JAPAN INTERNATIONAL COOPERATION AGENCY
DIRECTORATE FOR ROADS OF VIETNAM
MINISTRY OF TRANSPORT
THE SOCIALIST REPUBLIC OF VIET NAM

THE PROJECT FOR CAPACITY ENHANCEMENT IN ROAD MAINTENANCE PHASE-II

Final Report

VOLUME 3.1: GUIDELINE FOR ROAD FACILITY INSPECTION

March 2018

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

KATAHIRA & ENGINEERS INTERNATIONAL
CENTRAL NIPPON EXPRESSWAY CO. LTD.
ORIENTAL CONSULTANTS
PASCO CORPORATION

EI
JR
18-027

Concept of Development

(1) Guideline for Road Facility Inspection is a reference material aiming to provide information on the inspection procedures to the DRVN, RMBs and SBs staff currently involved in the national road maintenance and management activities in the field.

(2) The Guideline can also be referred to the revision of the Standards of Road Routine Maintenance (TCCS 07:2013/TCDBVN) currently applied to the routine maintenance of the national roads.

(3) This Guideline stipulates road facility inspection procedures for the national roads under the jurisdiction of DRVN and Provincial People's Committees.

(4) In formulating maintenance and repair plans based on the evaluation results of road facility inspection, users can also refer to the Road Maintenance Manual which was also developed in this JICA Project.

TABLE OF CONTENTS

BASIC STANDARD **TCCS XXX 2017**

1. SCOPE OF APPLICATIONS

(1) Guideline for Road Facility Inspection is a reference material aiming to provide information on the inspection procedures to the DRVN, RMBs and SBs staff currently involved in the road maintenance and management activities in the field.

(2) The Guideline can also be referred to the revision of the Standards of Road Routine Maintenance (TCCS 07:2013/TCDBVN) currently applied to the routine maintenance of the national roads.

(3) This Guideline regulates road facility inspection procedures for the national roads under the jurisdiction of DRVN and Provincial People's Committees.

(4) This Guideline does not apply to the facility inspection for expressways, local roads from provincial level and below, and roads managed by BOT scheme.

(5) The Guideline stipulates information on road facility inspection which includes inspection facilities, classification, devices, frequencies, schedule, safety assurance during inspection, evaluation on the inspection results and recording of inspection results and reporting.

(6) In formulating maintenance and repair plans based on the evaluation results of road facility inspection, users can also refer to the Road Maintenance Manual which was also developed in this JICA Project. .

(7) Responsibility assignment for management, supervision and implementation of road facility inspection shall be regulated by DRVN decisions separately.

(8) This Guideline covers road facility inspections including those for Road Slopes, Drainage Systems, Retaining Walls, Road Pavements, Tunnels, Box Culverts, Pipe Culverts, Traffic Safety Facilities and Traffic Management Facilities.

(9) This Guideline can also be applied as a reference material to the Bridge Inspection Guideline (VBMS) developed in conjunction with VBMS development and promulgated by DRVN separately. This Road Facility Inspection Guideline can supplement the Bridge Inspection Guideline (VBMS), in particular to the points not clearly defined in the Bridge Inspection Guideline (VBMS).

(10) For road facilities whose inspection guidelines are not stipulated in this Guideline, managing agencies for road facility inspection shall develop Inspection Guidelines from those for the similar facilities regulated in this Guideline.

(11) The articles of this Guideline is to be applied prior to those in the Standards of Road Routine Maintenance (TCCS 07:2013/TCDBVN), if there is any overlap in information relevant to road facility inspection.

2. QUOTED DOCUMENTS

Quoted documents shown below are necessary for the application of this Guideline.

- Technical Standard 22TCN243-98 Specifications for Highway Bridge Verification
- Bridge Loading Specification
- Bridge Inspection Guideline (August 2006) Developed by KEI & WSP Inc. & TEDI
- Bridge Periodical Inspection Sheet in VBMS Project
- Specification of Road Routine Maintenance – In House Standard TCCS 07: 2013/DRVN
- Others (Testing Specifications: Bearing Capacity,)
- The Government Decree No.46/2015/ND-CP, May 12, 2015, on Quality Control and Maintenance of Construction Works
- MOT Circular No. 52/2013/TT-BGTVT, Dec.12, 2013, on Regulations on Management, Operation and Maintenance of Road Construction Works.

3. TERMS AND DEFINITIONS

(1) Road facility inspection is a technical action carried out regularly to inspection the degree of defects and deterioration of road facilities in order to assure safety, continuity and smoothness of road transport. Road facility inspection is carried out in accordance with the specifications stipulated in the relevant articles of this Guideline

(2) Road management agency is the unit of implementing specialized state managerial function under MOT; specialized agencies belong to Provincial People's Committee, Centrally governed city, people's committee of cities, districts, towns under provinces; people's committee of communes, wards, townships.

(3) Managing agency of road facility inspection is the organization designated by DRVN Decisions to have full responsibility for managing road facility inspection of national roads under DRVN jurisdiction. Management agency shall have a right to outsource the implementation of inspection works to external companies which have business licenses for the inspection works, and to commit supervising agencies for road facility inspection to conduct supervision on the implementation of road facility inspection.

(4) Supervising agency of road facility inspection is the regional organization designated by DRVN Decisions to have full responsibility for supervising road facility inspection for national roads under DRVN jurisdiction.

(5) (Memo) Managing agency means RMBs and supervising agency means SBs in this Guideline.

(6) Evaluation committee on the inspection results is the entity to evaluate appropriateness of evaluation and make judgement on the unclear points of evaluation. The committee shall be organized and held upon request of management agency of road facility inspection. Commenting by competent agency can also be applied as an alternative measure of this evaluation committee, if the committee is not available.

(7) Road routine maintenance management according to executed method and quantity (MBC - Method Based Contract) is the management type of traditional routine maintenance implementation based on required methods and quantity and certified by Road Management Agency. The management type may follow routine maintenance plan assigned by year or fixed rate of routine maintenance quantity for unit carrying out road routine maintenance.

(8) Road routine maintenance management as per executed quality (PBC - Performance Based Contract)

is the management type of progressive routine maintenance implementation based on road quality and works on the roads which are evaluated periodically according to united norms. This type of management is carried out on the basis of road routine maintenance contracts through bidding.

(9) Pavement condition survey vehicle is a vehicle capable of measuring pavement conditions including crack rate, rut depth and International roughness indexes (IRIs) and is applied to the periodic inspection of road pavement facilities.

(10) Pavement Management System is a road asset management for pavement facility which was developed specialized for the periodic repair work plans for the national roads in Vietnam.

(11) Abbreviations

DRVN:	Directorate of Roads for Vietnam
RMBs:	Road Management Bureaus
SBs:	Sub Bureaus
RTC:	Road Technical Center
VBMS:	Vietnam Bridge Management System
PMS:	Pavement Management System
PBC:	Performance Based Contract
IRI:	International Roughness Index
FWD:	Falling Weight Defect-meter
BST:	Bituminous Surface Treatment

4. GENERAL REGULATION

4.1 Objective of Road Facility Inspection

Road facility inspection is part road maintenance activities and has the following objectives;

- To quickly detect any incidents and abnormalities on the road facilities which may hinder road and traffic functions.
- To provide information to the formulation of medium-term and long-term road asset management plans which aims at optimizing maintenance and repair investment in the long period of road maintenance.

4.2 Classification of Road Facility Inspection

(1) Road facility inspection for the national roads shall fall into the following five (5) categories; initial inspection; routine inspection; periodic inspection, emergency inspection and detailed inspection.

(2) Initial inspection is to survey the initial status of road facilities that are taken over from construction stage to maintenance stage.7

(3) Routine inspection is a daily inspection done by traffic patrol staff to quickly find any unusual incidents and defects which may provide negative effects on the road and traffic function of the roadway, thereby maintain the service level of the road.

(4) Periodic inspection is to regularly survey defects and deterioration of road facilities, to evaluate them in comparison with predetermined judgment criteria, to select the most suitable repair methods for the

damages and to preserve data in relevant databases. Periodic inspection provides base information to the road asset management which aims to find out the most appropriate mid-term/long-term investment for road maintenance and repair works.

