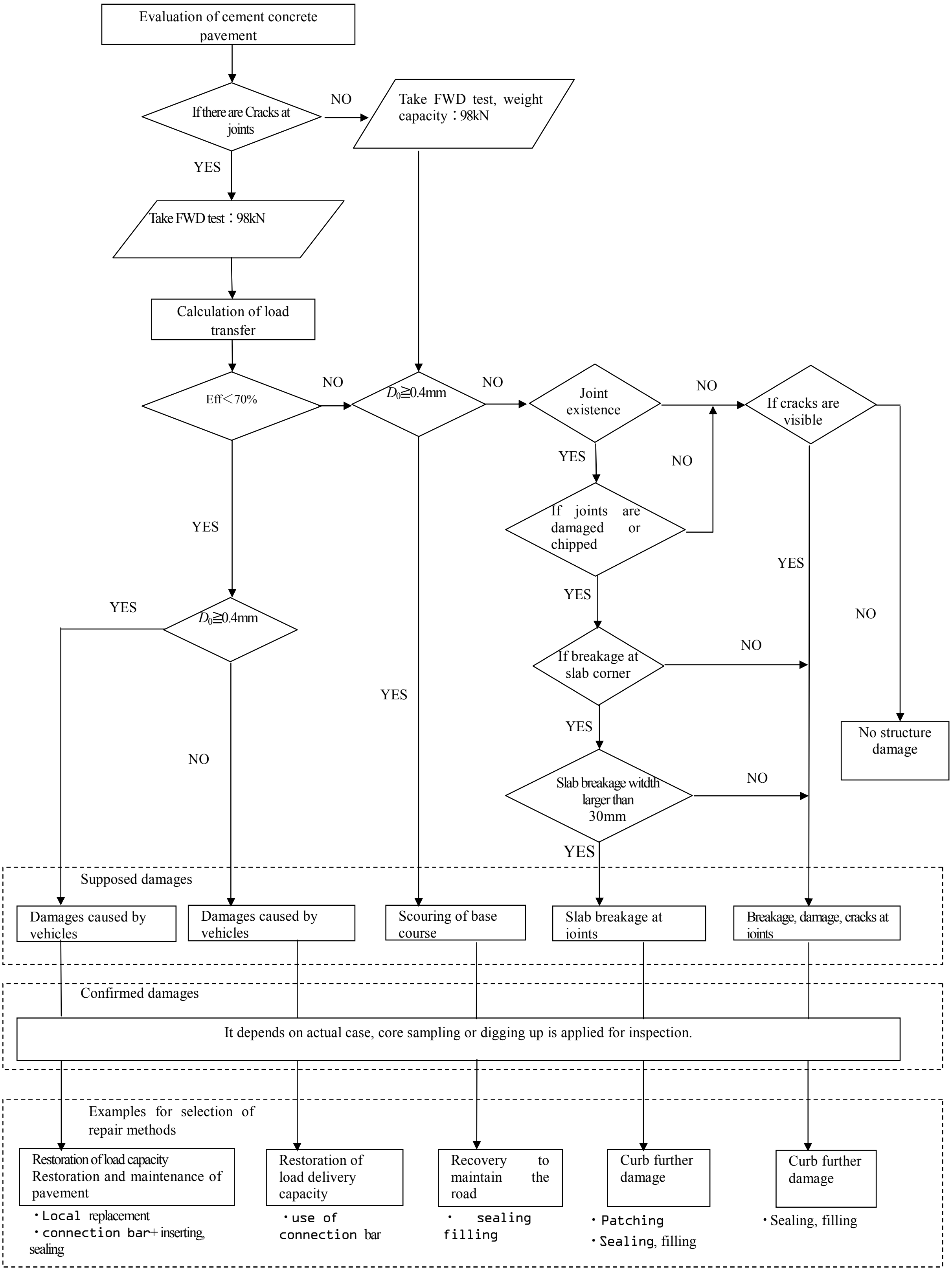
- Injection

  The method is implemented to fill the voids created between the concrete slab and base course and to push up the slab that subsided to the original level. Asphalt- and cement-type injection materials are generally available.

- Replacement

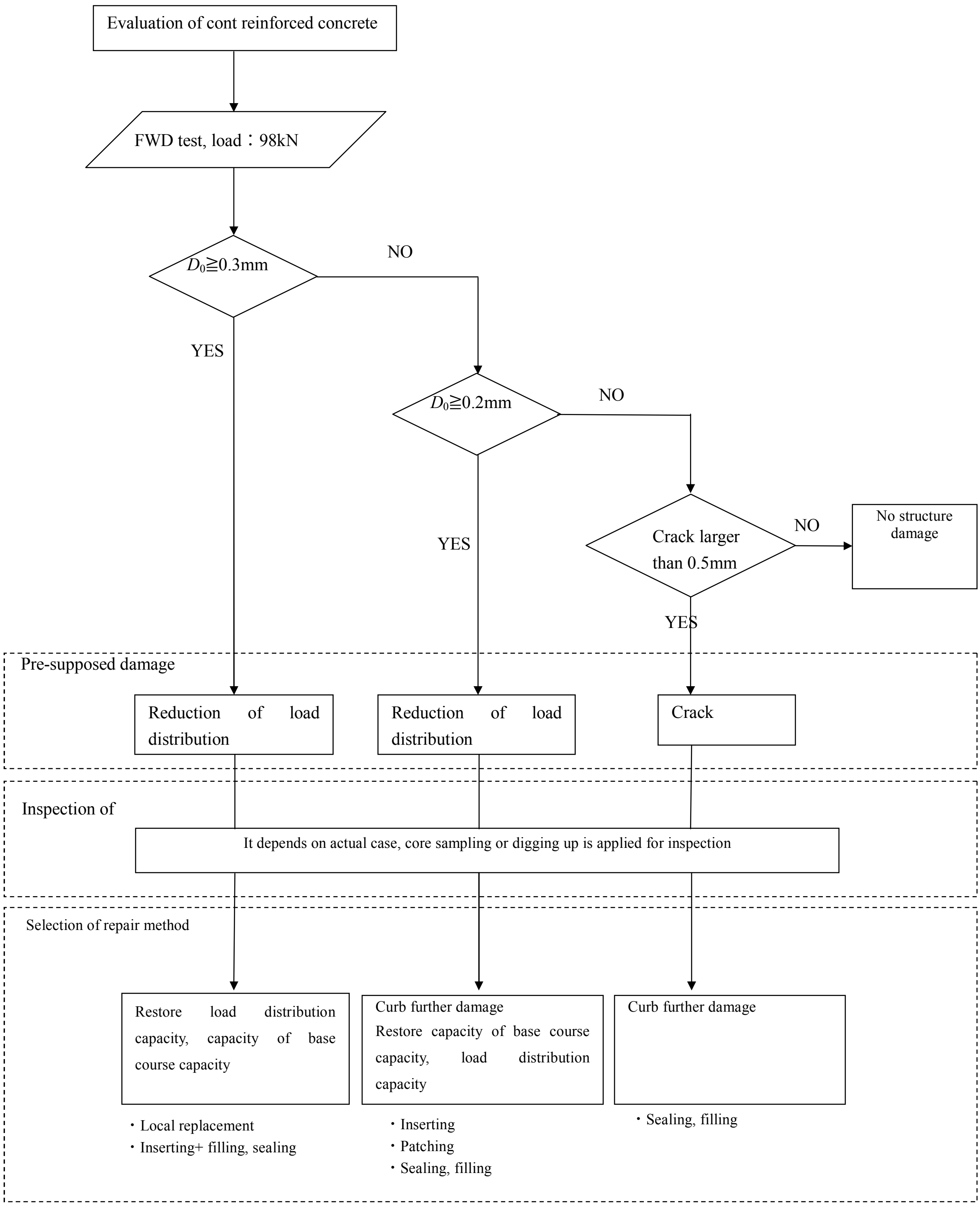
  Replacement is used for repair in cases where the existing concrete slab has been seriously damaged and no other methods are applicable such as maintenance and overlaying.

Cases of maintenance and repair on concrete pavement occurs less than on asphalt concrete pavement. It is due to the high durability of cement concrete pavement, currently there is no design and construction method for maintenance and repair of cement concrete pavement. Thus, for the repair and maintenance of cement concrete pavement, it is advised to select from the reference maintenance and repair in the diagram below. In planning the cement concrete pavement fixing, materials and repair methods are selected, based on a review of on-site damage conditions for rational maintenance and repair.



Reference: NEXCO, Design Protocol (pavement)

Table 1.6-1 Consideration of repair method (cement concrete pavement)



Reference: NEXCO, Design Protocol (pavement)

Table 1.6-2 Consideration of repair method (continuous reinforced concrete)

Directorate for Roads of Vietnam Japan International Cooperation Agency

The Project for Strengthening Operation and Maintenance System for Expressway in Vietnam

SECTION 2

TECHNICAL SPECIFICATION GUIDELINES FOR INSPECTION AND MAINTENANCE OF BRIDGE & CULVERT

Vietnam Expressway Management Office
JICA Experts Team

JUNE 2013

Table of Contents

2 Road Structures (Bridges, Box Culverts)

2.1 General

In implementing operation and maintenance works for structures on expressway, it is quite important that expressway operator shall formulate maintenance programs and properly carry out the maintenance activities in order to ensure satisfactory performance of road structures during expected service lives with experienced personnel and appropriate organization.

Terminologies used in this Chapter are defined in Table 2.2-1:

Table 2.1-1 Terminologies used for Maintenance Work of Road Structures

Terminology	Definitions
Maintenance Work	All the technical activities conducted so as to ensure the required level of service in structural performances during service lives.
Performance of Structures / Elements	Capacities to perform the required functions pursuant to the purposes and requirements.
Durability	Resistance to the reduction in performance capacities with time due to degradation of materials in structures under the specified service conditions.
Safety	No adverse effects to the lives / properties of road users and surrounding residents is required of the performance.
Inspection	All activities to investigate defect / damage on overall structures and structural elements for subsequent assessment.
Daily Inspection	Visual inspection conducted during daily patrol for early detection of defect / damage.
Routine Inspection	Inspection routinely conducted with visual observation and tools / equipment in order to maintain the structures in sound conditions.
Emergency Inspection	Inspection to check the safety of road structures when structures will be or were suffered from such disasters as earthquake, typhoon and heavy rain, and/or when defects and damage were found.
In-Depth Inspection	Inspection to obtain additional detail information, which is not available from daily / routine inspections.
Deterioration	General term of initial defect, damage and degradation.
Initial Defect	Defects such as crack / cold joint in concrete structure or welding crack in steel structure occurred during construction or immediately after construction. Defects observed after construction may be included if such defects are considered due to construction work activities.
Damage	Deterioration occurred within short period of time due to earthquake and collision with vehicles / vessels, not with time. Fatigue damage with external repetitive forces, though occurred for extended period of time, may be included. “Damage” will sometimes be used with the same meaning of “deterioration” in a broad sense.
Degradation	Various functions in the structure / element are degraded with time.
Repair	Measures taken to remove adverse effects to a third party and to restore / improve aesthetic appearance / landscape and durability. Included improvement of load-carrying capacity to a level the structure holds at the time of construction completion.
Reinforcement	Measures to increase load-carrying capacities to or greater than a level that such structures hold at the time of construction completion.
Life Cycle Cost	Total cost including all the costs for planning, design, construction, maintenance during service life and replacement (demolish cost included).
Primary Element	An element designed to carry the loads applied to the structure as determined from an analysis.
Secondary Element	An element in which the stress is not normally evaluated in the analysis.

2.1.1 Performance Requirements for Road Structures

Performance requirements for road structures shall be clearly defined prior to the maintenance activities.

(1) Performance requirements for typical road structures inspected are safety, serviceability, effects to a third party, aesthetic appearance / landscape and durability.
(2) Safety for the fracture of structural element, fatigue fracture and the overall stability of structure shall be inspected.
(3) Serviceability shall ensure comfort on use of structures by road users and surrounding residents as well as satisfactory levels of required performance for structures.
(4) Effects to a third party shall include injury to road users due to spalling of cover concrete and noise to the surrounding residents due to vehicle passage.
(5) Aesthetic appearance / landscape shall consider the degradation of performance to harmony with surrounding environments due to dirt / rust stain on surface and cracks.
(6) Durability on road structures shall be checked on four (4) performance requirements: safety, serviceability, effects to a third party, and aesthetic appearance / landscape.

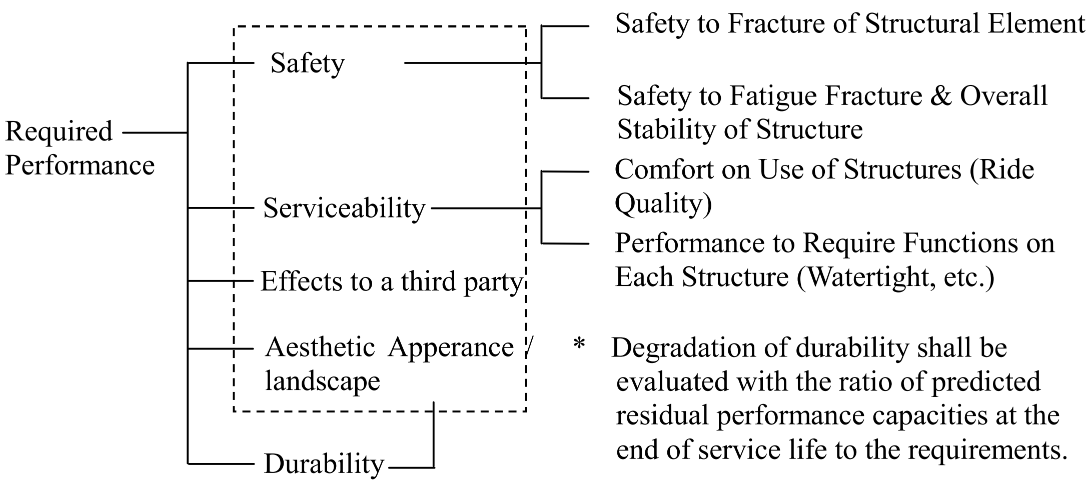


Figure 2.1-1 Classification on Performance Requirements

Expressway shall satisfy high performance requirements in providing smooth, safe and convenient traffic conditions even with high traffic volume under the inclement weather. Structures on expressway shall therefore satisfy the following requirements:

(1) Smooth transition between approach embankment and bridge / box culvert;
(2) Deflection of a structure within permissible limit.
(3) Stable structures with sufficient strength under any unforeseen conditions;
(4) No stagnation of water on the surface of bridge deck slab and box culvert;

(5) Free from inundation and overflow during floods with good drainage system;

(6) Structures shall be regularly monitored so that any defects / damage can be detected, evaluated, and appropriate measures taken so as to ensure required strength.

2.1.2 Evaluation on Soundness of Road Structures

Soundness of structures on expressway shall be evaluated on the followings:

a) Deflection of beam structures;

b) Lateral displacement and settlement of bridge abutments and piers;

c) Rate of deterioration with time on concrete elements, rate of corrosion on steel elements;

d) Dimensions and defect / damage conditions of parapet / railing on bridge and box culvert;

e) Current working performance of expansion joints and differences in level at expansion joints;

f) Dimensions of bridge bearings, current movement and rotation capacities;

g) Damage on the drainage system;

h) Cracks, locations of defect / damage, differences in level and flexural deformation on bridge beams, abutments and piers;

i) Riverbed scour and riverbank erosion.

2.1.3 Causes of Damage to Structures

Descriptions are given on major causes of damage to road structures.

2.1.3.1 Substructure

2.1.3.1.1 Scope of Application

This Clause shall apply to concrete abutments and piers, bridge foundations and such ancillary works as foundation protection, retaining walls and revetments.

2.1.3.1.2 Defect / Damage to Substructure

Typical defect / damage on substructures are described in Table 2.1-2.

Table 2.1-2 Typical Defect / Damage to Substructure

Defect / Damage
- Crack or damage on pier concrete due to collision of debris, vessels and vehicles; - Crack or damage on bearing seats; - Crack due to shrinkage and thermal effects on mass concrete; - Delamination at construction joint, deficiency between precast concrete element and cast-in-place concrete element; - Degradation with time and defect / damage on concrete in wetlands and water level variations. - Abrasion of pier concrete due to water flow; - Debris, rubbish or dirt sediment on abutments and piers after the floods; - Dirt / water stagnation on bearing seat.

Defects and damage on each type of structure are summarized in Table 2.1-3.

Those on abutments and piers are largely categorized into two (2) types: the ones on surfaces, and the ones on overall structures such as settlement or displacement.

For bridge foundations, defects and damage visually identified are listed.

For ancillary works, defects and damage resulting in loss of safety of overall structures are included in the Table.

Table 2.1-3 Defect / Damage to be Inspected by Type of Structure

Type of Structure	Defect / Damage to be Inspected
Abutment, Pier	(1) Crack, (2) Scaling / Delamination, (3) Rebar Exposed, (4) Void, Honeycomb, (5) Water Leakage, (6) Free Lime, (7) Rust Stain, (8) Degradation / Discoloration, (9) Settlement, (10) Displacement
Foundation	(1) Settlement, (2) Displacement, (3) Settlement, (4) Undermining
Ancillary Work	(1) Crack, (2) Scaling / Delamination, (3) Water Leakage, (4) Free Lime, (5) Rust Stain, (6) Settlement, (7) Displacement

Table 2.1-4 gives the descriptions on defects and damage to substructures.

Table 2.1-4 Description of Defect / Damage on Substructure to be Inspected

Damage	Descriptions
(1) Crack	Tension stresses, arisen from materials used, service environments, structural features and external forces, cause cracks on monolithic concrete elements.
(2) Scaling / Delamination	Cover concrete is dropped off or delaminated due to expansion of corroded steel reinforcement, internal stress in concrete, poor construction joint and so on.
(3) Rebar Exposed	Steel reinforcement in concrete is exposed due to scaling / delamination of concrete or poor construction.
(4) Void, Honeycomb	Deficiency due to insufficient filling / compaction of concrete in construction stage.
(5) Water Leakage	Water arisen out of road surface and backfilling materials flows out from the construction joints, cracks forming through element depth, expansion joints, structural joints such as isolation / contraction joints and deficiencies in drainage system.
(6) Free Lime	Lime contents exudate with water from construction joints or cracks forming through element depth and dried on concrete surface.
(7) Rust Stain	Rust on concrete surfaces effluxes from construction joints or cracks due to corrosion of steel reinforcement in concrete.
(8) Degradation, Discoloration	Degradation in performance of concrete will occur primarily due to chemical reactions. Discoloration on concrete surface will occur with chemical reactions.
(9) Settlement	Abutments, piers, bridge foundations and ancillary structures are settled.
(10) Displacement	Abutments, piers, bridge foundations or ancillary structures are displaced or inclined. Wing walls, retaining walls or revetments are displaced ahead
(11) Scour	Abutments on riverbank or piers in water may be subject to scour on pile caps / foundations due to water flow.
(12) Undermining	Bridge foundation is exposed / undermined.

2.1.3.2 Superstructure (Concrete Bridge)

2.1.3.2.1 Scope of Application

This Clause shall apply to the reinforced / pre-stressed concrete beams / girders on superstructures.

2.1.3.2.2 Defect / Damage on Concrete Superstructure

Defects and damage on concrete superstructures are described in Table 2.1-5.

Table 2.1-5 Typical Defect / Damage on Bridge Deck

Element	Defect / Damage
Reinforced Concrete / Pre-stressed Concrete Beam Structures	Cracks due to water leakage and surrounding environments, degradation with time, shrinkage, temperature change and shortage of curing time.
Bridge Deck Slab	Deformation on asphalt concrete, cracks on cement concrete, rupture in waterproofing

With steel reinforcements in concrete, defect / damage on concrete bridges will need a large scale of repair / reinforcement works if steel reinforcements are seriously corroded. Concrete bridges may have less durability due to poor construction or may be degraded at high rate of progress with severe ambient weather conditions.

Defect / damage to be inspected on concrete bridges are summarized by types of structures in Table 2.1-6.

Table 2.1-6 Defect / Damage by Types of Structures

Type of Structure	Defect / Damage
Reinforced Concrete	(1) Crack, (2) Water Leakage / Stagnation, (3) Free Lime, (4) Scaling / Delamination, (5) Rebar Exposed, (6) Rust Stains, (7) Degradation / Discoloration, (8) Excessive Deflection, (9) Abnormal Sound, (10) Excessive Vibration, (11) Extreme Big / Small Girder End Gap, (12) Settlement, (13) Displacement
Pre-stressed Concrete	(1) Crack, (2) Water Leakage / Stagnation, (3) Free Lime, (4) Scaling / Delamination, (5) Rebar Exposed, (6) Rust Stains, (7) Degradation / Discoloration, (8) Rupture of Steel, (9) Excessive Deflection, (10) Abnormal Sound, (11) Excessive Vibration, (12) Extreme Big / Small Girder End Gap, (13) Settlement, (14) Displacement

Visual inspection is of great importance to identify defect / damage on overall structures or on expansion joints, bearings, railings and substructure wherever accessibility is ensured, thereby contributing to the estimate of local defect / damage on other structural elements.

Table 2.1-7 describes defect / damage on overall bridge structures visually observed.

Table 2.1-7 Descriptions of Defect / Damage on Bridge Structures

Defect / Damage	Descriptions
(1) Excessive Deflection	Unfavorable upward / downward deflections on bridge beams / deck slabs due to creep and shrinkage in concrete, or shortage of pre-stressing forces given.
(2) Abnormal Sound	Gaps or ruptures at girder ends or element joints cause rattle noise. Poor connections or abrasion at element joints cause squeak noise.
(3) Excessive Vibration	Visually or sensibly observed excessive vibration of structures.
(4) Extreme Big / Small Girder End Gap	Collision with girder ends, abutment ballast walls, stoppers and expansion joints due to extreme small girder end gaps. Extremely big girder end gap.
(5) Settlement	Bridge supports such as bridge bearings, piers and abutments are settled.
(6) Displacement	Abutments and piers are inclined or laterally displaced.

All the defect / damage on structural elements will not be immediate harms to overall bridge structures. However, progressive defect / damage, which may cause subsequent serious problems, shall be identified at an earlier stage so that current degree of deterioration can be evaluated.

Table 2.1-8 describes defect / damage on bridge structural elements.

Table 2.1-8 Descriptions of Defect / Damage on Bridge Elements

Defect / Damage	Descriptions
(1) Crack	Tension stresses, arisen from materials used, service environments, structural features and external forces, cause cracks on monolithic concrete elements.
(2) Water Leakage	Water mainly arisen out of road surface flows out from the construction joints, cracks forming through element depth, expansion joints and deficiencies in drainage system.
(3) Free Lime	Lime contents exudate with water from construction joints or cracks forming through element depth and dried on concrete surface.
(4) Scaling / Delamination	Cover concrete is delaminated due to expansion of corroded steel reinforcement, internal stress in concrete, poor construction joint and so on.
(5) Rebar Exposed	Steel reinforcement is exposed due to scaling of cover concrete or poor construction.
(6) Rust Stain	Rust on concrete surfaces effluxes from cracks due to corrosion of steel reinforcement in concrete.
(7) Degradation / Discoloration	Degradation in performance of concrete will occur primarily due to chemical reactions. Discoloration on concrete surface will occur with chemical reactions.
(8) Corrosion	Steel elements in the air or in concrete are oxidized and rusted.
(9) Rupture of Steel	Such factors as poor grouting in ducts, chloride damage, carbonation, seepage water from cracks cause rupture of pre-stressing tendons or anchorage removal.

2.1.3.3 Ancillary Works

Typical defects and damage on ancillary works are given in Table 2.1-9.

Table 2.1-9 Typical Defect / Damage on Ancillary Works

Element	Defect / Damage on Ancillary Works
Bridge Expansion Joint	Damage on block out materials (concrete), clogging with soils or hard materials, rupture of rubber strip, rupture of drainage trough, dropping the bolts off, loosening of nuts at anchor bolts.
Bridge Bearing	Dirt on bridge bearing, bulging / deformation / cracks in elastomeric bearings, difference in level, cracks / rupture in PTFE plates, cracks in grouting materials, corrosion on steel bearing base plates, losses of functions in rotation and horizontal displacement.
Drainage System	Clogging with soils or rubbish in drain boxes and outlets, cracks or rupture in pipes, disconnection of pipe joints, losses of joints and attachments.
Bridge Parapet / Railing, Median Strip	Bend on steel railing or posts, cracks or rupture in concrete due to vehicle collision, corrosion in steel railings or posts, dropping off the bolts at post connections, welding cracks, cracks or ruptures in foundation grouting.

2.1.3.3.1 Bridge Bearing

2.1.3.3.1.1 Scope of Application

This Clause shall apply to the steel and elastomeric bridge bearings.

2.1.3.3.1.2 Defect / Damage on Bridge Bearing to be inspected

Defects and damage to be inspected on bridge bearings are summarized in Table 2.1-10.

Table 2.1-10 Defect / Damage on Bridge Bearing to be Inspected

Element	Type	Defect / Damage
Bridge Bearing	Steel Bridge Bearing	(1) Deficiency on Steel, (2) Deficiency on Attachments, (3) Corrosion, (4) Deficiency on Bearing Seat Concrete / Mortar, (5) Excessive Big / Small Gap, (6) Abnormal Sound, (7) Sediment of Dirt or Soils
	Elastomeric Bridge Bearing	(1) Degradation on Elastomer, (2) Deficiency on Attachments, (3) Corrosion, (4) Deficiency on Bearing Seat Concrete / Mortar, (5) Excessive Big / Small Gap, (6) Sediment of Dirt or Soils

2.1.3.3.1.3 Attentions on Defect / Damage to Bridge Bearing

Inspection shall, in principle, be conducted on 100% number of bridge bearings, however, at difficultly accessible places, it is advised to conduct the incorporated inspection by means of observing other bridge elements. In implementing the inspection, attention shall be given to the followings:

(1) Actual movement at horizontally movable bearing or girder end gaps shall be checked and evaluated in consideration of air temperature at time of inspection;

(2) Difference in levels shall be carefully checked at expansion joint where bearing seat mortar is deteriorated or ruptured;
(3) Difference between guided direction and horizontally moving direction, arisen from variable width or curved bridge decks, may cause defect / damage or abnormal sound;
(4) Bridge bearings with uplift forces are prone to defects and damage;
(5) Corrosion of bridge bearings is mainly due to sediment of dirt / soils or water leakage from expansion joints;
(6) Bridge bearing seat mortar will be deteriorated with water leakage;
(7) Wherever horizontal movement and rotation functions are degraded on steel bearings, sole plates are prone to welding cracks.

2.1.3.3.2 Bridge Expansion Joint

2.1.3.3.2.1 Scope of Application

This Clause shall apply to plug seal, strip seal, cushion seal, steel finger joints and modular joint system.

2.1.3.3.2.2 Defect / Damage on Bridge Expansion Joint to be inspected

Defects and damage on bridge expansion joints are summarized in Table 2.1-11.

Table 2.1-11 Defect / Damage on Bridge Expansion Joints to be Inspected

Location Inspected	Defect / Damage
Expansion Joint	(1) Rubber or Steel, (2) Sealing Material, (3) Finger / Sliding Plates, (4) Welding at Finger / Sliding Plates, (5) Seal / Strip / Cushion Rubber, (6) Loosening or Rupture of Anchor Bolts, (7) Cover Cap for Anchor Bolt
In the Vicinity of Joints	(1) Sealing Material, (2) Opening of Gap
Block out Materials	(1) block out Materials, (2) Construction Joints between Expansion Joints and block out Materials, (3) Construction Joints between Expansion Joints and Pavement Materials
Difference in Level	(1) Construction Joints between Expansion Joints and block out Materials, (2) Construction Joints between Expansion Joints and Pavement Materials
Girder End Gap	(1) Opening of Girder End Gap
Water Leakage	(1) Water Leakage from Joints, (2) Drainage Materials, (3) Water Leakage from Curbs
Abnormal Sound	(1) Abnormal Sound at Vehicle Passage

2.1.3.3.2.3 Attentions on Defect / Damage to Expansion Joints

Defects and damage on expansion joints may give discomfort ride quality to vehicles as well as unfavorable adverse effects to bridge structures. It is therefore necessary to give careful attentions and provide more frequent maintenance works on expansion joints and vicinities. Causes of defects and damage will mainly be the repetitive impacts with wheel loads. Such causes will also result in defects and damage on bridge bearing, bridge deck and substructures. Hence, careful attention shall also be given to the vicinities of expansion joints when inspection is implemented.

- Differences in level at expansion joints are caused by fracture of bearing seat mortar, breakage / depression of bearings and rupture of bearing seats.

Wherever extraordinary defects and damage are observed, it is suspected that the lateral displacement / settlement of substructures or settlement of approach embankment arises. In such cases, immediate investigation shall be conducted to recognize the causes.

Expected extraordinary defects and damage on expansion joints are as follows:

(1) Extreme movement or difference in level at girder ends;

(2) Abnormal sound without any reasons;

(3) Defects or damage due to fire or earthquake;

(4) Early detection of similar defects or damage at repair portions.

2.1.3.3.3 Bridge Parapet / Railing

2.1.3.3.3.1 Scope of Application

This Clause shall apply to the reinforced concrete parapet / curb and steel railing.

2.1.3.3.3.2 Defect / Damage on Bridge Parapet / Railing to be inspected

Defects and damage caused on bridge parapets / railings are summarized in Table 2.1-12.

Table 2.1-12 Defect / Damage on Bridge Parapet / Railing to be Inspected

Element	Defect / Damage to be Inspected
Reinforced Concrete Parapet / Curb	(1) Crack, (2) Water Leakage / Free Lime, (3) Scaling of Cover Concrete, (4) Spalling, (5) Rebar Exposed / Corroded
Steel Railing	(1) Deformation / Deficiency (due to vehicle collision), (2) Corrosion

2.1.3.3.4 Drainage System

2.1.3.3.4.1 Scope of Application

This Clause shall apply to drain inlets, drain pipes and attachments installed on bridge structures.

Drainage system shall perform its roles properly to drain the water out of the bridge deck to the specific outlets. Lacking of proper functions may cause damage to vehicles on bridge deck, corrosion or deterioration on bridge structures and adverse effects to a third party under the bridge deck. Careful attention shall, therefore, be given to the performance of required functions during the inspection.

2.1.3.3.4.2 Defect / Damage on Drainage System to be inspected

Table 2.1-13 and Table 2.1-14 give defect / damage to be inspected and descriptions of such defect / damage for drainage system.

Table 2.1-13 Defect / Damage on Drainage System to be Inspected

Element	Defect / Damage to be Inspected
Drain Inlet	(1) Deficiency, (2) Corrosion, (3) Clogging, (4) Deformation, (5) Deficiency / Corrosion on Fittings, (6) Deficiency on Drain Grates
Drain Pipe	(1) Deficiency, (2) Corrosion, (3) Clogging, (4) Disconnection / Unfit, (5) Deformation, (6) Water Leakage
Attachment	(1) Deficiency, (2) Corrosion, (3) Deformation

Table 2.1-14 Descriptions of Defect / Damage on Drainage System

Defect / Damage	Descriptions
(1) Deficiency	A part or all of drain inlets, drain pipes and attachments are missing.
(2) Corrosion	Steel elements are corroded.
(3) Clogging	Malfunction of drainage due to clogging in drain inlets and pipes.
(4) Disconnection / Unfit	Drain pipe joints are disconnected. Drain pipes are unfitted from attachments.
(5) Deformation	A part or all of drain inlets, drain pipes and attachments are deformed.
(6) Water Leakage	Water leakage is observed due to failure of drain pipe or loosening of joints.
(7) Deficiency on Drain Grates	Drain grates are broken, corroded or missing.

2.1.3.3.5 Seismic Structures

2.1.3.3.5.1 Scope of Application

This Clause shall apply to anchor bars, concrete blocks and end cross beams of bridge deck.

2.1.3.3.5.2 Defect / Damage to be inspected

Defects and damage on seismic structures are described in Table 2.1-15. Wherever water leakage is observed at end cross beams, it is expected corrosion of anchor bars has occurred. Attention shall be paid to treat the rust stains on structures.

Table 2.1-15 Defect / Damage on Seismic Structures to Be Inspected

Structure	Defect / Damage
End Cross Beam	(1) Crack, (2) Scaling, (3) Rebar Exposed, (4) Free Lime
Concrete Block	(1) Crack, (2) Scaling, (3) Rebar Exposed, (4) Free Lime, (5) Rust Stain from anchor bars

2.1.3.4 Culvert

2.1.3.4.1 Scope of Application

This Clause shall apply to box culvert and pipe culvert.

2.1.3.4.2 Defect / Damage on Culvert

Defects and damage caused on reinforced concrete culverts shall follow the specifications described in 2.1.3.1.

2.1.4 Necessity and Purposes of Maintenance Work for Road Structures

Maintenance work comprises inspection, formulation of maintenance program and maintenance activities, and shall be implemented so as to ensure safe road and to prevent adverse effects to a third party. Inspection is to collect fundamental data on existing structures in order to recognize current conditions and to implement scheduled repair / reinforcement works. Formulation of maintenance program and maintenance activities will be carried out with a view to ensure the required level of service, to minimize life-cycle cost and to minimize economic losses due to closure of expressway for repair / reinforcement works. Proper actions shall be taken to repair / replace defects and damage with appropriate measures before serviceability limit state is reached.

Specific roles on maintenance work for road structures are given as follows:

1) To ensure safe road and to prevent adverse effects to a third party through early detection of defects and damage;
2) To formulate mid- or long-term maintenance program by means of identifying deterioration conditions and properly recognizing rate of deterioration progress;
3) To ensure soundness of road structures for an extended period of time by assessing current defects / damage and properly evaluating the soundness.

In implementing the inspections, attention shall be paid not only to recognize current defects and damage, but also to understand the conditions of relevant structures, traffic conditions, roadside environment and previous incidents arisen out of road structures.

Maintenance program shall be formulated to ensure the required level of performance during the expected service life. Evaluation of inspection results, subsequent measures, and record-keeping shall properly be implemented.

2.1.5 Maintenance Work Flow for Road Structures

2.1.5.1 Major Maintenance Work Flow

As in Figure 2.1-2, maintenance work for road structures comprises assessment procedures including inspection, estimate of deterioration models, prediction of deterioration progress, evaluation of rate of current performances and judgment of necessity of measures, measures taken from the assessment results and record-keeping. Expressway operator shall formulate maintenance program in order to properly implement the maintenance activities.

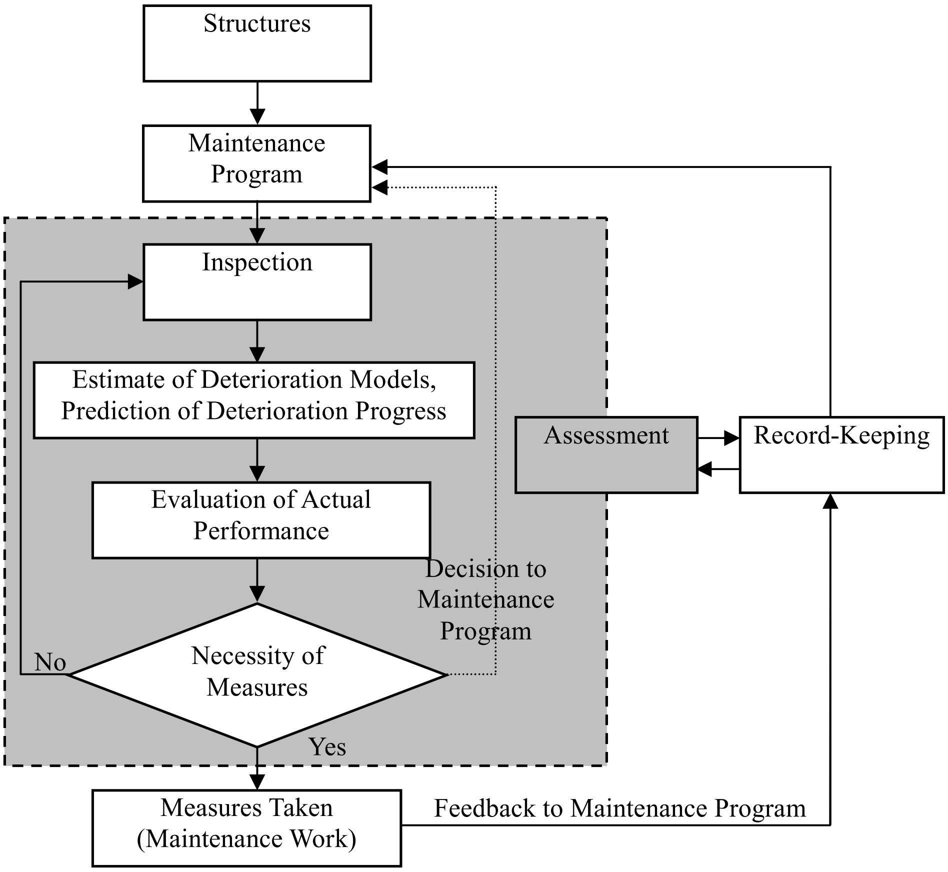


Figure 2.1-2 Major Maintenance Work Flow

2.1.5.2 Standard Intervals for Inspection and Maintenance Work

Standard intervals of inspection and maintenance work shall consider the previous inspection results, current conditions of structures, surrounding environments and service conditions.

(1) Inspections on structures shall consider the purposes of subsequent actions taken;

(2) Initial inspection shall be made so as to identify the initial conditions of structures;

(3) Daily and routine inspections shall be conducted in order to recognize the changes in structural conditions;

(4) Special and emergency inspections shall consider the purposes of such inspections;

(5) Daily and routine inspections shall follow the inspection intervals, items and methods specified in the maintenance program. When it is judged necessary to identify the detail conditions of structures from the inspection results, in-depth inspection shall be carried out.

(6) Whenever emergency measures are judged necessary from the inspection results, such measures shall immediately be taken.

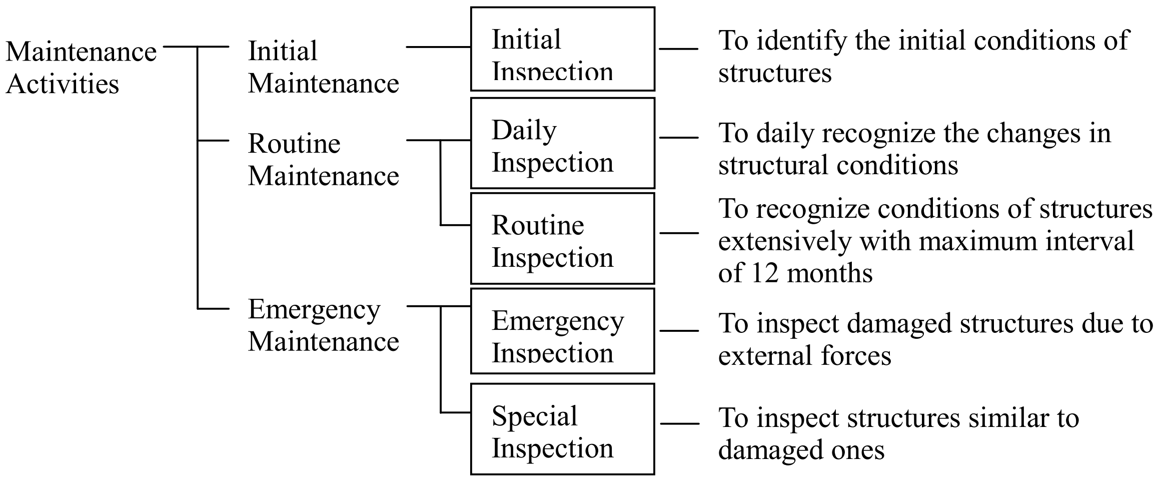


Figure 2.1-3 Types of Inspection

2.1.5.2.1 Daily Inspection

Table 2.1-16 Standard Intervals for Daily Inspection

Type of Inspection		Intervals	Traffic Volume, V
Safety Patrol		4 days / 2 weeks	V < 25,000 vehicle / day
		5 days / 2 weeks	25,000 ≤ V < 50,000 vehicle / day
		6 days / 2 weeks	50,000 ≤ V < 80,000 vehicle / day
		7 days / 2 weeks	80,000 vehicle / day ≤ V
Inspection of Defects / Damage	Monitoring	As required.	
	General Inspection	As required.	

For safety patrol, in addition to onboard inspection, direct visual inspection shall be conducted from outside of patrolling vehicles with maximum 6 month interval inspection.

2.1.5.2.2 Routine Inspection

Maximum inspection interval is 12 months.

2.1.5.2.3 In-Depth Inspection

(1) Maximum inspection interval of 60 months where adverse effects to traffic safety or a third party is expected.

(2) Maximum inspection intervals of 120 months for other places.

2.1.5.2.4 Emergency & Special Inspections

Emergency inspections shall be carried out wherever structures are in question in functioning required performance due to such accidental loads as a large-scale earthquake and typhoon, collision with vehicles and vessels, and fire.

Special inspections shall be implemented on structures similar to the ones with large scale defects and damage in other locations or under similar conditions.

2.2 Inspection

2.2.1 Daily Inspection

2.2.1.1 Items to be Inspected

Daily inspection is implemented to detect defect / damage on structures through daily patrol so that safe road transport and prevention of adverse effects to a third party are ensured. The early detection of defect / damage ensures maintained sound road conditions and enables the formulation of appropriate plans for emergency measures and repair.

It is to visually or sensibly detect the defect / damage on road structures from patrol vehicles only for the structures observed from the expressway.

Items to be inspected by daily inspection are given in Table 2.2-1. For pavement on road structures, it is described in Chapter 1.

Table 2.2-1 Defect / Damage to Be Visually or Sensibly Observed with Daily Inspection

Items to be Inspected	Defect / Damage Observed
(1) Discoloration / Stain on Concrete	● Presence and extent of water / free lime ● Presence and extent of water leakage ● Presence and extent of rust stain
(2) Rebar Exposed / Corroded	● Concrete cover of reinforcement steel, number and location of rebar exposed, degree of corrosion
(3) Deflection / Deformation of Structures	● Excessive deflection, displacement, settlement
(4) Bridge Expansion Joint	● Difference in level, damage on finger plate
(5) Bridge Railing / Curb	● Deformation, damage
(6) Drainage System	● Water stagnation, clogging with soils in drain inlet, damage on drain pipe, water leakage from drain pipe
(7) Rupture of Pre-stressing Tendons	● Projection of pre-stressing tendons on deck slab and cross beams due to rupture

2.2.1.2 Evaluation of Defect / Damage

Results of daily inspection are recorded in Forms 2-1, -2, -3, -4 in the Inspection Report.

Extent of defect / damage shall be evaluated with the criteria in Table 2.2-4 – Table 2.2-14 for each structure, and each defect / damage is classified into one of the following 4 categories in Table 2.2-2.