(5) Emergency inspection is generally carried out in order to supplement the above inspections and to cope with emergencies, such as unusual weather, traffic accidents and natural disasters.

(6) Detail inspection shall be implemented based on the decision made by competent experts to further study the details of structural defects and deterioration of road facilities after periodic inspection and to specify the causes of structural defects and deterioration. Also, it shall be implemented to provide information for the designs of road repair works, including F/S, basic designs and technical designs needed for repair works.

4.3 Procedures of Road Facility Inspection

Road facility inspection shall include the following tasks;

- Formulation of road facility inspection plans,
- Implementation of road facility inspection,
- Evaluation of inspection results,
- Formulation of monitoring plans,
- Registration of inspection data into road facility database and reporting.

Figure 4.3.1 shows the flowchart of these procedures.

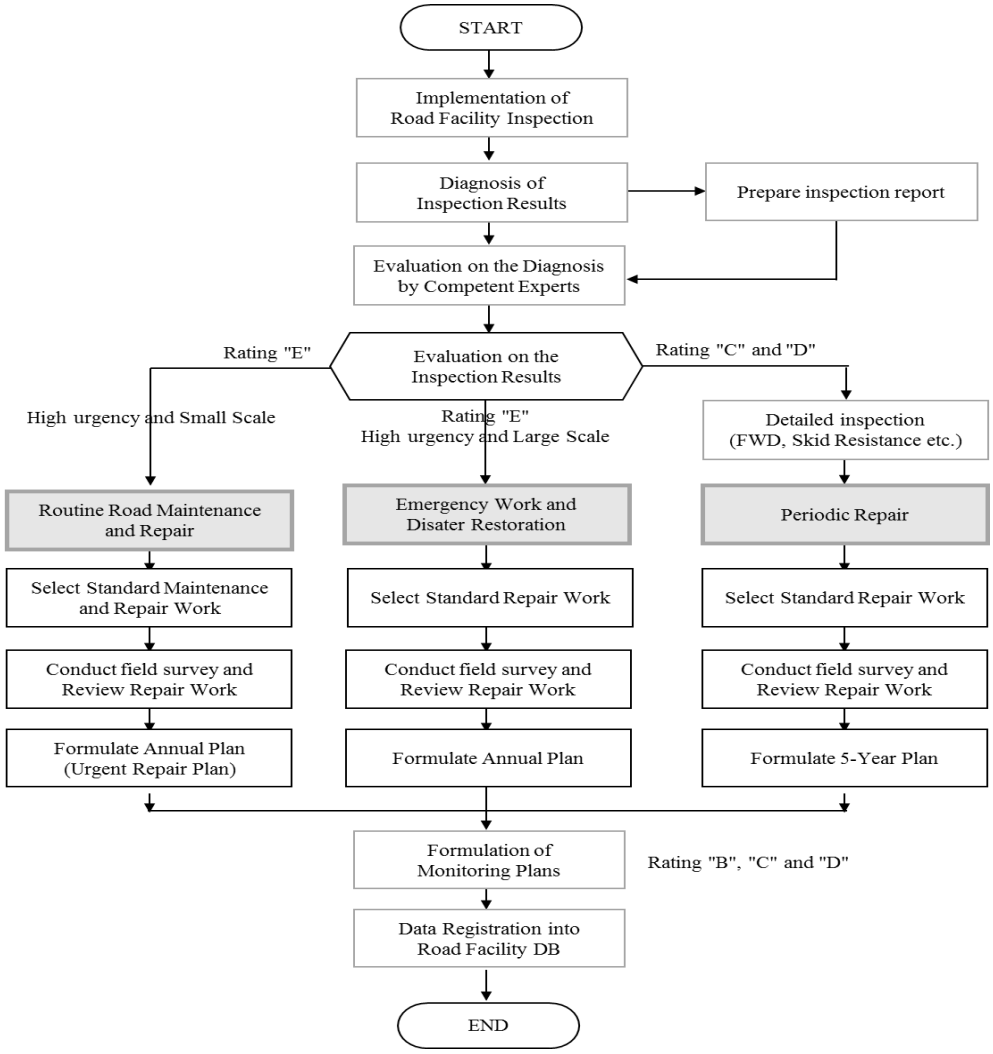


Figure 4.3.1 Implementation Procedures of Road Facility Inspection

4.3.1 Formulation of Road Facility Inspection Plans

Management agency of road facility inspection shall formulate inspection implementation plans for the road facilities under their jurisdiction on the basis of the relevant articles of this Guideline. The inspection implementation plans to be formulated shall include the plans for routine inspection and periodic inspection for the national roads under their jurisdiction. Toad facility inspection plans shall include the following information.

- Inspection facilities
- Inspection methods
- Inspection devices
- Inspection frequencies
- Inspection schedule
- Inspection team organization
- Safety assurance during inspection
- Evaluation on the inspection results
- Evaluation committee on the inspection results
- Recording of inspection results and reporting

For the implementation of initial road facility inspection on the new road facilities taken over to DRVN for road maintenance and operation, DRVN shall designate a management agency of road facility inspection in the region to implement inspection.

4.3.2 Inspection Facilities

Road facilities for inspection to be selected in this Guideline shall include road pavements, slopes, tunnels, box and pipe culverts, traffic safety and management facilities.

4.3.3 Inspection Methods

Inspection methods shall be properly selected for each inspection type. Standard methods of each inspection type are shown in **Table 4.3.1**

Table 4.3.1 Standard Inspection Methods

Inspection Type	Inspection Methods
Initial Inspection	● Short-distance visual inspection ● Hammering tests ● Pavement condition survey vehicle
Routine Inspection	● Vehicle on-board visual inspection ● Short-distance visual inspections
Periodic Inspection	● Pavement condition survey vehicle ● Short-distance visual inspection ● Hammering inspection, Crack gage, measuring tape ● Photos
Emergency Inspection	● Short-distance visual inspection ● Hammering inspection, Crack gage, measuring tape ● Photos
Detailed Inspection	● Short-distance visual inspection ● Hammering inspection, Crack gage, measuring tape ● Photos ● Non-destructive test equipment

(Source) Project for capacity enhancement in Road Maintenance Phase-II

4.3.4 Inspection Devices

Inspection devices shall be properly selected and applied to road facility inspection as the need arises. Standard inspection devices are shown below;

- Inspection equipment: crack gauge, gap gauge, dial gauge, hammer (230 grams for hammering), Schmidt hammer, binoculars, tape measure, metal tape, caliper square, tape, pole, wire-brush, shovel, hand mirror, thermometer, etc.
- Inspection safety gears: goggles (for hammering), mobile phones (for communication), anti-dust masks, safety belts, etc.
- Recording facilities: Digital camera, video recorder, black board, chalk, note pads, etc.;
- Other device: Traffic control facility (traffic cone, arrow signs, flags, etc.), stepladder, paint, cohesive substances

4.3.5 Standard Inspection Frequency

Road facility inspection shall be implemented based on the standard frequencies stipulated in **Table 4.3.2**.

However, managing agency of road facility inspection can adjust frequencies of inspection in order to meet local conditions of road facilities and their damages.

Table 4.3.2 Standard Inspection Frequencies

Inspection Type	Frequencies
Initial Inspection	● After the completion of road construction/reconstruction and before the opening of road facilities to the public, or, ● Within one year after the opening of road facilities to the public.
Routine Inspection	● Every day; When traffic volume is more than 10,000 vehicles per day ● Every other day; When traffic volume is less than 10,000 vehicles per day
Periodic Inspection	● Pavement facilities: Once every 3~5 years ● Slope facilities: Once every 5 years ● Bridge facilities: Once every 5 years ● Tunnel facilities: Once every 5 years ● Box and pipe culvert facilities: Once every 5 years ● Traffic Road safety facilities: Once every 5 years ● Road management facilities: Once every 5 years (Note) a. However, if the facilities are once rated as "C" in the evaluation of the periodic inspection, the next inspection should be carried out no later than two years after the previous inspection. b. Also, if the facilities are once rated as "D" or "E" in the evaluation of the periodic inspection, the inspection should be carried out no later than one year after the previous inspection. c. However, upon completion of repair works, original frequencies stated above are applied for the above two cases.
Emergency Inspection	● Immediately after unexpected incidents occur such as disasters.
Detailed Inspection	● When proposed by periodic inspection ● When proposed for the planning and the designing of road rehabilitation and reconstruction works

(Source) Project for capacity enhancement in Road Maintenance Phase-II

4.3.6 Inspection Team Organization

(1) Staff arrangement for one inspection team is shown in **Table 4.3.3**. The table shows the standard plan of staff arrangement, so that staff arrangement shall be adjusted in compliance with the scale and the difficulty of the survey.

Table 4.3.3 Standard Inspection Team Organization

Inspectors per one party	The number of staff
(1) Chief engineer	1
(2) Assistant engineer	3
(3) Vehicle operator Traffic control staff	As required

(2) Responsibility assignment for chief engineer and assistant engineer is shown below;

- Chief engineer is responsible for supervising overall road facility inspection including inspection, evaluation of the results of the inspections and data registration.
- Assistant engineer supports a chief engineer to conduct his responsibility.

(3) Staff arrangement per one party for the pavement condition survey and its standard norm is shown in

Table 4.3.4. The table shows the standard plan and norm, so that staff arrangement and norm shall be adjusted in compliance with scale and difficulty in survey.

Table 4.3.4 Staff Arrangement and Norm for Pavement Condition Survey

Survey stage	Inspectors per one party	The number of staff per Party	Standard Norm
(1) Road condition survey	● Chief engineer	1	50 km per day/party
	● Assistant engineer	2	
	● Navigator	1	
	● Car driver and traffic controller	1	
(2) Data analysis and registration	● Chief engineer	1	8 km per day/person
	● Assistant engineer	8	

(Source) Based on the data obtained in JICA pavement condition survey in 2012.

Navigator supports route guidance in the region all the way during road condition survey.

(4) Responsibility assignment for chief engineer, assistant engineer and navigator is as follows;

- Chief engineer is responsible for supervising overall pavement condition surveys including preliminary survey, road condition survey, data analysis and data registration.
- Assistance inspector assists a chief engineer including road condition survey, data analysis and data registration.

(5) Inspection team shall make a timely report about these incidents to the supervising organization.

4.4 Safety Measures during Inspection

Safety measures during inspection shall be properly taken in order to ensure traffic safety and inspection staff safety.

4.5 Evaluation of Inspection Results

4.5.1 Evaluation for the inspection results shall be conducted, applying criteria of 5 rating levels consisting of A/B/C/D/E. The criteria are selected based on the following concepts; effects on vehicle traffic and road environment; and the need of further survey.

- Rating “A” is applied when no damage or minor damages are observed, so that no repair work is needed at this stage.
- Rating “B” is applied to the medium structural damages whose rapid progress is not expected within 5 years. Repair work will be needed, but not urgent, so that monitoring is a major activity.
- Rating “C” is applied to medium and heavy structural damages expected to progress within 5 years. Repair works need to be planned within 5 years, so that detailed inspection is necessary to find out the causes of the damages and the detail planning of repair works.
- Rating “D” is applied to heavy structural damages which need urgent repair work, so that detailed inspection is needed to plan and design repair works in detail.
- Rating “E” is applied to the damages expected to give large negative effects on road traffic and road environment. Urgent repair work is needed regardless of damage decree.

Table 4.5.1 Evaluation Criteria

Rating	Evaluation Criteria	Effects on road structural function	Effects on traffic and environment	Need of further study	Measures to be taken
A	・ No damage or minor structural damages	Small	-----	-----	・ No repair work
B	・ Medium structural damages ・ Progress of damages is not expected within coming 5 years. ・ Repair works will be needed, but not urgent.	Medium	-----	-----	・ Monitoring
C	・ Medium to Heavy structural damages ・ Progress of damages is expected within coming 5 years. ・ Repair works will be needed within 5 years.	Medium-large	-----	Detailed inspection	・ Periodic repair (Planned works) ・ Monitoring
D	・ Heavy structural damages ・ Urgent repair work is needed.	Large	-----	Detailed inspection	・ Periodic repair ・ Urgent repair ・ Monitoring
E	・ Large effects on road environment are expected.	-----	Large	-----	・ Routine maintenance and repair

4.5.2 Evaluation Committee

4.5.2.1 Upon completion of road facility inspection, managing agency of road facility inspection shall organize an evaluation committee to evaluate the inspection results. Evaluation committee shall consist of the following members in principle; competent agency staff, managing agency staff; supervising agency staff; academic members; professional engineers; competent agency staff and inspection company staff. Evaluation committee shall be held, when the following diagnoses were made during the implementation of road facility inspection. Supervising agency including inspection companies shall prepare inspection reports and submit them to the evaluation committee.

However, if evaluation committee is not available, commenting of competent agency can be also applied as an alternative measure of this evaluation committee.

- When road facility damages are evaluated as a rating level of "D" or "E",
- When some confusion arises in rating "C" or "D", and
- When further detailed inspection is required.

4.5.2.2 Evaluation committee shall take responsibility for conducting the following evaluation and decisions;

- To evaluate the appropriateness of inspection results, in particular about rating "C" and "D"
- To make decision on the need of detailed inspection, in particular about rating "D"
- To make decision on the urgency of repair works, in particular about rating "E"

4.5.3 Implementation of Detailed Inspection

When the evaluation meeting makes a decision that further detailed inspection is needed (a rating level of "C" or "D"), managing agency of road facility inspection shall take immediate actions to conduct detailed inspection for the damages. Detailed inspection shall be implemented aiming to identify the causes of damages, to find out the most appropriate repair works and to design repair works.

4.5.4 Formulation of Monitoring Plans

Road facility inspection is in principle conducted based on the standard frequencies specified in this relevant article of this Guideline. However, if a road facility inspection was conducted and the evaluation was made on some of road facilities with "B", "C", "D" and "E" rating, the inspection frequencies until next inspections need to be adjusted in particular for "C" and "D" rating. Managing agency of road facility inspection shall formulate monitoring plans in order to keep watching the progress of damages on the road facilities.

4.5.5 Registration of Inspection Data and Reporting

Inspection results shall be recorded in the data registration forms shown in **Table 4.5.2**.

Table 4.5.2 Data Input Form

Inspection type	Data Registration Form	
Pavement inspection (by Road Condition Survey)	ANNEX-J_P1	ANNEX-K
Pavement inspection (by Visual Inspection)	ANNEX-J_P2	ANNEX-K
Bridge Inspection	ANNEX-J_B-1~5	ANNEX-K
Slope inspection	ANNEX-J_S-1	ANNEX-K
Tunnel inspection	ANNEX-J_T-1	ANNEX-K
Box and pipe culver inspection	ANNEX-J_C-1	ANNEX-K
Traffic safety facility inspection	ANNEX-J_TS-1	ANNEX-K
Traffic management facility inspection	ANNEX-J_TM-1	ANNEX-K

4.5.5.1 Inspection supervision agency (SB) shall report inspection results to inspection management agency (RMB) and DRVN regularly. The data shall be registered in the available database system as regulated.

4.5.6 Training

DRVN shall provide training programs on road facility inspection at least one a year to the regional agencies directly involved in the road facility inspection. Training program shall cover the following issues;

- Road facility inspection methods
- Evaluation of inspection results
- Data registration of inspection results
- Work safety and traffic control during road facility inspection
- Others

5. ROAD SLOPE INSPECTION

The Guideline regulates inspections for the main parts of slope facilities including general slopes without surface protection and structurally protected slopes.

5.1 Classification of Road Slopes

Road slopes in general fall into the following classifications;

a. General Slopes without Surface Protection

b. Structurally Protected Slopes

- Precast and cast-in-place concrete crib works
- Concrete or mortar spray

5.2 Inspection Facilities

Inspection shall be conducted on road slopes which include general slopes without surface protection and structurally protected slopes.