Table 2.2-2 Evaluation Category for Each Defect / Damage (Daily Inspection)

Level of damage		Level of priority	
Code	Description	Code	Description
A	Good (No defect / damage, or minor defect / damage are observed)	Normal	
B	Average. (Sound functions of a structure are maintained, even with defect / damage. Progress of defect / damage needs to be monitored periodically)	Normal It needs later inspection and continuous monitoring.	
C	High. Defect / damage may endanger the safety of traffic, safety of a third party or stability of the structure, and needs the study of measures.	T	Low (not much impact on the structure stability. Immediate counter-measures may not be needed.)
		C	High (much impact on the structure stability. Immediate counter-measures are needed.)
D	Emergency. Extraordinary defect / damage may cause traffic accidents, danger to a third party or collapse of the structure, and needs urgent measures.	C	High (great impact on the structure stability. Immediate counter-measures are certainly needed.)
		K	Emergency

2.2.1.3 Inspection Methods

Daily inspection is implemented with visual observation by naked eyes, cameras, and/or binoculars, and on-board sensible observation.

On-board observation is implemented to detect the damage of bridge expansion joints, excessive deflection and vibration of bridge girders / beams, and is effective for direct measurement of serviceability.

Wherever serious defect / damage categorized as C or D, which may result in danger to road transport or a third party, are observed, direct visual inspection or hammering test shall be carried out from outside of patrolling vehicles. Such results shall be recorded with digital cameras and in Daily Inspection Record Form.

Photographing is implemented in two forms: close-range view to identify the type and extent of defect / damage, and distant view to identify the location in a structure. Close-range view shall include crack gauge, convex and/or measuring poles, if possible.

2.2.2 Routine Inspection on Concrete Structures

2.2.2.1 Items to be Inspected

Routine Inspection is implemented using the binoculars or access on foot.

If necessary, Routine Inspection can be conducted with visual inspection, hammering, and simple measurement tools through access to the structure using special equipment. Degradation, defect / damage, initial defect of elements are investigated in detail on overall structure.

Items and descriptions to be inspected in routine inspection are given in Table 2.2-3.

Table 2.2-3 Typical Items to Be Inspected in Routine Inspection

Type of Defect / Damage	Descriptions
Overall Deterioration	Excessive deflection, abnormal sound, excessive vibration, excessive big / small girder end gap, displacement
Initial Defect	Cracks, air voids, honeycomb
Degradation	Cracks, free lime, rust stain, scaling / delamination, spalling, rebar exposed / corroded
Degradation (Pre-stressing Tendons)	Corrosion and rupture of pre-stressing tendons
Deterioration due to External Loads	Cracks
Water Leakage, Water Stagnation	Water leakage, water stagnation
Deterioration on Ancillary Works	Defect / damage on bridge bearing and expansion joints, drainage system

2.2.2.2 Evaluation of Defect / Damage

Results of routine inspection as well as evaluation of defect / damage are recorded in Form 2-1 – 2-5, 2-7, 2-8 of Routine Inspection Record Sheet. Wherever no inspection is implemented due to impossible access or it is difficult to evaluate, such reasons shall be recorded in “Remark” with the reasons for no evaluation.

Extent of defect / damage shall be evaluated with the criteria in Table 2.2-4 – Table 2.2-14 for each structure, and each defect / damage is classified into the following 4 categories in Table 2.2-2.

Whenever defect / damage, which need urgent measures, are found at the routine inspection, such defect / damage shall be recorded in Form 2-3 and reported. These defect / damage are also recorded in Form 2-7, since they need urgent measures for a short period of time after detection.

Table 2.2-4 Evaluation Criteria (Pre-stressed Concrete Bridge 1 / 2)

Structure	Type of Structure	Element / Location	Type of Defect / Damage	Defect / Damage	Descriptions of Defect / Damage	Evaluation		
						D	C	B
Bridge	Pre-stressed Concrete Bridge	Pre-stressed Concrete Girder	Overall Deterioration*	Excessive Deflection	Girders or slab beams are deformed upward or downward due to concrete creep or shrinkage, or excessive or short pre-stressing force.	Extraordinary excessive deflection is observed on girder or slab beam.	Deflection of girder or slab beam is observed to the extent it is visually confirmed.	—
				Abnormal Sound	Rattle noise due to gap or rupture at member joints at the time of vehicle passage or creaking noise due to defect or abrasion at member joints is observed.	—	Abnormal sound is observed at the time of vehicle passage.	—
				Excessive Vibration	Excessive vibration is visually or sensibly observed.	—	Excessive vibration is visually or sensibly observed.	—
				Excessive Big / Small Girder End Gap	Adjacent girder ends, girder and abutment, stoppers or expansion joint plates are collided or at an extraordinary distance.	—	Girder end gap is closed or excessively opened.	Excessive bigger or smaller girder end gap is detected compared to design value.
				Settlement	Uneven settlement between bridge bearings or supports (piers / abutments) is observed.	Due to uneven settlement of supports, reduction in load carrying capacity is observed on bridge deck.	Due to uneven settlement of supports, reduction in load carrying capacity is suspected on bridge deck.	Slight settlement is observed on bridge deck.
				Displacement	Abutment or pier is inclined or laterally displaced.	Bridge deck is largely displaced.	Bridge deck is slightly displaced.	—
			Water Leakage, Water Stagnation	Water Leakage	Concrete surface is wet due to water seepage through construction joint, filling of opening or crack, or due to water leakage from drainage system or expansion joint.	—	Water leakage is observed at all times irrespective of weather conditions. Water leakage is observed at the joints of segments.	Water leakage or water stain is observed after rain.
				Water Stagnation	Water is entered into crossing points of members or inside the box girder and stagnated.	—	Water stagnation is observed irrespective of weather conditions.	Water stagnation is observed after rain.
			Initial Defect	Crack	Fracture due to tension stresses caused mainly by materials used or construction workmanship such as dry shrinkage. Cracks around pre-stressing tendons or anchorage plates will be evaluated by corrosion or fracture of tendons.	—	Cracks, resulting in reduction of durability, are observed.	Small cracks, which may slightly lead to the reduction in durability, are observed.
				Air Void, Honeycomb	Air voids or honeycombs may present in concrete due to poor concrete works. Voids may be remained in pre-stressing tendon duct due to poor grouting works.	—	A large scale of air voids or honeycombs are observed. Voids are observed in pre-stressing tendon ducts due to poor grouting works.	Air void or honeycomb is observed.

* Wherever overall deterioration such as excessive deflection, abnormal sound and excessive vibration is observed, immediate in-depth inspection shall be implemented.

Table 2.2-4 Evaluation Criteria (Pre-stressed Concrete Bridge 2 / 2)

Structure	Type of Structure	Element / Location	Type of Defect / Damage	Defect / Damage	Descriptions of Defect / Damage	Evaluation		
						D	C	B
Bridge	Pre-stressed Concrete Bridge	Pre-stressed Concrete Girder	Degradation on Concrete	Crack	Fracture in concrete due to tensile stress mainly arisen from environmental conditions in use (chloride damage, etc.). Cracks around pre-stressing tendons or anchorage plates will be evaluated by corrosion or fracture of tendons.	—	Cracks, resulting in reduction of durability, are observed.	Small cracks, which may slightly lead to the reduction in durability, are observed.
				Free Lime	Lime contents exudate with water from construction joints or cracks forming through element depth and dried on concrete surface. Free lime around pre-stressing tendons or anchorage plates will be evaluated by corrosion or fracture of tendons.	—	Exudate of water and/or free lime is extensively observed.	Exudate of water and/or free lime is locally observed.
				Rust Stain	Rust arisen due to corrosion of reinforcement steel is flowed out with water from cracks in concrete. Rust stain around pre-stressing tendons or anchorage plates will be evaluated by corrosion or fracture of tendons.	—	Rust stain is remarkably observed.	Rust stain with water leakage is locally observed due to corrosion of reinforcement steel.
				Scaling / Delamination / Spalling	Scaling or delamination of concrete surface due to swell of corroded steel in concrete, internal stress in concrete or poor construction joint. Scaling / delamination around pre-stressing tendons or anchorage plates will be evaluated by corrosion or fracture of tendons.	—	A large scale of scaling or delamination is extensively observed. Scaling or delamination is scattered.	Scaling or delamination is locally observed.
				Rebar Exposed / Corroded	Reinforcement steel in concrete or in the air is corroded.	Loss of section of reinforcement steel is extensively observed.	Reinforcement steel is exposed and seriously corroded.	Reinforcement steel is locally exposed or corroded.
				Discoloration	Concrete element is deteriorated mainly due to chemical reaction and discolored on surface.	—	Discoloration is observed on concrete surface with cracks.	Discoloration is locally observed on concrete surface.
			Degradation on Pre-stressing Tendons *	Rupture of Pre-stressing Tendon	Pre-stressing tendon in concrete or in the air is corroded. Pre-stressing tendon is fractured due to corrosion.	Pre-stressing tendon is fractured or extruded.	Pre-stressing tendon is corroded. Cracks, free lime, rust stain, scaling / delamination or spalling is observed along the pre-stressing tendon. Block out material at anchorage plate has crack, free lime, rust stain, scaling / delamination or spalling.	—
			Deterioration due to Structural Features and External Forces	Crack	Fracture in concrete due to tensile or compressive stress mainly arisen from structural features or external forces.	Descriptions are given in Table 2.2-5 (evaluation criteria by pre-stressed concrete element).		

* In-depth inspection shall be implemented whenever water leakage and/or free lime are observed at pre-stressing tendons.

Table 2.2-5 Evaluation Criteria (Cracks by Locations of Pre-stressed Concrete Girder)

Structure	Type of Structure	Element / Location		Type of Defect / Damage	Defect / Damage	Descriptions of Defect / Damage	Evaluation		
							D	C	B
Bridge	Pre-stressed Concrete Bridge	Pre-stressed Concrete Girder	At End Support	Deterioration due to Structural Features or External Forces *	Crack	Fracture in concrete due to tension or compression stress arisen from structural features or external forces.	Vertical or diagonal cracks are observed around the support line.	—	—
			At Intermediate Support				Vertical cracks are observed on a girder.	—	—
			At the Center of a Span				Vertical cracks are observed at lower flange of a girder.	—	—
			At the Quarter of a Span				Diagonal cracks are observed on a girder web.	—	—
			Joint of Segment				Cracks are observed along the segment joint.	—	—
			At Anchorage				Progressive cracks are observed at anchorage plates of pre-stressing tendons.	—	Dead crack is observed around pre-stressing tendon anchorage plates.
			At the Notch				Diagonal cracks at the notch are observed.	—	—

* Immediate in-depth inspection shall be implemented when deterioration due to structural features or external forces is observed.

Table 2.2-6 Evaluation Criteria (Concrete Deck Slab)

Structure	Element	Location	Type of Defect / Damage	Defect / Damage	Descriptions of Defect / Damage	Evaluation		
						D	C	B
Bridge	Concrete Deck Slab	Concrete Deck Slab	Initial Defect	Crack *	Fracture in concrete due to tensile / compressive stress mainly arisen from materials used or construction workmanship.	Cracks with free lime and/or rust stain are extensively observed. Loss of section of reinforcement steel is suspected.	Cracks, resulting in reduction of durability, are observed.	Small cracks, which may slightly lead to the reduction in durability, are observed.
				Air Void, Honeycomb *	Air voids or honeycombs may present in concrete due to poor concrete works.	—	A large scale of air voids and/or honeycombs are observed.	Air voids and/or honeycomb are observed.
			Degradation	Crack *	Fracture in concrete due to tensile / compressive stress mainly arisen from environmental conditions in use.	Cracks with free lime and/or rust stain are extensively observed. Loss of section of reinforcement steel is suspected.	Cracks, resulting in reduction of durability, are observed.	Small cracks, which may slightly lead to the reduction in durability, are observed.
				Free Lime	Lime contents exudate with water from construction joints or cracks forming through element depth and dried on concrete surface.	—	Exudate of water and/or free lime is extensively observed.	Exudate of water and/or free lime is locally observed.
				Rust Stain	Rust arisen due to corrosion of reinforcement steel is flowed out with water from cracks in concrete.	—	Rust stain is remarkably observed. Rust stain from pre-stressing tendons or anchorage plates is observed.	Rust stain with water leakage is locally observed due to corrosion of reinforcement steel.
				Scaling / Delamination / Spalling *	Scaling or delamination of concrete surface due to swell of corroded steel in concrete, internal stress in concrete or poor construction joint.	—	A large scale of scaling or delamination is extensively observed. Scaling or delamination is scattered.	Scaling or delamination is locally observed.
				Rebar Exposed / Corroded *	Reinforcement steel in concrete or in the air is corroded.	Loss of section of reinforcement steel is extensively observed.	Reinforcement steel is exposed and seriously corroded.	Reinforcement steel is locally exposed or corroded.
			Water Leakage	Water Leakage	Concrete surface is wet due to water seepage through construction joint, filling of opening or crack, or due to water leakage from drainage system or expansion joint.	—	Water leakage is observed at all times irrespective of weather conditions.	Water leakage or water stain is observed after rain.

* Wherever precast reinforced concrete panel is used as form of deck slab concrete casting, it is not possible to detect such defect / damage as cracks on bridge deck slab by visual inspection and/or hammering test. Free lime or rust stain may be the clue for detection of defect / damage.

Table 2.2-7 Evaluation Criteria (Substructure)

Structure	Element	Location	Type of Defect / Damage	Defect / Damage	Descriptions of Defect / Damage	Evaluation D	Evaluation C	Evaluation B
Bridge	Substructure	Substructure	Initial Defect	Crack	Fracture in concrete due to tensile / compressive stress mainly arisen from materials used or construction workmanship.	Cracks with free lime and/or rust stain are extensively observed. Loss of section of reinforcement steel is suspected.	Cracks, resulting in reduction of durability, are observed.	Small cracks, which may slightly lead to the reduction in durability, are observed.
				Air Void, Honeycomb	Air voids or honeycombs may present in concrete due to poor concrete works.	—	A large scale of air voids and/or honeycombs are observed.	Air voids and/or honeycomb are observed.
			Degradation	Crack	Fracture in concrete due to tensile stress mainly arisen from environmental conditions in use (chloride damage, etc.).	—	Cracks, resulting in reduction of durability, are observed.	Small cracks, which may slightly lead to the reduction in durability, are observed.
				Free Lime	Lime contents exudate with water from construction joints or cracks forming through element depth and dried on concrete surface.	—	Exudate of water and/or free lime is extensively observed.	Exudate of water and/or free lime is locally observed.
				Rust Stain	Rust arisen due to corrosion of reinforcement steel is flowed out with water from cracks in concrete.	—	Rust stain is remarkably observed.	Rust stain with water leakage is locally observed due to corrosion of reinforcement steel.
				Scaling / Delamination / Spalling	Scaling or delamination of concrete surface due to swell of corroded steel in concrete, internal stress in concrete or poor construction joint.	—	A large scale of scaling or delamination is extensively observed. Scaling or delamination is scattered.	Scaling or delamination is locally observed.
				Rebar Exposed / Corroded	Reinforcement steel in concrete or in the air is corroded.	Loss of section of reinforcement steel is extensively observed.	Reinforcement steel is exposed and seriously corroded.	Reinforcement steel is locally exposed or corroded.
				Discoloration	Concrete element is deteriorated mainly due to chemical reaction and discolored on surface.	—	Discoloration is observed on concrete surface with cracks.	Discoloration is locally observed on concrete surface.
			Settlement, Displacement	Settlement	Overall substructure, bridge foundation or ancillary works are settled.	Overall substructure, bridge foundation or ancillary works are largely settled.	Overall substructure, bridge foundation or ancillary works are settled to a small extent.	—
				Displacement	Overall substructure, bridge foundation or ancillary works are displaced or inclined. Wing walls or riverbanks are horizontally displaced.	Overall substructure, bridge foundation or ancillary works are largely displaced.	Overall substructure, bridge foundation or ancillary works are displaced to a small extent.	—
			Water Leakage	Water Leakage	Concrete surface is wet due to water seepage through construction joint, filling of opening or crack, or due to water leakage from drainage system or expansion joint.	—	Water leakage is observed at all times irrespective of weather conditions.	Water leakage or water stain is observed after rain.
			Scour, Exposure	Scour	Abutments facing the river water or piers in the river may be subject to scour around footing / pile cap or bridge foundation.	Footing or caisson is exposed to the level exceeding the design consideration due to scour or riverbed degradation Wing walls on abutment are remarkably scoured.	Footing or caisson is exposed due to scour or riverbed degradation Wing walls on abutment are scoured.	—
				Exposure	Bridge foundation is exposed.	Bridge foundation is remarkably exposed.	Bridge foundation is exposed to a small extent.	—

Table 2.2-8 Evaluation Criteria (Bridge Bearing 1 / 2)

Structure	Element	Location	Type of Defect / Damage	Defect / Damage	Descriptions of Defect / Damage	Evaluation D	Evaluation C	Evaluation B
Bridge	Bridge Bearing	Steel Bridge Bearing	Deterioration on Bridge Bearing	Degradation on Bridge Bearing	Such degradation with time as cracks and deformation is observed on bridge bearing.	Load carrying function is impaired due to compressive failure of such vertical load carrying elements as upper bearing, lower bearing and base plate.	Due to abrasion of sliding / rolling elements, an up-and-down motion is observed. Slight deterioration such as cracks is observed on vertical load carrying elements.	Reduction in functions of displacement and rotation is observed.
				Defect / Damage on Bridge Bearing	Defect / damage due to such short-term events such as earthquake are observed on bridge bearing.	Load carrying function is impaired due to compressive failure of such vertical load carrying elements as upper bearing, lower bearing and base plate. Bearing plates are / may be in danger to be removed from the pot or derailed from lower bearing.	Slight deterioration such as cracks is observed on vertical load carrying elements.	Reduction in functions of displacement and rotation is observed.
				Corrosion on Bridge Bearing	Degradation on surface coating, corrosion, loss of section or fracture is observed on bridge bearing.	Due to serious corrosion, vertical load carrying function is impaired. Bearing plates are / may be in danger to be removed from the pot or derailed from lower bearing.	Due to corrosion, reduction in vertical load carrying capacity is observed.	Due to corrosion, reduction in functions of displacement and rotation is observed.
			Deterioration on Attachments	Defect / Damage on Attachments	Degradation with time such as cracks and deformation is observed. Defect / damage due to such short-term events such as earthquake are observed on attachments	—	Rupture of set bolts. Deterioration of side block, etc. Rupture of side block bolts. Anchor bolts are ruptured and extruded.	Loosening of set bolts, side block bolts and/or nuts used for anchor bolts are observed.
				Corrosion on Attachments	Degradation on surface coating, corrosion, loss of section or fracture is observed on attachments.	—	Loss of section is observed due to corrosion.	Attachments are corroded with deterioration of surface coating.
			Deterioration on Bridge Bearing Seat Mortar / Concrete	Defect / Damage on Bridge Bearing Seat Mortar / Concrete	Degradation with time or defect / damage due to earthquake is observed on bridge bearing seat mortar / concrete.	Due to deterioration of bridge bearing seat mortar / concrete, vertical load carrying function is impaired.	Cracks and voids are observed on bridge bearing seat mortar / concrete.	Small cracks or scaling are observed on bridge bearing seat mortar / concrete.
			Excessive Big / Small Girder End Gap	Excessive Big / Small Girder End Gap	Adjacent girder ends, girder and abutment, stoppers or expansion joint plates are collided or at an extraordinary distance.	Load carrying function is impaired due to remarkable displacement of upper and lower bridge bearings.	Actual displacement is reached to the maximum permissible level. (Stopper hits to the wall)	Actual displacement exceeds the design requirement.
			Abnormal Sound	Abnormal Sound	Rattle noise due to gap or rupture at member joints at the time of vehicle passage or creaking noise due to defect or abrasion at member joints is observed.	—	A large volume of sound is generated.	A sound is generated from a bridge bearing.
			Sediment of rubbish / soils	Sediment of rubbish / soils	Sediment of rubbish or soils adversely affect to bridge bearing and its attachments.	—	Bridge bearing is buried under rubbish and soils.	Rubbish and soils are sediment around bridge bearing.
			Water Leakage	Water leakage from drainage system	Bridge bearing is wet due to water leakage from drainage system or expansion joint.	—	Bridge bearing is wet at all times irrespective of weather conditions.	Bridge bearing is wet after rain.

Table 2.2-8 Evaluation Criteria (Bridge Bearing 2 / 2)

Structure	Element	Location	Type of Defect / Damage	Defect / Damage	Descriptions of Defect / Damage	Evaluation		
						D	C	B
Bridge	Bridge Bearing	Elastomeric Bridge Bearing	Deterioration on Bridge Bearing	Degradation on Bridge Bearing	Such degradation with time as cracks and deformation is observed on bridge bearing.	Vertical load carrying capacity is impaired due to compressive failure of elastomeric bearing.	Cracks, swell, shearing and/or tear off are observed on overall elastomeric bearing.	Cracks, swell, shearing and/or tear off are locally observed on elastomeric bearing.
				Defect / Damage on Bridge Bearing	Defect / damage due to such short-term events such as earthquake are observed on bridge bearing.	Vertical load carrying capacity is impaired due to compressive failure of elastomeric bearing.	Cracks, swell, shearing and/or tear off are observed on overall elastomeric bearing.	Cracks, swell, shearing and/or tear off are locally observed on elastomeric bearing.
				Corrosion on Bridge Bearing	Degradation on surface coating, corrosion, loss of section or fracture is observed on steel elements of bridge bearing.	—	Steel elements are corroded.	Upper / lower bridge bearing are corroded.
			Deterioration on Attachments	Defect / Damage on Attachments	Degradation with time such as cracks and deformation is observed. Defect / damage due to such short-term events such as earthquake are observed on attachments	—	Rupture of set bolts. Deterioration of side block, etc. Rupture of side block bolts. Anchor bolts are ruptured and extruded.	Loosening of set bolts, side block bolts and/or nuts used for anchor bolts are observed.
			Deterioration on Bridge Bearing Seat Mortar / Concrete	Corrosion on Attachments	Degradation on surface coating, corrosion, loss of section or fracture is observed on attachments.	—	Loss of section is observed due to corrosion.	Attachments are corroded with deterioration of surface coating.
				Defect / Damage on Bridge Bearing Seat Mortar / Concrete	Degradation with time or defect / damage due to earthquake is observed on bridge bearing seat mortar / concrete.	Due to deterioration of bridge bearing seat mortar / concrete, vertical load carrying function is impaired.	Cracks and voids are observed on bridge bearing seat mortar / concrete.	Small cracks or scaling are observed on bridge bearing seat mortar / concrete.
			Excessive Big / Small Girder End Gap	Excessive Big / Small Girder End Gap	Adjacent girder ends, girder and abutment, stoppers or expansion joint plates are collided or at an extraordinary distance.	Load carrying function is impaired due to remarkable displacement or falling out of a girder from the bearing.	Actual displacement is reached to the maximum permissible level. (Stopper hits to the wall)	Actual displacement exceeds the design requirement.
			Abnormal Sound	Abnormal Sound	Rattle noise due to gap or rupture at member joints at the time of vehicle passage or creaking noise due to defect or abrasion at member joints is observed.	—	A large volume of sound is generated.	A sound is generated from a bridge bearing.
			Sediment of rubbish / soils	Sediment of rubbish / soils	Sediment of rubbish or soils adversely affect to bridge bearing and its attachments.	—	Bridge bearing is buried under rubbish and soils.	Rubbish and soils are sediment around bridge bearing.
			Water Leakage	Water leakage from drainage system	Bridge bearing is wet due to water leakage from drainage system or expansion joint.	—	Bridge bearing is wet at all times irrespective of weather conditions.	Bridge bearing is wet after rain.

Table 2.2-9 Evaluation Criteria (Bridge Expansion Joint)

Structure	Element	Location	Type of Defect / Damage	Defect / Damage	Descriptions of Defect / Damage	Evaluation		
						D	C	B
Bridge	Bridge Expansion Joint	Steel Finger Plate Joint Cushion Seal Type Elastomeric Joint	Deterioration on Expansion Joint	Defect / Damage on Expansion Joint	Degradation with time or defect / damage due to earthquake is observed on expansion joints.	Cracks on face plate, defect or swell in welding is observed. Loss of anchor bolts and nuts is observed.	Loss of elastomeric material is observed.	—
			Deterioration on Blockout Material & Asphalt Plug Seal Material	Defect / Damage on block out Material & Asphalt Plug Seal Material	Degradation with time or defect / damage due to earthquake is observed on expansion joints.	—	Gap is observed between block out material and bridge deck, or between plug seal material and asphalt pavement material. Cracks are observed on block out material or plug seal material.	—
			Difference in Level	Difference in Level	Roughness or difference in level is observed at or in the vicinity of the expansion joint.	Vehicles are out of control or violently bounded at abutment due to remarkable difference in level. 20mm or greater difference in level is observed at abutment. 30mm or greater difference in level is observed at crossing structure or at boundary of cut / fill area.	Difference in level at abutment is 10mm or greater and less than 20mm. Difference in level at crossing structure or at boundary of cut / fill area is 10mm or greater and less than 30mm.	—
			Water Leakage	Water leakage	Water leakage from expansion joint affects adversely to other bridge elements.	Water leakage is observed even with small rains, and gives adverse effects to bridge bearings and bridge structures.	Water leakage is observed.	—
			Abnormal Sound	Abnormal Sound	Abnormal sound is generated at times of vehicle passage.	—	Abnormal sound is generated at times of vehicle passage.	—
			Excessive Big / Small Girder End Gap	Excessive Big / Small Girder End Gap	Girder end gap is excessively small or extraordinarily opened.	—	Girder end gap is closed or extraordinarily opened.	Girder end gap is smaller or bigger compared to design requirement.

Table 2.2-10 Evaluation Criteria (Bridge Railing and Curb)

Structure	Element	Location	Type of Defect / Damage	Defect / Damage	Descriptions of Defect / Damage	Evaluation D	Evaluation C	Evaluation B
Bridge	Bridge Railing & Curb	Concrete Parapet, Bridge Railing and Curb	Initial Defect	Crack	Fracture in concrete due to tensile / compressive stress mainly arisen from materials used or construction workmanship.	Cracks with free lime and/or rust stain are extensively observed. Loss of section of reinforcement steel is suspected.	Cracks, resulting in reduction of durability, are observed.	Small cracks, which may slightly lead to the reduction in durability, are observed.
				Air Voids, Honeycomb	Air voids or honeycombs may present in concrete due to poor concrete works. Voids may be remained in pre-stressing tendon duct due to poor grouting works.	—	A large scale of air voids or honeycombs are observed.	Air void or honeycomb is observed.
			Deterioration due to Degradation	Crack	Fracture in concrete due to tensile stress mainly arisen from environmental conditions in use (chloride damage, etc.).	—	Cracks, resulting in reduction of durability, are observed.	Small cracks, which may slightly lead to the reduction in durability, are observed.
				Free Lime	Lime contents exudate with water from construction joints or cracks forming through element depth and dried on concrete surface.	—	Exudate of water and/or free lime is extensively observed.	Exudate of water and/or free lime is locally observed.
				Rust Stain	Rust arisen due to corrosion of reinforcement steel is flowed out with water from cracks in concrete.	—	Rust stain is remarkably observed.	Rust stain with water leakage is locally observed due to corrosion of reinforcement steel.
				Scaling / Delamination / Spalling	Scaling or delamination of concrete surface due to swell of corroded steel in concrete, internal stress in concrete or poor construction joint.	—	A large scale of scaling or delamination is extensively observed. Scaling or delamination is scattered.	Scaling or delamination is locally observed.
				Rebar Exposed / Corroded	Reinforcement steel in concrete or in the air is corroded.	Loss of section of reinforcement steel is extensively observed.	Reinforcement steel is exposed and seriously corroded.	Reinforcement steel is locally exposed or corroded.
				Discoloration	Concrete element is deteriorated mainly due to chemical reaction and discolored on surface.	—	Discoloration is observed on concrete surface with cracks.	Discoloration is locally observed on concrete surface.
			Deterioration due to Structural Features and External Forces	Crack	Fracture in concrete due to tensile or compressive stress mainly arisen from structural features or external forces.	Due to extraordinary cracks, spalling and/or compressive failure in concrete are observed.	Though extraordinary cracks are observed, broken pieces of concrete are not dispersed.	Cracks are locally observed.
		Steel Bridge Railing	Deterioration due to Degradation	Corrosion	Steel elements in the air are corroded.	Losses of sections on primary steel elements are observed.	Steel elements are extensively corroded.	Steel elements are locally corroded.
			Deterioration due to Structural Features and External Forces	Deformation, Damage	Permanent deformation and damage caused due to vehicle collision and earthquake.	No required function is performed due to serious damage on primary elements with cracks and deformation.	Malfunction of primary elements is observed due to cracks and deformation.	Slight cracks and deformation are observed on primary elements.
				Loosening and Loss of Bolts / Nuts	Loosening or losses of bolts and nuts on connections between posts and railings are observed.	Posts and railings are in danger of dropping off due to losses of bolts and nuts.	Posts and railings are still remained, though bolts / nuts are lost.	Bolts / nuts are still remained, though they are loosened.

Table 2.2-11 Evaluation Criteria (Drainage System)

Structure	Element	Location	Type of Defect / Damage	Defect / Damage	Descriptions of Defect / Damage	Evaluation		
						D	C	B
Bridge	Bridge Surface Drainage Facilities	Drain Box	Deterioration on Drain Box	Deficiency, Corrosion, Deformation and Loss of Drain Box	Deterioration such as deficiency, corrosion, deformation and loss is observed on drain box.	With overflow even at time of small rain and deterioration on drain box, adverse effects are given to a third party or to bridge structure / bridge bearing	Drain box is not properly functioned due to deterioration.	Slight deterioration is observed on drain box.
			Deterioration on Drain Cover	Defect, Corrosion and Deformation of Cover	Deterioration such as deficiency, corrosion and deformation is observed on drain cover.	—	Extraordinary deterioration is observed on drain cover and/or attachments.	Drainage function is not well performed due to deterioration on drain cover and attachments.
			Sediment of Rubbish and Soils	Clogging with Soils	Clogging with soils is observed in drain box.	Drainage function is impaired due to clogging with soil in drain box, thereby resulting in overflow and adverse effects to a third party, bridge structure and bridge bearing.	Water stagnation is observed on bridge surface due to improper function of drainage system.	Though water stagnation is observed on bridge surface for a short period of time, drainage function is ensured.
		Trough on Expansion Joint	Deterioration on Trough	Deficiency, Corrosion, Deformation and Loss of Trough	Deterioration such as deficiency, corrosion, deformation and loss is observed on trough.	With overflow even at time of small rain and deterioration on trough, adverse effects are given to a third party or to bridge structure / bridge bearing.	Trough is not properly functioned due to deterioration. Extraordinary deterioration is observed on attachments.	Slight deterioration is observed on trough.
			Sediment of Rubbish and Soils	Clogging with Soils	Clogging with soils is observed in trough.	Drainage function is impaired due to clogging with soil in trough, thereby resulting in overflow and adverse effects to a third party, bridge structure and bridge bearing.	Water stagnation is observed on bridge surface due to improper function of trough.	Though water stagnation is observed on bridge surface for a short period of time, drainage function is ensured.
		Drain Pipe	Deterioration on Pipe	Deficiency, Corrosion, Deformation and Loss of Pipe	Deterioration such as deficiency, corrosion, deformation and loss is observed on drain pipe.	With overflow even at time of small rain and deterioration on drain pipe, adverse effects are given to a third party or to bridge structure / bridge bearing.	Drain pipe is not properly functioned due to deterioration. Extraordinary deterioration is observed on attachments.	Slight deterioration is observed on drain pipe.
			Deterioration on Joint	Corrosion, Deformation and Loss of Joint	Deterioration such as corrosion, deformation and loss is observed on drain pipe joint.	Water leakage is observed from the opened joints, thereby resulting in defect / damage to bridge structure and bridge bearing.	Drain pipe is not properly functioned due to deterioration of joints.	Though water leakage is observed, drainage function is ensured.
			Sediment of Rubbish and Soils	Clogging with Soils	Clogging with soils is observed in drain pipe.	Drainage function is impaired due to clogging with soil in drain pipe, thereby resulting in overflow and adverse effects to a third party, bridge structure and bridge bearing.	Water stagnation is observed on bridge surface due to improper function of drain pipe.	Though water stagnation is observed on bridge surface for a short period of time, drainage function is ensured.

Table 2.2-12 Evaluation Criteria (Earthquake-Resistant Devices)

Structure	Element	Location	Type of Defect / Damage	Defect / Damage	Descriptions of Defect / Damage	Evaluation		
						D	C	B
Bridge	Earthquake-Resistant Devices	Earthquake-Resistant Devices	Deterioration on Concrete Elements	Degradation / Damage on Concrete Elements	Deterioration such as crack, scaling, delamination and rebar exposed is observed.	Extraordinary deterioration such as cracks and scaling / delamination is observed. Load carrying capacity is thereby reduced.	Deterioration such as cracks is observed. It may cause reduction in load carrying capacity.	Slight deterioration such as cracks is observed.
			Deterioration on Steel Elements	Corrosion on Anchor Bars	Anchor bars are corroded.	With the anchor bars corroded, rust stain is extraordinarily observed.	Rust stain is observed due to corrosion of anchor bar.	—

Table 2.2-13 Evaluation Criteria (Inspection Platform)

Structure	Element	Location	Type of Defect / Damage	Defect / Damage	Descriptions of Defect / Damage	Evaluation		
						D	C	B
Bridge	Inspection Platform	Inspection Platform	Deterioration on Platform	Deficiency, Corrosion and Deformation on Steel Platform	Deterioration such as deficiency, corrosion and deformation is observed on steel platform including slab, ladder steps and attachments.	—	Required function is extraordinarily impaired due to deterioration on inspection platform such as deficiency, corrosion and deformation.	With the deterioration on platform, required function is not well performed.
				Deficiency and Scaling / Delamination on Concrete Platform	Deterioration such as deficiency, scaling / delamination is observed on concrete platform including slab and ladder steps.	—	Required function is extraordinarily impaired due to deterioration on inspection platform such as deficiency, scaling / delamination.	With the deterioration on platform, required function is not well performed.
			Deterioration on Railing	Deformation and Deficiency on Railing	Deficiency and/or deformation are observed on railing.	—	With the deficiency and/or deformation on railing, working on platform is in danger.	With the deficiency and/or deformation on railing, attention shall be paid in working on platform.

Table 2.2-14 Evaluation Criteria (Culvert)

Structure	Element	Location	Type of Defect / Damage	Defect / Damage	Descriptions of Defect / Damage	Evaluation		
						D	C	B
Culvert	Reinforced Concrete Culvert	Reinforced Concrete Culvert	Overall Deterioration	Displacement	Culvert is inclined, rotated or displaced.	—	Culvert is largely displaced, and is not properly functioned for vehicle passage and water flow.	Culvert is displaced to some extent.
				Settlement, Scour	Foundation may be scoured due to water flow.	—	Water stagnation is observed in culvert due to extraordinary settlement. A large scale of difference in levels between culvert and approach road is observed due to extraordinary settlement. Wing walls are seriously scoured.	Due to settlement, culvert is not properly functioned for water flow. Wing walls are scoured.
				Unusual Joint	Functions such as water stops and smooth passage of vehicles are not well performed due to irregularity in longitudinal line between adjacent segments.	—	Due to gap, opening and difference in level between adjacent segments, water stops may be dropped off.	Gap, opening and/or difference in level are observed.
			Initial Defect	Crack	Fracture in concrete due to tensile stress mainly arisen from materials used or construction workmanship (dry shrinkage, etc.)	—	Cracks, resulting in reduction of durability, are observed.	Small cracks, which may slightly lead to the reduction in durability, are observed.
				Air Void, Honeycomb	Air void and honeycomb may be remained in concrete due to poor concrete works.	—	A large size of air voids and honeycombs present in concrete.	Air voids and honeycombs present in concrete.
			Deterioration due to Degradation	Crack	Fracture in concrete due to tensile stress mainly arisen from environmental conditions in use (chloride damage, etc.).	—	Cracks, resulting in reduction of durability, are observed.	Small cracks, which may slightly lead to the reduction in durability, are observed.
				Free Lime	Lime contents exudate with water from construction joints or cracks forming through element depth and dried on concrete surface.	—	Exudation of water and/or free lime is extraordinarily observed.	Exudation of water and/or free lime is locally observed.
				Rust Stain	Rust arisen due to corrosion of reinforcement steel is flowed out with water from cracks in concrete.	—	Rust stain from steel reinforcement is extraordinarily observed.	Rust stain from steel reinforcement is locally observed.
				Scaling / Delamination / Spalling	Scaling, delamination or spalling of concrete surface due to swell of corroded steel in concrete, internal stress in concrete or poor construction joint.	—	A large scale of scaling or delamination is extensively observed. Scaling or delamination is scattered.	Scaling or delamination is locally observed.
				Rebar Exposed / Corroded	Reinforcement steel in concrete or in the air is corroded.	Loss of section of reinforcement steel is extensively observed.	Reinforcement steel is exposed and seriously corroded.	Reinforcement steel is locally exposed or corroded.
				Discoloration	Concrete element is deteriorated mainly due to chemical reaction and discolored on surface.	—	Discoloration with cracks is observed on concrete surface.	Discoloration is locally observed on concrete surface.
			Deterioration due to Structural Features and External Forces	Crack	Fracture in concrete due to tensile or compressive stress mainly arisen from structural features or external forces.	Progressive cracks in the direction of road / water flow are observed with free lime and rust stain. Loss of section of reinforcement steel is suspected.	Cracks in the direction of road / water flow are observed with free lime and rust stain.	Cracks in the direction of road / water flow are observed.
			Sediment of Rubbish and Soils	Sediment of Rubbish and Soils	Water stagnation is observed in culvert due to sediment of rubbish and soils.	—	Drainage function is extraordinarily impaired. Water stagnation is observed in culvert.	Drainage function is not well performed.

2.2.2.3 Inspection Methods

Routine inspection is implemented with visual inspection and hammering test. When defect / damage are detected, measurement of extent of defect / damage is conducted using the simple tools.

Such inspection is carried out from bridge surface and under the bridge. Wherever the access is difficult, scaffolds, vehicular lift, boat or under-bridge inspection vehicle is used.

Wherever defect / damage endanger the stability of a structure or safety of a third party, such extent or conditions are recorded in detail and immediately reported to the road operator.

2.2.3 In-Depth Inspection on Concrete Structures

To fully detect and evaluate the extent of defect / damage by routine inspection is beyond its capability.

Wherever it is difficult to estimate or predict the extent of defect / damage using the evaluation criteria in Clause 2.2.2.2, detail data shall be collected through in-depth inspection. Types of defect / damage requiring in-depth inspection and data to be collected are given in Table 2.2-15.

Table 2.2-15 Defect / Damage Requiring In-Depth Inspection and Data to Be Collected

Defect / Damage Requiring In-Depth Inspection		Data to be Collected
Settlement and Displacement		Settlement
Extraordinary Deformation		Deflection of a girder, inclination of a pier, compressive strength, elastic modulus
Cracks along Reinforcement Steel, Scaling / Delamination of Cover Concrete	Carbonation	Carbonation depth, quantity of rust, corrosion cracking
Cracks along Reinforcement Steel, Rust Stain, Section Loss of Concrete / Rebar	Chloride Damage	Chloride ion content, quantity of rust, corrosion cracking
Expansion Crack (Restriction Direction, Alligator Pattern)	Alkali-Silica Reaction	Expansion rate
Latticed Crack, Free Lime	Fatigue	Crack density, deflection

In the in-depth inspection, concrete compressive strength, carbonation depth and chloride ion content are usually investigated. Concrete compressive strength is used for evaluation of load carrying capacity, and carbonation depth and chloride ion content are to predict the timing of concrete defect / damage and rebar corrosion. These data can be obtained with comparative ease.

Descriptions and testing methods are given below.

2.2.3.1 Concrete Compressive Strength

Concrete compressive strength, as well as soundness of pre-stressing tendons and reinforcement steels in concrete, is one of the important factors in order to evaluate load carrying capacity of a structure.

Rebound hammer method is simple and frequently used. This is a convenient method, as the concrete compressive strength can be estimated on site, however, depending on the concrete surface, some cases could not be accurately estimated, and thus, concrete surface should be taken into consideration. Concrete compressive strength is estimated lower on concrete with scaling / delamination of cover concrete, honeycomb or uneven surface. When concrete compressive strength inside the structure or more precise strength is needed, drilled core method is used. Unconfined compressive strength test is made on test specimen taken with drilled core method in accordance with such appropriate specifications as ASTM or BS.

2.2.3.2 Carbonation Depth in Concrete

Reinforcement steels in concrete is in a high level of alkalinity and is protected against corrosion by passive state film. However, in a carbonated concrete, reinforcement steels are subject to corrosion. Measurement of carbonation depth will help to predict the rate of corrosion of reinforcement steels.

Drill powder method is simple and commonly used for carbonation depth measurement on concrete structures in operation.

Carbonation depth is assessed using a 1% solution of phenolphthalein indicator that appears pink in contact with alkaline concrete with pH values in excess of 9 and colorless at lower levels of ph. The powder from drill holes is sprayed or allowed to fall on indicator-impregnated paper.

When drilled core or concrete chipping surface is sprayed with a 1% solution of phenolphthalein, difference in color indicates the carbonation depth.

2.2.3.3 Chloride Ion Content

Chloride ion in concrete will deteriorate the reinforcement steels. Such chloride ions are contained in concrete during construction or penetrated into concrete from salt spray when a structure is constructed at the seashore.

In excess of chloride ion content of 1.2 kg / m3 at reinforcement steel, it is considered in corrosive environment. Distribution of chloride ion content in depth will be used for prediction of deterioration for structures in corrosive environment.

Potentiometric titration method is commonly used for chloride ion content measurement.

2.2.3.4 Crack Investigation

In a cracked concrete, corrosion factors such as water and oxygen as well as carbon dioxide expediting carbonation are penetrated into concrete with ease, thereby resulting in corrosion of reinforcement steels and pre-stressing tendons.

Crack pattern sketch will be prepared only for cracks visually detected. Rate of deterioration will be identified through comparison with previously prepared sketch.

2.2.3.4.1 Preparation of Crack Pattern Sketch

Cracks with surface width of 0.2mm or greater will be recorded in Form-2-5 with surface width, length, location, extent and pattern.

2.2.3.4.2 Measurement of Crack Surface Width and Depth

Crack surface width is measured at perpendicular direction to crack direction using the crack scale. It is noted crack surface width is not uniform in a continuous crack.

In a continuous crack, only the range with its surface width of 0.2 mm or greater will be recorded. Representative width of such a crack shall be the maximum width in a crack.

Crack depth measurement is carried out by ultrasonic wave method or drilled core method.

Ultrasonic wave method is to survey the concrete quality and crack depth by measuring the propagation velocities in concrete.

Drilled core method is to take the core with a crack from the structure and measure its depth. Before taking a core, colored ink shall be injected into a crack in order to observe its depth with ease.