5.3 Typical Damages of Road Slopes

Typical damages of road slopes are shown below;

5.3.1 General Slopes without Surface Protection

- Slope failure
- Cracks, swelling and subsidence
- Gully erosion and falling of slope surface soils
- Debris on slope berms
- Poor drainage Spring water
- Falling rock

5.3.2 Structurally Protected Slopes

5.3.2.1 Precast and cast-in-place concrete crib works

- Cracks and Peeling of concrete materials
- Looseness, swelling and subsidence
- Spring water

5.3.2.2 Concrete or mortar spray

- Cracks and Peeling of concrete or mortar materials
- Swelling and settlement
- Poor drainage and Spring water
- Voids

5.4 Focus Points of Inspection

Focus points of inspection are shown below;

5.4.1 It is known that general cut slope without protection is weathered and deteriorated and eventually becomes weakened as time passes by during road maintenance, so that it is important not to miss the first symptom of slope failure by facility inspection.

5.4.2 Cut slope cracks emerging on the slopes and forward swelling of cut slopes are the main symptoms of imminent slope failures. Cut slope failures often occur from the upper part of slopes including cut shoulders, so that it is necessary to investigate the existence of cracks in a wider area including natural slopes surrounding the cut slopes under consideration.

5.4.3 Attention should be paid to any spring water seen on the cut slope and water treatment on the cut shoulders, as heavy rainfall may raise ground water level near the slope and have negative effects on the stability of cut slopes. Care should be directed to any changes of water near the cut slopes including occurrence of

spring water, water volume and turbidity,

5.4.4 Block masonries and concrete frames on the slope often show the first symptom of slope failures, so that it is particularly important to check for deformation of these structures.

5.4.5 Road embankment constructed with half cutting and half fill on the narrow inclined valleys in the mountainous area should be carefully inspected as rainfalls often causes high concentrations of water in the narrow valleys which has negative effects on the embankment.

5.4.6 Any changes seen on the surface of the embankment, such as cracks on the slope shoulder, differences in level or swelling, should be carefully inspected.

5.4.7 Attention should also be paid on whether plants or grasses fully cover the slopes or whether soil erosion has occurred.

5.4.8 If urgent countermeasures are needed to ensure stability of the embankment by inspection, appropriate measures including the installation of drain borings should be implemented to drain out water from embankment.

5.4.9 The focus points of embankment and cut slope inspection are shown in **Figure 5.4.1**Error! Reference source not found. and **Figure 5.4.2**.

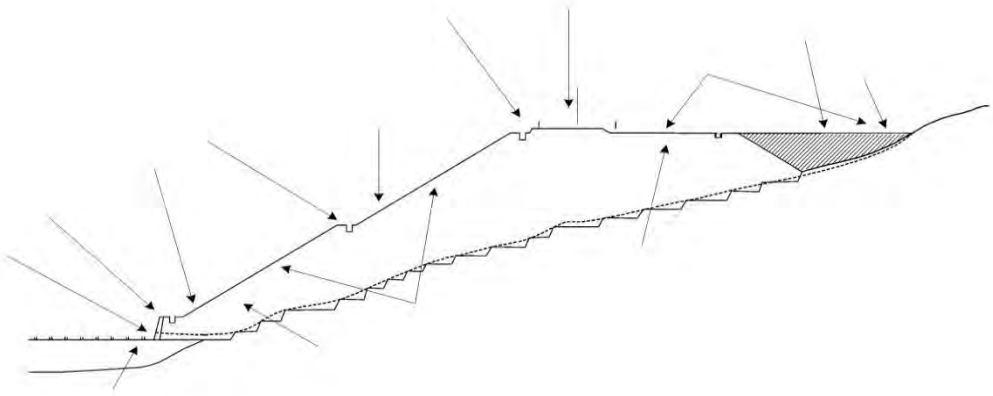


Figure 5.4.1 Focus Points of Inspection on Embankment Slopes

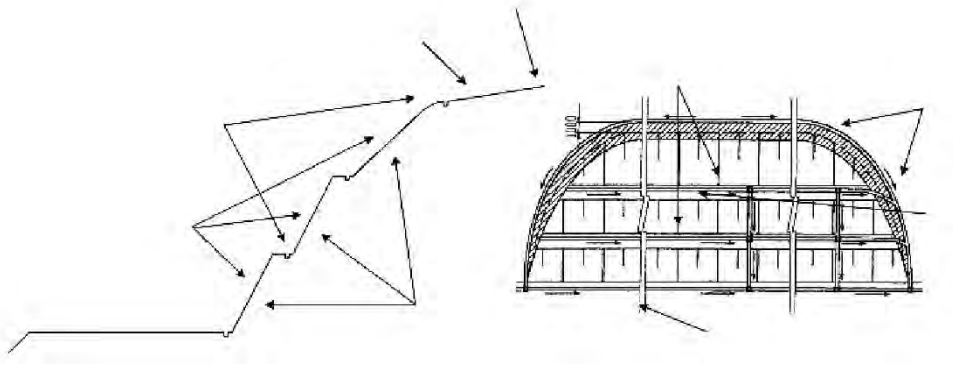


Figure 5.4.2 Focus Points of Inspection on Cut Slopes

5.5 Inspection Points

Road facility inspection for road slope facilities shall be implemented on the inspection points shown in **Table 5.5.1** for general cut slopes and in **Table 5.5.2** for protected slopes.

Routine inspection shall be in principle implemented by vehicle-on-board visual inspection. However, when damage is detected, the inspection staff shall get off the patrol car and conduct short-distance visual inspection. In the case of routine inspection which shall be carried out from national road side, the range of the inspection is the area visible from the patrol car on the national road. For the routine inspection on the road side slopes which are invisible from national road side, inspection shall be done within the visible range from the local road accessible by car.

Table 5.5.1 Inspection Points for General Cut Slopes & Embankment

Facility	Member	Damage	Initial inspection	Routine inspection	Periodic inspection	Emergency inspection	Detailed Inspection
General Slope	Cut slope & Embankment	Slope Failure	X	X	X	X	As required by Routine or Periodic Inspection
		Cracks / swelling /settlement	X	X	X	X	
		Gully erosion	X	X	X	X	
		Debris on the slope steps	X	-----	X	X	
		Poor drainage/ Spring water	X	X	X	X	
		Falling rock	X	X	X	X	

Table 5.5.2 Inspection Points for Structurally Protected Slopes

Facility	Member	Damage	Initial inspection	Routine inspection	Periodic inspection	Emergency inspection	Detailed Inspection
Structurally Protected slopes	Concrete block frame in situ /Concrete frame	Cracks/ Peeling	X	X	X	X	As required by Routine or Periodic Inspection
		Loosening /Swelling /Settlement	X	X	X	X	
		Spring water/ Poor drainage	X	X	X	X	
	Mortar spray Concrete	Cracks/ Peeling	X	X	X	X	
		Loosen / Swelling /Settlement	X	X	X	X	

Facility	Member	Damage	Initial inspection	Routine inspection	Periodic inspection	Emergency inspection	Detailed Inspection
	spray	Void	X	X	X	X	
		Spring water/ Poor drainage	X	X	X	X	
Masonries	Concrete Block Masonries	Cracks/ Swelling/ Loosening	X	X	X	X	As required by Routine or Periodic Inspection
		Settlement/ Movement/ Leaning	X	X	X	X	
		Scouring	X	X	X	X	
		Poor drainage or spring water	X	X	X	X	
	Slope gabion works	a. Steel wire rupture or corrosion	X	X	X	X	
		b. Deformation	X	X	X	X	

5.6 Inspection Methods and Frequencies

Inspection methods and inspection frequencies in principle shall follow the relevant articles of this Guideline.

5.7 Evaluation of Inspection Results

5.7.1 Evaluation of the inspection results obtained in routine inspection, periodic inspection and emergency inspection shall be conducted, following relevant articles in this Guideline. Sample evaluation criteria of the inspection results for general slopes and protected slopes are shown in **ANNEX-A.** Also, particular notes for the evaluation of some major damages are described below;

5.7.2 Slope failure of general cut slope gives serious damages to road facility and vehicle traffic, so that it is important not to miss the first symptom of slope failure by facility inspection. When any changes or damages are found on the cut slope such as small collapse, cracks, swelling, spring water and so forth, it is necessary to conduct monitoring of these changes, in particular for those which are expanding and progressing.

5.7.3 Slope damages which lead to slope failure often appear at the upper part of the cut slope due to heavy rain in the form of tensile cracks or depression. These damages have high potential for large scale slope failures.

5.7.4 Damages appearing on the structural slope protection are sometimes caused by the damages occurring in the background area, so that inspection area should be carefully selected in order not to miss the main causes of the damages.

5.8 Data Registration and Reporting

Registration of inspection data and reporting shall be conducted, following relevant articles in this Guideline.

6. DRAINAGE SYSTEM INSPECTION

Many damages of road facilities are often caused by improper treatment of water, so maintenance and repair of Drainage Systems is of critically important.

6.1 Classification of Drainage System

Drainage facilities in general falls into the following classifications;

6.1.1 Road Surface Drainage System

Road Surface Drainage System is to prevent the degradation of subgrade bearing capacity which is the softening of subgrade caused by rain. Road Surface Drainage System shall be classified into the following major facilities;

- Naked ditch
- Stone masonry ditch
- Concrete block masonry ditch
- Concrete L-shaped ditch
- Concrete U-shaped ditch
- Rolled gutter
- Concrete cast-in-place ditch

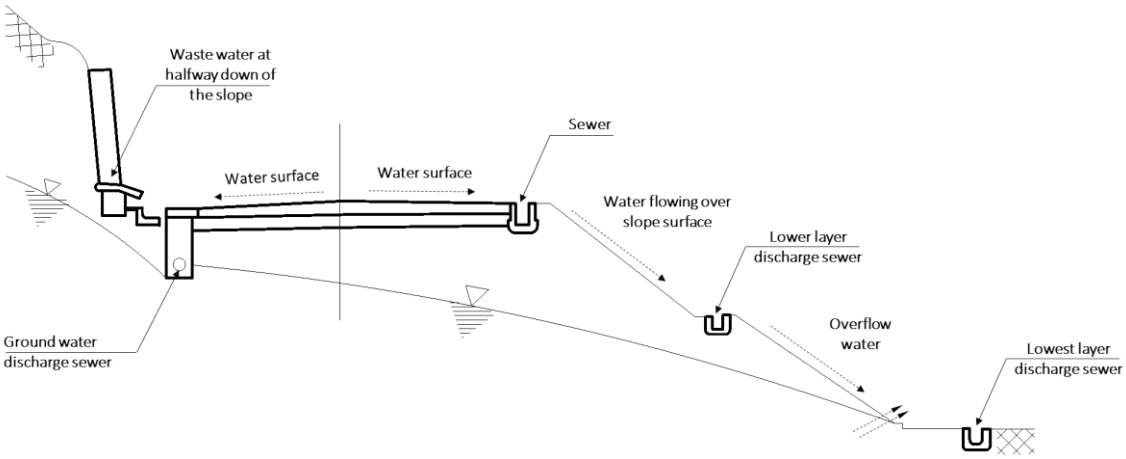


Figure 6.1.1 Road Surface Drainage Systems

6.1.2 Underground and Transverse Drainage System

Underground Drainage System is to prevent underground water infiltration into road structure from nearby area. Transverse Drainage System is to guide water crossing under road structure. There are mainly three types of Underground Drainage Systems as follows;

- Underground Drainage System is to prevent water infiltration into road body from neighbor areas and lead water to downstream outlet.
- Transverse Drainage System crossing over road facility
- Filter layer installed when groundwater level is high to prevent water infiltration into road body

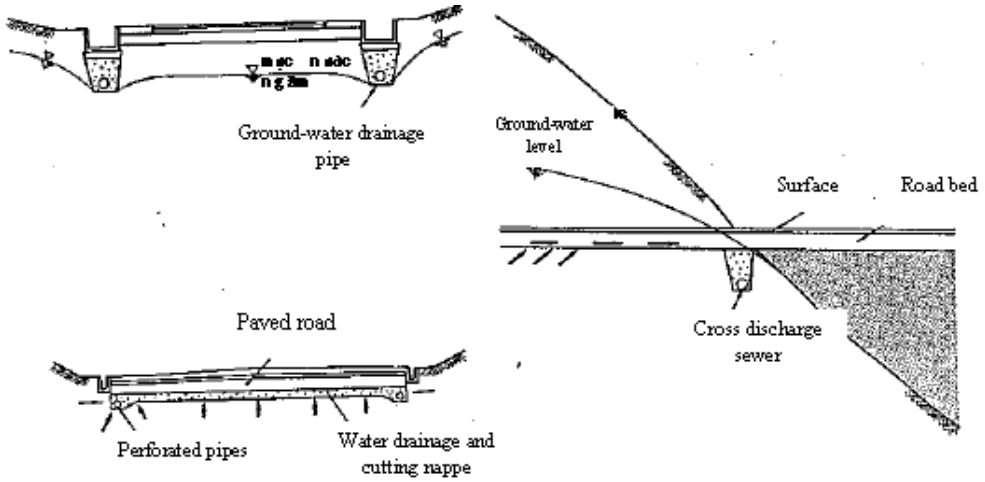


Figure 6.1.2 Underground Drainage System

6.1.3 Road Slope Drainage System

Road Slope Drainage System is to treat rain water or underground water and to prevent damages caused by them. There are mainly four types of Road Slope Drainage Systems available as shown below. **Figure 6.1.3** illustrates the installation of Road Slope Drainage System.

- Slope shoulder drainage system installed at the top of slope
- Vertical drainage installed along slope gradient from top to downward
- Drainage system installed on berms
- Stone filled drain installed horizontally

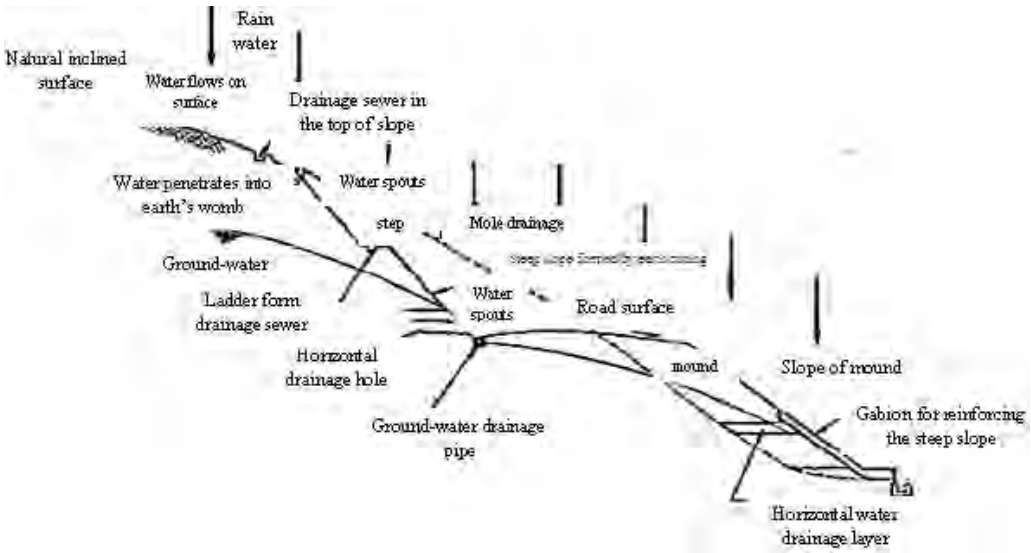


Figure 6.1.3 Slope Drainage System

6.1.4 Catch basin and water pit (**Figure 6.1.4**)

Downstream water outlet is to collect water from road area and discharge water to the Drainage System prepared outside of road area.