2.2.4 Emergency and Special Inspections

2.2.4.1 Inspection Items

2.2.4.1.1 Emergency Inspection

Emergency inspection is implemented to members or locations of a structure damaged due to such natural disasters as a large scale earthquake, typhoon and floods, collision with vehicles or vessels, and fire. Such inspection will be implemented at a high risk of work conditions. Special attention shall therefore be given to ensure the safety of inspection staff and to promptly complete such inspection.

Defect / damage on member or location of a structure for each event are given in Table 2.2-16. Other types of defect / damage than those described in Table 2.2-16 causing the collapse of a structure or endangering the safety of traffic shall also be inspected as necessary.

Table 2.2 16 Items to Be Inspected for Emergency Inspection

Event	Member / Location	Description of Defect / Damage
Large-Scale Earthquake	Girder End (Bridge Bearing)	Rupture of bridge bearing
		Rupture of bolts
		Girder dropped out of the bridge bearing
		Attachments of earthquake-resistant devices
	Bridge Deck	Damage on girder end due to displacement of substructure
		Damage due to collision between ballast wall and girder end
	Substructure	Cracks at bridge bearings
		Cracks resulting in shear failure
		Deformation / deficiency of bridge railing and curb
		Excessive big / small girder end gap
Typhoon, Flood, Collision	Bridge Deck	Defect / damage due to collision with debris
		Defect / damage due to collision with heavy equipment
		Defect / damage due to collision with vehicles
		Defect / damage due to collision with vessels

2.2.4.1.2 Special Inspection

Wherever any deterioration are found on a structure due to unexpected types of defect / damage or extraordinary deteriorations, not resulting in serious incidents, are observed, special inspection will be implemented on members / locations of a similar structure, which may have same types of deteriorations.

Inspection items for special inspection are those in routine inspection. However, for a structure requiring detail investigations such as prediction of deterioration, in-depth inspection shall be implemented.

2.2.4.2 Evaluation on Defect / Damage

In emergency inspection, defect / damage shall be evaluated with criteria used for routine inspection.

However, in case of degradation, new types of defects / damages, new criteria should be created and based for evaluation.

2.2.4.3 Inspection Methods

2.2.4.3.1 Emergency Inspection

In emergency inspection, safety shall initially be ensured against collapse of a structure through remote visual inspection, followed by direct visual inspection and hammering test using simple tools.

Where a structure seems to be inclined, settled or displaced, survey tools shall be used for measurement.

2.2.4.3.2 Special Inspection

Special inspection shall be implemented not only with visual inspection and hammering test, but also with non-destructive equipment and chipping method as required.

On structures designed and constructed with similar design standards and materials, as-build documents are useful for inspections. Such documents, as well as differences in environmental conditions, shall therefore be carefully investigated.

2.2.5 Record-Keeping System

The inspection staff shall record the inspection results in the prescribed forms and report to the road operator. Records of such inspection results shall be kept in a proper manner and be available whenever necessary.

(1) Results of inspection conducted to recognize the conditions of a structure are important as the database for formulation of inspection plans, measures to be taken and so on.

(2) In case emergency measures are taken on defect / damage found during the inspection, such measures shall be recorded. Evaluation results, after the measures are taken, shall also be recorded and reported.

(3) Digital camera shall be used to record the defect / damage. Such electronic data shall be kept in a proper manner.

(4) Records shall be kept during the operation period of a structure.

2.2.5.1 Record-Keeping Forms

As the results of inspection are precious database for efficient and effective maintenance activities, such results shall be kept in order of inspection date and compiled in Inspection Record Form (Form 2-1) for each structure.

2.2.5.2 Record of Inspection Results

Form of inspection results to be used for each type of inspection is summarized in Table 2.2-17.

Organization of inspection, defect / damage with sketch map, evaluation, selection of measures and measures taken shall be recorded in these Forms.

Table 2.2-17 Inspection Forms used for Each Type of Inspection

No of Form	Title of Form	Type of Inspection: Initial Inspection	Daily Inspection: Safety Patrol	Daily Inspection: Inspection – Monitoring	Daily Inspection: Inspection – General Inspection	Routine Inspection A B	In-Depth Inspection	Descriptions
Form 2-2	Form of Records for Daily Inspection, Routine Inspection Type-A		○	○		○		To record the route of inspection and defect / damage found at the site.
Form 2-3	Records of Defect / Damage Found in Daily Inspection & Necessary for Urgent Measures	○	○	○	○	(○)	(○)	To record the defect / damage found in daily inspection and/or requiring unguent measures for reporting.
Form 2-4	Monthly Summary Sheet of Inspection, Evaluation and Measures Taken		○	○	○			To summarize, on a monthly basis, the inspection, evaluation and measures taken for defect / damage requiring measures for a short period of time after detection.
Form 2-5	Inspection Records - Photographing	○			○	○	○	To summarize the photographs for defect / damage for each structure.
Form 2-6	Defect / Damage Map	○			○	○	○	To sketch the details of defect / damage for each structure.
Form 2-7	Annual Summary Sheet of Inspection, Evaluation and Measures Taken					○	○	To summarize, on an annual basis, the inspection, evaluation and measures taken defect / damage not requiring urgent measures for a short period of time after detection.

2.3 Assessment and Maintenance Program

Incidents arisen from defect / damage on structures will cause serious losses of economical benefits due to closure of expressway to traffic and losses of human lives.

However, since the rate of progress of degradation with time is generally slow and no urgent measures are required at time of detecting the signs of defect / damage, prompt preparation and implementation of measures will not be taken. In addition, it is well known that the greater the extent of defect / damage on structures, the bigger the cost for reinstatement, repair and reinforcement and losses of economical benefit due to closure to traffic. Under such circumstances, in order to use the existing structures effectively and efficiency, scheduled maintenance activities shall be implemented.

Defect / damage on structures shall be checked by inspection activities, recorded and evaluated in accordance with evaluation criteria in 2.2.2.2. Evaluation criteria are developed based on the extent of risks to road users and a third party due to each defect / damage.

To prevent troublesome in taking the measures for each defect / damage on an individual basis, grouping shall be made so that defect / damage within some range of rate of degradation can be repaired at the time, as in Table 2.3-1.

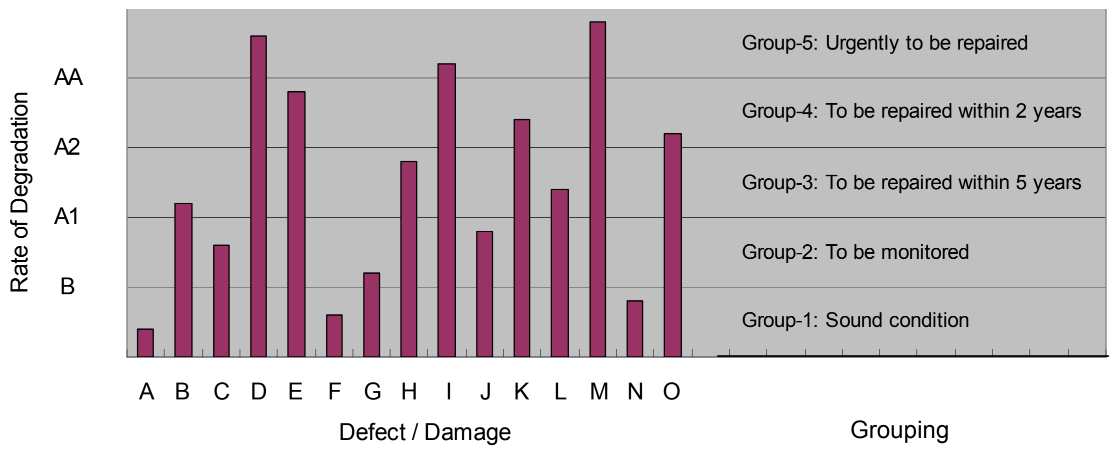


Table 2.3-1 Grouping of Defect / Damage for Efficient Measures

Therefore, with the inspection results on defect / damage and predicted economic losses considered, efficient maintenance program shall be developed. Scheduled inspection and repair works shall subsequently be implemented in accordance with the developed maintenance program.

2.3.1 Assessment based on Inspection Results

Information on types and deterioration levels of defect / damage on structures obtained from inspection activities shall be recorded and used for formulation of maintenance program. In the maintenance program, if it is judged defect / damage is categorized into D and C, such structures shall be basically repaired. However, defect / damage, which need low cost of repair for its ease of work, as indicated in 2.4.1.1 - 2.4.1.3, shall immediately be repaired after detection at times of daily inspection.

Defect / damage categorized into D, which will probably result in serious incidents, need urgent repair works within several days to several months after detection. It is supposed that these defect / damage are drastically degraded from the previous inspection to most recent inspection times, or have not been detected for an extended period of time with some reasons.

Defect / damage categorized into C will probably be degraded to the extent of category D within several months to ten years after detection. Depending on urgency, these will be categorized into T or C of Group C within approximate 3 years.

Deterioration of structures is generally progressed at the following four (4) stages:

(1) Dormant Stage: Though deterioration is not visually observed on surface, factors of deterioration are accumulated and/or microscopic change in materials is generated. It is categorized into A.

(2) Initiation Stage: Though deterioration is not visually observed on surface, it is progressed inside the structure. It is categorized into B.

(3) Acceleration Stage: Signs of deterioration can be visually observed. Deterioration is explicitly progressed. It is categorized into T of group C.

(4) Deterioration Stage: Such required functions as load carrying capacity are evidently degraded. It is categorized into priority C in group C and/or D for its urgency.

Degradation characteristics depend on structural types / forms, surrounding environments and traffic conditions on them. Such degradation characteristics as rate of degradation progress can be identified by means of statistical processing of previous inspection data classified by defect / damage type and surrounding environments. In order to implement the maintenance activities on structures more effectively, it is of great importance to assess the prioritization of repair on each defect / damage in consideration of degradation characteristics as well as integrated effect to overall structural stability by deteriorated members and effect to road network by defect / damage on structures.

2.3.2 Maintenance Program

It is well known that preventive maintenance, which implements repair works in an earlier and proper time with periodical inspection, understanding of defect / damage conditions and prediction of deterioration, is superior to breakdown maintenance with a large-scale repair works conducted immediately after detecting serious defect / damage, in order to keep the structures in sound conditions for an extended period of time and minimize the maintenance cost.

So as to prepare effective and efficient maintenance program, several types of maintenance scenarios shall be developed in consideration of the following:

(1) Several levels of repair work;

(2) Repair method and its cost for each level of repair work;

(3) Prediction of rate of degradation.

With the above, the following procedure shall be taken for development of maintenance program.

1. Basic maintenance scenario shall be determined through cost comparison among several maintenance scenarios;
2. Interval of repair work and its cost shall be assumed for each structure;
3. Based on the above (2), necessary budget for all the target structures in maintenance program shall be summed for a period of maintenance program. It will be recognized uneven budget is required for every year (a lot of budget for a year, small budget for another year).
4. Whenever necessary budget is concentrated for the year, budget leveling will be made by means of shifting the time of repair works for such year to the period of subsequent three (3) years.
5. Appropriate manuals including maintenance procedures shall be prepared after the maintenance program is developed.

2.4 Maintenance Works

2.4.1 Daily Maintenance Work

Daily maintenance work on structures shall be implemented to ensure safe and comfortable expressway with the removal of causes endangering the safety of vehicle travelling and to extend the intervals of large-scale repair works and/or improvement works with prompt and appropriate measures on detected defect / damage for slow progress of deterioration.

Activities implemented for daily maintenance works are described below. Water stagnation on road surface and defect / damage on bridge expansion joints may endanger the safety of road users. Defect / damage on bridge railings caused by vehicle collision may also lose the function preventing vehicles from falling off the bridge. Such deterioration as cracks on bridge deck / substructure concrete, leakage of surface water to girder ends and corrosion of steel elements will result in reduction of load carrying capacity if prompt and appropriate measures are not taken.

2.4.1.1 Bridge Drainage System

Clogging of drain boxes / pipes will cause water stagnation on road surface and may result in loss of steering wheel control or danger of vehicles travelling on adjacent / oncoming traffic lanes by splashed water. Covers dropped on traffic lane out of drain boxes will also result in serious accidents due to loss of steeling wheel control of vehicles travelling on such covers or hitting of covers to vehicles on adjacent / oncoming traffic lanes.

Such defect / damage on bridge drainage system shall immediately be repaired.

2.4.1.2 Bridge Expansion Joint

Wherever fracture of face plates or removal of part of expansion joint is observed, appropriate measures shall promptly be taken to prevent accidents. Defect / damage on bridge expansion joint resulting in uneven road surface shall be temporarily repaired with filling of bituminous mixtures or collection of scattered pieces / parts, and shall be replaced with sound ones as prompt as possible.

Figure 2.4-1 Temporary Filling with Bituminous Mixtures

Difference in level between block out material and adjacent pavement will be discussed in Chapter 1.

Surface water flowing to both ends of expansion joints shall be stopped at curbs with such appropriate measures as sealing materials along with backup material. However, such materials are subject to degradation with ease or were inappropriately installed at construction stage. So as to delay the deterioration progress on bridge bearings and substructures, it is quite important to execute appropriate water stop works at curbs using the sealing materials.

Figure 2.4-2 Inappropriate Water stop Works at Both Ends of Expansion Joint

Figure 2.4-3 Proper Water stop Works at Both Ends of Expansion Joint

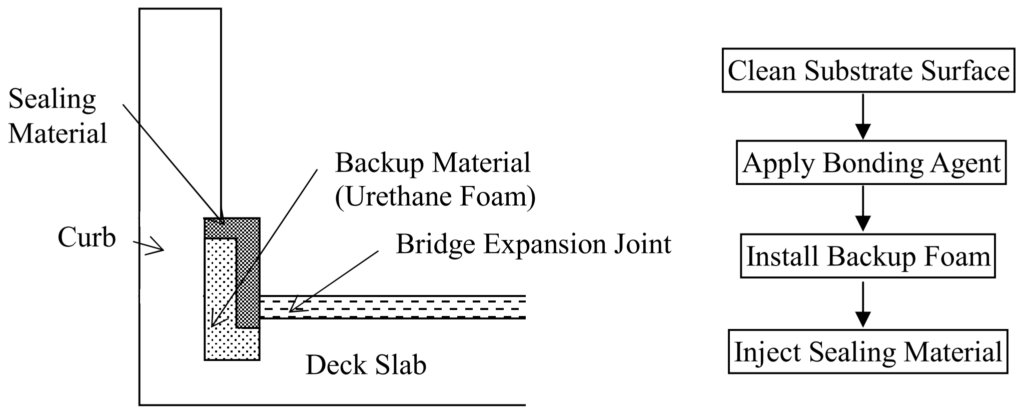


Figure 2.4-4 Guide for Water stop Works at Both Ends of Expansion Joint

2.4.1.3 Concrete Structure

Cracks will usually occur on concrete structure due to various actions as drying shrinkage. Cracks allow such deterioration factors as water and oxygen to penetrate into concrete and expedite the reduction in load carrying capacity of a structure. Wherever the crack with its surface width exceeding 0.2mm is detected, prompt measures shall be taken.

Due to expansion of corroded reinforcement steel, cracks will occur inside the concrete and cause spalling of cover concrete. In such a case, spalled concrete shall be restored properly after application of corrosion inhibitor on exposed reinforcement steels in order to prevent exposure of inside concrete to deterioration factors.

2.4.1.3.1 Crack Repair Method

Crack repair shall be carried out with low-pressure injection method at slow rate of injection so that materials can be injected completely to the crack. Injection material shall be of epoxy resin for the crack with small surface width.

Though several types of injection machine / gun are used for crack injection, hereby described is the cylinder type which can inject comparatively large amount of resin material with ease.

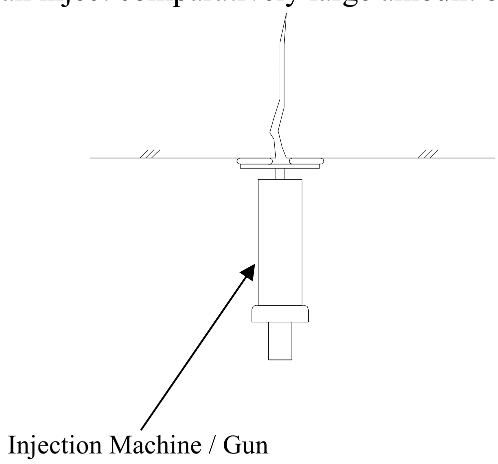
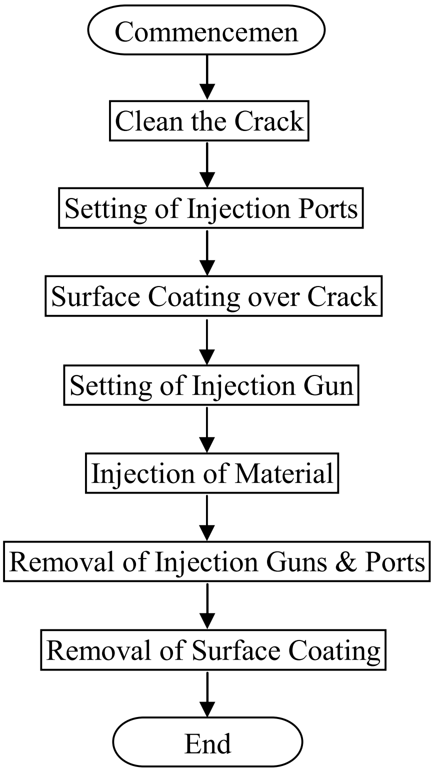


Figure 2.4-5 Low-Pressure Crack Injection Method



Note:
Injection material may be clogged in crack due to the removal of its moisture caused by dry crack surface. It is necessary to dampen the crack through injection of water in it.

Figure 2.4-6 Work Flow for Crack Injection

2.4.1.3.2 Restoration of Section of Element

Plaster work is preferred for small scale of restoration work for concrete structure.

Concrete scaling or delamination is caused by shortage of concrete cover to reinforcement steel with poor concrete work or such severe environments as water leakage. It is therefore required to prevent deterioration factors from penetrating into concrete. After the preparation of substrate surface and application of corrosion inhibitor on reinforcement steels are properly executed, polymer-cement material is injected for restoration.

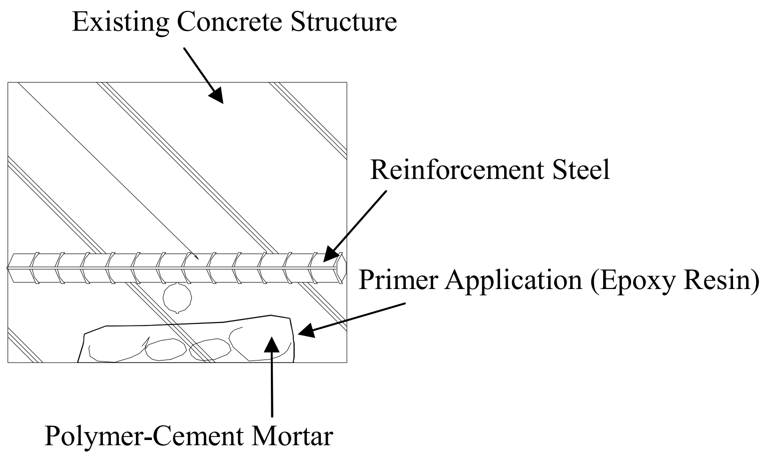
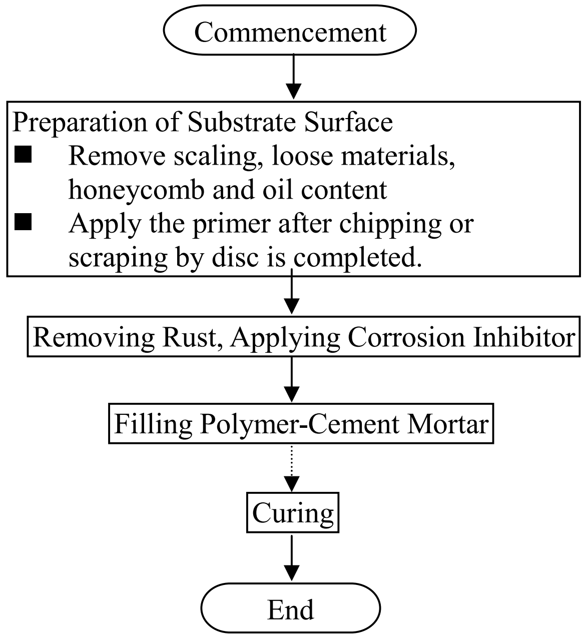


Figure 2.4-7 Method of Restoration of Element Section



Note:

1. Defect / damage shall be completely removed with chipping work followed by surface preparation with blasting and application of corrosion inhibitor on surface of reinforcement steel.
2. For surface preparation, removal of scaling, crack, honeycomb as well as portions containing large amount of chloride ions shall be conducted as much as possible.
3. No defect / damage shall be given to sound portions.

Figure 2.4-8 Work Flow for Restoration of Element Section

2.4.1.4 Removal of Soil Deposits on / around Steel Element, Surface Coating on Steels

2.4.1.4.1 Bridge Bearing

Whenever steel bridge bearings are corroded, rust shall be removed with wire brush or grinder as much as possible. Prior to surface coating, steel surface shall be free from oil, moisture and/or substances, and shall be dry. Surface coating material shall be of zinc-rich paints.

Corrosion on bridge bearing is caused with stagnation of water from bridge expansion joint. Corrosion of steel elements is expedited with moisture retained in soil deposits and/or dust around bridge bearing. Even without corrosion on bridge bearing, it is needed to remove soil deposits and dust from the bridge bearing seat as well as to improve water stop function at bridge expansion joint.

2.4.1.4.2 Bridge Railing

Such slight defect / damage as scratch on surface coating shall be repaired on prepared steel surface free from dust, oil and substances. Surface coating material shall be of quick drying repair paint for ordinary steel surface and of zinc-rich paint for plated surface.

Whenever it is difficult to implement surface coating at site, appropriate measures shall be taken to carry out surface coating in a factory or to replace deteriorated steel element, with the traffic safety ensured during such work.

2.4.2 Routine Maintenance Work

Defect / damage, evaluated as C, caused by degradation with time shall be repaired under the routine maintenance work program. Primary repair works are to improve load carrying capacity of concrete elements and to recover the serviceability of ancillary works.

A lot of modern repair technologies have been developed day by day with improved effects. Hereby described are several types of repair technologies with special attentions for the work.

2.4.2.1 Concrete Structure

Repair works on concrete structures are for cracks, scaling / spalling and corrosion of reinforcement steel and pre-stressing tendon. For routine maintenance work, repair technologies for the crack with large surface width and extensive scaling / spalling of concrete are discussed.

2.4.2.1.1 Crack Repair Method

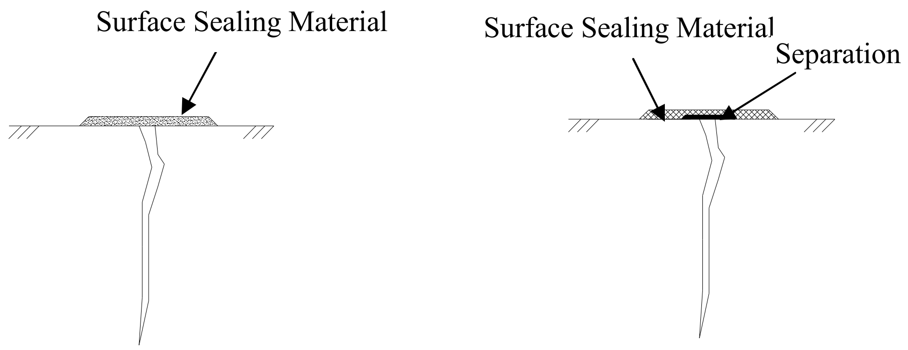
Hereby discussed are such repair techniques as surface sealing method and routing & patching method for cracks with variation in surface width.

2.4.2.1.1.1 Surface Sealing Method

A crack with comparatively small and variable surface width due to progressive degradation and live loads is sealed with flexible sealing materials or joint filling materials. Sealing material shall be of elastic waterproofing agent or polymer cement paste for small variation in its width, and shall be of flexible material for large variation in its surface width.

Procedure for surface sealing work shall be as follows:

(1) Concrete surface along the crack shall be roughed with such tools as wire brush.
(2) Remove the substances followed by cleaning with water and drying the surface.
(3) Filling the air voids on concrete surface with putty.
(4) Seal the crack surface with appropriate materials.



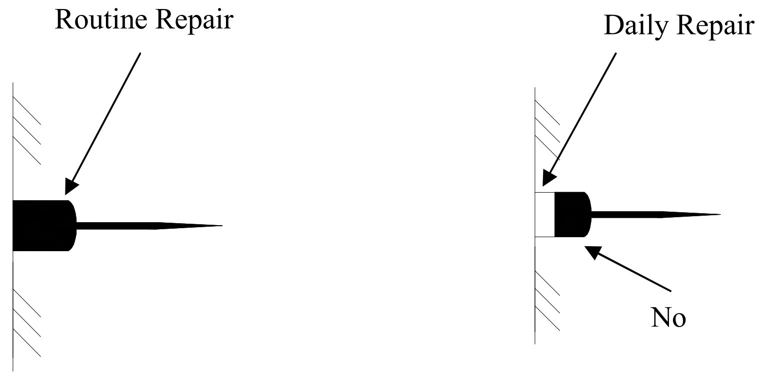
(a) Small Variation in Crack Surface Width (b) Large Variation in Crack Surface Width

Figure 2.4-9 Surface Sealing over Crack

2.4.2.1.1.2 Routing & Patching Method

Routing with V- or U- grooving followed by patching is implemented for cracks with 0.5mm or larger surface width in concrete without corrosion of reinforcement steels.

Concrete surface is grooved with V- or U-shape in approximately 10mm width along a crack. Such grooving is filled with such repair materials as sealing material, flexible epoxy resin or polymer cement mortar.



(a) Small Variation in Crack Surface Width (b) Large Variation in Crack Surface Width

Figure 2.4-10 Routing & Patching Method

2.4.2.1.2 Restoration of Section of Element

For the bridge deck with thin cover concrete, extensive restoration of concrete is implemented with filling of non-shrinkage mortar or pneumatically applied polymer cement mortar.

Defect / damage on substructures with thick cover concrete will be chipped followed by surface preparation, application of primer on substrate surface and corrosion inhibitor on reinforcement steels, and casting concrete.

2.4.2.1.2.1 Filling of Mortar

Forms shall be set to ensure the required dimensions and concrete cover to reinforcement steels, and be completely filled with joints between sheathings by sealing materials. Non-shrinkage mortar or high-performance polymer cement mortar are then filled by pressure pump.

Figure 2.4-11 Filling of Non-Shrinkage Mortar

2.4.2.1.2.2 Pneumatically Applied Polymer Cement Mortar

Polymer cement mortar is pneumatically applied to concrete surface with dry-mix or wet-mix system. Wet-mix system is to pump out the premixed mortar and apply to the concrete surface. On the other hand, dry-mix system is to pump out such materials as cement, sand and admixture to the nozzle, to add water at nozzle and to apply to the concrete surface. Each system uses exclusive equipment for application.

Figure 2.4-12 Pneumatically Applied Polymer Cement Mortar

2.4.3 Repair Works on Bridge Accessories

Replacement of all or part of components used will be carried out for bridge accessories.

2.4.3.1 Bridge Expansion Joint

Defect / damage on bridge expansion joint, directly degrade the safety of vehicle travelling, shall urgently be repaired. A large scale repair work such as replacement of whole expansion joint needs at least restriction of traffic lane(s). Therefore, in order to prevent degradation of service level on whole of expressway network, emergency measures are temporarily taken, followed by permanent maintenance works on expansion joints for selected areas during the periods with low traffic volume.

Repair works will be implemented with the following methods, considering the extent of defect / damage, impacts to the socioeconomic activities by closure of traffic lane(s), ease of repair works and safety during the work.

- Repair for Damaged Portions

  Face plates damaged will be partially repaired or replaced with new ones. Trough attached to the expansion joint will be replaced.

- Replacement of Whole Bridge Expansion Joint

  Whole of damaged expansion joint will be replaced with same type or different type of joint.

- Replacement of Block out Materials

  Block out materials used will be replaced.

Special attention shall be paid on safety management with traffic control, since such works are implemented very close to vehicles travelling at high speed.

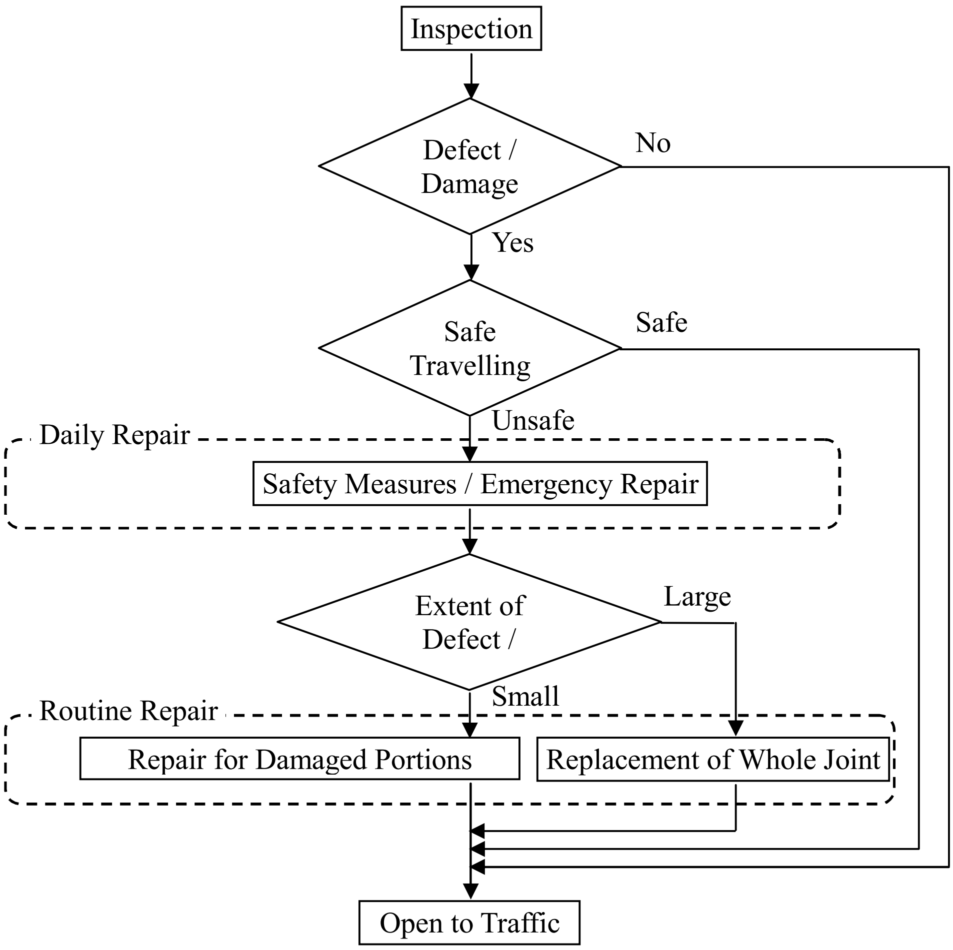


Figure 2.4-13 Repair Procedure for Bridge Expansion Joint

2.4.3.2 Bridge Bearing

Whenever decrease in vertical load carrying capacity is suspected or difference in level occurs at expansion joint due to fracture on bearing seat mortar and/or bridge seat concrete, such mortar and concrete shall be replaced.

Horizontal displacement on substructure may result in excessive deformation of bridge bearing out of the design limits. Whenever no serious fracture or defect / damage is observed on deformed bridge bearing, jacking up the bridge deck with slight raise will enable the release of deformation along with the casting of bearing seat mortar at different location. Jacking up can be done with traffic opening for reason of slight raise to approximately several millimeter difference in level at expansion joint.

Collapse or rupture in elastomeric materials or deformation in steel materials will need replacement of bridge bearing with big raise of bridge deck jacking up. To prevent any accidents due to large difference in level at expansion joint, the bridge shall be closed to traffic.

It is required to accurately calculate jacking forces as well as to check the loading capacities on bridge structure at jacking positions. Insufficient loading capacities need reinforcement on structures at jacking positions.

2.4.3.3 Bridge Railing

Whenever cracks and/or scaling are extensively observed on concrete element due to degradation with time, such defect / damage shall be repaired. Steel bridge railing degraded in load carrying capacity due to serious corrosion shall also be replaced.

Special attention shall be paid on safety management with traffic control, since such works are implemented very close to vehicles travelling at high speed.

2.4.3.4 Bridge Drainage System

Horizontally installed drain pipes are subject to clogging, deformation and defect / damage, water leakage from the pipe joints, defect / damage on attachments. Such defect / damage will result in injuries to a third party under the bridge, erosion on embankment fill or local degradation in concrete.

Maintenance activities on bridge drainage system will include restoration of drain box covers, replacement of drain pipes and attachments. During the work, soils and/or rubbish in drain pipes shall be removed.

2.4.4 Record-Keeping System

2.4.4.1 Documents in Construction Period

A variety of documents prepared during the construction period are effective for maintenance works. Such documents shall include design calculations, drawings, times and methods for inspection and repair, maintenance scenarios developed, and shall be kept in a proper manner for easy access for its service life.

Design standards, general and special conditions of contract and special conditions may be revised for its long service life. These documents used for design and construction of a structure shall also be kept for use for evaluation of soundness, development of maintenance program and repair works.

2.4.4.1.1 Design Documents

Design documents prepared during design periods shall include the following:

- Design calculations.
- General drawings.
- Detail drawings (bridge deck substructures, ancillary works).
- Quantity calculations.
- Topographical and geological data

2.4.4.1.2 Construction Records

Field management on concrete works is quite important to ensure required strength and durability and to prevent significant errors in reinforcement steel arrangement and unfavorable impurities in concrete, which cannot be detected after concrete casting. Records on quality control, construction progress and dimensions of finished works, in addition to design documents, shall therefore be kept for future maintenance work.

- Material tests and quality control data on cements, aggregates, admixtures and water.
- Records on concrete mix, pouring and curing, progress and quality control.
- Environments at times of concrete pouring.
- Photographs during construction.

2.4.4.2 Documents in Maintenance Period

2.4.4.2.1 Maintenance Program

Maintenance program will be revised many times during the service life. Design documents for repair work shall therefore include design service life of such repair as well as estimated heavy traffic volume and weather conditions, specified in the maintenance program.

2.4.4.2.2 Inspection Records

Various types of defect / damage occur on structures. Through collection and analysis on such defect / damage, it is expected that improvement of precision in prediction of degradation as well as analysis on mechanism of unprecedented defect / damage is achieved. Inspection results shall therefore be recorded.

2.4.4.2.3 Design Documents

Design documents for repair works as well as for original design shall be kept.

Repair works are designed based on defect / damage maps prepared at times of inspection. However such maps do not describe defect / damage inside the concrete. Actual quantities done will usually be increased compared to design ones. At the completion of repair works, revision and/or addition to design shall clearly be recorded in the design documents.

2.4.4.2.4 Records on Maintenance Work

Records on maintenance work shall include photographs during the work, material tests and quality control data on repair materials, as recorded in the original construction records.

2.4.5 Feedbacks

Structural details preferred for ease of maintenance works are specified in design standards. However, wherever such details are regarded not suitable through inspection and maintenance work activities, they shall be revised to better ones and specified in the standards. Such revisions shall be disseminated through seminars or workshops to the relevant organizations, governmental officials and engineers.

It will contribute to decrease in defect / damage on structures, time and cost savings.

2.5 Safety on Inspection and Maintenance Works

2.5.1 Safety Measures

In implementing inspection, investigation and repair works on expressway, due to passage of vehicles at high speed, traffic safety measures shall be taken. Traffic safety measures to be taken on expressway are discussed below:

2.5.1.1 General

2.5.1.1.1 Safe Driving

- The driver shall keep safe driving in mind as a member of road operator.
- The driver shall wear seat belt during driving.
- Vehicle used for maintenance work shall have visible indication in order to recognize itself as “Inspection Vehicle” from ordinary vehicles.

2.5.1.1.2 Clothes, Equipment and Health Care

- The work crew shall wear comfortable clothes for easy to move.
- The work crew shall wear such prescribed personal protective equipment (PPE) as hard hat, reflective safety vest, safety shoes and whistle.
- With prior medical checkup, the work crew physically in bad condition shall not work.

2.5.1.1.3 At Times of Parking / Stopping

- Hazard warning light shall be turned on at times of parking and stopping.
- Special attention shall be paid to ordinary vehicles at times of deceleration and acceleration.
- Vehicles shall park at a wider shoulder with an unobstructed view from ordinary vehicles.
- Front wheels shall direct to the outermost lane or shoulder at times of parking and stopping in order to prevent moving out to the traffic lane due to rear-end collision.

2.5.1.1.4 Traffic Control

- Traffic control is to ensure safety of work space and work crews.
- Traffic control devices and work space shall be arranged at locations easy to see from ordinary vehicles.
- Installation of traffic control devices shall be laid piece by piece in the direction of driving.
- Removal of traffic control devices shall be implemented against the direction of driving.

2.5.1.1.5 Work inside Protected Area by Traffic Control

- Watchmen deployed shall monitor the movement of ordinary vehicles.
- Work crews shall not work on expressway with their backs on ordinary vehicles.
- Work crews shall not go out of the protected area during the work.

2.5.1.2 Traffic Safety Measures at Times of Inspection / Investigation

2.5.1.2.1 General Precautions

- At least two (2) work crews shall inspect and investigate together.
- One work crew shall be a flagman to give the waning to ordinary vehicles and to ensure the safety.
- Vehicles on duty shall turn on yellow color revolving warning lamps in order to give the waning to ordinary vehicles.

At least two (2) work crews shall work together, of which one shall be a flagman for warning.

Figure 2.5-1 Safety management on the road surface

2.5.1.2.2 Precautions on Daily Inspection

- Daily patrol shall be implemented on slow lanes, not on overtaking lane, so that work crews can inspect the structures at slow speed.
- Whenever it is necessary to inspect the structures outside the patrol vehicle after detecting the defect / damage, the work crews shall ensure the safety in advance and patrol vehicle shall stop at a shoulder.
- Whenever high emergency is needed, work crews shall ensure the safety at work site with traffic control and promptly report to the head office for assistance.

2.5.1.2.3 Precautions on Routine Inspection and In-Depth Inspection

- The work crews shall wear safety belts when working at height.
- Special attention shall be paid not to drop off the inspection tools when working at height.
- So as to prevent incidents due to falling and stumbling, photographing with motion shall be prohibited.

- When working in the river / watercourse, safe evacuation route shall be secured for flooding.
- Such access equipment to bridge soffit as bridge inspection vehicles and suspended scaffolds will be described in 2.6.1.

2.5.1.2.4 Precautions on Emergency Inspection

- Work crews shall initially check the stability against the collapse of a structure and carry out the inspections to the extent work safety is ensured.
- Whenever any defect / damage, resulting in drastic reduction of load carrying capacity, are detected, work crews shall promptly report to the head office for assistance, and implement such necessary emergency measures as temporarily closure to traffic.

2.5.1.2.5 Traffic Safety measures during repair works

- Repair work shall be carried out within the work area protected by rubber pylons.
- No access to the work area is allowed except for members concerned.
- When the grinders / breakers are used, work crews shall wear safety goggles and work gloves to prevent injuries, and shall install sheets and plywood panels to prevent dispersion of fragments and sparks.
- When chemicals and hot materials are used, such appropriate equipment as safety goggles and work gloves shall be equipped.

2.5.2 Equipment for Safety Measures

Equipment for safety measures for inspection, investigation and repair works on expressway is described as follows:

2.5.2.1.1 Arrow Board

Arrow boards shall be installed at the beginning of traffic control area to provide the segment for reduction of traffic lanes. Eleven (11) numbers of arrow boards shall be arranged at 20m intervals for 200m long segment. Arrow board shall have suitable weight, not be so light to prevent blowing away by wind and not be so heavy for ease of transportation.

Arrow Board

Rubber Pylon

2.5.2.1.2 Rubber Pylon

Rubber pylon shall be arranged along the traffic lane marking so as to separate work area from vehicle driving lanes and at 10m to 20m intervals. Rubber pylon shall have suitable weight, not be so light to prevent blowing away by wind and not be so heavy for ease of transportation.

2.5.2.1.3 Mobile VMS (Variable Message Signs)

Mobile VMS shall be arranged at the beginning of traffic control area in order to clearly indicate the work area and to protect the work space. Mobile VMS shall equip arrow sign and hazard warning light for ease of recognition of work area.

2.5.2.1.4 Traffic Control Sign

Traffic control signs shall be installed in order to give the notice to the ordinary vehicles regarding the presence of traffic control. Contents displayed and installation locations shall be determined after discussion with road operator.

2.5.2.1.5 Flag

Using the flag, watchmen shall give the waning to ordinary vehicle on adjacent traffic lane.

2.6 Equipment for Inspection and Maintenance Work on Concrete Bridges

2.6.1 Equipment for Inspection

Provision of safe work space to the work crews and sufficient field of vision is of importance for inspection. Hereby described is the necessary equipment for inspection works.

2.6.1.1 Equipment for Daily Inspection

Equipment for daily inspection is given in Table 2.6-1.

Table 2.6-1 Necessary Equipment for Daily Inspection

Tools / Equipment		Remarks
Inspection Tools	inspection hammer, crack gauge or loupe, steel tape, measuring tape, measuring pole, binoculars, flashlight or headlight	
Writing Materials	recording papers, digital camera, black board, chalk, white board and pen	
Safety Equipment	work wear, hard hat, reflective safety vest, safety boots, work gloves, whistle, yellow flag for warning, mobile phones for communication, arrow board, rubber pylon	

2.6.1.2 Equipment for Routine and In-Depth Inspections

Equipment for routine inspection is given in Table2.6-2. Additional equipment will be needed for in-depth inspection, depending on types of defect / damage to be inspected.

Table2.6-2 Necessary Equipment for Routine Inspection

Tools / Equipment		Remarks
Inspection Tools	inspection hammer, crack gauge, steel tape, measuring tape, measuring pole, binoculars, flashlight or headlight, rebound hammer, vernier calipers, leveling string, wire brush, inspection mirror, phenolphthalein solution, drilling	
Writing Materials	recording papers, digital camera, black board, chalk, white board and pen	
Safety Equipment	work wear, hard hat, reflective safety vest, safety boots, work gloves, safety belt, safety goggles, dust mask, whistle, yellow flag for warning, mobile phones for communication, arrow board, rubber pylon, traffic control sign boards, life vest	Safety belts at high work place. Life vest on water.
Equipment for Access	rope, stepladder, ladder, mobile elevating work platform, under-bridge inspection vehicle, boat, wader, suspended scaffold	To be selected for site conditions.
Others	as-built drawings, thermometer, shovel, garbage bag, corrosion paint	Lighting equipment is needed for night work.