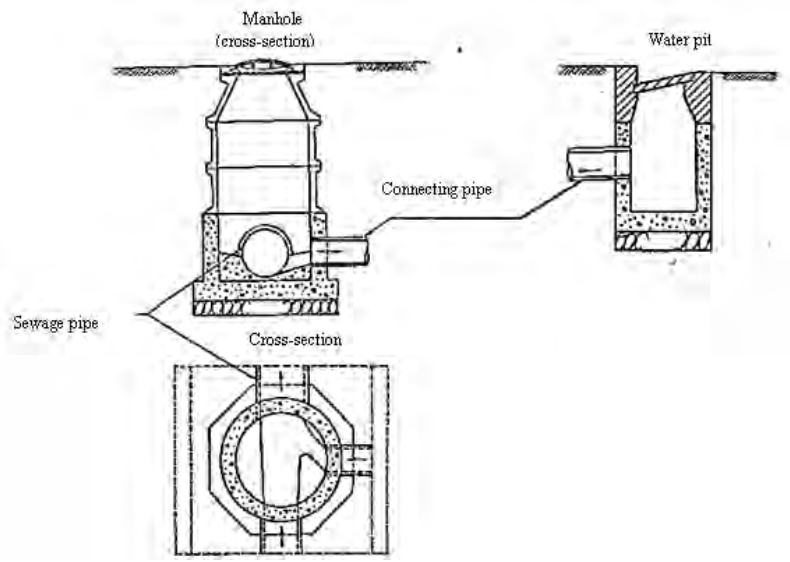


Figure 6.1.4 Catch-basin and Water Pit

6.2 Inspection Facilities

Inspection shall be conducted on the Drainage Systems which include Road Surface Drainage Systems, Underground and Transverse Drainage Systems, Road Slope Drainage Systems and catch-basin and water pit facilities.

6.3 Typical Damages of Drainage System

6.3.1 Road Surface Drainage System

The following damages are often observed on the Road Surface Drainage System:

- Interruption of water flow due to fallen plants, fallen trees, debris, loose silt or rocks.
- Piling of debris due to insufficient gradient of Drainage System
- Pavement surface cracks near Road Surface Drainage System
- Water overflow and puddle due to insufficient gradient or capacity of Drainage System
- Water flowing into road surface from surrounding area
- Soil erosion at invert or on the sides of drain due to steep gradient
- Soil erosion at drain exit due to steep water flow

The following are the typical damages for cast-in-place concrete Drainage System;

- Cracks or collapse of concrete drain due to the erosion of foundation
- Breakdown of drainage due to high water concentration
- For covered concrete drains, there observed some damages on the drain covers. Concrete covers are sometimes cracked or broken down due to traffic actions.

6.3.2 Slope Drainage System

The following are the typical damages for Slope Drainage System;

- Interruption of water flow due to debris in the drains, dense plants, etc.
- Overflow during heavy rain due to low or narrow capacity caused by piled soil, waste and debris.
- Broken or collapsed drains due to erosion lining

- Damage of joints between drains

6.3.3 Underground Drainage System

The following are the typical damages for Underground Drainage System;

- Cracks or unevenness on road pavement surface
- Water volume fluctuation at water outlet

6.3.4 Transverse Drainage System

The following are the typical damages for Transverse Drainage System;

- Cracks and water leakage
- Piling of debris or garbage
- Damage of joints and water leakage
- Water puddle due to uneven settlement
- Deterioration of Drainage System

6.3.5 Catch-basin and Water Pit

The damages of catch-basin and water pit include the following;

- Physical damages on the facilities
- Piling of debris in the facilities and malfunction of water flow
- Pavement cracks caused by the damages of catch-basin and water pit.
- High concentration of water and overflow from the facilities

6.4 Focus Point of Inspection

6.4.1 Focus points of inspection are shown below; Inspection on the Drainage Systems on the cut slope is important because any change of cut slope often appears on the Drainage Systems. Drain systems which are clogged or deformed by debris induce water infiltration into cut slope and cause slope failure in the long run.

6.4.2 Attention should be paid to any spring water seen on the cut slope and water treatment on the cut shoulders, as heavy rainfall may raise ground water level near the slope and have negative effects on the stability of cut slopes. Care should be directed to any changes of water near the cut slopes including occurrence of spring water, water volume and turbidity.

6.4.3 Inspection on the Drainage Systems on the cut slope is important because any change of cut slope often appears on the Drainage Systems. Drain systems which are clogged or deformed by debris induce water infiltration into cut slope and cause slope failure in the long run.

6.4.4 It is in general very hard to inspect Underground Drainage Systems, so that their functions shall be inspected after rainfall.

6.4.5 Attention shall be paid to the inspection on whether the drainage systems including outlets and catch-basis have capacity enough to treat water.

6.5 Inspection Points

Inspection of road slope facilities shall be implemented on the inspection points shown in **Table 6.5.1**. However, the table regulates the minimum requirement of inspection points, so that users can supplement some inspection points whenever needed.

Routine inspection shall be in principle implemented by vehicle-on-board visual inspection. However, when damage is detected, the inspection staff shall get off the patrol car and conduct short-distance visual inspection. In the case of routine inspection which shall be carried out from national road side, the range of the inspection is the area visible from the patrol car on the national road. For the routine inspection on the road side drainages which are invisible from national road side, inspection shall be done within the visible range from the local road accessible by car.

Table 6.5.1 Inspection Points for Drainage System

Facility	Member	Damage	Initial inspection	Daily inspection	Periodic inspection	Emergency inspection	Detailed Inspection
Drainage	All drainage system	Structural damages	X	X	X	X	As required by Routine or Periodic Inspection
		Erosion of foundation	X	X	X	X	
		Joint damage	X	X	X		
		Piling of debris		X	X	X	
		Flow capacity	X	X	X	X	
		Water puddle	X	X	X	X	
		Damages given to nearby road facilities	X	X	X	X	

6.6 Inspection Methods and Frequencies

Inspection methods and inspection frequencies in principle shall follow the relevant articles of this Guideline.

6.7 Evaluation of Inspection Results

6.7.1 Evaluation of the inspection results obtained in routine inspection, periodic inspection and emergency inspection shall be conducted, following relevant articles in this Guideline. Sample evaluation criteria for the inspection results of road Drainage System are shown in **ANNEX-B**. Also, particular notes for the evaluation of some major damages are described below;

6.7.2 Failures of Slope Drainage Systems often lead to slope failures which may provide serious damages to road facility and vehicle traffic, so that it is important not to miss the damages of the Drainage Systems leading to slope failures. When any damages are found by the inspection on the Drainage Systems or on the nearby slope facilities such as small collapse, cracks, swelling, spring water and so forth, it is necessary to repair the damaged Drainage System as quickly as possible and conduct monitoring of these slope failures.

6.8 Data Registration and Reporting

Registration of inspection data and reporting shall be conducted, following relevant articles in this Guideline.

7. RETAINING WALL INSPECTION

Retaining Walls are structural support to prevent slope failures or landslides where natural or structurally protected slopes cannot ensure the stability of slopes due to topographic, geological, hydraulic reasons or limited availability of land.

7.1 Classification of Retaining Walls

Retaining Walls can be classified by used materials and the shape of walls, but in general fall into the following walls;

a. Concrete block and stone masonry
b. Wire cylinder and mat gabion masonry
c. Retaining Walls
   - Gravity-type Retaining Wall
   - Cantilever-type Retaining Wall
   - Counterfort Retaining Wall.

7.2 Inspection Facilities

Inspection shall be conducted on the Retaining Walls which include concrete block and stone masonry, wire cylinder and mat gabion masonry and Retaining Walls.

7.3 Typical Damages of Retaining Walls

Retaining Walls shall have damages such as cracking, swelling, falling down due to the change of load working behind wall or the tope of wall, or may be leaned or broken due to subsidence of wall foundation. Typical damages are explained below;

7.3.1 Concrete block and stone masonry

- Cracks and swelling
- Settlement, movement and leaning
- Scouring
- Abnormal joint gap
- Scouring
- Poor drainage and spring water

7.3.2 Wire cylinder and mat gabion masonry

- Deformation
- Wire corrosion and rupture

7.3.3 Retaining walls

- Cracks, corner collapse, peeling, creeping
- Exposure of steel bars and corrosion
- Settlement, movement and leaning
- Abnormal joint gaps
- Scouring
- Poor drainage and spring water

7.4 Focus Point of Inspection

7.4.1 Damages of Retaining Walls shall often appear in unusual weather conditions such as heavy rain, storm, flooding, earthquakes etc., so that emergency inspection shall be implemented immediately after such disasters.

7.4.2 In case big damages are detected, detailed investigation shall be implemented to evaluate potential hazard and to find out countermeasures. In order to facilitate the designing of repair works, road inventory data including Retaining Wall initial design data should be preserved.