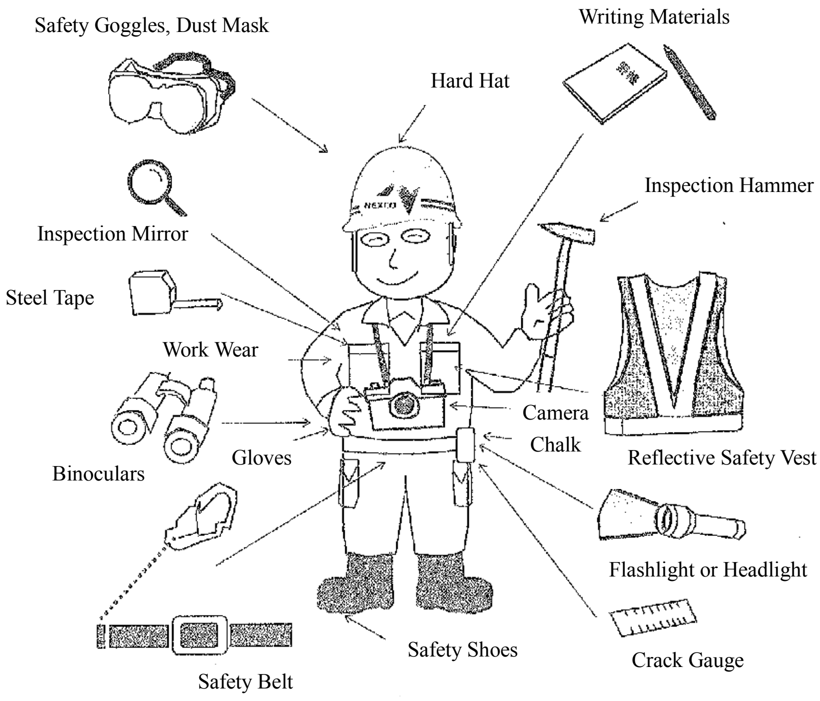


Figure 2.6-1 Standard Equipment and Clothes Necessary for Inspection

2.6.2 Equipment for Repair Works

Equipment for repair works shall be selected and prepared so that they are appropriate for use with types of defect / damage and repair methods. Particularly, for working on expressway, safety equipment shall fully be prepared to protect work place and work crews from vehicles at high speed.

Suspended scaffolds shall have sufficient strength to support work crews, materials and equipment used and impacts during the work. Safety net shall be provided to prevent fall of work crews, equipment and materials used and to prevent injuries / accidents to a third party due to disperse of sparks and broken pieces of materials.

Appendix Inspection Recording Form

Bridge Name.. BRIDGE INSPECTION SHEET **Form 2-1**

Routine, Daily Inspection for Bridge

General Information

Company: ………………………………	*Name Of The Bridge: …………………………..…………………………………………*
Inspection Department: ………………………………………	*Name of Expressway: ……………………………………… Inter Change: …………*
Inspector: ……………………………………….........	*Type of Bridge:...*
District:……………………………........	*Position(Longitude):……….……………….. (Latitude):………………..……………*
Province/City……………………………………………………………	*Allowable Load and Speed:………………………………………………………….....*
Start Time...................................	*Date of Inspection: day …… month …… year ……..…*
End Time..................................	*Total pages (Including the Sketch and Photos.............*

Results of inspection, evaluation, and diagnose for action to be taken are recorded in this form.

Sketch/photo of structures and damage positions are attached in additional pages at the end of the report, if applicable.

General comments: Engineer in charge

(Signature with full name)

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Report checked and approved by:

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Proposal form the managing Unit: ……………….………..……….………......

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(Notation):

(1) Instructions on how to make data entries*: It is imperative to fill in all the space boxes, on the degree of damage. In case of missing structural parts, enter the dash to confirm that there is no such part. In case it is impossible to check, clearly state* ***"Failure in checking"*** *and indicating the reasons.*

A=Good, B=Intermatiate, C= Bad , D= Very Bad

(2) Estimating the volume of damage: *recording the volume or the number of estimated damages for each damage level in the scale A, B, C, D as in the classified handbook. Total estimated volume or number of 4 levels of damage should be equal to the total volume / number as in the previous column.*

Description of damage: *to ensure those who read the test results can visualize the* ***extent, scope and location*** *of the damage. For all the damage evaluated* ***at level C or D there must be graphics and photos,*** *to indicate the degree of damage (measures in the taken photos). For structural components such as beams, piers of the bridge span, the description must specify the location of the damage to such detail as which span, which pier. It needs sketches of the damage location, photos and a detailed description of the damage location, attached with relevant document and bridge inspection sheet.*

(3) Proposed measures: *including maintenance work normally with pre-calculated volumes (including cleaning, rust brushing, re-painting, surface filling, crack filling, repairing the warping, greasing, coating the concrete, clearance and dismantling...) or proposing for overall repair when badly damaged. If the inspector is not sure to propose a repair, enter a note which says "for further discussions with engineers" and make sure to provide adequate information to help the engineer make decisions in office.*

(4) Priority: priority is proposed by writing: K – Khẩn *cấp =* ***Emergency****;* ***C – C****ao =* ***High****;* ***T – T****hấp =* ***Low****.*

Bridge Name.. BRIDGE INSPECTION SHEET

No	Structure / Damaged Part	Unit	Volume/Quantity	Level of Damage				Description of Damage (with Sketch in Case of C and D Level)	Proposed Measures	Priority
				A	B	C	D			
1	Superstructure									
1.1	Concrete Bridge									
	Abnormal Deflection	mm								
	Abnormal Sound	piece								
	Abnormal Vibration	piece								
	Abnormal Big/Small Girder End Gap	piece								
	Water Leakage	piece								
	Crack	m								
	Scaling/Delamination	m^2								
	Rebar Exposed/Corroded	piece								
	Void	piece								
	Honeycomb	piece								
	Free Lime (at Crack)	m								
	Rust Stain (at Crack)	m								
	Degradation/Discoloration	piece								
	Rupture of Prestressing Tendon	piece								
	Other									

No	Structure / Damaged Part	Unit	Volume/Quantity	Level of Damage				Description of Damage (with Sketch in Case of C and D Level)	Proposed Measures	Priority
				A	B	C	D			
1.2	Concrete Deck Slab									
	Crack	m								
	Scaling/Delamination	m^2								
	Rebar Exposed/Corroded	piece								
	Void	piece								
	Honeycomb	piece								
	Free Lime (at Crack)	m								
	Rust Stain (at Crack)	m								
	Degradation/Discoloration	piece								
	Water Leakage	piece								
	Other									
2	Substructure									
2.1	Abutment									
	Crack	m								
	Scaling/Delamination	m^2								
	Rebar Exposed/Corroded	piece								
	Void	piece								
	Honeycomb	piece								

No	Structure / Damaged Part	Unit	Volume/Quantity	Level of Damage				Description of Damage (with Sketch in Case of C and D Level)	Proposed Measures	Priority
				A	B	C	D			
	Free Lime (at Crack)	m								
	Rust Stain (at Crack)	m								
	Degradation/Discoloration	abutment								
	Other									
2.2	Pier									
	Crack	m								
	Scaling/Delamination	m^2								
	Rebar Exposed/Corroded	piece								
	Void	piece								
	Honeycomb	piece								
	Free Lime (at Crack)	m								
	Rust Stain (at Crack)	m								
	Degradation/Discoloration	pier								
	Other									
2.3	Foundation	cái								
	Settlement/Displacement	mm								
	Scour/Undermining	piece								
	Other									

No	Structure / Damaged Part	Unit	Volume/Quantity	Level of Damage				Description of Damage (with Sketch in Case of C and D Level)	Proposed Measures	Priority
				A	B	C	D			
2.4	Ancillary Work									
	Settlement/Displacement	piece								
	Crack	m								
	Scaling/Delamination	m^2								
	Other									
4	Bridge Bearing									
4.1	Steel Bridge Bearing									
	Deficiency on Steel Bearing	piece								
	Corrosion on Steel Bearing	piece								
	Deficiency on Attachments	piece								
	Corrosion on Attachments	piece								
	Deficiency on Bearing Seat Concrete/Mortar	piece								
	Abnormal Big/Small Gap	bearing line								
	Sediment of Dirt or Soil	bearing line								
	Abnormal Sound	piece								
	Other									
4.1	Elastomeric Bridge Bearing									
	Deficiency/Degration on Elastomer	piece								

No	Structure / Damaged Part	Unit	Volume/Quantity	Level of Damage				Description of Damage (with Sketch in Case of C and D Level)	Proposed Measures	Priority
				A	B	C	D			
	Deficiency on Attachments	piece								
	Corrosion on Attachments	piece								
	Deficiency on Bearing Seat Concrete/Mortar	piece								
	Abnormal Big/Small Gap	bearing line								
	Sediment of Dirt or Soil	bearing line								
	Other									
5	Bridge Expansion Joint									
5.1	Cushion Seal Type									
	Deficiency on Expansion Joint	piece								
	Deficiency on Joint Vicinity	piece								
	Deficiency on Blockout Materials	piece								
	Water Leakage	piece								
	Deficiency on Water Treatment Facility	piece								
	Girder End Gap	piece								
	Difference in Lever	piece								
	Abnormal Sound	piece								
	Other									
5.2	Steel Finger Joint									

No	Structure / Damaged Part	Unit	Volume/Quantity	Level of Damage				Description of Damage (with Sketch in Case of C and D Level)	Proposed Measures	Priority
				A	B	C	D			
	Deficiency on Expansion Joint	piece								
	Deficiency on Joint Vicinity	piece								
	Deficiency on Blockout Materials	piece								
	Water Leakage	piece								
	Deficiency on Water Treatment Facility	piece								
	Girder End Gap	piece								
	Difference in Lever	piece								
	Abnormal Sound	piece								
	Other									
6	Bridge Parapet/Railing									
6.1	Reinforced Concrete Parapet									
	Crack	m								
	Scaling/Delamination	m^2								
	Rebars Exposed/Corroded	piece								
	Free Lime	piece								
	Rust Stain	piece								
	Degration/Discoloration	piece								
	Water Leakage	piece								

No	Structure / Damaged Part	Unit	Volume/Quantity	Level of Damage				Description of Damage (with Sketch in Case of C and D Level)	Proposed Measures	Priority
				A	B	C	D			
	Other									
6.2	Curb									
	Crack	m								
	Scaling/Delamination	m^2								
	Rebars Exposed/Corroded	piece								
	Free Lime	piece								
	Rust Stain	piece								
	Degration/Discoloration	piece								
	Water Leakage	piece								
	Other									
6.3	Steel Railing									
	Deformation/Deficiency	m								
	Corrosion	m^2								
	Other									
7	Drainage System									
7.1	Drain Inlet									
	Deficiency on Inlet	piece								
	Deficiency/Corrosion on Fittings	piece								

No	Structure / Damaged Part	Unit	Volume/Quantity	Level of Damage				Description of Damage (with Sketch in Case of C and D Level)	Proposed Measures	Priority
				A	B	C	D			
	Deficiency on Drain Grates	piece								
	Clogging	piece								
	Deformation	piece								
	Other									
7.2	Drain Pipe									
	Deficiency	piece								
	Corrosion	piece								
	Clogging	piece								
	Disconnection/Unfit	piece								
	Deformation	piece								
	Water Leakage	piece								
	Other									
7.3	Attachment									
	Deficiency	piece								
	Corrosion	piece								
	Clogging	piece								
	Deformation	piece								
	Other									

Form 2-1

Summary Sheet for Inspection, Evaluation and Measures Taken

Bridge Name: (Kilometer-Post :) Type of Structure: Bridge, Culvert

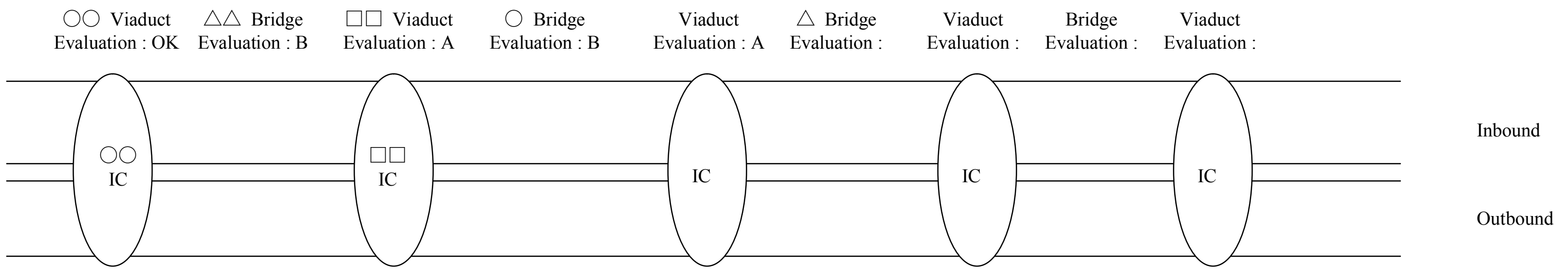
Sequence No	Date	Type of Inspection	Records on Inspection / Investigation Results		Repair History		Remarks
			Element Position in Element	Results of Inspection / Investigation	Date of Repair	Repair Method	Department in Charge

Note 1: Type of Inspection is recorded as Routine Inspection Type-A, Routine Inspection Type-B, In-Depth Inspection, Emergency Inspection or Special Inspection.
Note 2: Element or Position in Element is recorded as girder / beam, cross beam, deck slab, pier, abutment, bridge beating, bridge expansion joint, bridge drainage system, bridge railing / curb, or inspection platform.
Note 3: Results of Inspection / Investigation is recorded focusing on:
Good / fair, element / position in element not inspected, drastic progress of deterioration, unexpected defect / damage due to accidents / fire, progressive defect / damage, effect of repair
Note 4: Repair Method is recorded as resin injection, restoration of body of element, surface coating on steel element or so on.

Form 2-2

Form of Records for Daily Inspection, Routine Inspection Type-A 1 / 2

<table>
<tr><td rowspan="3">Name of Expressway</td><td rowspan="3"></td><td>Date</td><td></td><td>Vehicle Registration No.</td><td></td><td rowspan="2">Checked By:</td><td rowspan="2" colspan="3"></td></tr>
<tr><td>Section</td><td>～</td><td rowspan="2">Time of Inspection</td><td>Departure ：</td></tr>
<tr><td>Weather</td><td></td><td>Arrival ：</td><td>Department</td><td></td><td>Inspector</td><td></td></tr>
</table>



Form 2-2

Form of Records for Daily Inspection, Routine Inspection Type-A 2 / 2

<table>
<tr><td rowspan="3">Name of Expressway</td><td rowspan="3"></td><td>Date</td><td></td><td>Vehicle Registration No.</td><td></td><td colspan="4" rowspan="2"></td></tr>
<tr><td>Section</td><td>～</td><td rowspan="2">Time of Inspection</td><td>Departure ：</td></tr>
<tr><td>Weather</td><td></td><td>Arrival ：</td><td>Department</td><td></td><td>Inspector</td><td></td></tr>
</table>

1. Bridge				
(1) Concrete Bridge □ Excessive Deflection □ Abnormal Sound □ Excessive Vibration □ excessive Big / Small Girder End Gap □ Water stagnation / Leakage □ Rebar Exposed / Corroded □ Rust Stain □ Rupture of Pre-stressing Tendon (2) Concrete Deck Slab □ Rebar Exposed / Corroded □ Water Leakage, Free Lime, Rust Stain	(3) Substructure 1) Abutment □ Rebar Exposed / Corroded □ Rust Stain 2) Pier □ Rebar Exposed / Corroded □ Rust Stain	(4) Bridge Bearing 1) Steel Bridge Bearing □ Defect / Damage on Bearing □ Defect / Damage on Attachments □ Corrosion □ Defect / Damage on Bearing Seat Concrete / Mortar □ Excessive Big / Small Girder End Gap □ Abnormal Sound □ Sediment of Rubbish / Soils 2) Elastomeric Bridge Bearing □ Degradation on Elastomeric Materials □ Defect / Damage on Attachments □ Corrosion □ Defect / Damage on Bearing Seat Concrete / Mortar □ Excessive Big / Small Girder End Gap □ Abnormal Sound □ Sediment of Rubbish / Soils	(5) Bridge Expansion Joint 1) Cushion Seal Type a) Expansion Joint □ Elastomeric Materials b) In the Vicinity of Joints □ Sealing Materials □ Opening of Joint c) Block out Material □ Block out Materials □ Seam between Expansion Joint and Block out Material □ Seam between Block out Materials and Pavement d) Difference in Level □ Seam between Expansion Joint and Block out Material □ Seam between Block out Materials and Pavement	e) Girder End Gap □ Opening of Gap f) Water Leakage □ Water Leakage from Girder End Gap □ Water stop Sealing Materials □ Water Leakage from Curb 2) Steel Finger Joint a) Expansion Joint □ Steel Materials □ Sealing Materials □ Face Plates □ Welding on Face Plates □ Loosening and Rupture of Anchor Bolts □ Capping of Anchor Bolt b) In the Vicinity of Joints □ Sealing Materials □ Opening of Joint

1. Bridge				2. Culvert
c) Block out Material □ Block out Materials □ Seam between Expansion Joint and Block out Material □ Seam between Block out Materials and Pavement d) Difference in Level □ Seam between Expansion Joint and Block out Material □ Deam between Block out Materials and Pavement e) Girder End Gap □ Opening of Gap f) Water Leakage □ Water Leakage from Girder End Gap □ Water stop Sealing Materials □ Water Leakage from Curb	(6) Bridge Railing 1) Reinforced Concrete Parapet □ Crack □ Water Leakage , Free Lime □ Scaling / Delamination of Cover Concrete □ Spalling □ Rebar Exposed / Corroded 2) Curb □ Crack □ Water Leakage , Free Lime □ Scaling / Delamination of Cover Concrete □ Spalling □ Rebar Exposed / Corroded 3) Steel Railing □ Deformation / Damage □ Corrosion	(7) Bridge Drainage System 1) Bridge Drain Box □ Deficiency □ Corrosion □ Clogging with Soils □ Deformation □ Deficiency / Corrosion on Attachments □ Defect / Damage on Cover 2) Drain Pipe □ Deficiency □ Clogging with Soils □ Dropping Off □ Deformation □ Water Leakage	3) Attachments □ Deficiency □ Clogging with Soils □ Deformation	(1) Reinforced Concrete Culvert □ Displacement □ Settlement / Scour □ Irregularity on Joint □ Crack □ Air Void / Honeycomb □ Free Lime □ Rust Stain □ Scaling / Delamination / Spalling □ Rebar Exposed / Corroded □ Discoloration □ Sediment of Rubbish / Soils

* After the check, ☐ shall be marked with “x”.
* Wherever defect / damage is judged D or A, such defect / damage shall be recorded in Form 2-2.

Form 2-3

Records of Defect / Damage Found in Daily Inspection & Necessary for Urgent Measures

<< Daily Inspection, Routine Inspection Type-A, Routine Inspection Type-B, Emergency Inspection, Special Inspection >>

Name of Expressway: Section: IC / JCT – IC / JCT
Inbound / Outbound: Name of Bridge / Culvert:

Day / Month / Year, Weather Condition ( )	Inspector				Checked By:	

<table>
<tr><td colspan="2" rowspan="2">Location
Kilometer-Post
Name of Ramp way</td><td colspan="3">Position in Element</td><td colspan="3">Detail of Defect / Damage</td><td rowspan="3"></td></tr>
<tr><td>Span /
Substructure</td><td>Name of Structure</td><td>Detail Position in Element</td><td>Defect / Damage</td><td>Evaluation</td><td>Quantity</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="8">[Descriptions of Defect / Damage]</td><td>[Comments by Checker]</td></tr>
<tr><td colspan="9">[Photograph, Figures, Comments, etc.] : Photographs shall be taken in both close-range and distant views. Sketch shall be drawn in order to identify the detail positions of defect / damage in element.</td></tr>
</table>

Form 2-4

Monthly Summary Sheet of Inspection, Evaluation and Measures Taken

<< Defect / Damage necessary for Daily Inspection and Emergency Measures >>

Name of Expressway :

Target Section :

Sequence No.	Location		Type of Structure	Name of Structure	Element	Position in Element	Type of Defect / Damage	Descriptions of Defect / Damage	Evaluation	Date of Evaluation	Measures Taken			Department in Charge	Type of Repair	Date of Repair
	Inbound / outbound	Kilometer-Post									Measures Taken	Expected Date	Interval of Monitoring			

Form 2-5

Inspection Records - Photographing

Expressway Route	IC (From)	IC (To)	Type of Structure	Name of Structure

Sequence No.		Sequence No.		Sequence No.		Sequence No.	
Defect / Damage		Defect / Damage		Defect / Damage		Defect / Damage	
Date		Date		Date		Date	
Descriptions of Defect / Damage		Descriptions of Defect / Damage		Descriptions of Defect / Damage		Descriptions of Defect / Damage	
Element		Element		Element		Element	
Sequence No.		Sequence No.		Sequence No.		Sequence No.	
Defect / Damage		Defect / Damage		Defect / Damage		Defect / Damage	
Date		Date		Date		Date	
Descriptions of Defect / Damage		Descriptions of Defect / Damage		Descriptions of Defect / Damage		Descriptions of Defect / Damage	
Element		Element		Element		Element	

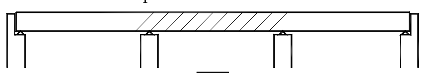
Form 2-6 (Sample)

Defect / Damage Map (Sample)

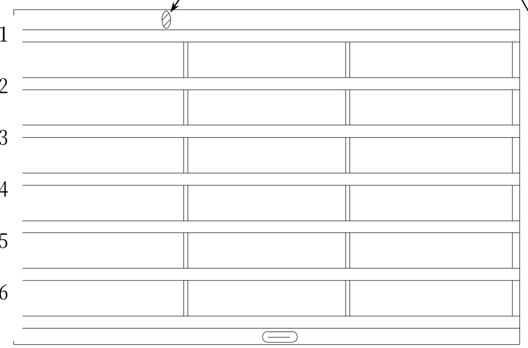
Defect / Damage Map for Girder / Beam per Span

(Bridge Deck)

Location Map



Crossing Route Name



Bridge Name	
Type of Bridge	
Type of Structure	
Target Span	P ～P
Span	Inbound / Outbound m
Curb-to-Curb Width	
Crossing Road	

History of Inspection

Date	Inspector	Name of Firm
2000.6.20	aaa	bbb
2001.9.15	ccc	bbb
2002.3.10	ddd	bbb

Remarks

Legend on Defect / Damage

Time of Detection

No of Element

Type of Defect / Damage (refer to Legend)

Evaluation of Defect / Damage

Quantity of Defect / Damage

②-2000.6 U-AA-0.6m^2

Width 0.3m x Length 2.0m

Breakdown of Defect / Damage Quantity

Legend

Defect / Damage	Illustration	Symbol	Element
Crack		Hi	Girder, Slab, Railing, Curb
Broken Edge		K	Girder, Slab, Railing, Curb
Blister		U	Girder, Slab, Railing, Curb
Scaling		Ha	Girder, Slab, Railing, Curb
Spalling		N	Girder, Slab, Railing, Curb
Air Void, Honeycomb		Ma	Girder, Slab, Railing, Curb
Water Leakage		R	Girder, Slab, Railing, Curb
Free Lime		Y	Girder, Slab, Railing, Curb
Rebar Exposed / Corroded		T	Girder, Slab, Railing, Curb

* Hammering test results shall be enclosed √ .

Measures Taken at Times of Construction

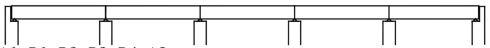
Prepared By:	Date of Completion: Year, Month, Day	Name of Contractor :
(Example) This is a 3-span continuous steel plate girder bridge. Since honeycombs are detected around drip groove of deck overhang after completion of concreting deck slab, chipping work was conducted. Attention shall be paid on this work at the time of inspection, as defect / damage will be expedited with deterioration in concrete with time. (recorded on day / month / year)		

Form 2-6 (Sample)

Defect / Damage Map (Sample)

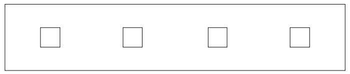
Defect / Damage Map per Substructure
(Substructure)

Location Map



(Destination side)
③

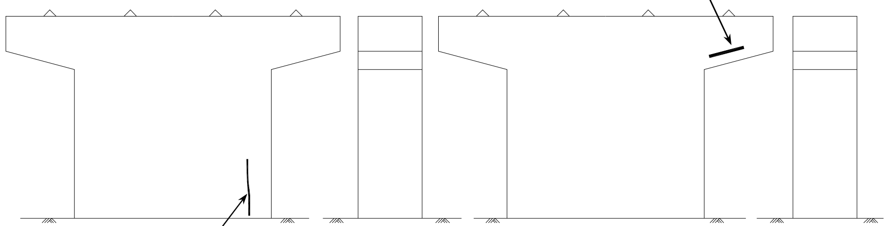
(Median side)



② (Shoulder side)

①
(Origin side)

Record of Repair at time of Construction
0.2mm wide and 1.00m long crack
- Crack Injection



①-2000.6 Hi-B-1.0m
Width 0.2m

Bridge Name	
Type of Bridge	
Type of Structure	
Target Span	P ～P
Span	Inbound / Outbound m
Curb-to-Curb Width	
Crossing Road	

History of Inspection

Date	Inspector	Name of Firm
2000.6.20	aaa	bbb

Legend

Defect / Damage	Illustration	Symbol	Element
Crack		Hi	Abutment, Pier
Broken Edge		K	Abutment, Pier
Blister		U	Abutment, Pier
Scaling		Ha	Abutment, Pier
Spalling		N	Abutment, Pier
Air Void, Honeycomb		Ma	Abutment, Pier
Water Leakage		R	Abutment, Pier
Free Lime		Y	Abutment, Pier
Rebar Exposed / Corroded		T	Abutment, Pier

Remarks

Measures Taken at Times of Construction

Prepared By:	Date of Completion: Year, Month, Day	Name of Contractor :
(Example) At the completion of construction, a 1.0 m long and 0.2mm wide crack was detected on the wall. Crack injection using polymer-cement resin was conducted. (recorded on day / month / year)		

Legend on Defect / Damage

Type of Defect / Damage (refer to Legend)
Time of Detection
Evaluation of Defect / Damage
No of Element
Quantity of Defect / Damage
②-2000.6 U-AA-0.6m²
Width 0.3m x Length 2.0m
Breakdown of Defect / Damage Quantity

* Hammering test results shall be enclosed w .

Form 2-7

Annual Summary Sheet of Inspection, Evaluation and Measures Taken

<< Routine Inspection, In-Depth Inspection >>

Name of Expressway :

Target Section :

Sequence No.	Location		Type of Structure	Name of Structure	Element	Position in Element	Type of Defect / Damage	Descriptions of Defect / Damage	Evaluation	Date of Evaluation	Measures Taken			Department in Charge	Type of Repair	Date of Repair
	Inbound / outbound	Kilometer-Post									Measures Taken	Expected Date	Interval of Monitoring			

Directorate for Roads of Vietnam   Japan International Cooperation Agency

The Project for Strengthening Operation and Maintenance System for Expressway in Vietnam

SECTION 3

TECHNICAL SPECIFICATION GUIDELINES FOR INSPECTION AND MAINTENANCE OF ELECTRICAL FACILITIES

Vietnam Expressway Management Office

JICA Experts Team

JUNE 2013

Table of Contents

3 Electrical Facilities

3.1 Outline

3.1.1 Scope of Application

General matters regarding checking and inspection work of the electrical facilities and power distribution equipment for the highways of Vietnam are covered in the following.

3.1.2 Overview of Work

Checking and inspection work are carried out to keep highway operations in a consistently normal state, and conducted as follows for electrical facilities and equipment. In addition, while conducting the maintenance checks and inspections as appropriate for enforcement of highway safety and reliability, it is crucial to strive for the optimal employment of equipment, such as checking and constant re-examination of the techniques used and frequency of inspections, as may be required.

3.1.2.1 Periodic inspections

Daily routine checks as part of periodic inspections involve visual observation of equipment and checking of operation and maintenance, and include basic checks and general attention to the existence of abnormalities mainly through the use of the physical senses, such as sight and touch. More thorough periodic checks are also done, generally requiring the functional stop of the system, and involving the coordinated checking of operations using measurement equipment and metering, at which time maintenance procedures are also undertaken.

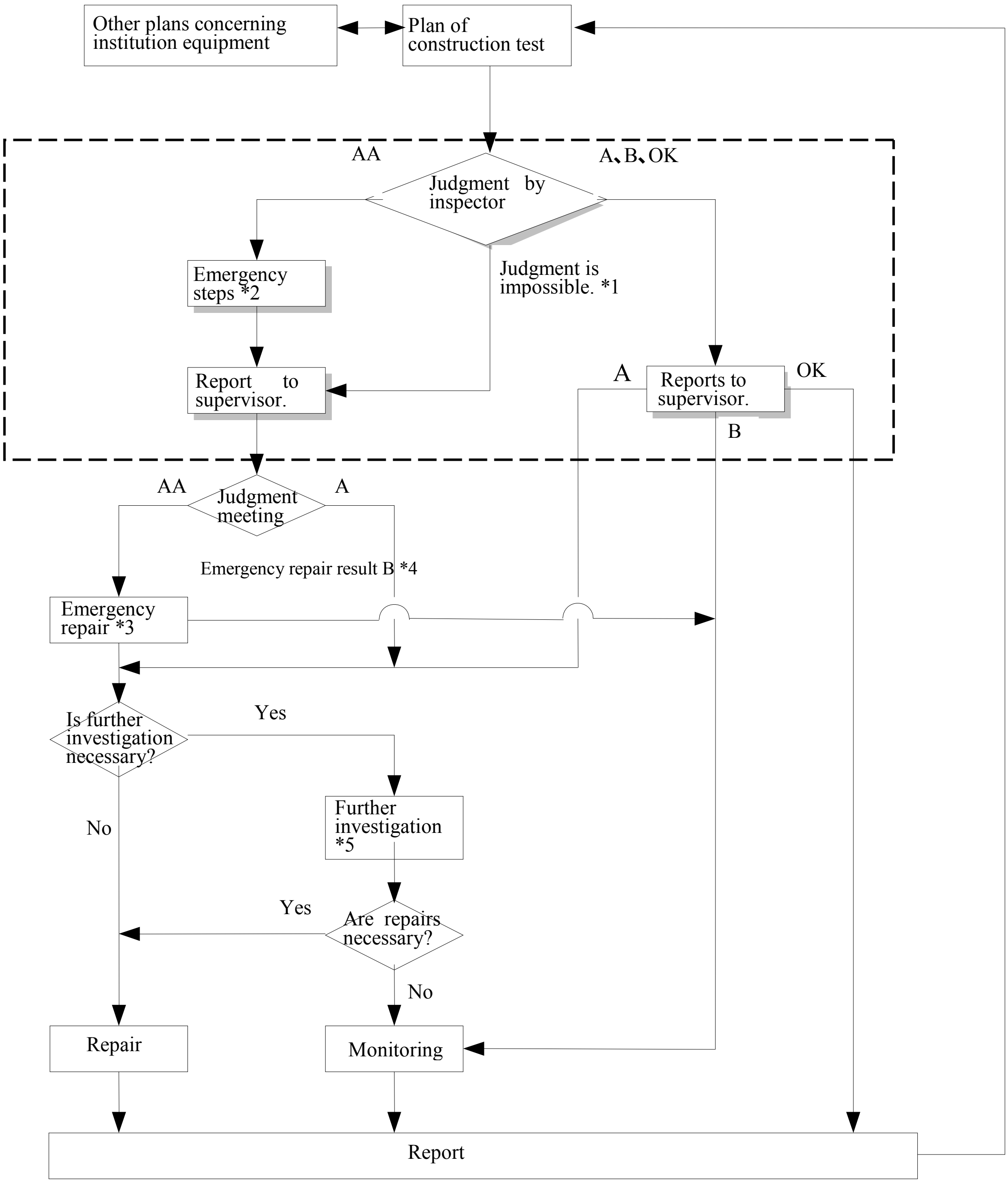
A structural test shall be used to assess a potentially abnormal condition of a component or system, and follows a progressive assessment sequence that is performed on-site, and which shall be carried out using a combination of close-up visual observation, electrical probe, simple meter, or measuring instrument. Securing safe and smooth road traffic aims at the prevention of third party*1 damage by suitable structural test described below.

*1 “Third party” refers to all passing vehicles using the road system other than those engaged in road management.

As shown in

Figure 3.1-1, structural inspection is not a separate function but it plays purposed functions: after the inspection, diagnose will be performed for either for urgent repair, or further detailed investigation, maintenance or repair, and moreover, data will be recorded for the next inspection.

Therefore, in order to conduct the structural test most effectively, it is necessary to make precise



*1: "A judgment is impossible" refers to cases which are difficult to judge because they are on the border between judgment categories AA and A.

*2: "Emergency steps" refers to measures to prevent falling or collapse, and similar measures, which can be performed by the inspector.

*3: "Emergency repair" refers to temporary emergency measures to restore diminished structural function or eliminate the risk of damage to third parties.

*4: "Emergency repair result B" refers to the state following emergency repairs when the judgment category has been restored to B.

*5: "Further investigation" refers to investigation conducted by experienced academic professionals in related fields, specialist engineers, and similar experts to decide the methods of repair.

recording and make use of the test result, and link them to other associated areas and sections.

Figure 3.1-1 Flowchart for structural test

The results of the structural test shall be determined by the following judgment classifications.

Judgment classification	Judgment criteria
AA	When damage etc. is significant and urgent repair is required as seen from the functional aspect.
A	While there is damage, etc., and functional decline is apparent and repair is required, urgent repair itself is not mandated.
B	Although there is some damage, functional decline is not immediately evident and it is necessary to monitor the gradual progress of deterioration that may ultimately occur.
OK	There is no damage.

3.1.2.1.1 Criteria of judgment classifications

Judgment classifications used to assess the damage or deterioration of a subject, etc., fall into the four classifications of "AA," "A," "B," and "OK," as determined by the urgency and extent of damage and the repair measures required as seen from the structural functional aspect.

In addition, the criteria of each judgment classification are considered as the transition of a) to d) in the following.

a) Judgment classification AA

Assessment of judgment classification AA results from the possibility that structural functional decline may be or is presently significant or may cause trouble to a third party, etc., and considered to be a condition for which urgent repair is mandated.

b) Judgment classification A

A condition of minor damage or gradual deterioration can be assessed as judgment classification A, and is considered to be a condition for which repair is not urgently required but is expected to result in eventual structural functional decline.

c) Judgment classification B

Although the extent of damage or deterioration can be assessed as judgment classification B, repair measures for structural functional decline are considered unnecessary for the time being, and it is assessed as a condition for which progressive stages of deterioration must be monitored.

d) Judgment classification OK

Judgment classification OK is assessed as a case in which damage or deterioration cannot be seen, or damage or deterioration is slight and does not need either repair or progress monitoring.

In addition, the judgment classification OK is formed in order to assist in inspection planning and the prevention of omission during an inspection, and to record the fact of inspection implementation.

3.1.2.1.2 Proximity viewing

Proximity viewing is the most basic inspection method using a high-type or elevated vehicle, platform, scaffold, etc., if needed, so that the object of inspection can be approached and viewed at a close range, and an abnormal situation can be assessed using observation, probe, or simple meter, and forms the basis of a structural test.

Key aspects in proximity viewing are to:

a) Carry out the procedure after the structure inspection, previous checking results, failure history, and repair history have been reviewed and understood.
b) Detect the abnormal changes not only by visual observation, touch, or utilizing a probe, simple meter but also by slightly tapping and shaking.
c) For equipment located in a place under vibration, it is advised to compare the results of inspection with that of the same object in no-vibration operation condition.
d) When the judgment of an item being inspected is assessed as "AA," be sure to check as well whether the same damage may exist in neighboring structures or parts.

3.1.2.2 Emergency inspections

In emergencies, such as outright equipment failure, the identification of the nature of a road obstacle or hazard, etc., shall be performed immediately and shall be dealt with by restoration or initial communications to highway control staff, etc.

3.1.2.3 Records

Following checking and inspection works, the responsible person shall write the result in report form.

3.1.3 Target Equipment

Equipment that is the target of checking and inspection work is covered in 3.2 Inspection Work (ITS excluded), below.

3.2 Inspection Work（ITS excluded）

3.2.1 Power Distribution Equipment

3.2.1.1 Work description

Power distribution equipment inspection work refers to the daily check on each apparatus of the power distribution equipment installed in interchanges, mainly conducted by the senses, such as viewing and touch. This also involves the daily visual check performed on each apparatus of the electrical line equipment installed in interchanges.

Power distribution equipment inspection includes performing status observation, checking operation and care, and may include carrying out a functional stop, if needed, of the system or each apparatus of the power distribution equipment installed in interchanges, and requires coordinated checking of operations using measurement devices such as meters and testers. Moreover, junction boxes, electrical conduits, etc., particularly for electrical lines and equipment installed outdoors, and suspended conduits and support conduits are approached, and close-up inspection is performed by observation, using a probe, simple meter, measuring instrument, etc. The parts to be given particular attention are shown in Figure 3.2-1 and Figure3.2-2.

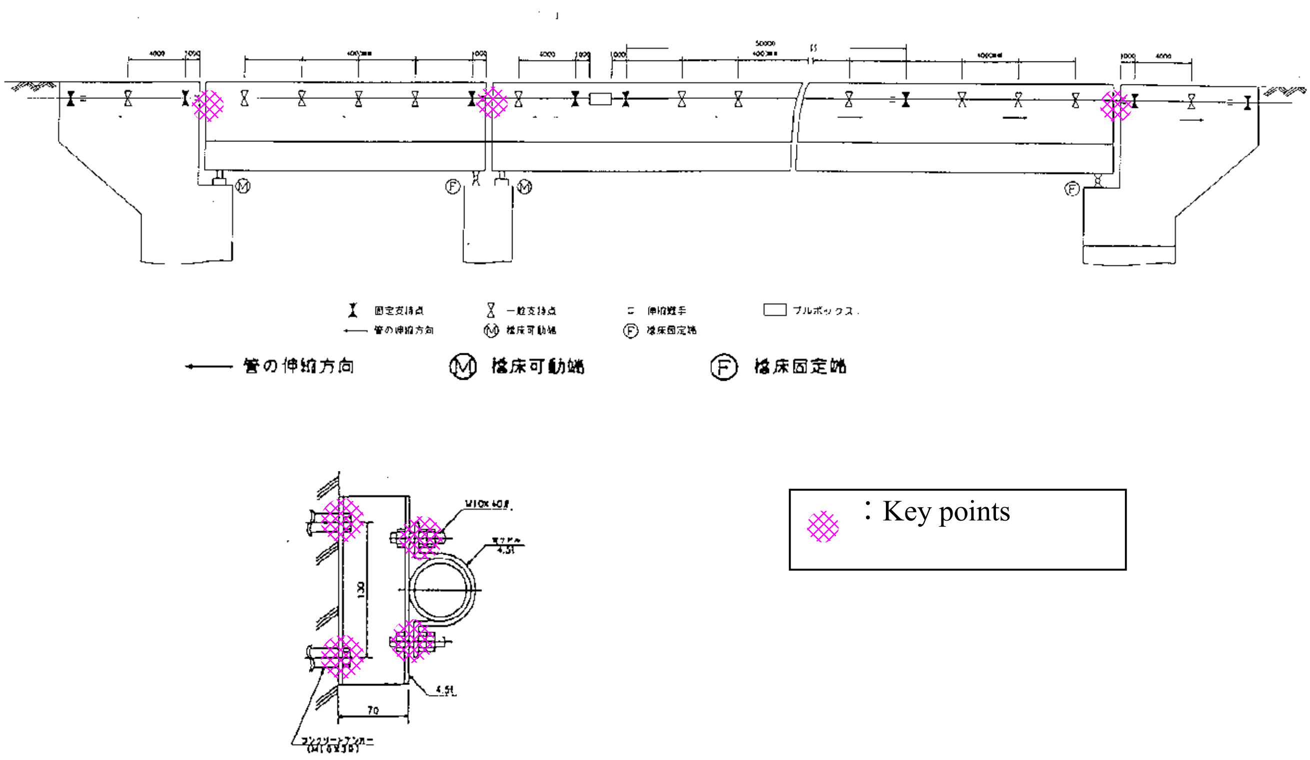


Figure 3.2-1 Key points for inspection of electrical line equipment

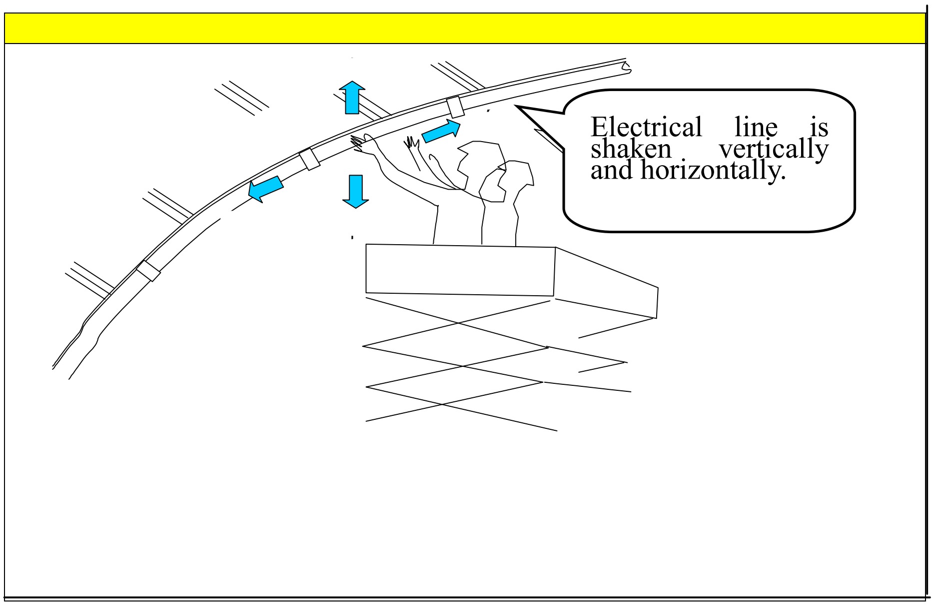


Figure3.2-2 Schematic of close-up visual inspection of electrical line equipment

3.2.1.2 Types of work

The types of work are as shown below.

3.2.1.2.1 Daily checking of high-voltage enclosed switchboards, low-voltage enclosed switchboards, and control center panels that are installed in power receiving equipment.

3.2.1.2.2 Regular checking of power distribution equipment that receives high-voltage and low-voltage power, conducted at intervals of 12 months

3.2.1.2.3 Replacement of the insulating oil in oil circuit breakers and oil-immersed transformers

3.2.1.2.4 Daily checking of high-voltage leading-in poles, high-voltage leading-in cables, and other cables that are installed as power supply lines

3.2.1.2.5 Structural inspections of support conduits and suspended conduits of electrical line equipment and similar equipment that is installed outdoors. The inspections are performed visually, by touch, and using simple instruments.