7.4.3 Focus points of inspection are shown below;

- Any concrete cracks, joint cracks, swelling and deterioration of wall surface
- Leaning, sliding and subsiding of Retaining Wall
- Damages on the drain holes, water reserve on the back fill and water seepage
- Gaps and voids between wall body and backfill soil
- Damages on wall foundation

7.4.4 In particular, much attention shall be paid on the damages on the Drainage Systems. The damages often cause imbalanced load working on the back of Retaining Wall, thereby give serious damages on the wall body.

7.5 Inspection Points

Inspection points of Retaining Walls are summarized in **Table 7.5.1**. However, the table regulates the minimum requirement of inspection points, so that users can supplement some inspection points whenever needed.

Table 7.5.1 Inspection Points for Retaining Walls

Facility	Member	Damage	Initial inspection	Routine inspection	Periodic inspection	Emergency inspection	Detailed Inspection
Retailing walls	Reinforced concrete retailing walls and Stone Masonry	Cracks	X	X	X	X	As required by Routine or Periodic Inspection
		Peeling	X	X	X	X	
		Steel bar exposure	X	X	X	X	
		Settlement or movement	X	X	X	X	
		Abnormal joint gap	X	X	X	X	
		Scouring	X	X	X	X	
		Poor drainage or spring water	X	X	X	X	

(Note) X: Inspection items.

7.6 Inspection Methods and Frequencies

Inspection methods and inspection frequencies in principle shall follow the relevant articles of this Guideline.

7.7 Evaluation of Inspection Results

Evaluation of the inspection results obtained in routine inspection, periodic inspection and emergency inspection shall be conducted, following relevant articles in this Guideline. Sample evaluation criteria for the inspection results of retaining walls are shown in **ANNEX-C**.

7.8 Data Registration and Reporting

Registration of inspection data and reporting shall be conducted, following relevant articles in this Guideline.

8. ROAD PAVEMENT INSPECTION

The Guideline regulates inspections on the main part of pavement facilities including asphalt pavements, bituminous pavements and cement concrete pavements.

8.1 Classification of Road Pavement

Road pavement for the national roads can be classified by used materials as follows;

a. Asphalt concrete pavement and bituminous surface treatment
b. Concrete pavement

8.2 Inspection Facilities

Inspection shall be conducted on the pavement facilities which include asphalt concrete pavement, cement concrete pavement, bituminous surface treatment.

8.3 Typical Damages of Road Pavement

8.3.1 Damages on the asphalt concrete pavement and bituminous surface treatment are shown below;

- Cracks
- Pot holes/ peeling/ depressions
- Rutting
- IRIs
- Bumps
- Edge Break

8.3.2 Damages on the concrete pavement are shown below;

- Bumps
- Cracks
- Concrete slab joint damages

8.4 Focus Points of Inspection

8.4.1 Pavement inspection are not only to detect pavement damages promptly which may lead to traffic accidents, but also to obtain data for strategic planning of maintenance and repair works of the road pavement. The following are the points to be focused on in implementing pavement inspection.

8.4.2 Asphalt Pavement & Bituminous Surface

8.4.2.1 Asphalt pavement cracks allow water infiltration into the pavement body and have a negative effect on

the pavement life-cycle. The following are the points to note in carrying out the inspections.

- Observe pavement cracks from slow moving vehicles on the road shoulder. If needed, stop the car and conduct a visual observation of the cracks.
- Drying time after rainfall for crack sections is in general much longer than that for the non-crack sections.
- Brief sketching or photographing crack conditions with measurement scales, which facilitates the computation of crack rates, will help support the evaluation of the defects and deterioration of asphalt pavements

8.4.2.2 Potholes, peeling and depression of asphalt pavement often give a serious influence on drivability, in particular to motorcycles and cause traffic accidents, so that inspection needs to be conducted with much attention.

- Observe the magnitude of damages in depth and in width.
- Carefully observe influence on vehicle drivability

8.4.2.3 Rutting, caused by asphalt flow and abrasion and scattering of aggregate, allows water to puddle and water splash on the pavement surface, causing a decline in skid resistance and visibility during night driving. The following are the points to note in carrying out the inspections.

- Observe straightness or wave form of pavement and road markings
- Observe whether car loses driving control
- Observe steering ability when crossing lanes
- Observe puddles and splash of water when it rains
- Observe humidity resources nearby that may cause deterioration for road pavement

Deformation of asphalt pavements is usually relevant to stabilities of bituminous mixtures under high temperature. Inspection and monitoring should be more intensive in hot and sunny days; inspection report must be attached with description of weather conditions, temperatures, traffic condition, existing of hazardous humidity sources and so forth. In order to examine progression of pavement rutting, cross-sections to be inspected or measured should be consistent in different inspection times.

8.4.2.4 Longitudinal roughness, when it becomes noticeable, often causes a decline in driving comfort and increased driving fatigue to vehicle drivers, thereby lowering driving safety. Large longitudinal corrugations not only cause discomfort to drivers, but cause lateral vibration in the vehicles and thus impair driving safety. Also, impact load often causes noise and vibration of the pavement, bridge structures and roadside environment. It is therefore necessary to carry out inspection carefully.

- Observe driving comfort and vibration while driving.
- Observe straightness of guardrails and road markings.

8.4.2.5 Bumps often appear at the connection with bridges, box and slab culverts, at the places where there are crossing structures and at the transition between cut and fill, and often cause big shocks to vehicles. Shocks not only cause damage to road pavements and structure like bridge concrete decks, but will be a source of noise and vibration to the roadside areas. The following are the points to note in carrying out the inspections.

- Carefully observe roughness in driving and vibration while driving

- Getting out of the car, carefully observe noise and vibration when vehicles pass
- Observe the magnitude of damages in depth, width and broken or crack

8.4.2.6 Edge Break is a break of asphalt pavement wearing surface around pavement edges upwards to road center as its expansion. Edge breaks generally occur when the road shoulder is worn, when there is inadequate strength of the pavement at the edge, when water scours soft shoulder of road and weaken pavement edge. Significant edge drops narrows lane width and resulting bumps may damage vehicle tires, causing vehicle or motorcycle accidents.

8.4.2.7 Other Defects

- Pumping is the phenomenon often observed when water infiltrates into a subgrade layer through pavement layers. With vehicle load, small/fine particles of subgrade or base course materials which contain water will spout out through pavement surface cracks. Inspection should be carefully carried out when fine soil particles or sand in the cracks on the pavement surface are observed. Repair works need to be done promptly before damages develop into serious pavement structural damages.
- Blistering is a phenomenon often appearing on the bridge pavements. When the water that remains between a bridge deck and the pavement vaporizes, pavement surfaces are often swollen. This often happens in the summer season. Blistered areas easily turn into potholes, so that inspection should be done carefully on the blistered areas of bridge pavements.

8.4.3 Concrete Pavement

8.4.3.1 Bumps often appear at the joints between concrete slabs or broken due to uneven settlement leads to shaking and reduction of riding comfort. As a consequence of uneven settlement, tie bars in the pavement are sometimes sheared or bend, causing a difference in the levels at joints between concrete slabs and thus impart shocks to running vehicles. Bumps also occur at the adjacent cracks of broken blocks. Points of inspection to investigate the voids under the concrete pavements are as follows.

- Measure unevenness of concrete slabs
- Hammer concrete slabs and listen to the sound
- Excavate the side of concrete slabs and confirm voids
- Take core samples and checking

8.4.3.2 Concrete pavement cracks, which come out at the end surface of the concrete slabs due to the effects of tie bars, tend to develop in accordance with the growth in the traffic volumes of large vehicles, so that special attention should be directed to the surface of the concrete slabs during inspection. In addition, small cracks observed in the stage of construction tend to be increased by repeated loading of vehicle traffic or the reduction of bearing capacity of subgrade or foundation. Moreover, concrete pavement cracks can be caused by poor function of slab joints due to stuck of stones or gravels and tightly filled by sand as well as the poor anti-water penetration. Data should be preserved to clarify the progress of cracks comparatively.

8.5 Inspection Points

8.5.1 Damages at concrete slab joints occur in accordance with the increase in large vehicle traffic. Concrete slabs are reinforced by tie bars and therefor are not deformed, so that stress concentration arises at or nearby joint structures between concrete slabs. In general, it is preferable to inspect the joints of concrete pavements

in the winter season, since joints gaps become wider in the winter season.