3.2.2 Checking and Inspection Work for Private Power Generation Equipment

3.2.2.1 Work

Inspection work for private power generation equipment refers to observing the conditions, checking operation, and performing simple maintenance of the various devices on private power generation equipment that is installed at interchanges. As necessary, system functions are stopped in order to perform measurement using instruments, checks of coordinated operation between sets of equipment, and other inspections.

3.2.2.2 Types of work

The types of work are as shown below:

3.2.2.2.1 Daily checking of private power generation equipment. The checking shall not involve operation with actual loads.

3.2.2.2.2 Regular checking of private power generation equipment, conducted at intervals of 12 months. The checking shall involve operation with actual loads.

3.2.2.2.3 Regular checking of radiator-type private power generation equipment, conducted at intervals of 12 months.

3.2.2.2.4 Replacement of engine oil, radiator coolant, and air compressor V-belts in compressed-air driven private power generation equipment.

3.2.3 Checking and inspection Work for Road Lighting Equipment

3.2.3.1 Work description

Checking work for road lighting equipment refers to daily checking primarily of various devices on road lighting equipment that is installed on main expressway roads and interchanges. The checking is performed by visual and other sensory inspection.

Inspection work for road lighting equipment refers to observing the conditions, checking operation, and performing simple maintenance of various devices on the road lighting equipment that is installed on main expressway roads and at interchanges. As necessary, system functions are stopped in order to perform measurement using instruments, checks of coordinated operation between sets of equipment, and other inspections.

Structural inspection work for road lighting equipment refers to observation and inspections of poles, steel towers, and lights on road lighting equipment that is installed on main expressway roads and interchanges. The observation and inspections are performed by moving up close to the structures and inspecting visually, by touch, by using simple instruments or measuring devices, and other means. The points that require particular attention are shown in Figure 3.2-3 and Figure 3.2-4.

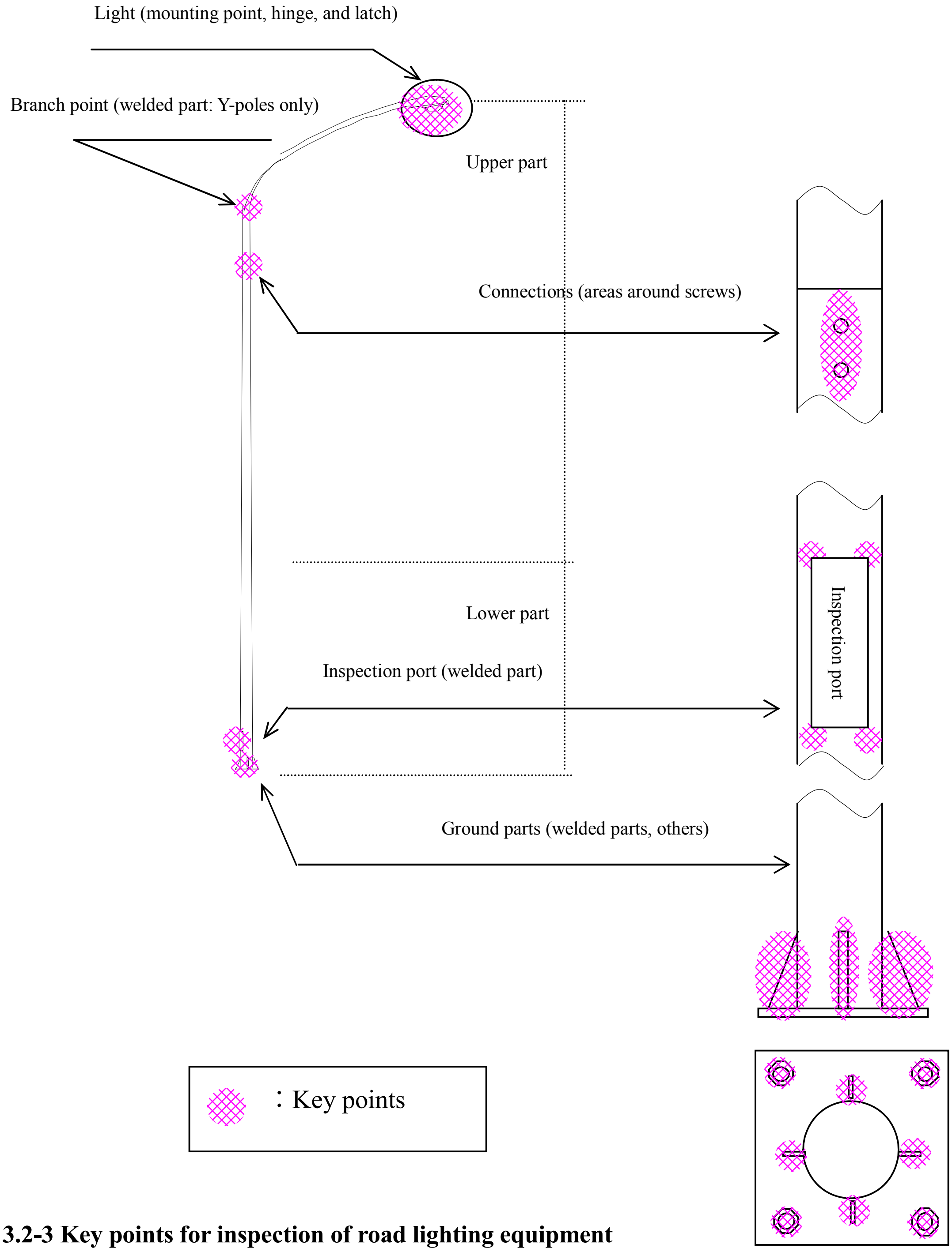


Figure 3.2-3 Key points for inspection of road lighting equipment

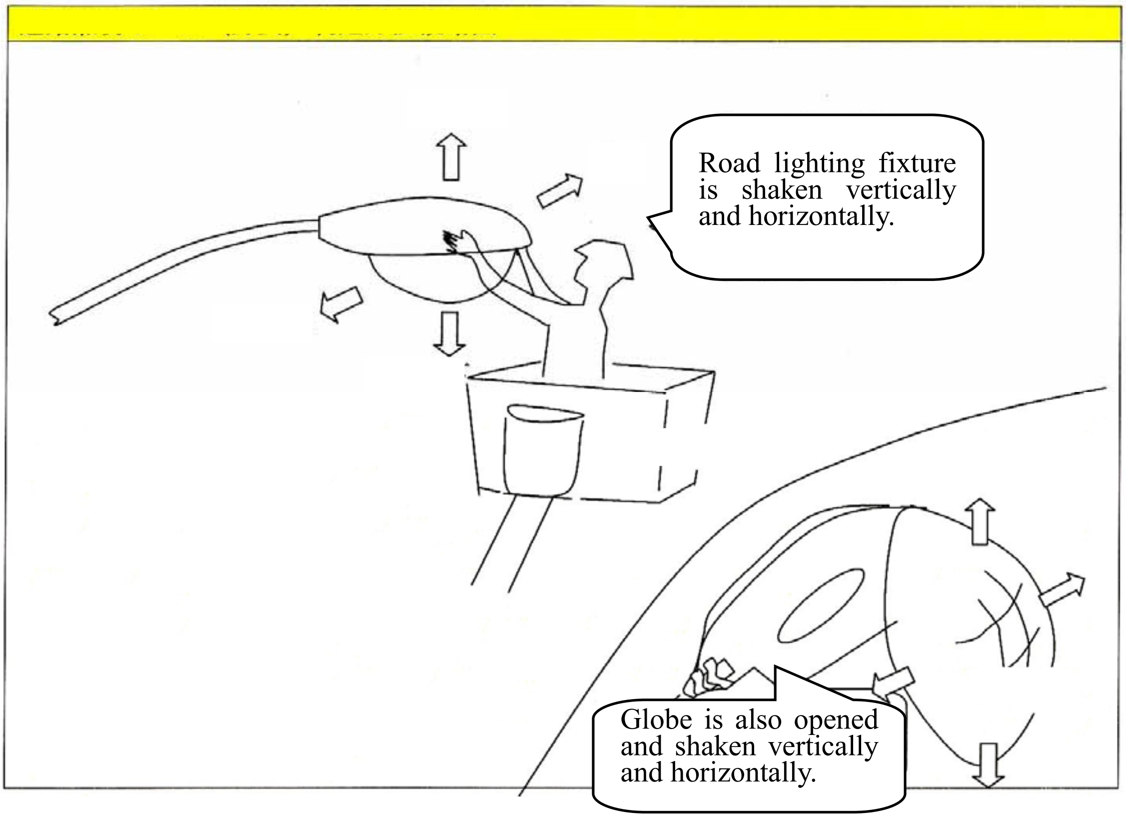


Figure 3.2-4 Schematic of close-up visual inspection of road lighting equipment

3.2.3.2 Types of work

The types of work are as shown below.

3.2.3.2.1 Regular checking of road lighting equipment that is installed on main expressway roads and at interchanges, conducted at interval of 12 months.

3.2.3.2.2 Structural inspections of road lighting equipment supports and lights, performed visually, by touch, and using simple instruments

3.2.4 Checking and Inspection Work for Warning Light Equipment

3.2.4.1 Work description

Inspection work for warning light equipment refers to observing the conditions, checking the operation, and performing simple maintenance of the flashing lights at branching points that are installed on main expressway roads and at interchanges. As necessary, system functions are stopped in order to perform measurement using instruments and other inspections.

3.2.4.2 Types of work

The types of work are as shown below.

3.2.4.2.1 Regular checking of warning light equipment, conducted at intervals of 12 months

3.2.5 Checking and Inspection Work for Variable Road Information Board Equipment

3.2.5.1 Work description

Checking work for variable road information board equipment refers to daily checking performed by visual and other sensory inspection, and by operation of the equipment.

Inspection work for variable road information board equipment refers to observing the conditions, checking operation, and performing simple maintenance of the variable road information board equipment that is installed on main expressway roads. As necessary, system functions are stopped in order to perform measurement using instruments, checks of coordinated operation between sets of equipment, and other inspections.

Structural inspection work for variable road information board equipment refers to observation and inspections of the supports and foundations of the variable road information board equipment that is installed on main expressway roads. The observation and inspections are performed by moving up close to the structures and inspecting visually, by touch, by using simple instruments or measuring devices, and other means. The points that require particular attention are shown in Figure 3.2-5.

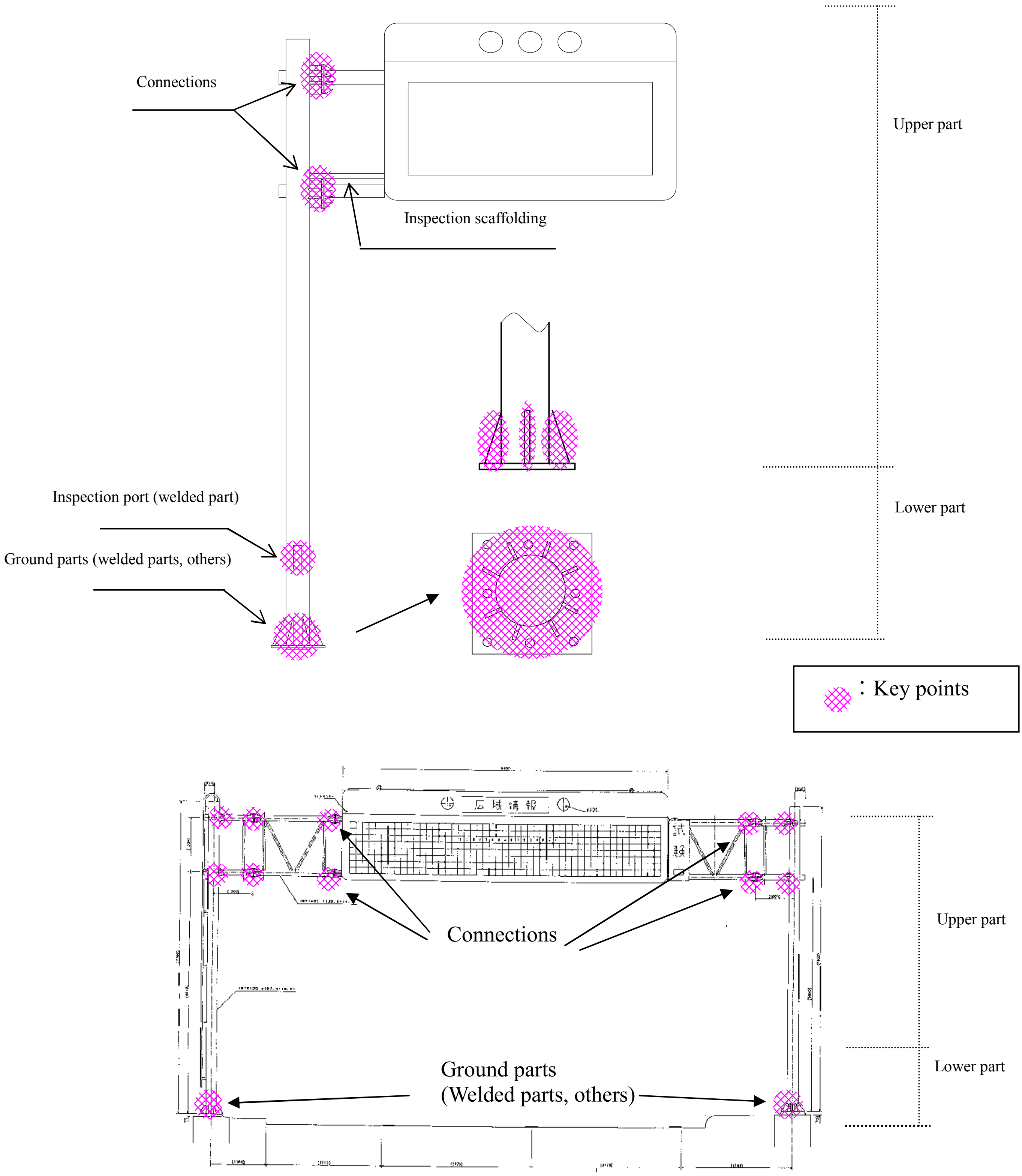


Figure 3.2-5 Key points for inspection of variable road information board equipment

3.2.5.2 Types of work

The types of work are as shown below.

3.2.5.2.1 Daily checking of LED-type variable road information board equipment that is installed on main expressways.

3.2.5.2.2 Regular checking of LED-type variable road information board equipment, conducted at intervals of 12 months

3.2.5.2.3 Structural inspections of the F-type supports and gate-type supports of variable road information board equipment, performed visually, by touch, and by using simple instruments

3.2.6 Checking and Inspection Work for Mobile Radio Equipment

3.2.6.1 Work description

Inspection work for mobile radio equipment refers to observing the condition, checking operation, and performing simple maintenance of the various devices of mobile radio equipment that is installed at interchanges, in vehicles, and at other locations. As necessary, system functions are stopped in order to perform measurement using instruments, checks of coordinated operation between sets of equipment, and other inspections. At 12-month inspection intervals, the information listed in the application documents for the radio station license shall be checked against the serial numbers, models, and specifications of the radio equipment.

Structural inspection work for mobile radio equipment refers to observation and inspections of the steel towers, foundations, and guide wires of mobile radio equipment that is installed at interchanges. The observation and inspections are performed by moving up close to the structures and inspecting visually, by touch, by using simple instruments or measuring devices, and other means.

3.2.6.2 Types of work

The types of work are as shown below.

3.2.6.2.1 Daily checking of the base stations, portable base stations, and control fixed stations of mobile radio equipment (analog radio)

3.2.6.2.2 Regular checking of the base stations, portable base stations, control fixed stations, steel towers, land-based mobile stations, portable stations, and antennas (excluding measurement of antenna receiver input voltage) of mobile radio equipment (analog radio), conducted at intervals of 12 months. If the equipment is subject to the regular inspections prescribed in radio laws and regulations, the Registration Inspection Results Notice (reference document) shall be created.

3.2.6.2.3 Measurement of the receiver input voltage (dBμV) of mobile radio equipment (analog radio) at locations along the road

3.2.6.2.4 Structural inspections of the steel towers of mobile radio equipment, performed visually, by touch, and using simple instruments

3.2.7 Checking and Inspection Work for Communication Line Equipment

3.2.7.1 Work description

Inspection work for communication line equipment refers to observing the conditions, checking operation, and performing simple maintenance of various cables, conduit lines, and related equipment. As necessary, system functions are stopped in order to perform measurement using instruments, checks of coordinated operation between sets of equipment, and other inspections.

Structural inspection work for communication line equipment refers to observation and inspections of support conduits and suspended conduits of communication line equipment that is installed on bridges and other locations. The observation and inspections are performed by moving up close to the structures and inspecting visually, by touch, by using simple instruments or measuring devices, and other means. The points that require particular attention are shown in Figure 3.2-6 and Figure 3.2-7.

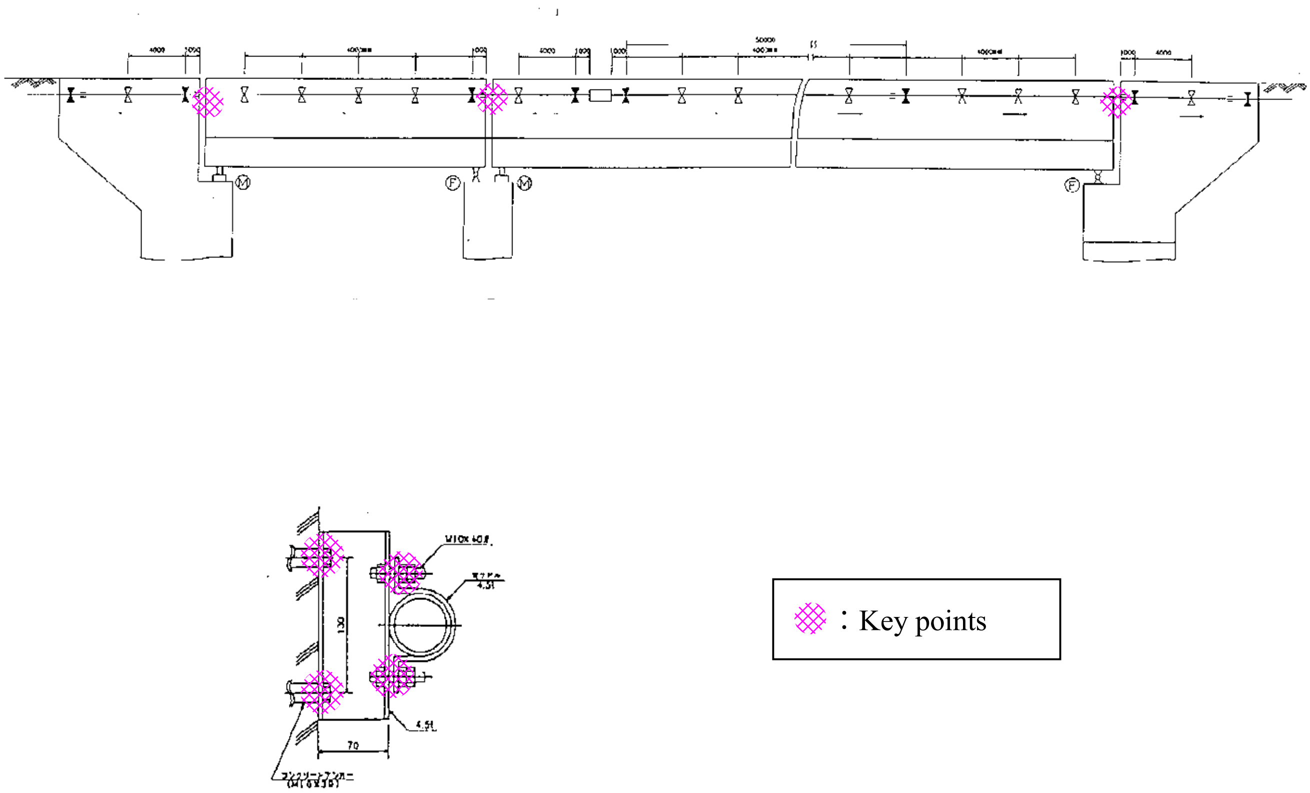


Figure 3.2-6 Key points for inspection of communication line equipment

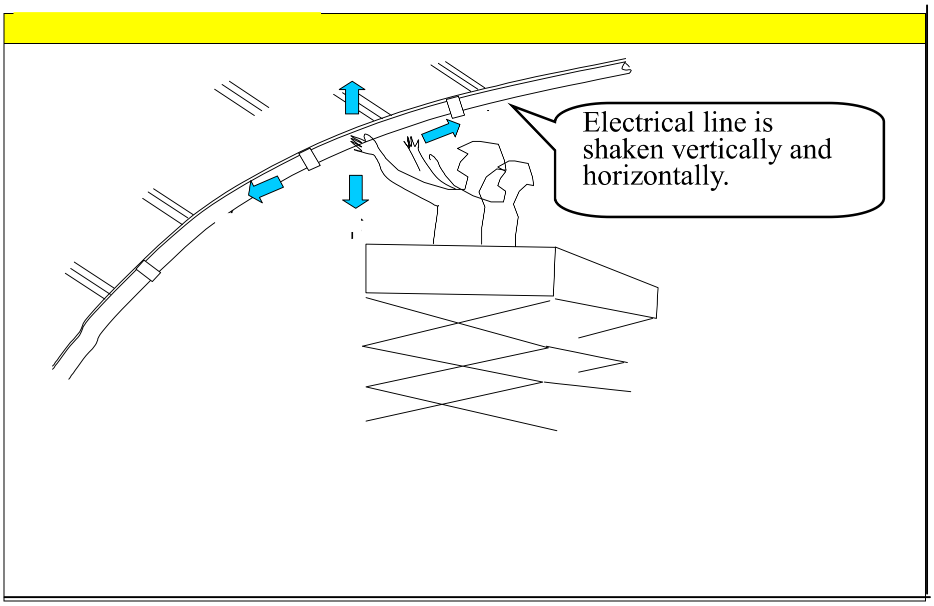


Figure 3.2-7 Schematic of close-up visual inspection of communication line equipment

3.2.7.2 Types of work

The types of work are as shown below.

3.2.7.2.1 Daily checking (alarm line insulation resistance test) of metallic cables.

3.2.7.2.2 Regular checking of metallic cables, conduits, hand holes, optical-fiber cables, and other equipment, conducted at intervals of 12 months.

3.2.7.2.3 Structural inspections of support conduits and suspended conduits of the communications line equipment that is installed outdoors and elsewhere. The inspections are performed visually, by touch, and using simple instruments.

3.3 Maintenance and Management Work

3.3.1 Daily Maintenance and Management

3.3.1.1 Cleaning of power distribution equipment

3.3.1.1.1 Work description

Cleaning of power distribution equipment refers to cleaning and dead lamp replacement for MDP panels and similar equipment. It also includes cleaning of manholes and hand holes.

3.3.1.1.2 Types of work

The types of work are as shown below.

a) Cleaning of MDP panels and other equipment using cloth, brushes, and similar means in order to remove dust, grime, and other substances

b) Replacement of dead lamps refers to replacing lamps both inside and outside the panels.

c) Cleaning of manholes and hand holes refers to using manual means or cleaning machines to clean accumulated substances and water from inside the manholes and hand holes that are installed on expressway main roads, interchanges, and other locations.

3.3.1.2 Cleaning of private power generation equipment

3.3.1.2.1 Work description

Cleaning of private power generation equipment refers to work for removing dust, grime, and other substances from generators and other equipment.

3.3.1.2.2 Types of work

The types of work are as shown below.

a) Cleaning of generators and other equipment using cloth, brushes, and similar means in order to remove dust, grime, and other substances

3.3.1.3 Cleaning of road lighting equipment

3.3.1.3.1 Work description

Cleaning of road lighting equipment refers to cleaning lighting equipment that is installed on main expressway roads, interchanges, and other locations, as well as lamp replacement that is performed at the same time as the cleaning. The range to be cleaned is the lamp, inside and outside the light cover, reflecting plates, and the exterior of the light. However, when a lamp is replaced at the same time with lamp cleaning, then the cleaning of old lamp is not necessary.

3.3.1.3.2 Types of work

The types of work are as shown below.

a) Cleaning and lamp replacement, using an elevating work vehicle, of lights installed at heights of 8 – 14 meters, and of elevating-type lights that are installed on high poles and on steel towers for lighting

3.3.1.3.3 Required performance

(1) There must not be 3 or more consecutive lights that do not illuminate.

(2) Work to ensure that (1) above is satisfied must be performed within 1 month after the check for lights that do not illuminate.

3.3.1.3.4 Performance check method

The performance check shall be performed at the time of the inspection for checking the light illumination conditions that is carried out each month.

3.3.1.3.5 Handling in case required performance is not satisfied

If the required performance is not satisfied following the work, the party that ordered the work and the party that contracted the work shall immediately investigate to determine the cause, and shall hold discussions concerning corrections with a supervisor.

3.3.1.4 Cleaning of warning light equipment

3.3.1.4.1 Work description

Cleaning of warning light equipment refers to cleaning of the blinker lights that are installed at interchanges.

3.3.1.4.2 Types of work

The types of work are as shown below.

a) Cleaning of the blinker lights using cloth, brushes, and similar means in order to remove dust, grime, and other substances

3.3.1.5 Cleaning of variable information board equipment

3.3.1.5.1 Work description

Cleaning of variable information boards refers to work for cleaning of the variable road information boards that are installed on main expressway roads, interchanges, ordinary roads, and other locations. The area to be cleaned is the front of the main unit display.

3.3.1.5.2 Types of work

The types of work are as shown below.

a) Cleaning of LED-type variable road information boards that are installed on main expressway roads, interchanges, and ordinary roads

3.3.1.5.3 Required performance

(1) Cleaning must be performed a minimum of once each year.

(2) If there are regional characteristics resulting from traffic volume or other factors, the matter shall be discussed with a supervisor.

3.3.1.6 Cleaning of mobile radio equipment

3.3.1.6.1 Work description

Cleaning of mobile radio equipment refers to work for cleaning of various devices of the mobile radio equipment that is installed at interchanges, in vehicles, and in other locations.

3.3.1.6.2 Types of work

The types of work are as shown below.

a) Cleaning of various devices on the mobile radio equipment that is installed at interchanges, in vehicles, and in other locations, using cloth, brushes, and similar means in order to remove dust, grime, and other substances

3.3.1.7 Cleaning of communications line equipment

3.3.1.7.1 Work description

Cleaning of communications line equipment refers to work for cleaning of communications manholes and hand holes.

3.3.1.7.2 Types of work

The types of work are as shown below.

a) Manhole cleaning work and hand hole cleaning work refer to using manual means or cleaning machines to clean accumulated substances and water from inside the communications manholes and hand holes that are installed on expressway main roads, interchanges, and other locations.

3.3.1.8 Repair work

3.3.1.8.1 Work description

Repair work refers to repairs for extending the lifetimes at locations where minor deterioration was discovered at regular inspections, structural inspections, and other inspections.

3.3.1.8.2 Types of work

The types of work are as shown below.

a) Repairs of corrosion caused by minor rusting of embedded-type light poles (hot-dip galvanized finish) at the locations that contact the ground, or other repairs, of sizes 0.02 m^2 or more to less than 0.07 m^2. The repairs consist of removing the rust and applying a rust-replacement type synthetic resin anti-corrosion agent.

b) Repairs of corrosion caused by minor rusting of steel plate (painted finish) lighting equipment, or other repairs, of sizes 0.005 m^2 or more to less than 0.05 m^2. The repairs consist of removing the rust and applying a rust-replacement type synthetic resin anti-corrosion agent.

c) Repairs of corrosion caused by minor rusting of stainless steel (painted finish) lighting equipment, or other repairs, of sizes 0.005 m^2 or more to less than 0.05 m^2. The repairs consist of removing the rust and applying an anti-corrosion agent for use with stainless steel.

d) Repairs of corrosion caused by minor rusting of steel towers for mobile radio equipment (hot-dip galvanized finish) at the locations that contact the ground, or other repairs, of sizes 0.02 m^2 or more to less than 0.07 m^2. The repairs consist of removing the rust and applying a rust-replacement type synthetic resin anti-corrosion agent.

3.4 Emergency Responsive Work

3.4.1 Work Description

Emergency work refers to the emergency work and similar work necessary for maintenance and management of road facilities.

3.4.2 Types of Work

The types of work are as shown below.

3.4.2.1 Emergency work and similar work that is necessary for maintenance of road facilities and requires approximately 2 hours of time

3.5 <Appendix> Standards Related to Checking and Inspection Work

For electrical equipment and communications equipment that are installed on expressways in Vietnam, the work contents that serve as the standards for checking and inspection work shall be as prescribed in the "Standards Related to Checking and Inspection Work" defined herein.

3.5.1 Checking and Inspection Work (Facilities)

3.5.1.1 Checking and inspection work for power distribution equipment

Power distribution equipment refers to equipment that receives, converts, and distributes electrical power. The range covers up to the secondary-side terminals of power receiving panels, transformer panels, switchboards, and load switches (including wiring inside and between panels). It also covers the range from the leading-in poles to the primary sides of switchboards or equivalent devices, as well as the range from the switchboard secondary side to the power distribution panels or equivalent devices of terminal loads.

3.5.1.2 Checking and inspection work for stand-by power generation equipment

Stand-by power generation equipment refers to equipment that supplies electrical power to various load equipment during times of power blackouts. The range covers up to the secondary-sides of generator panel main switches.

3.5.1.3 Checking and inspection work for road lighting equipment

Road lighting equipment refers to lighting equipment that is installed on roads. The range covers from the electrical lines to the terminal devices.

3.5.1.4 Checking and inspection work for warning light equipment

Warning light equipment refers to the warning lights installed on roads.

3.5.1.5 Checking and inspection work for variable road information board equipment

Variable road information board equipment refers to the variable signboard equipment that is installed on roads in order to communicate various road information. The range covers the devices, supports, and foundations.

3.5.1.6 Checking and inspection work for mobile radio equipment

Mobile radio equipment refers to base stations, land-based mobile stations, portable stations, and ancillary equipment.

3.5.1.7 Checking and inspection work for communication line equipment

Communication line equipment refers to the following.

3.5.1.7.1 This refers to the range from the low-voltage leading-in poles for a road communication facility to the power distribution panels or equivalent devices of terminal loads (if direct loads are connected, up to the load terminal block or equivalent device). Ancillary power distribution panels are also included.

3.5.1.7.2 This refers to the metallic cables, optical-fiber cables, and ancillary equipment that are used as transmission lines between sets of road communications equipment.

3.5.2 Inspection Items and Frequency for Checking and Inspection Work

Facility name	System name	Inspection location	Inspection item	Frequency							Inspection method	Work procedure
				Daily checking Random failure period				Periodic checking				
				1,2days	3days	1w	1 mo.	3mo.	6 mo.	12 mo.		
Power distribution equipment(for special high voltage and high voltage)	Disconnect switch	General	1 Appearance check (dirt,damage)				○			○	Visual inspection	Check that there is no dirt, damage, corrosion, paint peeling, or deformation.
			2 Overheating (temp. indicator tape), discoloration				○			○	Visual inspection	Check that there is no deformation or discoloration caused by overheating. Check that there is no discoloration of temp. indicator tape.
			3 Contact of blade and blade receiver, looseness (retighten),contact roughness							○	Visual, touch,operation, and tool inspection	Check that blade contacts blade receiver without looseness during operation. Check marking of bolts, etc. and retighten if necessary. Check that there is no corrosion or roughness of contacts and contacting parts.
			4 Application of grease to contacting surfaces							○	Visual, touch, and operation inspection	Remove old grease from the contacting surfaces of the blade and blade receiver, and apply new grease.
			5 Insulation resistance							○	Measurement by instrument	Check that insulation resistance is within the prescribed range.
			6 Interlock system check							○	Visual and operation inspection	Check that operation is not possible when breaker is ON, and that operation is possible when breaker is OFF.
		Installation parts	1 Function of steady brace system, looseness (retighten)							○	Visual, operation, and tool inspection	Check that blade does not deviate and contacts the blade receiver smoothly during operation. Check marking of bolts, etc. and retighten if necessary.
		Switchgear mechanism	1 Operation check, looseness(retighten)							○	Visual, operation, and tool inspection	Check that there is no looseness, abnormal noise, or other abnormal feel during operation. Check marking of bolts, etc. and retighten if necessary.
		Insulator	1 Cracking							○	Visual inspection	Check that there is no cracking or damage.
		Connecting terminal	1 Looseness (retighten)							○	Visual and tool inspection	Check marking of bolts, etc. and retighten if necessary.
	Transformer	General	1 Appearance check (dirt,damage)				○			○	Visual inspection	Check that there is no dirt, damage, corrosion,paint peeling, or deformation.

Facility name	System name	Inspection location	Inspection item	Frequency							Inspection method	Work procedure
				Daily checking				Periodic checking				
				Random failure period								
				1,2days	3days	1w	1 mo.	3mo.	6 mo.	12 mo.		
Power distribution equipment(for special high voltage and high voltage)	Transformer	General	2 Oil leakage, vibration, noise				○			○	Visual and sound inspection	Check that there is no oil leakage at welded parts and packing. Check that there is no abnormal noise or vibration.
			3 Installation condition				○			○	Visual inspection	Check that installation onto mounting supports is solid and secure.
			4 Oil level, temp. (using provided meter)				○			○	Measurement by provided meter	Check that oil level gauge and temp. gauge readings are within the prescribed range.
			5 Condition of attachments							○	Visual and touch inspection	Check that there is no dirt, damage, corrosion,paint peeling, or deformation. Check that installation is solid and secure.
			6 Insulation resistance							○	Measurement by instrument	Check that insulation resistance is within the prescribed range.
			7 Grounding resistance							○	Measurement by instrument	Check that grounding resistance value is within the prescribed range.
			8 Insulating oil withstand voltage test							○	Measurement by instrument	Check that insulation breakdown voltage is within the prescribed range.
			9 Insulating oil oxidation measurement							○	Measurement by instrument	Check that degree of oxidation is within the prescribed range.
		Installation parts	1 Looseness (retighten)							○	Visual and tool inspection	Check marking of bolts, etc. and retighten if necessary.
		Bushing	1 Cracking							○	Visual inspection	Check that there is no cracking or damage.
		Heat dissipation system	1 Cracking							○	Visual inspection	Check that there is no cracking or damage.
		Dehumidifying system	1 Desiccant discoloration,condition of moisture adsorption							○	Visual inspection	Check that there is no discoloration or deformation of desiccant. Check that there is no discoloration caused by deterioration of desiccant, and replace if necessary.
		Connecting terminal	1 Looseness (retighten)							○	Visual and tool inspection	Check marking of bolts, etc. and retighten if necessary.
	Lightning arrester	General	1 Appearance check (looseness)							○	Visual and tool inspection	Check marking of bolts, etc. and retighten if necessary.
			2 Condition of parts (dirt,damage, looseness (retighten),cracking)							○	Visual and tool inspection	Check that there is no dirt, damage, or cracking of all parts. Check marking of bolts, etc. and retighten if necessary.

Facility name	System name	Inspection location	Inspection item		Frequency							Inspection method	Work procedure
					Daily checking Random failure period				Periodic checking				
					1,2days	3days	1w	1 mo.	3mo.	6 mo.	12 mo.		
Power distribution equipment(for special high voltage and high voltage)	Lightning arrester	General	3	Marks from discharge							○	Visual inspection	Check that there are no marks from electrical discharge
			4	Insulation resistance							○	Measurement by instrument	Check that insulation resistance is within the prescribed range.
			5	Grounding resistance							○	Measurement by instrument	Check that grounding resistance value is within the prescribed range.
	Leading-in poles		1	Pole health				○				Visual inspection	Check that there is no dirt, cracking, or inclination. Check that the foundation is not covered by dirt and that earth has not been washed out from under it.
			2	Tension of support wires				○				Visual and touch inspection	Check that there is no looseness of support wires. Check that there is no damage to ball insulator. Check that support wire grips have not fallen off or are loose.
			3	Installation condition of protective materials and signs				○				Visual inspection	Check that there is no damage to mounting bolts or that they have fallen off. Check that there is no damage to protective covers or that they have fallen off. Check that there is no damage to signs or that they have fallen off.
			4	Corrosion, damage of pole brackets				○				Visual, touch, and tool inspection	Check that there is no damage, rusting, or corrosion of cross arms. Check that there is no looseness of mounting bolts. Check that there is no looseness of scaffolding bolts or that they have fallen off. Check that there is no looseness of binding wires.

Facility name	System name	Inspection location	Inspection item		Frequency							Inspection method	Work procedure
					Daily checking				Periodic checking				
					Random failure period								
					1,2days	3days	1w	1 mo.	3mo.	6 mo.	12 mo.		
Power distribution equipment(for special high voltage and high voltage)	Leading-in poles		5	Appearance check (dirt, damage) of pole devices				○				Visual inspection	Check that there is no dirt, corrosion, damage, rusting, paint peeling, or deformation. Check that the installation is not inclined.
	Wires and support brackets		1	Installation condition				○				Visual, touch, and tool inspection	Check that there is no dirt, corrosion, damage, rusting, paint peeling, or deformation. Check that the installation is not inclined.
			2	Distance from other objects				○				Visual inspection	Check that there is no contact with surrounding trees or other objects. Check that there is no damage or rusting of protective conduits at rise-up points.
			3	Insulation resistance				○				Measurement by instrument	Check that insulation resistance is within the prescribed range.
	Cables (including leading-in cables)	For load	1	Condition of head connections (overheating, damage)				○				Visual and touch inspection	Check that there is no deformation or discoloration caused by overheating.
			2	Underground installation condition (presence of unauthorized digging, etc.)				○				Visual inspection	Check that there is no evidence of digging. Check that there is no subsidence.
			3	Distance from other objects				○				Visual inspection	Check that there is no contact with surrounding trees or other objects. Check that there is no damage or rusting of protective conduits at rise-up points.
			4	Dirt, damage on exterior				○				Visual inspection	Check that there is no dirt, corrosion, damage, cracking, or deformation.
			5	Dirt, damage on parts				○				Visual inspection	Check that there is no dirt, corrosion, damage, cracking, or deformation.
			6	Insulation resistance							○	Measurement by instrument	Check that insulation resistance is within the prescribed range.

Facility name	System name	Inspection location	Inspection item		Frequency							Inspection method	Work procedure
					Daily checking				Periodic checking				
					Random failure period								
					1,2days	3days	1w	1 mo.	3mo.	6 mo.	12 mo.		
Power distribution equipment(for special high voltage and high voltage)	Conduits	Conduits and support brackets	1	Installation condition (presence of unauthorized digging, etc.)				○			○	Visual inspection	Check that there is no evidence of digging. Check that there is no subsidence.
			2	Condition of underground installation sign poles				○			○	Visual inspection	Check that letters and symbols have not disappeared. Check that signs are not covered by weeds or dirt.
	Manholes, hand-holes		1	Condition of cover installation				○			○	Visual and touch inspection	Check that there is no dirt, damage, or chipping. Check that there is no looseness. Check that they are not covered by weeds or dirt.
			2	Installation condition (presence of unauthorized digging, etc.)				○			○	Visual inspection	Check that there is no evidence of digging. Check that there is no subsidence.
Power distribution equipment Low voltage switchboard	Distribution panel, relay panel, etc. (hereafter, "distribution panel, etc.")	General	1	Appearance check (dirt, damage)				○			○	Visual inspection	Check that there is no dirt, damage, corrosion, paint peeling, or deformation. Check that there are no marks from rainwater intrusion or condensation. Check that space for inspections has been secured. Check that locks and related items are good.
			2	Abnormalities of instruments, indicator lamps, failure indicators				○			○	Visual inspection	Check that there is no damage to instrument covers or frames. Check that there is no damage to indicator lamps and that lenses have not fallen off. Replace any lamps that do not light. Check that indication and display condition are good.
			3	Abnormalities of operation switches, selector switches, relays, electromagnetic switches, wiring breakers				○			○	Visual, sound, smell, and touch inspection	Check that there is no dirt, damage, abnormal noise, abnormal odor, overheating, or other problems with switches, etc.

Facility name	System name	Inspection location	Inspection item		Frequency							Inspection method	Work procedure
					Daily checking				Periodic checking				
					Random failure period								
					1,2days	3days	1w	1 mo.	3mo.	6 mo.	12 mo.		
Power distribution equipment Low voltage switchboard	Distribution panel, relay panel, etc. (hereafter, "distribution panel, etc.")	General	4	Dirt, damage, overheating, open circuit of wiring inside panel				○			○	Visual and touch inspection	Check that there is no dirt, damage, overheating, or open circuit. Check that there are no unnecessary wires, displaced wires, or foreign objects.
			5	Voltage, current measurement (using provided meter)				○			○	Measurement by provided meter	Check that voltage and current values are within the prescribed ranges.
			6	Main conducting part insulation resistance				○			○	Measurement by instrument	Check that insulation resistance is within the prescribed range.
			7	Control circuit insulation resistance							○	Measurement by instrument	Check that insulation resistance is within the prescribed range.
		Panel body	1	Looseness (retighten)							○	Visual and tool inspection	Check marking of bolts, etc. and retighten if necessary.
		Operation switches and selector switches	1	Operation check							○	Visual, touch, and operation inspection	Check that switching operation is smooth.
		Wiring, terminals inside panel	1	Wiring condition, looseness (retighten)				○			○	Visual and tool inspection	Check that wiring connections are neat and organized. Check that there are no unnecessary wires, displaced wires, or foreign objects. Check marking of bolts, etc. and retighten if necessary.
		Indicator	1	Condition of connections for provided resistor, shunt, and other devices							○	Visual and touch inspection, and manual cleaning	Check that there is no deterioration, cracking, overheating, or discoloration. Check that installation and connections are solid and secure. Use a shopcloth, brush or similar tool to remove dust or other material.
			2	Insulation resistance							○	Measurement by instrument	Check that insulation resistance is within the prescribed range.
			3	Calibration test							○	Measurement by instrument	Check that instrument measurement value and indicator reading are within the prescribed range.
		Automatic circuit breaker	1	Operation check							○	Visual, touch, and operation inspection	Check that switching operation is smooth. Check that installation is solid and secure.

Facility name	System name	Inspection location		Inspection item	Frequency: Daily checking / Random failure period: 1,2days	3days	1w	1 mo.	Periodic checking: 3mo.	6 mo.	12 mo.	Inspection method	Work procedure
Power distribution equipment Low voltage switchboard		Insulating coating	1	Dirt, damage							○	Visual and smell inspection	Check that there is no dirt, damage, abnormal odor, or discoloration.
	Outdoor distribution panel	General	1	Same as the above "distribution panel, etc." item				○			○	Same as the above "distribution panel, etc." item	
			2	Water intrusion				○			○	Visual inspection	Check that there are no marks from rainwater intrusion or condensation. Check that there is no risk of rain or snow intrusion from ventilation holes, doors, or elsewhere.
		Lightning arrester	1	Appearance check (looseness)				○			○	Visual and tool inspection	Check marking of bolts, etc. and retighten if necessary.
			2	Condition of parts (dirt,damage, looseness (retighten),cracking)				○			○	Visual and tool inspection	Check that there is no dirt, damage, or cracking of all parts. Check marking of bolts, etc. and retighten if necessary.
			3	Marks from discharge				○			○	Visual inspection	Check that there are no marks from electrical discharge
			4	Grounding resistance				○			○	Measurement by instrument	Check that grounding resistance value is within the prescribed range.
	MDP panel	General	1	Appearance check (dirt, damage)				○			○	Visual inspection	Check that there is no dirt, damage, corrosion, paint peeling, or deformation. Check that there are no marks from rainwater intrusion or condensation. Check that space for inspections has been secured. Check that locks and related items are good.
			2	Abnormalities of instruments, indicator lamps, failure indicators				○			○	Visual inspection	Check that there is no damage to instrument covers or frames. Check that there is no damage to indicator lamps and that lenses have not fallen off. Replace any lamps that do not light. Check that indication and display condition are good.

Facility name	System name	Inspection location	Inspection item		Frequency							Inspection method	Work procedure
					Daily checking				Periodic checking				
					Random failure period								
					1,2days	3days	1w	1 mo.	3mo.	6 mo.	12 mo.		
Power distribution equipment Low voltage switchboard	MDP panel	General	3	Abnormalities of operation switches, selector switches, relays, electromagnetic switches, wiring breakers				○			○	Visual, sound, smell, and touch inspection	Check that there is no dirt, damage, abnormal noise, abnormal odor, overheating, or other problems with switches, etc.
			4	Dirt, damage, overheating, open circuit of wiring inside panel				○			○	Visual and touch inspection	Check that there is no dirt, damage, overheating, or open circuit. Check that there are no unnecessary wires, displaced wires, or foreign objects.
			5	Voltage, current measurement (using provided meter)				○			○	Measurement by provided meter	Check that voltage and current values are within the prescribed ranges.
			6	Main conducting part insulation resistance				○			○	Measurement by instrument	Check that insulation resistance is within the prescribed range.
			7	Control circuit insulation resistance							○	Measurement by instrument	Check that insulation resistance is within the prescribed range.
		Panel body	1	Looseness (retighten)							○	Visual and tool inspection	Check marking of bolts, etc. and retighten if necessary.
		Operation switches and selector switches	1	Operation check							○	Visual, touch, and operation inspection	Check that switching operation is smooth.
		Wiring, terminals	1	Wiring condition, looseness (retighten)				○			○	Visual and tool inspection	Check that wiring connections are neat and organized. Check that there are no unnecessary wires, displaced wires, or foreign objects. Check marking of bolts, etc. and retighten if necessary.
		Indicator	1	Condition of connections for provided resistor, shunt, and other devices							○	Visual and touch inspection, and manual cleaning	Check that there is no deterioration, cracking, overheating, or discoloration. Check that installation and connections are solid and secure. Use a shopcloth, brush or similar tool to remove dust or other material.
			2	Insulation resistance							○	Measurement by instrument	Check that insulation resistance is within the prescribed range.

Facility name	System name	Inspection location		Inspection item	Frequency							Inspection method	Work procedure
					Daily checking				Periodic checking				
					Random failure period								
					1,2days	3days	1w	1 mo.	3mo.	6 mo.	12 mo.		
Power distribution equipment Low voltage switchboard	MDP panel	Indicator	3	Calibration test							○	Measurement by instrument	Check that instrument measurement value and indicator reading are within the prescribed range.
		Wiring breaker	1	Operation check							○	Visual, touch, and operation inspection	Check that switching operation is smooth. Check that installation is solid and secure.
		Insulating coating	1	Dirt, damage							○	Visual and smell inspection	Check that there is no dirt, damage, abnormal odor, or discoloration.
		Grounding resistance	4	Grounding resistance				○			○	Measurement by instrument	Check that grounding resistance value is within the prescribed range.
	Cables (including leading-in cables)	For load	1	Condition of head connections (overheating, damage)				○				Visual and touch inspection	Check that there is no deformation or discoloration caused by overheating.
			2	Underground installation condition (presence of unauthorized digging, etc.)				○				Visual inspection	Check that there is no evidence of digging. Check that there is no subsidence.
			3	Distance from other objects				○				Visual inspection	Check that there is no contact with surrounding trees or other objects. Check that there is no damage or rusting of protective conduits at rise-up points.
			4	Dirt, damage on exterior	○					○		Visual inspection	Check that there is no dirt, corrosion, damage, cracking, or deformation.
			5	Dirt, damage on parts				○			○	Visual inspection	Check that there is no dirt, corrosion, damage, cracking, or deformation.
			6	Insulation resistance							○	Measurement by instrument	Check that insulation resistance is within the prescribed range.
	Conduits	Conduits and support	1	Installation condition (presence of unauthorized digging, etc.)	○					○		Visual inspection	Check that there is no evidence of digging. Check that there is no subsidence.
	Manholes, hand-holes		1	Condition of cover installation	○					○		Visual and touch inspection	Check that there is no dirt, damage, or chipping. Check that there is no looseness. Check that they are not covered by weeds or dirt.

Facility name	System name	Inspection location	Inspection item		Frequency							Inspection method	Work procedure
					Daily checking				Periodic checking				
					Random failure period								
					1,2days	3days	1w	1 mo.	3mo.	6 mo.	12 mo.		
	Manholes, hand-holes	Conduits and support brackets	2	Installation condition (presence of unauthorized digging, etc.)	○					○		Visual inspection	Check that there is no evidence of digging. Check that there is no subsidence.
Private power generation equipment	Operation	General	1	Start/stop test				○			○	Visual and operation inspection	Operate and check that start and stop operations are good.
			2	Establish rated speed and voltage (by provided meter)				○			○	Measurement by provided meter	Check that values of each indicator reading are within the prescribed range.
			3	Operation check of each equipment				○			○	Visual and operation inspection	Check that operating conditions of equipments are good.
			4	Hydraulic pressure, abnormal noise, vibration, overheating				○			○	Visual inspection, by hearing and tentacles	Check that hydraulic pressure is within the prescribed range. Check that there is no abnormal noise, abnormal odor, obnormal vibration and overheating.
			5	Temperature condition of each part				○			○	Visual inspection	Check that there is no abnormal temperature rise.
	Diesel engine	General	1	Appearance check (dirt, damage)				○				Visual inspection	Check that there is no dirt, corrosion, damage, rusting, paint peeling, or deformation.
			2	Abnormality, oil leakage, water leakage of instruments				○				By visual inspection and tentacles	Check that indication and display condition are good. Check that the installation of tachometers and thermometers are solid and secure. Check that there is no oil and liquid leakage from joint parts.
			3	Apply oils and fats to each part						○		Visual inspection	After checking oils and fats, apply them an appropriate amount if necessary.
			4	Looseness of each part (retighten)							○	Visual and tool inspection	Check marking of bolts, etc. and retighten if necessary.

Facility name	System name	Inspection location	Inspection item		Frequency							Inspection method	Work procedure
					Daily checking				Periodic checking				
					Random failure period								
					1,2days	3days	1w	1 mo.	3mo.	6 mo.	12 mo.		
Private power generation equipment	Diesel engine	General	5	Various noise and vibration measurement							○	Measurement by instrument	Check that values of noice and vibration are within the prescribed range.
			6	Check the rise values of oil temperature, water temperature and exhaust temperature on rotating machines							○	Visual inspection Measurement by provided meter	Check that the temperature rise values of oil, water and exhaust air are within the prescribed range.
	Generator	General	1	Appearance check (dirt, damage)				○				Visual inspection	Check that there is no dirt, corrosion, damage, rusting, paint peeling, or deformation.
			2	Grounding resistance							○	Measurement by instrument	Check that grounding resistance value is within the prescribed range.
		lead wire	1	Contact condition							○	Visual inspection Measurement by provided meter	Check that contact conditions are good. Check that there is no adhesion and burn mark caused by overheating. Use a shopcloth, brush or similar tool to remove dust or other material. Check that there is no rusting and rough part on contact areas.
	Electricsystem		1	Insulation resistance							○	Measurement by instrument	Check that insulation resistance is within the prescribed range.
	starter	electric starting accumulator(alkali)	1	Appearance check (dirt,damage)				○				Visual inspection	Check that there is no dirt, corrosion, damage, rusting, paint peeling, deformation and cracking on battery cases, covers and terminals
			2	Liquid surface, precipitation, hue, curved polar plate, separator				○				Visual inspection	Check that there is no short circuit, parts fallen off, cracking and curvature between polar plates. Check that separator conditions are good. Check that hues of each cell are good. Check that fluid volume is appropriate. Apply fluid replacement if necessary. Check that there is no precipitation in electrolytes. Check that there is no turbidity in electrolytes

Facility name	System name	Inspection location	Inspection item		Frequency							Inspection method	Work procedure
					Daily checking				Periodic checking				
					Random failure period								
					1,2days	3days	1w	1 mo.	3mo.	6 mo.	12 mo.		
Private power generation equipment	starter	electric starting accumulator (alkali)	3	Loosening of the terminal, leakage Loosening of terminals, liquid leakage							○	Visual and tool inspection	Check that there is no looseness of cable connection and connection bar. Retighten those parts if necessary. Check that there is no liquid leakage caused by cracks and deformation of cases.
			4	Voltage of each cell, liquid temperature							○	Measurement by instrument	Check that voltage levels for each battery are within the prescribed range. Check that liquid temperature levels are within the prescribed range.(Measurement of the degree of one cell per line)
		Other	1	Corrosion of the floor surface, damage Damage and corrosion on floor surfaces							○	Visual inspection	Check that there is no damage and corrosion on floor surfaces caused by liquid leakage.
	fuel system	General	1	Appearance check (dirt,damage)				○				Visual inspection	Check that there is no dirt, corrosion, damage, rusting, paint peeling, or deformation.
			2	Oil leakage, an amount of oil to be stored (performed during operation)				○				Visual inspection	Check that there is no oil leakage from piping. Check that an appropriate amount of oil has been stored.
	lubricating oil system	General	1	Appearance check (dirt,damage)				○				Visual inspection	Check that there is no dirt, corrosion, damage, rusting, paint peeling, or deformation.
			2	Viscosity test of lubricating oil (Inspection of oil quantity and viscosity)							○	Visual and touch inspection	Check that the amount of lubricating oil is within the prescribed range. Check that there is no extreme deterioration of viscocity compared with new oil.
	cooling system	Radiator system	1	Appearance check (dirt,damage)				○				Visual inspection	Check that there is no dirt, corrosion, damage, rusting, paint peeling, or deformation. Check that there is no looseness in exhaust air ducts.

Facility name	System name	Inspection location		Inspection item	Frequency: Daily checking / Random failure period 1,2days	3days	1w	1 mo.	Periodic checking 3mo.	6 mo.	12 mo.	Inspection method	Work procedure
Private power generation equipment	cooling system	Radiator system	3	State of the fan belt Fan belt conditoin				○				Visual, sound, and touch inspection	Check that there is no crack caused by deterioration. Check that fan belts keep good tention. Check that there is no abnormal noise during operation. Check that pressure sensors keep good condition.
	Equipment supply and	Damper, ventilation fan	1	Appearance check (dirt,damage)				○				Visual inspection	Check that there is no dirt, corrosion, damage, rusting, paint peeling, or deformation.
			2	The color of exhaust gas				○			○	Visual inspection	Check that there is no unusual color. Check that it is close to colorless state during warming.
			3	Cracking or corrosion of exhaust pipes and mounting brackets							○	Visual inspection	Check that there is no dirt, corrosion, damage, rusting, paint peeling, or deformation.
	Vibration-proofing device	General	1	Deformation or damage of anchor bolts and vibration-proof rubbers etc							○	Visual and tool inspection	Check that there is no deformation and damage on vibration-proof rubbers, no deformation on anchor bolts. Check marking of bolts, etc. and retighten if necessary.
	Grounding line	General	1	Open circuit, condition and looseness (retighten) of connections							○	Visual and tool inspection	Check that there is no open circuit in the grounding line. Check marking of bolts, etc. and retighten if necessary.
	Other	General	1	Cleaning of fine parts							○	Manual cleaning	Use a shopcloth, brush or similar tool to remove dust or other material.
Road lighting equipment	Poles and steel towers	Main bodies	1	Appearance check (dirt, damage)				○			○	Visual inspection	Check that there is no dirt, corrosion, damage, rusting, paint peeling, or deformation.
			2	Installation condition				○			○	Visual and touch inspection	Check that the structure is maintained level and vertical. Check that there is no abnormal vibration.
		Foundation	1	Installation condition				○			○	Visual inspection	Check that there is no cracking, damage, or inclination. Check that the foundation is not covered by dirt and that earth has not been washed out from under it.

Facility name	System name	Inspection location	Inspection item		Frequency							Inspection method	Work procedure
					Daily checking				Periodic checking				
					Random failure period								
					1,2days	3days	1w	1 mo.	3mo.	6 mo.	12 mo.		
Road lighting equipment	Poles and steel towers	Anchor bolts	1	Appearance check (dirt, damage)				○			○	Visual and tool inspection	Check that there is no dirt, corrosion, damage, rusting, paint peeling, or deformation. Check marking of bolts, etc. and retighten if necessary.
	Road lights	General	1	Appearance check (dirt, damage)				○			○	Visual inspection	Check that there is no dirt, corrosion, damage, rusting, paint peeling, or deformation. Check that there is no cracking or damage of glass surfaces.
	Other		1	Grounding resistance							○	Measurement by instrument	Check that grounding resistance value is within the prescribed range.
blinker lights equipment	blinker light	General	1	Appearance check (dirt, damage)				○			○	Visual, touch, and operation inspection	Check that there is no dirt, corrosion, damage, rusting, paint peeling, or deformation. Check that there are no marks from rainwater intrusion or condensation. Check that there is no damage and deterioration of lenses and seals etc. Check that there is no inclination. Check marking of bolts, etc. and retighten if necessary.
Mobile radio equipment	Base station、Control Fixed station、Portable base station(analog Radio)		1	Appearance check (dirt, damage)					○		○	Visual inspection	Check that there is no dirt, corrosion, damage, rusting, paint peeling, or deformation.
			2	Call testing					○		○	Visual and operation inspection	Check that we can get a clear line with traffic control room by pressing press-to-talk switch
			3	VSWR measurement and transmitting output							○	Measurement by instrument	Check that values of transmitting output and VSWR are within the prescribed range.
			4	Transmit frequency measurement							○	Measurement by instrument	Check that transmit frequency values are within the prescribed range.
			5	Spurious transmission intensity measurement							○	Measurement by instrument	Check that spurious intensity values are within the prescribed range.

Facility name	System name	Inspection location	Inspection item		Frequency: Daily checking / Random failure period				Frequency: Periodic checking			Inspection method	Work procedure
					1,2days	3days	1w	1 mo.	3mo.	6 mo.	12 mo.		
Mobile radio equipment	Base station、Control Fixed station、Portable base station(analog Radio)		6	Measured maximum frequency deviation and modulation characteristics							○	Measurement by instrument	Check that values of modulation characteristics and values of maximum frequency deviation are within the prescribed range.
			7	Receiver sensitivity measurement							○	Measurement by instrument	Check that values of receiving sensitivity are within the prescribed range.
			8	S / N Measurement (send and receive)							○	Measurement by instrument	Check that values of S/N is within the prescribed range.
			9	Distortion measurement							○	Measurement by instrument	Check that values of distortion are within the prescribed range.
	Land mobile station、Mobile station(Analog Radio)		1	Appearance check (dirt, damage)							○	Visual inspection	Check that there is no dirt, corrosion, damage, rusting, paint peeling, or deformation.
			2	Call testing							○	Visual and operation inspection	Check that we can get a clear line with traffic control room by pressing press-to-talk switch
			3	VSWR measurement and the transmitting output							○	Measurement by instrument	Check that values of VSWR are within the prescribed range.
			4	Transmit frequency measurement							○	Measurement by instrument	Check that values of transmit frequency are within the prescribed range.
			5	Spurious transmission intensity measurement							○	Measurement by instrument	Check that values of transmission spurious intensity are within the prescribed range.
			6	Measured maximum frequency deviation and modulation characteristics							○	Measurement by instrument	Check that values of modulation characteristics and values of maximum frequency deviation are within the prescribed range.
			7	Receiving sensitivity measurement							○	Measurement by instrument	Check that values of receiving sensitivity are within the prescribed range.
			8	S / N Measurement (send and receive)							○	Measurement by instrument	Check that values of S/N are within the prescribed range.
			9	Distortion measurement							○	Measurement by instrument	Check that values of distortion are within the prescribed range.
			10	Modulation input level measurement							○	Measurement by instrument	Check that values of modulation input level are within the prescribed range.
	Steel tower	Steel tower	1	Appearance check (dirt, damage)							○	Visual inspection	Check that there is no dirt, corrosion, damage, rusting, paint peeling, or deformation.
			2	Installation condition							○	Visual inspection	Check that the structure is maintained level and vertical.

Facility name	System name	Inspection location	Inspection item		Frequency							Inspection method	Work procedure
					Daily checking				Periodic checking				
					Random failure period								
					1,2days	3days	1w	1 mo.	3mo.	6 mo.	12 mo.		
Mobile radio equipment	Steel tower	Steel tower	3	State of lightning rods (disconnection, the state of each connection and damage)							○	Visual and touch inspection	Check that there is no dirt, corrosion, damage, rusting, paint peeling, or deformation. Check that there is no open circuit in the grounding line. Check that installation for each connection are solid and secure.
		Basis	1	Installation condition							○	Visual inspection	Check that there is no cracking, damage, or inclination. Check that the foundation is not covered by dirt and that earth has not been washed out from under it.
		Anchor bolt	1	Appearance check (dirt, damage)							○	Visual and tool inspection	Check that there is no dirt, corrosion, damage, rusting, paint peeling, or deformation. Check marking of bolts, etc. and retighten if necessary.
Variable type road information board equipment	LED type label board	board	1	Appearance check (dirt,damage)				○			○	Visual inspection	Check that there is no dirt, corrosion, damage, rusting, paint peeling, or deformation. Check that there are no marks from rainwater intrusion or condensation. Check that locks and related items are good.
			2	Operation check of heat exchanger fan				○			○	Visual, sound, smell, and touch inspection	Check of shutdown operation by manual operation good Check that there is no dirty, abnormal noise, abnormal odor, obnormal vibration and overheating.
			3	Operation check of Automatic ON/OFF device							○	Visual and operation inspection	Check of Automatic ON/OFF device operation
			4	Abnormalities of wiring breakers,magnetic contactor,transformer,surge absorption element							○	Visual, sound, smell, and touch inspection	Check that there is no dirt, damage, abnormal noise, abnormal odor, overheating, or other problems with breakers, etc.
			5	Condition of printed circuit board ,relay							○	Visual and touch inspection	Check that there is no looseness. Check that locks and related items are good.
			6	Cleaning of heat exchanger							○	Manual cleaning	fan and air duct Use a shopcloth, brush or similar tool to remove dust or other material.
			7	Transmit level measurement							○	Measurement by instrument	Check that Transmit level measurement are within the prescribed ranges.
			8	Loosening of the terminal(retighten)							○	Visual and tool inspection	Check marking of bolts, etc. and retighten if necessary.
		Label board	1	condition of LED type laber board unit							○	Visual, touch, and operation inspection	Check that there is no looseness. Check that locks and related items are good.

Facility name	System name	Inspection location		Inspection item	Frequency: Daily checking / Random failure period: 1,2days	3days	1w	1 mo.	Periodic checking: 3mo.	6 mo.	12 mo.	Inspection method	Work procedure
Variable type road information board equipment	Pole	Body,basis,Anchor bolt	1	Same as the above "Poles and steel towers." item							○	Same as the above "Poles and steel towers." item	
	Hand board (Manual control board ?)	General	1	Operation check from Hand board							○	Visual and operation inspection	Check of all item control operation
	Control board	General	1	Appearance check (dirt,damage)							○	Visual inspection	Check that there is no dirt, corrosion, damage, rusting, paint peeling, or deformation. Check that there are no marks from rainwater intrusion or condensation. Check that space for inspections has been secured. Check that locks and related items are good.
			2	Abnormalities of instruments, indicator lamps, failure indicators							○	Visual inspection	Check that there is no damage to instrument covers or frames. Check that there is no damage to indicator lamps and that lenses have not fallen off. Replace any lamps that do not light. Check that indication and display condition are good.
			3	Abnormalities of operation switches, selector switches, relays, electromagnetic switches, wiring breakers							○	Visual, sound, smell, and touch inspection	Check that there is no dirt, damage, abnormal noise, abnormal odor, overheating, or other problems with switches, etc.
			4	Dirt, damage, overheating, open circuit of wiring inside panel							○	Visual and touch inspection	Check that there is no dirt, damage, overheating, or open circuit. Check that there are no unnecessary wires, displaced wires, or foreign objects. Check marking of bolts, etc. and retighten if necessary.
			5	Voltage, current measurement (using provided meter)							○	Measurement by provided meter	Check that voltage and current values are within the prescribed ranges.
			6	Condition of parts (dirt,damage,overheating,looseness,displaced wires,open circuit.)							○	Visual, touch, and operation inspection	Check that there is no dirt, loss, or open circuit. Check marking of bolts, etc. and retighten if necessary. Check that there is no open circuit or contact.
			7	Condition of terminal wiring mark							○	Visual inspection	Check that there is no dirt, damage, overheating, or open circuit.
			8	Cleaning of fine parts							○	Manual cleaning	Use a shopcloth, brush or similar tool to remove dust or other material.
		Transmission part	1	Transmit level measurement							○	Measurement by instrument	Check that Transmit level measurement are within the prescribed ranges.
		Control board	1	Operation check from Control Board							○	Visual and operation inspection	Check of select item control operation
		Other	1	Insulation resistance							○	Measurement by instrument	Check that insulation resistance is within the prescribed range.
			2	Grounding resistance							○	Measurement by instrument	Check that grounding resistance value is within the prescribed range.

Facility name	System name	Inspection location	Inspection item		Frequency							Inspection method	Work procedure
					Daily checking				Periodic checking				
					Random failure period								
					1,2days	3days	1w	1 mo.	3mo.	6 mo.	12 mo.		
Communication wireway equipment	Communication cable	Metallic cable	1	Path loss（About 15% of all the logarithm is extracted and measured)							○	Measurement by instrument	Check that Path loss is within the prescribed range.
			2	Insulation resistance（About 15% of all the logarithm is extracted and measured)							○	Measurement by instrument	Check that Insulation resistance is within the prescribed range.
		Optical cable	1	Optical loss test							○	Measurement by instrument	Check that optical loss is within the prescribed range.
		Optical cable in office	1	Maintenance and accommodation state of cable（Bend,Support and Protection etc）							○	Visual and touch inspection	Check of Maintenance and accommodation state of cable load. Check of damage in covering
	Conduits	Conduits and support brackets	1	Installation condition (presence of unauthorized digging, etc.)							○	Visual inspection	Check that there is no evidence of digging. Check that there is no subsidence. Check that there is no dirt, corrosion, damage, rusting, paint peeling, or deformation.
			2	Condition of Burial ranging poles							○	Visual inspection	Check of Character and Sign disappeared Check that they are not covered by weeds or dirt.
	Manholes, hand-holes		1	Condition of cover installation							○	Visual inspection	Check that there is no dirt, corrosion, damage, rusting, paint peeling, or deformation. Check that there is no looseness. Check that they are not covered by weeds or dirt.
			2	Installation condition (presence of unauthorized digging, etc.)							○	Visual inspection	Check that there is no cracking, damage, or inclination. Check that the foundation is not covered by dirt and that earth has not been washed out from under it.

3.5.3 Report Form

Power Distribution Equipment

NO 1／3

Inspection Area			Inspection Day	
			Weather	
			Temprature	
			Humidity	
System Name	Inspection Location	Work procedure	Inspection Result	Remarks
Disconnect switch	General	1 Appearance check (dirt,damage)	Nothing	
		2 Overheating (temp. indicator tape), discoloration	Nothing	
		3 Contact of blade and blade receiver, looseness (retighten),contact roughness	Good	
		4 Application of grease to contacting surfaces	Do	
		5 Insulation resistance	Good	
		6 Interlock system check	Good	
	Installation parts	1 Function of steady brace system, looseness (retighten)	Good	
	Switchgear mechanism	1 Operation check, looseness(retighten)	Good	
	Insulator	1 Cracking	Nothing	
	Connecting terminal	1 Looseness (retighten)	Nothing	
Transformer	General	1 Appearance check (dirt,damage)	Nothing	
		2 Oil leakage, vibration, noise	Nothing	
		3 Installation condition	Good	
		4 Oil level, temp. (using provided meter)	Good	
		5 Condition of attachments	Good	
		6 Insulation resistance	Good	
		7 Grounding resistance	Good	
		8 Insulating oil withstand voltage test (Perform every 3 years.)	—	
		9 Insulating oil oxidation measurement(Perform every 3 years.)	—	
	Installation parts	1 Looseness (retighten)	Nothing	
	Bushing	1 Cracking	Nothing	
	Heat dissipation system	1 Cracking Visual	Nothing	
	Dehumidifying system	1 Desiccant discoloration,condition of moisture adsorption	—	
	Connecting terminal	1 Looseness (retighten)	Nothing	
Lightning arrester	General	1 Appearance check (looseness)	Nothing	
		2 Condition of parts (dirt,damage, looseness (retighten),cracking)	Nothing	
		3 Marks from discharge	Nothing	
		4 Insulation resistance	Good	
		5 Grounding resistance	Good	
Leading-in poles	General	1 Pole health	Good	
		2 Tension of support wires	Good	
		3 Installation condition of protective materials and signs	Good	
		4 Corrosion, damage of pole brackets	Nothing	
		5 Appearance check (dirt,damage) of pole devices	Nothing	
Wires and support brackets		1 Installation condition	Good	
		2 Distance from other objects	Good	
		3 Insulation resistance	Good	
Remarks				

Power Distribution Equipment

NO 2／3

Inspection Area			Inspection Day	
			Weather	
			Temprature	
			Humidity	
System Name	Inspection Location	Work procedure	Inspection Result	Remarks
Cables (including leading-in cables)	For load	1 Condition of head connections (overheating, damage)	Good	
		2 Underground installation condition (presence of unauthorized digging, etc.)	Good	
		3 Distance from other objects	Good	
		4 Dirt, damage on exterior	Nothing	
		5 Dirt, damage on parts	Nothing	
		6 Insulation resistance	Good	
Conduits	Conduits and support brackets	1 Installation condition (presence of unauthorized digging, etc.)	Good	
		2 Condition of underground installation sign poles	Good	
Manholes, hand-holes		1 Condition of cover installation	Good	
		2 Installation condition (presence of unauthorized digging, etc.)	Good	
Distribution panel, relay panel, etc. (hereafter, "distribution panel, etc.")	General	1 Appearance check (dirt,damage)	Nothing	
		2 Abnormalities of instruments, indicator lamps, failure indicators	Nothing	
		3 Abnormalities of operation switches, selector switches, relays, electromagnetic switches, wiring breakers	Nothing	
		4 Dirt, damage, overheating, open circuit of wiring inside panel	Nothing	
		5 Voltage, current measurement (using provided meter)	Good	
		6 Main conducting part insulation resistance	Good	
		7 Control circuit insulation resistance	Good	
	Panel body	1 Looseness (retighten)	Nothing	
	Operation switches and selector switches	1 Operation check	Good	
	Wiring, terminals inside panel	1 Wiring condition, looseness (retighten)	Nothing	
	Indicator	1 Condition of connections for provided resistor, shunt, and other devices	Good	
		2 Insulation resistance	Good	
		3 Calibration test	Good	
	Wiring breaker	1 Operation check	Good	
	Insulating coating	1 Dirt, damage	Nothing	
Outdoor distribution panel	General	1 Appearance check (dirt,damage)	Nothing	
		2 Abnormalities of instruments, indicator lamps, failure indicators	Nothing	
		3 Abnormalities of operation switches, selector switches, relays, electromagnetic switches, wiring breakers	Nothing	
		4 Dirt, damage, overheating, open circuit of wiring inside panel	Nothing	
Remarks				

Power Distribution Equipment

NO 3／3

Inspection Area			Inspection Day	
			Weather	
			Temprature	
			Humidity	

System Name	Inspection Location	Work procedure	Inspection Result	Remarks
Outdoor distribution panel	General	5 Voltage, current measurement (using provided meter)	Good	
		6 Main conducting part insulation resistance	Good	
		7 Control circuit insulation resistance	Good	
		8 Water intrusion	Nothing	
Lightning arrester	General	1 Appearance check (looseness)	Nothing	
		2 Condition of parts (dirt,damage, looseness (retighten),cracking)	Nothing	
		3 Marks from discharge	Nothing	
		4 Grounding resistance	Good	
MDP panel	General	1 Appearance check (dirt,damage)	Nothing	
		2 Abnormalities of instruments, indicator lamps, failure indicators	Nothing	
		3 Abnormalities of operation switches, selector switches, relays, electromagnetic switches, wiring breakers	Nothing	
		4 Dirt, damage, overheating, open circuit of wiring inside panel	Nothing	
		5 Voltage, current measurement (using provided meter)	Good	
		6 Main conducting part insulation resistance	Good	
		7 Control circuit insulation resistance	Good	
	Panel body	1 Looseness (retighten)	Nothing	
	Operation switches and selector switches	1 Operation check	Good	
	Wiring, terminals inside panel	1 Wiring condition, looseness (retighten)	Nothing	
MDP panel	Indicator	1 Condition of connections for provided resistor, shunt, and other devices	Good	
		2 Insulation resistance	Good	
		3 Calibration test	Good	
	Wiring breaker	1 Operation check	Good	
	Insulating coating	1 Dirt, damage	Nothing	
	Grounding resistance	1 Grounding resistance	Good	
Cables (including leading-in cables)	For load	1 Condition of head connections (overheating, damage)	Good	
		2 Underground installation condition (presence of unauthorized digging, etc.)	Good	
		3 Distance from other objects	Good	
		4 Dirt, damage on exterior	Nothing	
		5 Dirt, damage on parts	Nothing	
		6 Insulation resistance	Good	
Conduits	Conduits and support brackets	1 Installation condition (presence of unauthorized digging, etc.)	Good	
Manholes, hand-holes		1 Condition of cover installation	Good	
		2 Installation condition (presence of unauthorized digging, etc.)	Good	
Remarks				
			Inspection Person	

Generation Electric Equipment

NO 1／1

Inspection Area			Inspection Day	
			Weather	
			Temprature	
			Humidity	
System Name	Inspection Location	Work procedure	Inspection Result	Remarks
Operation	General	1 Start/stop test	Good	
		2 Establish rated speed and voltage (by provided meter)	Good	
		3 Operation check of each equipment	Good	
		4 Hydraulic pressure, abnormal noise, vibration, overheating	Nothing	
		5 Temperature condition of each part	Good	
Diesel engine	General	1 Appearance check (dirt,damage)	Good	
		2 Abnormality, oil leakage, water leakage of instruments	Nothing	
		3 Apply oils and fats to each part	Good	
		4 Looseness of each part (retighten)	Good	
		5 Various noise and vibration measurement	Good	
		6 Check the rise values of oil temperature, water temperature and exhaust temperature on rotating machines	Good	
Generator	General	1 Appearance check (dirt,damage)	Good	
		2 Grounding resistance	Good	
	lead wire	1 Contact condition	Good	
Electricsystem		1 Insulation resistance	Good	
starter	electric starting accumulator(alkali)	1 Appearance check (dirt,damage)	Good	
		2 Liquid surface, precipitation, hue, curved polar plate, separator	Good	
		3 Loosening of the terminal, leakage Loosening of terminals, liquid leakage	Good	
		4 Voltage of each cell, liquid temperature	Good	
	Other	1 Corrosion of the floor surface, damage Damage and corrosion on floor surfaces	Good	
fuel system	General	1 Appearance check (dirt,damage)	Good	
		2 Oil leakage, an amount of oil to be stored (performed during operation)	Good	
lubricating oil system	General	1 Appearance check (dirt,damage)	Good	
		2 Viscosity test of lubricating oil (Inspection of oil quantity and viscosity)	Good	
cooling system	Radiator system	1 Appearance check (dirt,damage)	Good	
		2 State of the fan belt Fan belt conditoin	Good	
Equipment supply and exhaust	Damper, ventilation fan	1 Appearance check (dirt,damage)	Good	
		2 The color of exhaust gas	Good	
		3 Cracking or corrosion of exhaust pipes and mounting brackets	Good	
Vibration-proofing device	General	1 Deformation or damage of anchor bolts and vibration-proof rubbers etc	Good	
Grounding line	General	1 Open circuit, condition and looseness (retighten) of connections	Good	
Other	General	1 Cleaning of fine parts	Good	
Remarks				
			Inspection Person	

Road Lighting Equipment

NO 1／1

Inspection Area			Inspection Day	
			Weather	
			Temprature	
			Humidity	
System Name	Inspection Location	Work procedure	Inspection Result	Remarks
Poles and steel towers	Main bodies	1 Appearance check (dirt, damage)	Good	
		2 Installation condition	Good	
	Foundation	1 Installation condition	Good	
	Anchor bolts	1 Appearance check (dirt, damage)	Good	
Road lights	General	1 Appearance check (dirt, damage)	Good	
Other		1 Grounding resistance	Good	
Remarks				
			Inspection Person	

Warning Light Equipment

NO 1／1

Inspection Area			Inspection Day	
			Weather	
			Temprature	
			Humidity	
System Name	Inspection Location	Work procedure	Inspection Result	Remarks
blinker light	General	1 Appearance check (dirt, damage)	Good	
Remarks				
			Inspection Person	

Road Electric Sign Equipment

NO 1／1

Inspection Area			Inspection Day	
			Weather	
			Temprature	
			Humidity	
System Name	Inspection Location	Work procedure	Inspection Result	Remarks
LED type label board	board	1 Appearance check (dirt,damage)	Nothing	
		2 Operation check of heat exchanger fan	Good	
		3 Operation check of Automatic ON/OFF device	Good	
		4 Abnormalities of wiring breakers,magnetic contactor,transformer,surge absorption element	Nothing	
		5 Condition of printed circuit board ,relay	Good	
		6 Cleaning of heat exchanger	Do	
		7 Transmit level measurement	Good	
		8 Loosening of the terminal(retighten)	Good	
	Label board	1 condition of LED type laber board unit	Good	
Poles	Main bodies	1 Appearance check (dirt, damage)	Good	
		2 Installation condition	Good	
	Foundation	1 Installation condition	Good	
	Anchor bolts	1 Appearance check (dirt, damage)	Good	
Hand board	General	1 Operation check from Hand board	Good	
Control board	General	1 Appearance check (dirt,damage)	Nothing	
		2 Abnormalities of instruments, indicator lamps, failure indicators	Good	
		3 Abnormalities of operation switches, selector switches, relays, electromagnetic switches, wiring breakers	Nothing	
		4 Dirt, damage, overheating, open circuit of wiring inside panel	Nothing	
		5 Voltage, current measurement (using provided meter)	Good	
		6 Condition of parts (dirt,damage,overheating,looseness,displaced wires,open circuit.)	Nothing	
		7 Condition of terminal wiring mark	Good	
		8 Cleaning of fine parts	Do	
	Transmission part	1 Transmit level measurement	Good	
	Control board	1 Operation check from Control Board	Good	
	Other	1 Insulation resistance	Good	
		2 Grounding resistance	Good	
Remarks				
			Inspection Person	

Movement Radio Equipment

NO 1／1

Inspection Area		Inspection Day	
		Weather	
		Temprature	
		Humidity	

System Name	Inspection Location	Work procedure	Inspection Result	Remarks
Base station、Control Fixed station、Portable base station(analog Radio)		1 Appearance check (dirt, damage)	Good	
		2 Call testing	Good	
		3 VSWR measurement and transmitting output	Good	
		4 Transmit frequency measurement	Good	
		5 Spurious transmission intensity measurement	Good	
		6 Measured maximum frequency deviation and modulation characteristics	Good	
		7 Receiver sensitivity measurement	Good	
		8 S / N Measurement (send and receive)	Good	
		9 Distortion measurement	Good	
Land mobile station、Mobile station(Analog Radio)		1 Appearance check (dirt, damage)	Good	
		2 Call testing	Good	
		3 VSWR measurement and the transmitting output	Good	
		4 Transmit frequency measurement	Good	
		5 Spurious transmission intensity measurement	Good	
		6 Measured maximum frequency deviation and modulation characteristics	Good	
		7 Receiving sensitivity measurement	Good	
		8 S / N Measurement (send and receive)	Good	
		9 Distortion measurement	Good	
		10 Modulation input level measurement	Good	
Steel tower	Steel tower	1 Appearance check (dirt, damage)	Good	
		2 Installation condition	Good	
		3 State of lightning rods (disconnection, the state of each connection and damage)	Good	
	Basis	1 Installation condition	Good	
	Anchor bolt	1 Appearance check (dirt, damage)	Good	
Remarks				
			Inspection Person	

Communication Wire Way Equipment

NO 1／1

Inspection Area			Inspection Day	
			Weather	
			Temprature	
			Humidity	
System Name	Inspection Location	Work procedure	Inspection Result	Remarks
Communication cable	Metallic cable	1 Path loss(About 15% of all the logarithm is extracted and measured)	Good	
		2 Insulation resistance(About 15% of all the logarithm is extracted and measured)	Good	
	Optical cable	1 Optical loss test	Good	
	Optical cable in office	1 Maintenance and accommodation state of cable (Bend,Support and Protection etc)	Good	
Conduits	Conduits and support brackets	1 Installation condition (presence of unauthorized digging, etc.)	Good	
		2 Condition of Burial ranging poles	Good	
Manholes, hand-holes		1 Condition of cover installation	Good	
		2 Installation condition (presence of unauthorized digging, etc.)	Good	
Remarks				
			Inspection Person	

Construction Test Result Form(Proximity Viewing)

Inspection Equipment:
Inspection Person:

Place(Sta)		Place(Fin)		

	Complete View	View1	View2	View3	View4	Last Quantity	This Quantity	Remarks
A A								
A								
B								
OK								
					Total		0	

Directorate for Roads of Vietnam Japan International Cooperation Agency

The Project for Strengthening Operation and Maintenance System for Expressway in Vietnam

SECTION 4
TECHNICAL SPECIFICATION GUIDELINES FOR TRAFFIC MANAGEMENT

Vietnam Expressway Management Office

JICA Experts Team

JUNE 2013

Table of Contents

4 Traffic Management

4.1 Traffic Management System

4.1.1 Outline

Traffic Management Crews of the expressway, shall ensure safe and smooth traffic, and shall endeavor to communicate and cooperate closely with the police, fire brigade, ambulance, toll gate, rescue company, maintenance and repair workers and other related agencies.

Traffic Management System comprises a “Traffic Patrol Team” and a “Traffic Control Center”.

The “Traffic Patrol Team” carries out patrol intended to prevent occurrence of unusual incidents, collect relevant information, and to maintain preparedness to recover rapidly from unexpected incidents.

The “Traffic Control Center”, as the core function of Traffic Management System, carries out control of the Traffic Patrol Team, collection and dissemination of the information and cooperation with other responsible agencies to resolve incidents on the expressway.

The traffic patrol teams and the Traffic Control Center frequently communicate with each other in dealing with traffic control on the expressway.

4.1.2 Patrol stations

Traffic Patrol Team patrols are on duty and based at stations.

The Patrol stations shall be established at the place where the Traffic Patrol Team can arrive at the farthest points within about 30 minutes, by driving at the maximum speed allowed by the Law.

4.1.3 Deployed Staff

Traffic Patrol Team shall always (for 24 hours 365 days) mobilize more than 1 team on duty to ensure continuous operation (for 24 hours/ day of 365 days/ year)

Traffic Control Center shall mobilize more than 2 operators on duty (for 24 hours/ day of 365 days/ year).

4.1.4 Frequency of patrol

The number of regular traffic patrols per day shall be determined upon the traffic volume of the expressway (see the below Table) and the frequency of traffic patrol may be adjusted, taking into consideration of the road structures and other elements.

Traffic volume (daily average traffic volume)	Frequency of Regular patrols/day
Less than 5,000 vehicles	3
5,000 – Less than 10,000 vehicles	4
10,000 - Less than 15,000 vehicles	5
15,000 - Less than 20,000 vehicles	6
20,000 - Less than 25,000 vehicles	7
25,000 - Less than 30,000 vehicles	8
30,000 - Less than 40,000 vehicles	9
40,000 - Less than 50,000 vehicles	10
50,000 - Less than 70,000 vehicles	11
70,000 - Less than 90,000 vehicles	12
90,000 - Less than 110,000 vehicles	13
110,000 or more vehicles	14

4.2 Traffic Patrol

4.2.1 General

4.2.1.1 Principal Code of Conduct

Crews engaged in Traffic Patrol shall, at all times, work to ensure the safe and smooth flow of traffic on the expressway, and shall observe the principal code of conduct enumerated below.

(1) Traffic Patrol Team operates under the order of the Traffic Control Center. However, in case road traffic safety is in risk, necessary measures, within the scope of ensuring the safe and smooth traffic flow, may be taken without instructions from the Road Traffic Control Center, only if safe and smooth traffic is hindered or is likely to be hindered and there is not enough time to obtain instructions from the Traffic Control Center. In such a case, the taken measures shall be reported immediately to the Traffic Control Center.

(2) When delivering on-road duties such as handling of unusual incidents, enforcing traffic regulations, the patrol crews shall maintain close communications with related agencies, and cooperate with them.

(3) During working hours, the patrol crews must not leave the Patrol station or the expressway.

And shift changes shall be carried out quickly, to ensure no hindrance to duty work.

(4) The patrol crew shall maintain or improve their physical agility by doing stretching exercises before commencement of the duty work, in order to effectively deliver on-road duty works and keep themselves safe.

(5) Patrol crews of the Patrol station shall be given technical training related to vehicle operation and on-road work, as well as knowledge of relevant laws and regulations, several times a month.

4.2.1.2 Standard accessories of the Patrol Crews

In delivering duties of the expressway patrol, the Patrol crews shall be equipped with the following particles as enumerated below.

(1) Helmet

(2) Safety vest

(3) Whistle

4.2.1.3 Standard Set of On-Vehicle Equipment

At the time of the expressway patrol, as a general rule, the patrol crews ensure the following apparatuses ready with them inside the patrol vehicle:

No	Purpose of Use	Equipment	Quantity
1	Traffic Regulations	Reflective Color cone	7
2		Arrow sign	4
3		High intensity light	2
4		Directing/guidance baton	2
5		Hand flag (Red flag)	2
6	O&M Works	Handkerchief	2
7		Rubber gloves	2 pairs
8		Working gloves	2 pairs
9		Shovel	2
10		Bamboo broom	2
11		Bucket	1
12		Tow rope	1
13		Rope	1 roll
14		Plastic bag	discretionary
15		Jude bag	discretionary
16		Chemicals for treating	discretionary
17		Water tank	1

No	Purpose of Use	Equipment	Quantity
18		other tool gadget	1
19		Hammer	1
20		Fire extinguisher	1
21		First aid box	1
22		Blanket	2
23		Wheel chock	1
24	Communication	Handy micro	1
25		Portable transceiver	1
26		Mobile telephone	1
27	Other subordinate tools	Camera	1
28		Binoculars	1
29		Rolled ruler	1
30		Log book and document	1

4.2.1.4 Standard specifications of the vehicle

Standard specifications of the vehicle for traffic patrol is enumerated below:

(1) Name of Comp: Station Wagon

(2) Engine: 2,800cc or more

(3) Drive system: 4WD

(4) Equipment: Radio Equipment, Rotation lamp, Siren, Loudspeaker

(5) Body Color : Yellow and White Line (Body), Red and White (Bumper)

4.2.2 Crews Organizational Setup

A basic patrol unit comprises two traffic patrol crews, including a chief patrol crew, in one traffic patrol vehicle, except the cases enumerated below:

(1) The vehicle is accompanied by another traffic patrol vehicle.

(2) The patrol crew is going to support the implementation of secondary traffic control at the site where traffic control has already been put in place.

(3) The vehicle is going to transport equipment or materials that are required by other traffic patrol crews to the work site.

(4) The patrol crew has received special instruction from the Traffic control center, which can be safely implemented by a single person.

4.2.3 Traffic Patrol

4.2.3.1 Inspection and Maintenance of the Patrol Vehicle

The patrol crews shall endeavor to keep traffic patrol vehicles and a standardized set of on-vehicle equipment clean and organized. And they shall inspect the items enumerated below. If the inspection results identify insufficient quantity or articles with guarantee dates expired, it shall be replenished or replaced immediately.

(1) Before departing for patrol, the patrol crews shall inspect the items enumerated below:

- Operating conditions of braking and steering systems
- Visibility of rearview mirrors
- Degree of wear and air pressure of tires
- Fuel level
- Radio equipment setting
- Illuminating condition of warning lights and other lights

(2) Each time the patrol crews are dislodged from field duties, they shall inspect the items enumerated below:

- Fuel level
- Check for leakage of fuel, lubricating oil, or coolant
- Degree of wear and air pressure of tires
- Other abnormal items identified during the patrol

(3) Each time the patrol team switches the shift to the succeeding team, both shall inspect the items enumerated below:

- The standardized set of on-vehicle equipment shall be checked to confirm that it is present in designated quantities.
- Operating condition of the standardized set of on-vehicle equipment shall be checked.

4.2.3.2 Regular Patrols

4.2.3.2.1 Objectives

The primary objectives of regular expressway patrol are to collect information related to road traffic, and to remove damaged and/or disabled vehicles and debris from the road. These are ultimately intended to prevent accidents and other incidents from occurring (preventive management) to ensure safe and smooth flow of expressway traffic.

4.2.3.2.2 Traffic Patrol Plan

Crews, responsible for the operation of patrol station, should make a patrol plan in accordance with the attachment "Creating the Traffic Patrol Plan", which is then approved by the Traffic Control Center.

Patrol team should carry out regular patrol trips in accordance with this plan.

4.2.3.2.3 Reporting during the Regular Patrol

During the regular patrol, the patrol team shall report the items enumerated below to the Traffic Control Center

(1) Embarking on and dislodging from the patrol duties
(2) The clock time of the incidence of the patrol vehicle’s passage through the interchange and the junction
(3) Traffic conditions; weather conditions and road conditions
(4) Other particular items instructed by the Traffic Control Center

4.2.3.3 Special Patrols

4.2.3.3.1 Purpose

When the patrol team waiting on standby for instructions at the patrol station, receives an instruction for emergency mobilization from the Traffic Control Center, they shall hurry to the scene instructed by the Traffic Control Center and carry out the instructed duties.

4.2.3.3.2 Report during the Special Patrol

During the Special Patrol, the patrol team shall report the following items to the Traffic Control Center:

(1) Commencement and dislodge from duty engagement
(2) The clock time of the incidence of the patrol vehicle’s passage through the interchange and/or junction
(3) Arrival at and dislodge from the site where unusual incident is handled
(4) Matters of the unusual incidents specified in the Chapter 4.4
(5) Other items for which reporting is instructed by the Traffic Control Center

4.2.4 Reporting and record

At the end of the duty work shift, the traffic patrol crews shall fill in details of dutiable works performed and other necessary items on a daily work report. At this duty changeover time, handover information described in the daily work report shall be confirmed by both parties - the crew handing them over and the crew receiving them.

Attachment

Creating the Traffic Patrol Plan

(4.2.3.2.2)

1. Objectives of Regular Patrols

Traffic patrol team patrols the expressway regularly in a 24-hour day, 365-day year basis, in order to ensure the safety, high-speed service, and punctuality for travelling vehicles. In the event that a traffic accident or other unusual incident occurs, traffic patrol crews immediately hurry to the site and handle the situation to ensure public safety.

The primary objectives of regular road patrols are: (1) to collect information related to road traffic, and (2) to remove damaged/disabled vehicle and/or debris from the roads. These are ultimately intended to prevent accidents and other incidents from occurring (preventive management) to ensure safe and smooth flow of expressway traffic.

Primary objectives of regular patrols

① **Collect accurate information related to road traffic and report it to the Traffic Control Center.**

Major types of information collected

I. Road condition
- Existence of Road obstacles (disabled vehicles, debris, fallen objects, etc.)
- Road surface condition

II. Traffic conditions
- Occurrence and prediction of traffic congestion

III. Weather conditions
- Fog, wind, rain, or other weather that interferes with driving

② **Removal of road obstacles (Disabled vehicles, debris, fallen objects, etc.)**
(Whenever the Traffic patrol crews discover road obstacles, remove those articles that may interfere with expressway driving, so that accidents or congestion caused by these articles are prevented.)

2. Preparation of the Patrol Plan

The patrol plan prescribes the frequency and routes for the regular patrols to be conducted based on traffic volume, expressway characteristics and the structure. The patrol plan shall be produced so that the objectives of regular patrols described above can be achieved.

The following items shall be satisfied in producing the patrol plan.

(1) Prerequisites

The average driving speed for regular patrols shall be designated as 50 km/h. For sections where the actual average patrol speed is 50 km/h or above, the speed may be set as 60 km/h.

(2) Key consideration

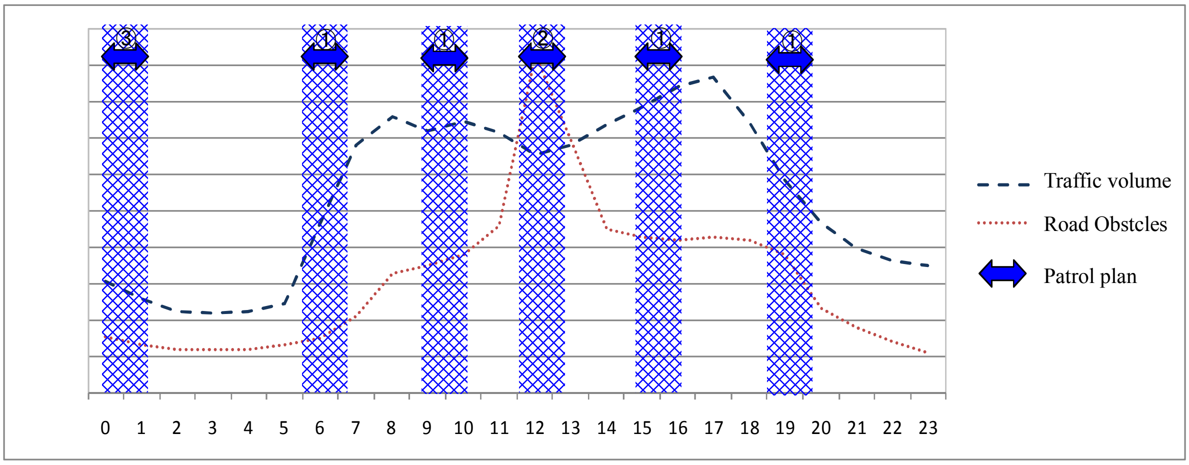
① Patrol time zones shall be so designated for intensive patrol, just before and after the peak hours, through examination of hourly distribution pattern of traffic volume over a day (24 hours）.

② Patrol time zone shall also be designated for intensive patrol at hours when road obstacles are frequently detected.

③ Patrol plan shall carefully be produced to minimize the time length unattended by patrol.

④ Considering the expressway characteristics within the responsible sections, the patrol may also be scheduled so as to attend the high time of occurrence of unusual incidents or changing weather conditions.

Traffic volume / Road obstacles over 1 day



4.2.5 On-road works

4.2.5.1 Glossary of Terms

The terms used in this chapter is defined as enumerated in the table below:

Term	Meaning
Red flags, etc.	Red flags, yellow flags, powerful lights and directing/ guidance batons
Signals	Signals using red flags, voice, or warning whistles For important signals, see separately listed *Attachment table*.
Pointing and calling	Finger-pointing and visually confirming safety before and after each individual task, and using signals. It includes other means of communicating with other traffic patrol crew when necessary, in order to ensure work safety
Monitoring and related activities	Activities that include traffic monitoring, cautioning or guiding traffic, detecting and warning vehicles driving recklessly or entering restricted areas, and providing instructions for evacuation
the Monitor and the Worker	At the site of the On-road work, “Monitor” is the person who is responsible for monitoring and related activities, and “Worker” is the person who is responsible for investigation and works.
Crew 1 and Crew 2	"Crew 1" is the person who is seated in the driver's seat and is responsible for driving and patrol inspections. "Crew 2" is the person who is seated in the assistant driver’s seat or back seat and is responsible for patrol inspections, reporting, and recording.
Obstacle	Accident vehicle, disabled vehicle, objects on the road, road damage, injured persons on the road difficult to be moved, or other items which obstruct traffic
Controlled area	Lanes, etc. where vehicle traffic is restricted by means of traffic control installments
Advance warning point	The point where arrow signs are placed for advance warning, located approximately 60 m in advance of the restriction start point
Start point of Control	The point in the taper section where the traffic control equipment is installed farthest from the patrol vehicle
Taper section	The section beginning from the starting point of control where traffic control equipment is installed at an angle relative to the lanes
Parallel section	The section from the changeover point to the end of the control where the traffic control equipment is installed parallel to the lanes
Changeover point	Location where the taper section changes to the parallel section

4.2.5.2 Code of Conduct During Duty Driving

Traffic patrol crews shall observe the items enumerated below during duty driving.

(1) In order to be able to respond immediately in the event of spotting unusual incident, in general, patrol crews shall drive somewhat toward the right side of the traffic lane (the first lane in the case of a 6-lane section),.

(2) Patrol crews shall drive at a speed which can ensure safety, whenever driving at the speed limit is perceived dangerous, in such instances as; at night, in bad weather, poor visibility, slippery road, and heavy traffic.

(3) During emergency driving, headlights shall be turned on with blazing sirens. As necessary, loudspeakers shall be used to warn other vehicles on the expressway.

(4) Headlights and side lights shall be turned on when driving inside the tunnels.

(5) Whenever merging with or out of the main expressway, or changing lanes, the Crew 2 shall point and call, followed by the Crew 1's calling out, in order to ensure complete checking for safety.

4.2.5.3 Code of Conduct for Parking and Stopping Vehicles

The traffic patrol crews shall observe the items enumerated below when parking or stopping. In order to prevent incidents of rear-end collisions, the traffic patrol crew shall turn on the flashing lights when parking or stopping, and also use the loudspeaker to warn surrounding passing vehicles and encourage customers to evacuate their vehicles.

(1) In general, the traffic patrol crew shall park and stop the vehicles in the positions prescribed by the restriction diagrams contained in the attached "Collection of Traffic Restriction Diagrams". However, when it is dangerous to park vehicles at the position prescribed by the restriction diagram, it is advised to first temporarily stop at the shoulder or other location confirmed as safe and not interfering with work, and then verifying safety and performing traffic restrictions as necessary before moving the vehicle to the position prescribed by the diagram. When stopping on the shoulder, if the shoulder at that location is narrow, stop as close as possible to the left side so that the vehicle does not protrude into the cruising lane.

(2) When parking or stopping, the traffic patrol crew shall engage the parking brake and turn the front wheels of the traffic patrol vehicle toward the shoulder side when stopping at the shoulder side, and toward the median strip when stopping at the median strip side.
When parking or stopping a traffic patrol vehicle on a steep slope, wheel chocks must be used.

(3) When stepping away from a traffic patrol vehicle, as necessary, the traffic patrol crew shall lock the vehicle and place traffic restriction equipment to the rear of it.

4.2.5.4 Code of Conduct for Exiting the Vehicle

The traffic patrol crew shall observe the items enumerated below when exiting the Vehicle.

(1) Exiting the Vehicle Parked or Stopped on the Shoulder Side

When exiting a traffic patrol vehicle that is parked or stopped on the shoulder side, first Crew 2 points and calls to verify safety to the rear, then exits from the right side of the vehicle. Next Crew 1 waits for Crew 2 to point and call to verify safety to the rear, then points and calls himself/herself to verify safety to the rear, and then exits to the left side of the vehicle. However when traffic is heavy or other circumstances make exiting from the left side of the vehicle dangerous, Crew 1 shall also exit from the right side of the vehicle.

(2) Exiting the Vehicle Parked or Stopped on the Median Strip Side

When exiting a traffic patrol vehicle parked or stopped on the median strip side, the first Crew 1 points and calls to verify safety to the rear, then exits from the left side of the vehicle. Then, the Crew 2 waits for the Crew 1 to point and call to verify safety of the rear side, then points and calls himself/herself to verify safety to the rear, and then exits to the right side of the vehicle. However, when the traffic is heavy or other circumstances make exiting from the right side of the vehicle dangerous, Crew 2 shall also exit from the left side of the vehicle.

(3) Exiting the Vehicle Parked or Stopped in a Cruising lane

When exiting a traffic patrol vehicle parked or stopped at the cruising lane of a 4-lane section, or at the first lane or the second lane of a 6-lane section, first point and call to verify safety to the right and left sides of the vehicle, then either Crew 1 or Crew 2 (whomever is on the safe side) points and calls to verify safety to the rear and then exits the vehicle first. After the crew who exited the vehicle first points and calls to verify safety of the rear side, the other crew points and calls to verify safety to the rear side and then exits the vehicle on the safe side.

4.2.5.5 Patrol Crews' Duty Assignment for On-road Operations

When two patrol crews ride the vehicle, on-road work shall be as prescribed by the items enumerated below. However this may not be applicable more than three patrol crews ride.

(1) When the patrol vehicle is parked or stopped on the road shoulder, the "work on the road" shall be done by "Crew 1" assigned to undertake the worker's role while "Crew 2"is assigned to monitor traffic and enforcement

(2) When parked or stopped at the median side (passing) lane , the "work on the road" shall be carried out by "Crew 1" assigned to monitor traffic and enforcement, while "Crew 2" is assigned to undertake worker's role.

(3) When parked or stopped at the cruising lane of a 4-lane section, or at the first lane or the

second lane of a 6-lane section, work shall be carried out with the crew who exited the traffic patrol vehicle first as the monitor and the crew who exited second as the worker.

(4) Exchanging of Roles

"Crew 1" and "Crew 2" shall exchange roles when necessary. However when traffic control is required, roles shall not be switched until installation of the traffic control equipment (used in the taper section when performing traffic control) has been completed.

4.2.5.6 Code of Conduct When Patrol Crews Are Engaged in On-Road Work

The traffic patrol crews shall observe the items enumerated below while engaged in on-road work.

(1) General Items to be Observed

① The patrol crews shall give first priority in securing the safety of the customers and themselves, and shall take action promptly, being aware of places of evacuation, and shall maintain close communications with the other patrol crews on duty.

② When moving parallel to the lanes, in general, movement shall be on the shoulders, median strip of, or off the road.

③ When crossing travel lanes, patrol crews shall point and call in order to check safety of left/right sides, use red flags, etc. while crossing, and run across perpendicular to the lane whenever possible.

④ One patrol crew assigned as a Worker and the Other as a Monitor shall point and call with each other in order to ensure safety before the commencement of and after the executing the "on the road work".

⑤ Traffic patrol crews shall confirm with each other the signals deployed by them versus intended messages for ensuring mutual understanding, and securing the smooth conduct of the work on the road.

(2) Code of Conduct of the Monitor

The monitor shall stand facing toward oncoming traffic in a location on the road shoulder, median strip, or inside a restricted area where he/she can communicate with the workers, while avoiding danger, using red flags, engaged in monitoring and related activities, thereby protecting the safety of the workers until all on-road work is completed. When the monitor detects a danger, he/she shall use the designated signals so that the worker can immediately avoid the danger, and also shall take steps to avoid the danger him/herself.

(3) Code of Conduct for the Worker

The worker shall always keep aware of the place of evacuation, and in general shall face toward the oncoming traffic and perform work during breaks in the traffic flow when safety has been confirmed. When the worker detects a danger, or receives instructions to evade danger from a monitor, the worker shall immediately move to the road shoulder, median strip, off the road, or another safe location.

4.2.5.7 Traffic Control by Traffic Patrol Team

Upon arriving at the scene of unusual incident, the Traffic patrol team shall impose traffic control, as stipulated by the articles enumerated below. However, this may not be the case when the incident was due to an obstacle on the expressway, which can be handled quickly.

4.2.5.7.1 Measures of Traffic Controls

When traffic control is necessary, the Traffic patrol team shall determine the most suitable type of control with a minimum impact on traffic, considering the extent of the expected traffic disturbance and possible scope of adverse impacts during traffic control, as well as the safety of the lanes for travelling vehicles. The Traffic Patrol team shall pay attention to the matter enumerated below during traffic control.

(1) Installing Traffic Control Devices/Equipment

Traffic control devices/equipment shall in general be installed in the positions shown in the control diagrams contained in the collection of “Traffic Control Diagrams”. While transporting the traffic control devices/equipment from the traffic patrol vehicle to the restriction starting point, the devices/equipment may temporarily be placed on the shoulder or median strip close to the planned installation positions.

(2) Procedure for Installing Traffic Control Devices/Equipment

The worker (Crew-1/Crew 2) shall secure own safety by means of signals from the monitor (Crew-1/Crew 2) while moving the traffic control devices/equipment from their temporary position and installing them at the designated position. When imposing traffic control on a section with a taper section, firstly traffic control devices/equipment in the taper section shall be installed, followed by installing them in the parallel section.

(3) Spacing Between Traffic Control Devices/equipment

① Traffic control devices/equipment in the taper section shall be installed with an interval of approximately 10 m each, at as small an angle as possible to the cruising lane.

② Traffic control devices/equipment in the parallel section shall be installed with an interval of approximately 30 m each, so that all the obstacles (debris and damaged vehicles) are within the control area.

③ Traffic control devices/equipment placed perpendicular to the cruising lanes shall be installed at intervals of approximately1.5m each.

4.2.5.7.2 Disengaging Traffic Control

In general when disengaging the traffic control, the Traffic Patrol team shall remove the traffic control devices/equipment in the reverse order when they were initially installed at the imposition of the restriction.

4.2.5.8 Dislodging from the Site

Traffic patrol crews shall observe the items enumerated below and report to the Traffic Control Center before dislodging from the site of on-road work.

4.2.5.8.1 Items that need to be completed before dislodgement

When dislodging from the site of on-road work, duly observe the items enumerated below and report to the Traffic Control Center before leaving.

(1) All the on-road duty tasks performed by patrol crews are completed.

(2) Ascertain that no more monitoring and related activities by the monitor (Crew 1/Crew 2) are necessary in order to ensure the safety of the worker (Crew 1/Crew 2) engaged and travelling vehicles.

4.2.5.8.2 Procedure of Launching Vehicles from the Site

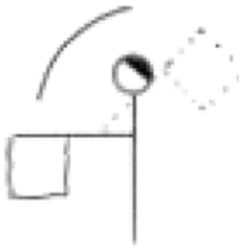
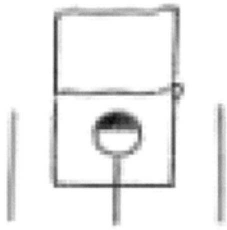
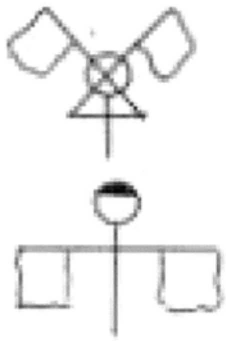
In disengaging all vehicles engaged in traffic control on-road work and withdrawing from the site, the following items are to be observed.

(1) Pay attention to other passing vehicles, and conduct pointing and call to verify safety.

(2) Keep the red warning lights, yellow warning lights, and flashing lights on until the vehicles reach approximately the same speed as other vehicles

(3) Keep the flashing lights on until the vehicles reach approximately the same speed as other vehicles

Attachment

(I) For approaching traffic				
No.	Meaning	Flag Waving		Warning whistle
1	Caution	Slowly wave flag overhead in big motions. (Repeat.)		
2	Proceed with caution.	Bend the elbow to raise flag from in front of the body to behind the head. (Repeat.)		
3	Move to the right (left).	Wave flag in big motions from right (left) to left (right). (Repeat, moving body together with flag.) When returning flag, hold it level.		
4	Slow down.	Hold flag above the head with both hands and then lower it. (Repeat.)		
5	Stop.	Cross flags above the head several times, then hold flags level and still. (If using only one flag, use your hand in place of the other flag.)		Multiple short whistles (Repeat extremely forcefully.) Pi! Pi! Pi!

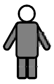
(II) For on-site workers				
No.	Meaning	Hands/flags		Warning whistle
1	Attention OK	Raise hand (flag) straight over the head and hold it there.		1 long whistle (Continue until other party notices.) Piiiiii!
2	Start the work.	Lower hand (flag) from overhead.		1 short whistle Pi!
3	Stop the work. End of work.	Cross hands (flags) in front of the body.		1 long whistle (Continue until other party notices.) Piiiiii!
4	Caution	Same as (I)-1	Same as at left	Multiple long whistles (Repeat forcefully.) Piiiiii!
5	Danger Run to a safe place.	Wave hand (flag) forcefully side to side over the head. (Repeat.)		Multiple short whistles (Repeat extremely forcefully.) Pi! Pi! Pi!

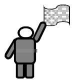
A Collection of Traffic Control Diagrams

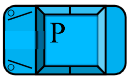
(Meanings of symbols)

 ···· Color cone

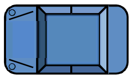
 ···· Arrow sign

 ···· Worker

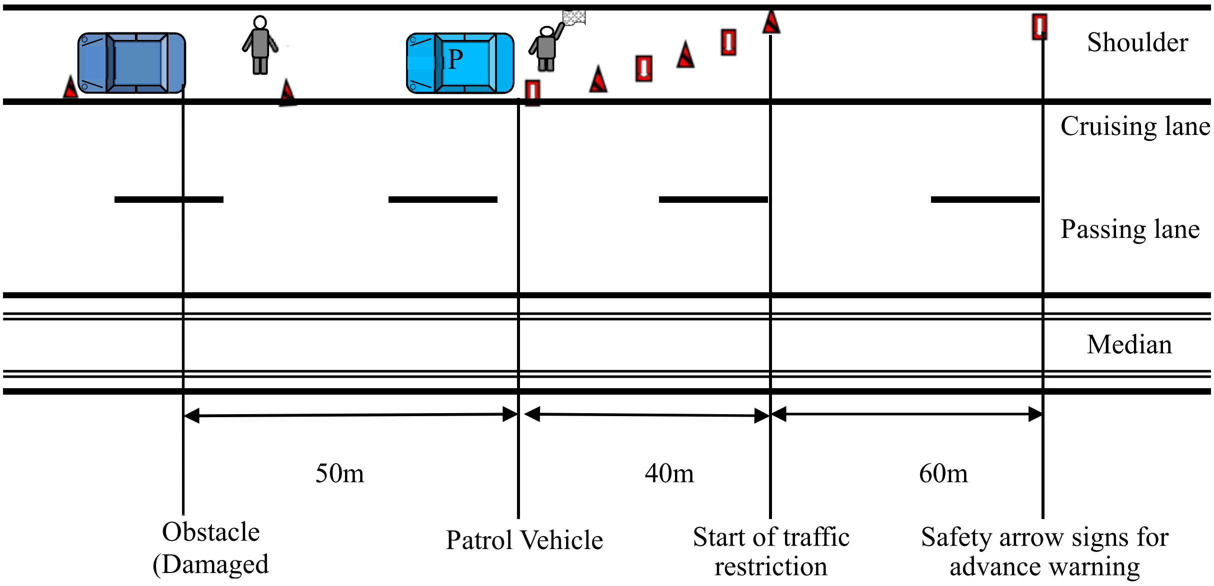
 ···· Monitor



···· Patrol Vehicle

 ···· Obstacle

■Shoulder control



① Patrol vehicle shall park on the shoulder approximately 50 m behind the obstacle.

② Patrol crews assigned as a worker and a monitor shall move to the point on the shoulder approximately 40 m behind the patrol vehicle.

③ The patrol crew assigned as a monitor shall further proceed to reach the point approximately 60m behind the start point of control, and shall install arrow sign devices/equipment on the shoulder in order to warn approaching vehicles. During that time, the worker shall perform monitoring and related activities.

④ After the work described in ③ is completed, the monitor shall start monitoring and related activities inside the advance warning point.

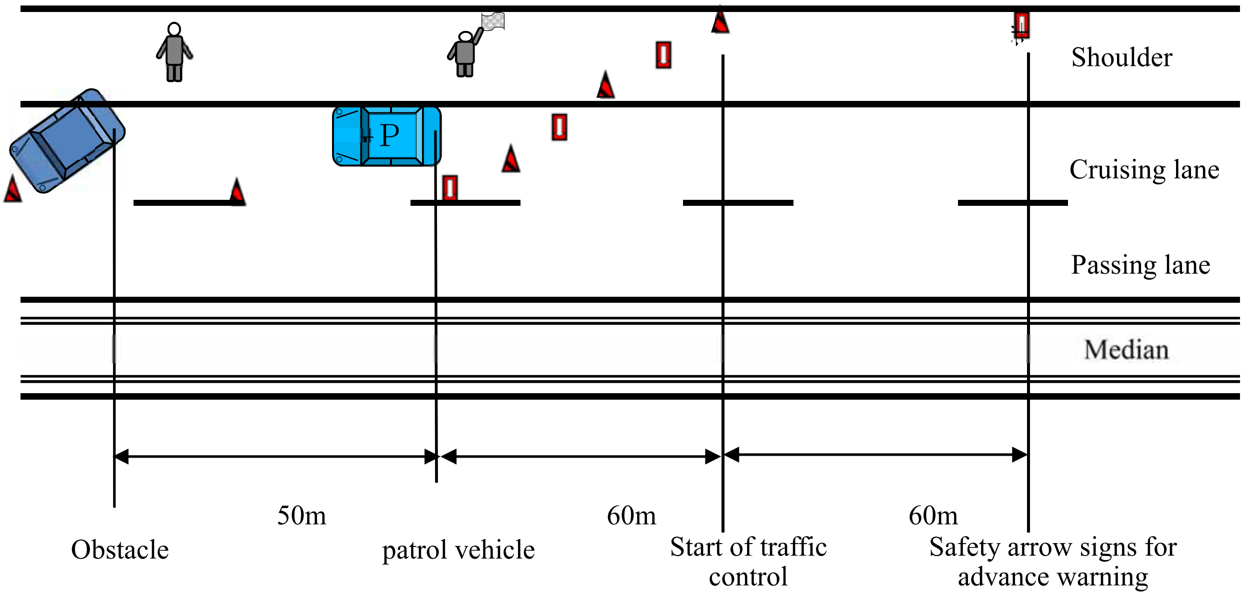
⑤ The worker shall install traffic control devices/equipment (color cones) behind the patrol vehicle, at a distance of approximately 40 m, in a way that the color-cones cross the shoulder diagonally

⑥ After the worker completes the work described above ⑤ the monitor shall move and stay inside the restricted area, and resume monitoring and related activities.

⑦ The worker shall install the traffic control devices/equipment in a line, parallel to the lane until they reach in front of the obstacle.

⑧ The worker shall report the conditions of the obstacle to the Traffic Control Center.

■Traffic lane control



① Patrol vehicle shall park approximately 50m behind of the obstacle.

② The worker and the monitor shall move to the point on the shoulder approximately 60 m behind the patrol vehicle.

③ The monitor shall further proceed to reach the point approximately 60 m behind the beginning point of the control, and shall install arrow signs on the shoulder in order to warn approaching vehicles. During delivering the task, the worker shall perform monitoring and related activities

④ After the task ③ is completed, the monitor shall proceed to the zone inside the advance warning point and resume monitoring.

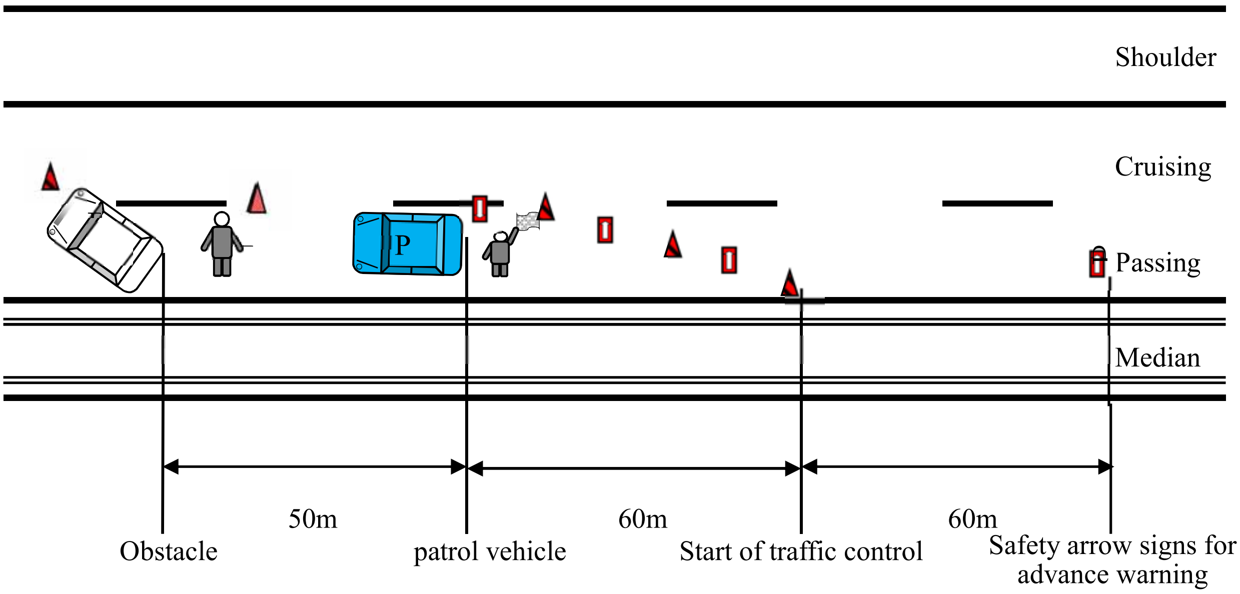
⑤ While the monitor resume monitoring and related activities as described in ④, the worker shall install color-cones approximately 60m behind the patrol vehicle in a way that the color-cones cross the shoulder diagonally..

⑥ After the above task ⑤ is completed, the monitor shall move and stay inside of the controlled area, and resume monitoring and related activities.

⑦ The worker shall place colored cones in a line up to the point of obstacle, in parallel with the lane.

⑧ The worker shall report the conditions of the obstacle (debris and the damaged vehicle) to the Traffic Control Center.

■Passing lane control



① A patrol vehicle shall park approximately 50m behind the obstacles (damaged vehicle and debris).

② The worker and the monitor shall move to the point on the shoulder approximately 60 m behind the patrol vehicle.

③ The monitor shall further proceed to reach the point approximately 60 m behind the beginning of the control point, and shall install arrow signs near the median strip in order to warn approaching vehicles. While the monitor is delivering the task, the worker shall undertake monitoring and related activities.

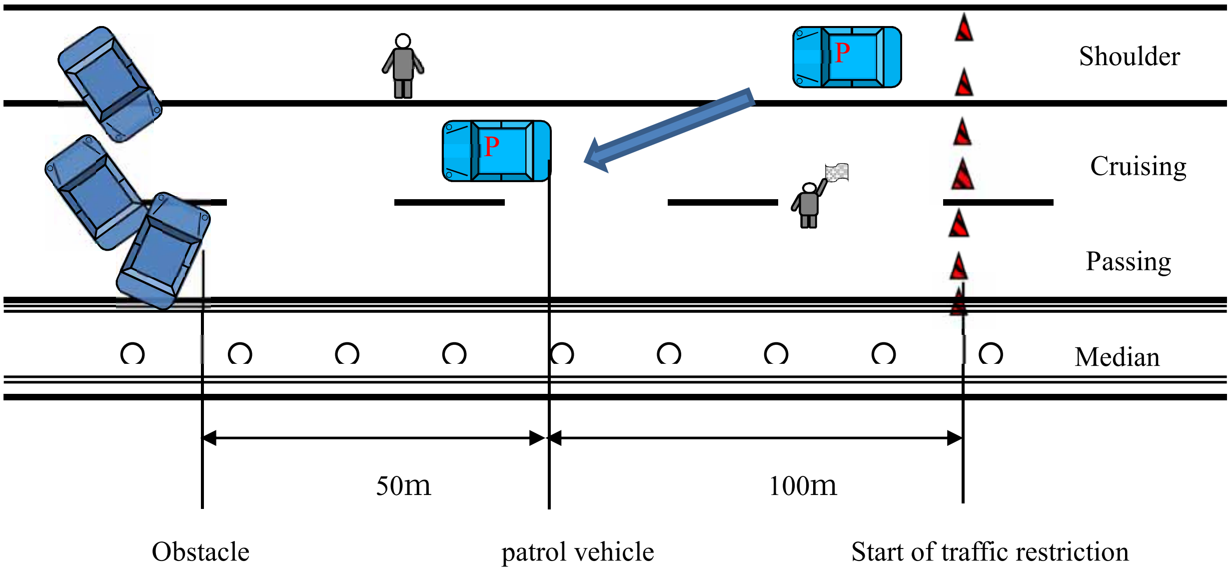
④ After the above task ③ is completed, the monitor shall resume monitoring and related activities staying inside of the advance warning point.

⑤ The worker shall install traffic control devices/equipment behind the patrol vehicle, over the length of approximately 60 m, in a way that the devices/equipment to cross the passing lane diagonally from the edge of the median strip..

⑥ After the worker completes the above task ⑤, the monitor shall move and stay inside of the restricted area, and resume monitoring and related activities.

⑦ The worker shall install the traffic restriction devices/equipment parallel to the lane until it passes over the obstacle. The worker shall report the conditions of the obstacle to the Traffic Control Center.

■Road closure on site



① Patrol vehicle shall stop approximately 100m behind the obstacle. If the flow of traffic on the main expressway road is being blocked, this shall be done in a way that fits the circumstances.

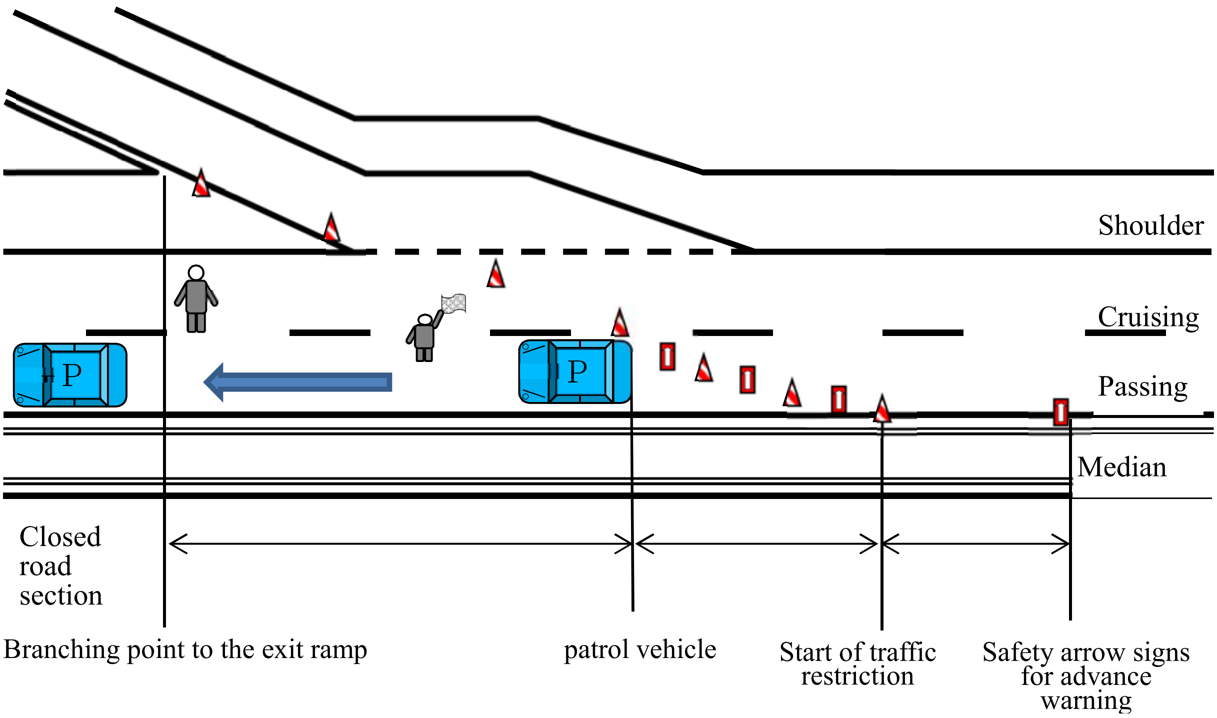
② The monitor and worker shall stand behind the patrol vehicle, with red flags in hand to direct approaching vehicles to slow down and stop.

③ The monitor and worker shall confirm that vehicles on the road are slowing down and safety is secured After the work described in completed, the worker shall install traffic control devices/equipment perpendicular to the lanes, beginning from the shoulder toward the median, behind the patrol vehicle (or starting from the median in case that the restriction is changed from passing lane restriction to road closure).

④ After installing the traffic control devices/equipment is completed, the monitor shall make the necessary announcements to the stopped vehicles and conduct monitoring and related activities while staying inside the control area.

The worker shall report the conditions of the obstacles (debris and the damaged vehicles) to the Traffic Control Center, and shall move the patrol vehicle to the position approximately 50 m behind the obstacles.

■Road closure between the ICs



① Patrol vehicle shall stop on the passing lane approximately 150m behind the branching point to the exit ramp.

② The worker and the monitor shall move to the point on the median strip, approximately 60 m behind the patrol vehicle.

③ The monitor shall further proceed to reach the median strip, approximately 60 m behind the beginning of the control point, and shall install the warning signal arrow signs.

④ When the above task ③ is completed, the monitor shall conduct monitoring and related activities inside the advance warning point, and shall direct approaching traffic to slow down and guide them to the exit ramp, with red flags in hand

⑤ After the monitor has started the monitoring and related activities described in ④, the worker shall confirm that vehicles on the road are slowing down and that safety is secured, followed by installing traffic control devices/equipment in sequence in a way that the equipment crosses lanes, diagonally, starting from the point on the median strip approximately 60m behind where the patrol vehicle to the point where patrol vehicle is parked

⑥ After the above task ⑤ is completed,

・ The worker shall move the patrol vehicle forward and park it there.

・ The monitor shall perform monitoring and related activities while staying inside the control area.

⑦ The worker guides and controls traffic flow at the place where the patrol vehicle is parked. The worker shall report to the Traffic Control that the disengaging control is complete..

4.3 Traffic Control (Excluding ITS)

4.3.1 General

4.3.1.1 Code of Conduct

The traffic control operators engaged in Traffic Control shall, at all times, deliver duties of ensuring the safe and smooth traffic flow on the expressway, and shall observe the code of conduct enumerated below.

(1) Traffic control operators shall maintain close communication with the police department, fire department, and other related agencies, and cooperate with them.

(2) Traffic control operators shall comprehend the current traffic conditions in the area of responsibility through the Traffic Patrol Team or related agencies.

(3) Traffic control operators shall respond to inquiries and reports received by the Traffic Control Center.

(4) The equipment used for works shall be operated correctly and quickly in accordance with the designated procedures.

(5) If the equipment used for works has failed, and it is not possible to carry out the work, or if an abnormality in the equipment is detected, it shall be replenished or replaced immediately.

(6) Except inevitable necessity, leaving the position is not allowed during duty hours. If it is necessary for inevitable reasons, the approval from one of the other traffic control operators shall be obtained.

And duty shift changeover shall be carried out promptly, and there shall be no interruption with duty work resulting from shift changeover

(7) At the end of the shift, the details of works performed and other necessary items shall be recorded in a daily work report. In shift changeover briefing, records of the daily work shall be confirmed by both parties.

4.3.1.2 Control of Traffic Control Crews

The traffic Control Center shall give necessary instructions to the Traffic Patrol crews, and receive necessary reports from them, by radio communications or by other means.

4.3.1.2.1 Locating the position of the Patrol Vehicle

The traffic Control Center shall receive the report on respective items cited below from the Traffic patrol crews by means of wireless phones or by other means, in order to confirm the positions of the Patrol Vehicle.

(1) Embarking on and disengagement from the patrol duties

(2) The time of the incidences of patrol vehicle's passing through the interchange and junction
(3) Arrival at and disengagement from the scene of unusual incident to be handled

4.3.1.2.2 Wireless Communications

The Traffic Control Center shall pay attention to the matter enumerated below when they uses wireless equipment,

(1) When using radio communications, traffic control operators shall only conveys key points, briefly and accurately.
(2) If the communicated message is understood, the traffic control operator receiving the call shall respond, saying "Roger" as a sign of understanding.
(3) If Traffic Control operator has difficulty understanding what the other party says, or if traffic control operator misses it, he/she shall endeavor to confirm the content of the communication to understand it accurately.
(4) When communications from multiple mobile stations are received at the same time, the traffic control operator shall communicate with one mobile station, instructing the other mobile station to "Hold", and maintain control over communications.
(5) When an "Urgent" communication request is received from a mobile station, traffic control operator shall stop the communication with the other mobile station and communicate with the mobile station requesting an urgent communication.

4.3.1.2.3 Record of the report

Duty operators at the Traffic Control Center shall record the contents of communication with the Traffic patrol crews.

4.3.2 Comprehending the Traffic Conditions

The Traffic Control Center shall be held responsible for collecting information from the Traffic Patrol crews, travelling vehicles, and other relevant agencies, and are responsible for comprehending the current traffic conditions in the area of responsibility.

4.3.2.1 Collecting Relevant Information from the Traffic Patrol Crews on Duty

The Traffic Control shall receive reports of the traffic condition, weather conditions and road conditions from the Traffic Patrol crews on duty. If an unusual incident occurs, the Traffic Control Center shall receive a detailed report specified in the chapter 4.4.

4.3.2.2 Traffic information gathering from travelling vehicles

Whenever the Traffic Control Center receives a report from the travelling vehicle, attention shall be paid to the matter enumerated below.

(1) The Traffic Control Center shall process the call in an efficient way.

(2) In confirming the reported facts over the communication link, the traffic control operators shall take initiatives in raising questions and confirm the fact as accurately and concisely as possible.

(3) If multiple calls arrive at the same time, the traffic control operators shall make sure not to be confused, and take necessary actions, such as giving priority to one call based on the importance of the contents while placing the other call on hold.

4.3.2.3 Traffic information collection from related Agencies

The Traffic Control Center shall exploit all available means to collect expressway traffic information from the police department, the fire department, and other related agencies. The Traffic Control Center shall not disclose to other parties the contents obtained from radio communication with police crews or with any police-related information learned during the course of the duty work.

4.3.3 Traffic information dissemination

The Traffic control Center shall undertake the following actions when such expressway information is received as shown below

(1) In principle, the traffic control operator shall immediately transfer messages to the Traffic patrol crews..

(2) If indications are that the situation could potentially hinder safe and smooth traffic, the traffic control operator shall notify the police department of such an incident immediately.

(3) When a report on an unusual incident is received, the Traffic Control Center shall take necessary actions stipulated by the rules of chapter 4.4.

4.4 Countermeasures to be taken against unusual incidents

4.4.1 Traffic accidents

4.4.1.1 Role of the Traffic Patrol Crews

Whenever the traffic patrol crews encounter a traffic accident, or when they receive instructions for emergency mobilization from the Traffic Control Center and arrive at the scene of the traffic accident, they shall respond by taking measures and report it as prescribed below.

4.4.1.1.1 Details on Measures To be Taken

At the traffic accident scene, traffic patrol crews shall deliver duties as enumerated below. At the accident scene, top priority shall be given to protection of life and safety of persons involved, and to taking urgent measures most suitable under the circumstances.

(1) When traffic patrol crews arrives close to the traffic accident scene, traffic patrol crews shall use loudspeakers to make the public aware of the incident and of enforcement measures being taken as follows.

① Targeting at vehicles travelling by the accident scene, alert them that the patrol vehicle (s) are stopping or parking at the site (excluding those making emergency stops)

② Targeting at persons involved in the accident, evacuate them off-the-road to a safer place.

(2) If the traffic control is deemed necessary, traffic patrol crews shall execute necessary measures as prescribed in the chapter 4.2.5.

(3) Traffic patrol crews shall rescue injured persons, and guide people to a safe place off-the -road. However depending on the severity of the injury, there are cases when the injured persons shall not be moved unless prior diagnosis indicates it will not worsen their injury. Be sure to carefully examine the conditions of the injured before assisting them to be evacuated or providing them with first aid.

(4) Traffic patrol crews shall investigate and check the items enumerated below

① Number of vehicles involved and positions where accident vehicles are stopped

② Types and model of accident vehicles and the severity of the damage

③ Vehicles loaded with hazardous substances and/or substances of potential leakage

④ Conditions of the injured persons

⑤ Damage to the road or road accessories, ⑥ Objects/debris scattered on the road

⑦ Traffic conditions

⑧ Supplementary information on unusual incidents

(5) Traffic patrol crews shall undertake the following tasks enumerated below.

① In case of a minor fire, extinguish the fire using portable fire extinguishers.

② If scattered obstacles/debris on the road is manageable, relocate the objects off-the-road where they will not interfere with the traffic. If removal of obstacles/debris is deemed beyond the capacity of the traffic patrol crews, they shall ask the Traffic Control Center to dispatch workers from maintenance and repair unit. And if obstacles are deemed to be associated with the accident or crime, the permission of the police department or an order from the Traffic Control Center shall be obtained.

③ In handling minor road surface contamination, the patrol crews shall undertake an urgent cleansing of the road surface. If cleansing operation is unsuccessful, traffic patrol crews shall report to the Traffic Control Center and request dispatch of workers of maintenance and repair unit.

④ Cooperate with the emergency medical department or other agencies in their rescue operation.

⑤ Cooperate with accident investigations conducted by the police department or other agencies.

⑥ If mobilization of a vehicle towing service is deemed necessary, urge the occupants of the accident vehicle to ask the towing company for a towing service. If they are unwilling to seek assistance of particular towing service provider, traffic patrol crews shall report the fact to the Traffic Control Center.

⑦ When removing the accident vehicle with a towing vehicle, the traffic patrol crews shall supervise the work.

⑧ Other tasks to be delivered on instructions from the Traffic Control Center

⑨ Other matters that can be handled by the traffic patrol crews by themselves. If the traffic patrol crews are unable to execute the task, traffic patrol crews shall report to the Traffic Control Center and demand assistance of workers who are used to be engaged in maintenance and repair.

4.4.1.1.2 Items to be Reported

At the traffic accident scene, traffic patrol crews shall report the items enumerated below to the Traffic Control Center.

(1) Location (kilometer post on inbound/outbound route) of the incident
(2) Number of deaths or injuries and the status of the injuries
(3) Need for and required number of ambulances
(4) General situation of the traffic accident
(5) Number and the model of accident vehicles, and the severity and extent of the damage
(6) Need for and required number of towing vehicles
(7) Flow of traffic at the accident site
(8) Need for and required type of traffic control
(9) Damage to the road or road accessories, or the situation where debris scattered on the road
(10) Need for and required number of maintenance/cleaning personnel, required type and required number of cleaning vehicles
(11) Name, property and quantity of the hazardous and/or difficult-to-handle substances carried by the accident vehicle, if any
(12) Name and quantity of cargo carried by the accident vehicle which needs to be disposed of immediately, if any
(13) Other necessary items

4.4.1.2 The Roles of Traffic Control Center

When a traffic accident occurs, the Traffic Control Center shall take necessary actions as prescribed below.

4.4.1.2.1 Initial Response

When an initial report on the traffic accident is received, the Traffic Control Center shall confirm the facts and take necessary actions as prescribed below.

(1) When an initial report on the traffic accident is received, the Traffic Control Center shall confirm the items listed below.
 ① Road name
 ② Inbound or outbound route
 ③ Kilometer post
 ④ Description of the accident

⑤ Need for ambulance

⑥ Whether or not the accident vehicle can run

⑦ Other items thought to be necessary in order to respond to the traffic accident

(2) When a report on a traffic accident is received, the Traffic Control Center shall immediately notify responsible police department of checked items and request mobilization.

(3) If the accident situation suggests that the traffic accident requires mobilization of a fire engine or ambulance, the Traffic Control Center shall immediately request mobilization of such vehicles from the responsible fire department.

(4) If the situation suggests that the traffic accident demands mobilization of the Traffic Patrol crews, the Traffic Control Center shall immediately instruct the Traffic Patrol Team to hurry.

(5) If the situation suggests that the traffic accident demands alerting passing vehicles of the incident, the Traffic Control Center shall notify it of adjacent toll gates.

(6) If the situation suggests that the traffic accident incident is needed to be notified to other related agencies, the Traffic Control Center shall do so.

4.4.1.2.2 Follow up Actions

When the Traffic Patrol crews arrives at the site of the traffic accident, the Traffic Control Center shall order them to check and take necessary actions as listed below.

(1) The Traffic Control Center shall check the items listed below.

① Location (kilometer post on inbound/outbound route) of the incident

② Number of deaths or injuries and condition of injuries

③ Need for and required number of ambulances

④ Details and particulars of the traffic accident

⑤ Number and types of accident vehicles, and condition of the damage

⑥ Need for and required number of towing vehicles

⑦ Traffic condition around the site

⑧ Need for and required type of traffic control

⑨ Damage to the road or road accessories, or condition of debris scattered on the road

⑩ Need for and required number of maintenance/cleaning personnel, required type and required number of cleaning vehicles

⑪ Name, property and quantity of the hazardous or difficult-to-handle substances carried by the accident vehicle, if any

⑫ Name and quantity of cargo carried by the accident vehicle which needs to be disposed of immediately, if any

⑬ Other necessary items

(2) The Traffic Control Center shall immediately notify the responsible police department of the facts confirmed by the Traffic Patrol Team.

(3) If the report from the Traffic Patrol crews suggests that mobilization of a fire engine or ambulance is needed, the Traffic Control Center shall immediately request mobilization of such vehicles from the responsible fire department.

(4) If the report from the Traffic Patrol crews suggests that alerting passing vehicles of the incident is necessary, the Traffic Control Center shall notify the incident to the adjacent toll gates.

(5) If the report from the Traffic Patrol crews suggests that mobilization of a towing vehicle is necessary, the Traffic Control Center shall notify the towing company of the incident.

(6) If the report from the Traffic Patrol Crews suggests that mobilization of maintenance and repair personnel is necessary, the Traffic Control Center shall notify the incident to the maintenance and repair unit.

(7) If the report from the Traffic Patrol Crews suggests that alerting other responsible agencies of the incident, the Traffic Control Center shall do so.

4.4.2 Disabled Vehicles

4.4.2.1 Role of Traffic Patrol Crews

When the traffic patrol crews encounters a disabled vehicle, or when they receive a command for emergency mobilization from the Traffic Control Center and arrive at the site of the disabled vehicle, they shall handle it and report as prescribed below.

4.4.2.1.1 Details of handling

At the site of the disabled vehicle, traffic patrol crews shall deliver the duties enumerated below.

(1) When traffic crews arrive close to the site of the disabled vehicle, traffic patrol crews shall use loudspeakers to make public announcements and emergency measures as below.

① Announcing the publics and the travelling vehicles in its vicinity on the situation that the patrol vehicles are stopping or parking (Such announcement shall not be done when patrol vehicles are making emergency stops)

② Evacuating persons involved in the disabled vehicle off of the road or transporting them to another safe location

(2) If the situation leads to traffic control, traffic patrol crews shall control traffic as prescribed in chapter 4.2.5

(3) Traffic patrol crews shall investigate and check the items as listed below

① Position where the disabled vehicle is stopped

② The type of the disabled vehicle and description of trouble

③ Whether or not the cargo contains hazardous substances

④ Whether or not asking for the service of a tow operator or a repair shop

⑤ Traffic conditions

⑥ Other unusual incidences involved with the accident

(4) Traffic patrol crews shall undertake the following tasks as below.

① In mobilizing a towing service, urge the persons charged with the accident vehicle to request the service of the tow and removal. If they do not wish to have a towing service, the traffic patrol crews shall report the fact to the Traffic Control Center.

② Traffic patrol crews shall be engaged in watch and alert at the rear of a disabled vehicle, upon an instruction from the Traffic Control Center, in the event that the lives of the on-board occupants are exposed to such risks as passengers aboard the bus, the vehicle loaded with hazardous substances, or in anticipation of longer repair time.

③ When removing the disabled vehicle with a towing vehicle, the traffic patrol crews shall supervise the operation. If supervision is deemed not necessary in ensuring the safety of occupants of the disabled vehicle, or safe travel of passing traffic, the patrol crews can offload such a duty.

④ Other duties as demanded by instructions from the Traffic Control Center

4.4.2.1.2 Items to be reported

At the scene of the disabled vehicle, traffic patrol crews shall report the items enumerated below to the Traffic Control Center.

(1) Location (kilometer post on inbound/outbound route) of the disabled vehicle

(2) Model of disabled vehicle

(3) Causes of the vehicle disabled

(4) Location where the vehicle stopped and the status of the stopped vehicle

(5) Traffic situation around the site
(6) Need for and required type of traffic control
(7) Need for staff from a repair shop
(8) Need for and required number of towing vehicles
(9) Name, property and quantity of the hazardous or difficult-to-handle substances carried by the accident vehicle, if any
(10) Other items

4.4.2.2 Role of the Traffic Control Center

Upon receipt of a report on an incident of disabled vehicle, the Traffic Control Center shall take necessary actions in the following.

4.4.2.2.1 Initial Response

When a report on an incident of a disabled vehicle is received, the Traffic Control Center shall check and take necessary actions as below.

(1) When a report on an incident of a disabled vehicle is received, the Traffic Control Center shall check the items listed below.
  ① Road name
  ② Inbound or outbound route
  ③ Kilometer post
  ④ Positions where a disabled vehicle is stopped
  ⑤ Description on causes of vehicle disabled
  ⑥ Need for towing vehicles
  ⑦ Other items thought to be necessary in order to respond to the disabled vehicle
(2) If the situation suggests that the disabled vehicle indicates the risk of a secondary accident or matters under the jurisdiction of police department, the Traffic Control Center shall immediately notify the responsible police crews of said incident.
(3) If the situation suggests that the disabled vehicle demands mobilization of fire department, the Traffic Control Center shall immediately request mobilization of such vehicles from the responsible fire department.
(4) If the situation suggests that the disabled vehicle requires mobilization of the Traffic Patrol Team, the Traffic Control Center shall immediately instruct the dispatch of the Traffic Patrol Team.
(5) If the situation of the disabled vehicle suggests that travelling vehicle need to be alerted,,

the Traffic Control Center shall notify the incident to adjacent toll gates.

(6) If the situation suggests that the disabled vehicle needs mobilization of a towing vehicle, the Traffic Control Center shall urge the driver or occupants of the disabled vehicle to seek the service of the towing company. If they do not specify a particular towing company of their choice, the Traffic Control Center shall appoint a towing company for service delivery.

(7) If the situation of the disabled vehicle suggests that other jurisdictional authority shall intervene, the Traffic Control Center shall notify the incident to relevant authorities.

4.4.2.2.2 Follow up actions

When the Traffic patrol crews arrives at the site of the disabled vehicle, the Traffic Control Center shall order the crews to check and take necessary actions based as prescribed below.

(1) The Traffic Control Center shall check the items listed below.

① Location (kilometer post on inbound/outbound route) of occurrence

② Type of disabled vehicle

③ Causes of vehicle disabled

④ Location where the vehicle stopped and the condition of the stopped vehicle

⑤ Traffic condition around the site

⑥ Need for and required type of traffic control

⑦ Need for a service of a repair shop

⑧ Need for and required number of towing vehicles

⑨ Name, property and quantity of the hazardous or difficult-to-handle substance carried by the disabled vehicle, if any

⑩ Other necessary items

(2) If the situation report from the Traffic Patrol crews suggests the necessity for mobilization of the police department, the Traffic Control Center shall immediately notify the responsible police department of the incident.

(3) If the situation report from the Traffic Patrol crews suggests the necessity for mobilization of a fire engine, the Traffic Control Center shall immediately request mobilization of such vehicles from the responsible fire department.

(4) If the situation report from the Traffic Patrol crews suggests the necessity of alerting passing vehicles, the Traffic Control Center shall notify adjacent toll gates of the incident.

(5) If the situation report from the Traffic Patrol crews suggests the necessity for mobilizing a

towing vehicle, the Traffic Control Center shall notify the towing company of the incident..

(6) If the situation report from the Traffic Patrol crews suggests the necessity for mobilization of maintenance and repair unit, the Traffic Control Center shall notify the unit of the incident.

(7) If the situation report from the Traffic Patrol crews suggests the necessity to alert other responsible agencies of the incident, the Traffic Control Center shall notify them of the incident.

4.4.3 Road Obstacles

4.4.3.1 Role of the Traffic Patrol Crews

When the traffic patrol crews encounters road obstacles, or when they mobilized themselves on command from the Traffic Control Center, and arrived at the road obstacle site, they shall deliver duties to handle the situation and report it to the Traffic Control Center as prescribed below.

4.4.3.1.1 Details of handling

At the site of the road obstacle, traffic patrol crews shall perform the works enumerated below.

(1) When traffic patrol crews arrives close to the location where the road obstacle will be handled, traffic patrol crews shall use loudspeakers to make the public aware of the obstacle and exercise enforcement as enumerated below.

・Notify surrounding passing vehicles of presence of the patrol vehicle stopped or parked (except for the events of patrol vehicle's emergency stop or park)

(2) Traffic patrol crews shall relocate objects on the road to the shoulder, off of the road, or to another location where they do not interfere with traffic. If removal is beyond the crews' capacity, traffic patrol crews shall report to the Traffic Control Center and demand assistance of workers from maintenance and repair unit. And if obstacles suggest an association with the accident or crime, the permission of the police department or order from the Traffic Control Center is required for the removal.

(3) If traffic control is deemed necessary to remove on-road obstacles, traffic crews shall perform it as prescribed in chapter4.2.5.

(4) When traffic control is deemed not necessary in removing obstacles, traffic patrol crews

shall remove them as prescribed below

① When it is possible to safely stop the vehicle in front of the obstacle after the object on the road was discovered, in general, traffic patrol crews shall stop the patrol vehicle on the shoulder or in another safe location approximately 50 m in front of the object on the road. If it is not possible to stop the patrol vehicle safely in front of the obstacle because the obstacle was discovered too late, traffic patrol crews shall stop the vehicle on the shoulder or in another safe location at a distance beyond the object on the road. Care shall be taken not to make a sudden stop or take any other action that would interfere with the flow of traffic.

② The monitor shall in general be engaged in monitoring and related activities staying at the shoulder or median strip, at a position approximately 50 m behind the workers, and shall guarantee safety before giving the workers the signal to commence work. Even on receipt of the signal to start work from the monitor, the workers shall confirm own safety before commencing the work.

(5) If the road obstacle is a valuable one, the traffic patrol crews shall recover and store it in the traffic patrol vehicle, and shall obtain instructions from the Traffic Control Center. Traffic patrol crews must abandon their claims to valuables that are acquired during the course of duty work.

4.4.3.1.2 Items to be reported

At the site of the obstacles on the expressway, traffic patrol crews shall report the items enumerated below to the Traffic Control Center.

(1) Location (kilometer post on inbound/outbound route) of the obstacles detected
(2) Type and shape of road obstacles
(3) Traffic condition around the site
(4) Need for and required type of traffic control
(5) Need for and required number of trucks to load and haul obstacles
(6) Other necessary items

4.4.3.2 The Role of the Traffic Control Center

When detection of a road obstacle is reported, the Traffic Control Center shall take necessary actions based as prescribed below.

4.4.3.2.1 Initial Response

When detection of the road obstacle is reported, the Traffic Control Center shall order the traffic patrol crews to check and take necessary actions based as prescribed below.

(1) When detection of a road obstacle is reported, the Traffic Control Center shall order the traffic patrol crews to check the items listed below.

① Road name

② Inbound or outbound route

③ Kilometer post

④ Type and shape of road obstacles

⑤ Other items thought to be necessary in order to respond to the road obstacle

(2) If the situation suggests that the road obstacle represents a risk of secondary accident or matters of police jurisdiction, the Traffic Control Center shall immediately notify the responsible police department of the obstacles.

(3) If the situation suggests that the road obstacle demands mobilization of a fire engine, the Traffic Control Center shall immediately request mobilization of such vehicles from the responsible fire department.

(4) If the situation suggests that the road obstacle demands mobilization of the Traffic patrol crews, the Traffic Control Center shall immediately instruct the Traffic Patrol Team to hurry to the scene.

(5) If the situation suggests that the travelling vehicles need to be aware of the road obstacle, the Traffic Control Center shall notify it to toll gates.

(6) If the situation suggests that the road obstacle demands mobilization of workers of maintenance and repair unit, the Traffic Control Center shall notify the unit of the incident..

(7) If the situation suggests that other related agencies shall be aware of said road obstacle, the Traffic control Center shall notify them of the incident.

4.4.3.2.2 Follow up actions

When the Traffic Patrol crews arrives at the road obstacle scene, the Traffic Control Center shall order them to check and take necessary actions based as prescribed below

(1) The Traffic Control Center shall instruct the Traffic Patrol crews to check the items listed below.

① Location (kilometer post on inbound/outbound route) of obstacles occurrence

② Type and shape of road obstacles

③ Traffic condition around the site

④ Need for and required type of traffic restriction

⑤ Need for and required number of trucks for loading and hauling obstacles

⑥ Other necessary items

(2) If the report from the Traffic Patrol crews suggests that mobilization of police is necessary, the Traffic Control Center shall immediately notify it to the responsible police department.

(3) If the report from the Traffic Patrol crews suggests that mobilization of a fire engine is necessary, the Traffic Control Center shall immediately demand mobilization of such vehicles from the responsible fire department.

(4) If the report from the Traffic Patrol crews suggests that the travelling vehicles shall be aware of the incident, the Traffic Control Center shall notify toll gates of the incident.

(5) If the report from the Traffic Patrol crews suggests mobilization of workers engaged in maintenance and repair is necessary, the Traffic Control Center shall notify the workers of the incident.

(6) If the report from the Traffic Patrol crews suggests that other related agencies need to be aware of the incident of road obstacle, the Traffic Control Center shall notify them of the incident.

4.4.4 Vehicle on fire

4.4.4.1 The Role of the Traffic Patrol Crews

When traffic patrol crews encounter a vehicle on fire, or when they receive instructions for emergency mobilization from the Traffic Control Center and arrive at the site of the vehicle fire, they shall handle and report as prescribed below.

4.4.4.1.1 Details of handling

At the site of the vehicle on fire, traffic patrol crews shall perform the works enumerated below. At the work site, top priority shall be given to protection of life and safety, and the prioritize measures that are most appropriate for the circumstances.

(1) When traffic patrol crewss arrive close to the location where the vehicle fire will be handled, traffic patrol crewss shall use the loudspeakers to make the public aware of the incident and enforcement measures as below.

① Making aware passing vehicles of the presence of the patrol vehicle stopped or parked (except for parking vehicles making emergency stops)

② Evacuating personnel involved in the vehicle on fire off-the-road or to another safe location

(2) If traffic control is deemed necessary, the traffic control crews shall impose control as prescribed in chapter4.2.5.

(3) Traffic patrol crews shall rescue injured persons, and guide people to a safe place off-road. However depending on the conditions of the injured, there are cases when the injured person must not be moved unnecessarily. Be sure to carefully examine the conditions of the injured before assisting evacuation or providing first aid.

(4) Traffic patrol crews shall investigate and check the items enumerated below

① Number of vehicles on fire and positions where vehicles on are stopped

② Types of vehicles on fire, and condition of the damage

③ Presence of vehicles carrying hazardous substances and potential leakage

④ Presence and conditions of the injured

⑤ Damage to the road or road accessories

⑥ Conditions of objects on the road

⑦ Traffic conditions

⑧ Other unusual conditions

(5) Traffic patrol crews shall perform the works enumerated below.

① In case of a minor fire, extinguish the fire using portable fire extinguishers.

② If the vehicle suffers minor fire, relocate the object to the shoulder or other location where they will not interfere with the traffic. If it is impossible, traffic patrol crews shall report to the Traffic Control Center and demand dispatching workers from the maintenance and repair unit to assist removal and clearance. And if the causes of fire suggest an association with an incident or crime, the permission of the police or order from the Traffic Control Center shall be obtained for the removal.

③ In case of minor fouling, perform temporary cleaning of the road surface. If it is impossible, traffic patrol crews shall report to the Traffic Control Center and demand an assistance of workers from the maintenance and repair unit.

④ Cooperate with the fire-fighting activities by the fire department or other agencies

⑤ Cooperate with rescue activities conducted by the medical department or other agencies

⑥ In case of mobilization of a towing vehicle, urge the driver or other person involved in the vehicle fire to seek assistance of the towing company. If they do not specify a particular towing company, traffic patrol crews shall report to the Traffic Control Center.

⑦ When removing the vehicles on fire with a towing vehicle, supervise the work.

② Other works based on instructions from the Traffic Control Center

③ Other items that can be handled by the traffic patrol crews by themselves. If it is impossible, traffic patrol crews shall report to the Traffic Control Center and require the assistance of workers of maintenance and repair unit.

4.4.4.1.2 Items to be reported

At the site of the vehicle fire, traffic patrol crews shall report the items enumerated below to the Traffic Control Center.

(1) Location (kilometer post on inbound/outbound route) of occurrence
(2) Number of deaths or injuries and condition of injuries
(3) Name, property and quantity of the hazardous or difficult-to-handle substance carried by the vehicle on fire, if any
(4) Need for and required number of fire engines
(5) Need for and required number of ambulances
(6) Condition of fire
(7) Number and types of vehicles on fire, and condition of the damage
(8) Need for and required number of towing vehicles
(9) Traffic condition around the site
(10) Need for and required type of traffic restriction
(11) Damage to the road or road accessories, or condition of debris scattered on the road
(12) Need for and required number of maintenance/cleaning staff, required type and required number of cleaning vehicles
(13) Other necessary items

4.4.4.2 The Role of the Traffic Control Center

When a vehicle fire occurs, the Traffic Control Center shall take necessary actions based as prescribed below.

4.4.4.2.1 Initial Response

When information concerning the vehicle fire is received, the Traffic Control Center shall order the traffic patrol crews to check the following items and take necessary actions as below.

(1) When a report on the vehicle fire is received, the Traffic Control Center shall order the traffic patrol crews to check the items listed below.

① Road name

② Inbound or outbound route

② Kilometer post

③ Description of the fire

④ Need for fire engines

⑤ Need for ambulance

⑥ Whether or not the vehicles on fire can be driven

⑦ Other items thought to be necessary in order to respond to the vehicle fire

(2) When information that the vehicle fire occurred is received, the Traffic Control Center shall immediately notify report the checked items to the responsible fire department, and request mobilization.

(3) When a report on the vehicle on fire is received, the Traffic Control Center shall immediately notify responsible police department of the incident and request mobilization.

(4) If the situation suggests that the incident of “vehicle on fire” demands mobilization of ambulance, the Traffic Control Center shall immediately request mobilization of such vehicles from the responsible medical department.

(5) If the situation suggests that the incident of “vehicle on fire” demands mobilization of the Traffic Patrol crews, the Traffic Control Center shall immediately instruct the Traffic Patrol crews to hurry to the scene.

(6) If the situation suggests that the passing vehicles shall be made aware of “vehicle on fire” incident, the Traffic Control Center shall notify toll gates of the incident.

(7) If the situation suggests that the other related agencies need to be made aware of the incident of “vehicle on fire” , the Traffic Control Center shall notify them of the incident.

4.4.4.2.2 Follow up actions

When the Traffic Patrol Team arrives at the scene of the “vehicle on fire”, the Traffic Control Center shall order the traffic patrol crews to check and take necessary actions based as prescribed below.

(1) The Traffic Control Center shall order the traffic patrol crews to check the items listed below.

① Location (kilometer post on inbound/outbound route) of occurrence

② Number of deaths or injuries and condition of injuries

② Name, property and quantity of the hazardous or difficult-to-handle substance carried by the vehicle on fire, if any

③ Need for and required number of fire engines

④ Need for and required number of ambulance

⑤ Condition of vehicle fire

⑥ Number and type of accident vehicles on fire, and condition of the damage

⑦ Need for and required number of towing vehicles

⑧ Traffic condition around the site

⑨ Need for and required type of traffic control

⑩ Damage to the road or road accessories, or condition of debris scattered on the road

⑪ Need for and required number of maintenance/cleaning personnel, required type and required number of cleaning vehicles

⑫ Other necessary items

(2) The Traffic Control Center shall immediately notify the responsible fire department of the incident report from the Traffic Patrol crews.

(3) The Traffic Control Center shall immediately notify the responsible police department of the incident report from the Traffic Patrol crews.

(4) If the report from the Traffic Patrol crews suggests that an ambulance shall be mobilized, the Traffic Control Center shall immediately request mobilization of such vehicles from the responsible fire department.

(5) If the report from the Traffic Patrol crews suggests that the passing vehicles nearby the vehicle fire scene shall be made aware of the incident, the Traffic Control Center shall notify toll gates of the incident

(6) If the report from the Traffic Patrol crews suggests that a towing vehicle need to be mobilized, the Traffic Control Center shall notify the towing company of service delivery.

(7) If the report from the Traffic Patrol crews suggests that the workers from the maintenance and repair unit need to be mobilized, the Traffic Control Center shall notify the unit of assistance delivery.

(8) If the report from the Traffic Patrol crews suggests that other related agencies need to be aware of the incident, the Traffic Control Center shall notify them of the incident.

4.4.5 Traffic Jam

4.4.5.1 The Role of Traffic Patrol Crews

When traffic patrol crews encounter traffic jam, or when they receive instructions for emergency mobilization from the Traffic Control Center and arrive at the traffic jam scene, they shall handle it and report the situation as prescribed below

4.4.5.1.1 Details of handling

At the traffic jam scene, traffic patrol crews shall perform the works enumerated below.

(1) When traffic patrol crews arrive close to the traffic jam scene, the patrol vehicle should follow the tail end of the traffic queue, as necessary, in order to give warnings to vehicles approaching from the rear. The position of a patrol vehicle giving warnings to approaching vehicles shall in general be in a safe location, such as the shoulder, at least 400 m away from the tail end of the traffic jam.

(2) When there is a change in the traffic queue length, or when it is deemed that the road condition is dangerous, traffic patrol crews shall immediately report to the Traffic Control Center and follow its instructions.

(3) When a patrol vehicle, giving warnings to vehicles approaching from the rear, needs to move in the reverse direction, one of the patrol crews should stand behind the vehicle as a guide in order to confirm safety. However when it is recognized that moving the vehicle in reverse is dangerous, reversing is prohibited. In such a case, the vehicle should turn around at the next interchange to resume providing such warnings.

(4) The vehicle engaged in warning the approaching vehicles shall suspend the task if emergency mobilization is invoked elsewhere..

4.4.5.1.2 Items to be reported

At the site of traffic jam, traffic patrol crews shall report the items enumerated below to the Traffic Control Center.

(1) Location (kilometer post on inbound/outbound route) of incident occurrence

(2) Condition of traffic jam and prospects for its clearing

(3) Cause of traffic jam

(4) Need for and required type of traffic restriction

(5) Other necessary items

4.4.5.2 The Role of the Traffic Control Center

When traffic jam occurs, the Traffic Control Center shall take necessary actions based as prescribed below.

4.4.5.2.1 Initial Response

When a report on the traffic jam is received, the Traffic Control Center shall order the traffic patrol crews to check and take necessary actions based as prescribed below.

(1) When a report on the traffic jam is received, the Traffic Control Center shall order the traffic patrol crews to check the items listed below.

① Road name

② Inbound or outbound route

③ Kilometer post

④ Causes of the traffic jam

⑤ Other items thought to be necessary in order to respond to the traffic jam

(2) When a report on the incident of traffic jam is received, the Traffic Control Center shall notify the responsible police crews of the incident.

(3) If the traffic jam situation suggests that emergency mobilization of the Traffic Patrol crews is necessary, the Traffic Control Center shall instruct the Traffic Patrol crews to hurry to the traffic congestion scene.

(4) If the situation suggests that the passing vehicles need to be alerted about the incident of traffic jam, the Traffic Control Center shall notify toll gates of the incident.

(5) If the situation suggests that other related agencies shall be made aware of the traffic jam, the Traffic Control Center shall notify them of the incident.

4.4.5.2.2 Follow up Actions

When the Traffic Patrol Team arrives at the site of the traffic jam, the Traffic Control Center shall order the traffic patrol crews to check and take necessary actions listed below.

(1) The Traffic Control Center shall order the traffic patrol crews to check the items listed below.

① Location (kilometer post on inbound/outbound route) of traffic jam incident

② Condition of traffic jam and prospects for its clearing

④ Cause of traffic jam

⑤ Need for and required type of traffic control

⑥ Other necessary items

(2) The Traffic Control Center shall immediately notify the responsible police department of the report from the Traffic Patrol crews

(3) If the report from the Traffic Patrol crews suggests that the passing vehicles shall be

alerted about the incident, the Traffic Control Center shall notify toll gates of the incident.

(4) If the report from the Traffic Patrol crews suggests that other related agencies shall be alerted about the incident, the Traffic Control Center shall notify them of the incident.

4.4.6 Sudden changes in the weather

4.4.6.1 The Role of Traffic Patrol Crews

When traffic patrol encounter a sudden change in weather, or when they receive instructions for emergency mobilization from the Traffic Control Center and arrive at the site of the unusual weather, they shall handle the scene and report as prescribed below.

4.4.6.1.1 Details of handling

At the site of the unusual weather, traffic patrol crews shall perform the works enumerated below.

(1) In order to prevent danger to traffic, traffic patrol crews shall perform road closures and take other necessary steps as needed.

(2) As necessary, Traffic patrol crews shall use loudspeakers and other means to alert traffic about the abnormal weather, and provide instructions for appropriate driving.

4.4.6.1.2 Items to be reported

At the site of the unusual weather, traffic patrol crews shall report the items enumerated below to the Traffic Control Center.

(1) Time and location (kilometer post on inbound/outbound route) of the incident of usual weather occurrence

(2) Weather type and conditions

(3) Need for and required type of traffic control

(4) Other necessary items

4.4.6.2 The Role of the Traffic Control Center

When unusual weather occurs, the Traffic Control Center shall take necessary actions as prescribed below.

4.4.6.2.1 Initial Response

When a report on an unusual weather is received, the Traffic Control Center shall check and take necessary actions based as prescribed below

(1) When information concerning the abnormal weather is received, the Traffic Control Center shall check the items listed below.

① Road name

② Inbound or outbound route

③ Kilometer post

④ Weather conditions

⑤ Other items thought to be necessary in order to respond to sudden change in weather

(2) When a report on an unusual weather incident is received, the Traffic Control Center shall notify responsible police department of the confirmed facts..

(3) If an unusual weather condition suggests that emergency dispatch of the Traffic Patrol Team is needed, the Traffic Control Center shall instruct the Traffic Patrol Team to mobilize immediately..

(4) If an unusual weather condition suggests that travelling vehicles need to be alerted, the Traffic Control Center shall notify toll gates of the incident.

(5) If an unusual weather condition suggests that other responsible agencies need to be alerted about the incident, the Traffic Control Center shall notify them of the incident.

4.4.6.2.2 Follow up actions

When the Traffic patrol team arrives at the site of the abnormal weather, the Traffic Control Center shall order the Traffic patrol to check and take necessary actions based as prescribed below.

(1) The Traffic Control Center shall check the items listed below

① Time and location (kilometer post on inbound/outbound route) of occurrence

② Weather type and conditions

③ Need for and required type of traffic control

④ Other necessary items

(2) The Traffic Control Center shall notify the responsible police departments of the report from the Traffic Patrol Team.

(3) If a report from the Traffic Patrol Team suggests that the passing vehicles need to be alerted about the incident, the Traffic Control Center shall notify toll gates of the incident.

(4) If it is considered that the report from the Traffic Patrol Team requires the information to other related agencies, the Traffic Control Center shall notify to them.

4.4.7 Other unusual incidents

4.4.7.1 The Role of Traffic Patrol Team

When traffic patrol crews encounter an unusual incident, or when they receive instructions for emergency mobilization from the Traffic Control Center and arrive at the site of the unusual incident scene, they shall handle and report as prescribed below.

4.4.7.1.1 Details of handling

At the unusual incident scene, traffic patrol crews shall perform the works enumerated below. At the work site, top priority shall be given to protection of life and safety of persons involved, and to measures most suited to the circumstances.

4.4.7.1.2 Items to be reported

At the unusual incident scene, traffic patrol crews shall report the items enumerated below to the Traffic Control Center.

(1) Time and location (kilometer post on inbound/outbound route) of the incident's occurrence

(2) Details of the unusual incident

(3) Other necessary items

4.4.7.2 The Role of Traffic Control Center

When an abnormal condition occurs, the Traffic Control Center shall take necessary actions based as prescribed below.

4.4.7.2.1 Initial Response

When a report on the unusual incident scene is received, the Traffic Control Center shall check and take necessary actions based as prescribed below.

(1) When information concerning the abnormal condition is received, the Traffic Control Center shall confirm the facts listed below and take necessary actions.

① Road name

② Inbound or outbound route

③ Kilometer post

④ Description of the unusual incident

⑤ Other items thought to be necessary in order to respond to the unusual incident

(2) If the unusual incident suggests that the mobilization the Traffic Patrol Team is necessary, the Traffic Control Center shall instruct the Traffic Patrol Team to hurry to the scene.

(3) If the unusual incident suggests that the passing vehicles need to be alerted about the incident, the Traffic Control Center shall notify toll gates of the incident.

(4) If the unusual incident suggests that the handling the incident falls under police jurisdiction, the Traffic Control Center shall notify the responsible police department of the incident.

(5) If the unusual incident suggests that other related agencies need to be alerted about it, the Traffic Control Center shall notify them of the incident.

4.4.7.2.2 Follow up actions

The Traffic Control Center shall confirm the items below and instruct actions when the Traffic Patrol arrives at the unusual incident scene.

(1) The Traffic Control Center shall confirm the items below
  ① Time and location (kilometer post on inbound/outbound route) of the incident's occurrence
  ② Details of the unusual incident
  ③ Other necessary items

(2) If the report from the Traffic Patrol crews suggests that travelling vehicles need to be alerted ,about the incident, the Traffic Control Center shall notify toll gates of the incident.

(3) If the report from the Traffic Patrol crews suggests that the police department shall be alerted about the incident, the Traffic Control Center shall notify responsible police department of the incident.

(4) If the report from the Traffic Patrol crews suggests that other related agencies need to be alerted about the incident, the Traffic Control Center shall notify them of the incident.

Forms for Reporting

Form 1

Reporting Notes on Traffic Control Patrol

№ 1

Ghi chép tuần tra quản lý giao thông

Ngày: ____________________

Nhân viên tuần tra		Số xe	
Tên đường			
Khoảng cách	~		

Thời gian tuần tra		
Giờ xuất phát (A)	Giờ quay về (B)	Thời gian yêu cầu （B-A)

Cự ly tuần tra		
Số công tơ mét lúc xuất phát (α)	Số công tơ mét lúc trở về (β)	Cự ly tuần tra (β－α)

Số vụ xử lý								
Tai nạn giao thông	Hỏng xe	Chướng ngại vật	Cháy xe	Tắc đường	Biến đổi thời tiết	Sự cố khác		

Giờ	Phút	Hướng	KP	Nội dung phát hiện - Thông tin - Xử lý

№ 2

Giờ	Phút	Hướng	KP	Nội dung phát hiện - Thông tin - Xử lý

Reporting Notes on Taken Measures to Tackle Incidents

Ghi chép đối phó sự cố

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<tr><td>Nội dung</td><td>Có nguy hiểm hay không</td><td>Cần/ không cần</td><td>Số lượng xe cần</td><td>Cần/ không cần</td><td>Số lượng xe cần</td></tr>
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<tr><td rowspan="5">Hỏng đường</td><td colspan="5">Có/không hỏng đường</td><td colspan="5">Cần/không cần nhân viên làm việc</td><td rowspan="2">Ngoài ra</td></tr>
<tr><td>Có/không</td><td colspan="4">Nội dung</td><td>Cần/ không cần</td><td>Số người cần</td><td>Số lượng xe cần</td><td>Thiết bị cần</td><td>Khác</td></tr>
<tr><td></td><td colspan="4"></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
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<tr><td rowspan="5">Vật rơi vãi</td><td colspan="5">Có/không có vật rơi vãi</td><td colspan="5">Cần/không cần nhân viên làm việc</td><td rowspan="2">Ngoài ra</td></tr>
<tr><td>Có/không</td><td colspan="4">Nội dung</td><td>Cần/ không cần</td><td>Số người cần</td><td>Số lượng xe cần</td><td>Thiết bị cần</td><td>Khác</td></tr>
<tr><td></td><td colspan="4"></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
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<tr><td>Cần/ không cần</td><td colspan="3">Loại hình hạn chế</td><td colspan="2">Thời gian bắt đầu</td><td colspan="2">Thời gian kết thúc</td></tr>
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<tr><td rowspan="5">Cơ quan hợp tác</td><td colspan="2">Tên cơ quan</td><td colspan="4">Nội dung xử lý</td><td colspan="2">Thời gian bắt đầu</td><td colspan="2">Thời gian kết thúc</td><td>Ngoài ra</td></tr>
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<tr><td>Ngoài ra</td><td colspan="11"></td></tr>
</table>

Form 2

Shift Handover Sheet (Traffic Patrol)

Phiếu giao ca (Tuần tra quản lý giao thông)

1. Thời gian làm việc

Ngày/Tháng/năm		Thời gian	～

2. Người phụ trách

3. Tình trạng tuần tra

Tên đường	Khoảng cách	Thời gian tuần tra	Cự ly tuần tra
		~	
		~	
		~	
		~	
		~	
		~	

4. Tình trạng phát sinh sự cố

Tên đường	Số vụ phát sinh sự cố						
	Tai nạn giao thông	Hỏng xe	Chướng ngại vật	Cháy xe	Tắc đường	Biến đổi thời tiết	Các sự cố khác

5. Ghi chú đặc biệt

6. Nội dung bàn giao

Form 3

Shift Handover Sheet (Traffic Control Center)

Phiếu giao ca (Trung tâm điều hành giao thông)

1 . Thời gian làm việc

Ngày/Tháng/năm		Thời gian	~

2 . Người phụ trách

3 . Tình trạng xử lý thông tin

Tên đường	Số vụ xử lý thông tin			
	Vô tuyến di động	Điện thoại	Thông tin trực tiếp	Phương tiện khác

4 . Tình trạng phát sinh sự cố

Tên đường	Số vụ phát sinh sự cố						
	Tai nạn giao thông	Hỏng xe	Chướng ngại vật	Cháy xe	Tắc đường	Biến đổi thời tiết	Các sự cố khác

5 . Ghi chú đặc biệt

6 . Nội dung bàn giao

Form 4

Recordings of Correspondence and Information at the Traffic Control Center

№ 1

Ghi chép thông tin Trung tâm điều hành giao thông

Ngày: ________________

Người phụ trách						
Tên đường						
Giờ	Phút	Nhận thông tin	Gửi thông tin	Phương tiện trao đổi thông tin	Đối phương	Nội dung trao đổi

Phương tiện trao đổi thông tin: A : Vô tuyến di động B: Điện thoại C: Thông tin trực tiếp D: Phương tiện khác

№ 2

Giờ	Phút	Nhận thông tin	Gửi thông tin	Phương tiện trao đổi thông tin	Đối phương	Nội dung trao đổi

Phương tiện trao đổi thông tin: A : Vô tuyến di động B: Điện thoại C: Thông tin trực tiếp D: Phương tiện khác

Reference: Supplement Materials to Dispose of Difficult-to-Treat Substances

(Tham khảo) Các vật chất hỗ trợ xử lý chất khó xử lý

Tên gọi	Tiêu chuẩn・Thông số kỹ thuật	Công dụng/VD cách sử dụng
Bột thấm dầu trên mặt đường 	· Gốm xốp · Dạng hạt nhỏ	Thấm hút dầu loang trên mặt đường   
Tấm thảm thấm dầu 	· Hóa chất than hoạt tính · Khoảng 25cm×25cm	Thấm hút và chống loang rộng những chất như dầu trên mặt đường.   
Túi chắn dầu 	· Hoá chất than hoạt tính · Khoảng φ15cm×2m	Chống dầu loang trên đường tràn xuống cống rãnh