Road facility inspection for pavement facilities shall be implemented on the inspection points shown in **Table 8.5.1.**

Table 8.5.1 Inspection Points for Pavement

Facility	Member	Damage	Initial inspection	Routine inspection	Periodic inspection	Emergency Inspection	Detailed Inspection
Road Pavement	Asphalt Pavement	Pot holes/ /Peeling/ depressions	X	X	---	X	As required by Routine or Periodic Inspection
		Cracks	---	---	XX	---	
		Rutting Depth	---	---	XX	---	
		IRI	---	---	XX	---	
		Edge Break	X	X	---	X	
		Bumps	X	X	---	X	
		Pumping	X	X	---	X	
		Blistering	X	X	---	X	
	Concrete pavement	Bumps	X	X	---	X	As required by Routine or Periodic Inspection
		Cracks	---	---	XX	---	
		IRI	---	---	XX	---	
		Concrete slab joint damages	X	X	X	X	
	Road surface drainage system	Drainage facilities	X	X	X	X	As required by Routine or Periodic Inspection
		Joint	X	X	X	X	
		Piling of debris	X	X	X	X	

(Note) X: Inspection items, XX: Inspection items to be measured by pavement condition survey vehicle.

8.5.2 Routine inspection shall detect pavement damages, in particular focusing on the damages causing unsafety to road traffic such as pot holes, bumps, rutting, water paddle etc.

Routine inspection shall be in principle implemented by vehicle-on-board visual inspection. However, when damage is detected, the inspection staff shall get off the patrol car and conduct short-distance visual inspection.

8.5.3 Periodic inspection shall cover surveys not only on the asphalt concrete pavement, bituminous surface treatment and cement concrete pavement, but also on the Road Surface Drainage Systems.

8.5.4 In case pavement condition survey vehicle is applied to the periodic inspection, it shall measure pavement condition indexes including crack rate, rut depth and IRIs every 100 meters. Of these pavement condition indexes, rut depth and IRIs are automatically measures by the on-board sensors, on the other hand, crack rate shall be manually calculated by analysing video data recorded all the way during pavement condition survey. Other damages on the concrete slab joint and on the Road Surface Drainage Systems shall be separately inspected by patrol staff, following the relevant above articles in this Guideline.

8.5.5 Periodic inspection by pavement condition survey vehicle shall be conducted by professional organization designated by DRVN. Managing agency of road facility inspection shall commit the road condition survey in the region to the professional agency by contract.

8.5.6 Professional organization shall take responsibilities for carrying out the field survey on pavement conditions, analysing crack data, proceeding data, evaluating the results of inspection, registering data into the pavement condition database and preparing and submitting inspection reports to the managing agency of

road facility inspection.

8.5.7 Detail inspection shall be conducted when proposed by periodic inspection or when proposed for the planning and the designing of road rehabilitation and reconstruction works. Detailed inspection shall apply advance inspection equipment and make professional judgement in finding out the causes of the damages and in planning proper countermeasures of the damages. The following are the typical tasks for the detailed inspection.

- To evaluate pavement structure and its current load bearing by NDT testing like: Falling Weight Defect meter (FWD), Benkelman Deflection Beam, Plate Loading Test, etc.
- To evaluate pavement structure and its current load bearing by DT testing like: sample boring, cutting, excavation in combination with site experiments and testing on samples in laboratory.
- To identify areas or locations where poor skid resistance is observed, thereby many vehicle accidents occur, by applying skid resistance survey equipment.
- To make decisions on the repair work priorities.
- To examine locations where vehicle accident frequently occur.

8.6 Inspection Methods and Frequencies

Inspection methods and inspection frequencies in principle shall follow the relevant articles of this Guideline. However, inspection methods and frequencies specialized for the periodic inspection and the detailed inspection for pavement facility shall follow the methods prescribed in **Table 8.6.1**.

Table 8.6.1 Inspection Methods and Frequencies

Inspection Type	Inspection Method	Inspection Frequency
Periodic inspection	● Pavement condition survey vehicle for cracking, rutting and IRI survey ● Short-distance visual inspections for edge break and other damages	Once every 3~5 years
Detailed Inspection	● NDT testing like: Falling Weight Defect meter (FWD), Benkelman Deflection Beam, Plate loading test, etc. ● NDT testing like: sample boring, cutting, excavation in combination with site experiments and testing on samples in laboratory ● Skid Resistance Survey	Refer to Table 4.3.2

8.7 Evaluation of Inspection Results

8.7.1 Evaluation of the results of routine inspection, periodic inspection and emergency inspection shall be conducted, following the relevant articles in this Guideline. Sample evaluation criteria for road pavement inspection results are shown in **ANNEX-D**. **ANNEX-E** shows maintenance and repair works for road pavement as reference. Also, particular notes for the evaluation of some damages are described below;

8.7.2 In this Guideline, road facility damages expected to give large effects to vehicle traffic are rated as “D”, such as pothole, peeling and depression damages over 20 cm in diameter and 20 mm in depth, crack ratio in area percentage over 40 percent and rutting depth over 40 mm. Pavement depression discussed in this Guideline is a local depression arising in spots.

8.7.3 In case PMS is applied to the formulation of periodic repair plans for road pavement, evaluation on the inspection results shall be automatically carried out in the computation processes of PMS model. Other

damages shall be separately inspected by patrol staff in the routine inspection and evaluated, following the relevant above articles in this Guideline.

8.8 Data Registration and Reporting

Registration of inspection data shall be conducted, following relevant articles in this Guideline.

9. BRIDGE INSPECTION

The Guideline regulates inspections on the main part of bridge facilities including concrete superstructure, steel superstructure, concrete and steel substructure, bridge accessories such as bearing shoe, expansion joint, drainage system, guardrail, approach road embankment, and pavement. Inspection of traffic control sign board, lighting system are regulated in the other section of this guideline.
Large-scale bridges, including suspension bridges and cable-stayed bridges, are out of this manual since the above mentioned bridges are so special that inspection manuals should be prepared separately.

9.1 Classification of Bridges

Bridges on the national roads can be classified by used materials and functions as follows;

a. Concrete bridge (superstructures and substructure)
b. Steel bridge (superstructures and substructures)
c. Bearing shoe (Rubber shoe and steel shoe)
d. Expansion joint (Rubber face plate and steel face plate)
e. Others such as drainage facilities, traffic safety facilities, traffic sign boards, and embankment for approach road including pavement.

9.2 Inspection Facilities

Inspection shall be conducted on the bridge facilities which include all bridge facilities categorized above.

9.3 Typical Damages of Bridge

9.3.1 Defects and deterioration common to all bridges

Following are common defects and deteriorations to all type of bridges. These defects/deteriorations sometimes affect stability and durability of the bridge.

9.3.1.1 Abnormal deflection

Sagging or hogging deflection which is observed due to concrete creep, internal stresses caused by concrete drying shrinkage and inadequate PC wire stresses.

Following is the point to note in carrying out the inspections.
- Observe the alignment of the lane marking and the handrail/guardrail.

9.3.1.2 Abnormal noise

Abnormal banging noise or creaking noise which are observed due to damage of the joints or internal movement of the joints.

Following is the point to note in carrying out the inspections.

- Pay attention on noise carefully near the joints.

9.3.1.3 Abnormal vibration

Abnormal vibration is palpably observable.

Following is the point to note in carrying out the inspections.

- Pay attention on vibration at the span centre area of the bridge.

9.3.1.4 Abnormal expansion gaps

Expansion gaps between girders, abutments and joints which are too narrow or too wide, which caused by tilting of the substructures, lack of consideration on the design, and lack of accuracy of structure dimension at construction stage.

Following is the point to note in carrying out the inspections.

- Measure the expansion gaps when it identified

9.3.1.5 Settlement

Settlement is observed on bridge structures including sub structures, foundations and their associated facilities. Uneven settlement observed at joints, which is caused settlement of substructures.

Following is the point to note in carrying out the inspections.

- Conduct visual inspection on the joints, and vertical alignment of the handrail/guardrail.

9.3.1.6 Movement

Rotation or movement of structures occurs at bridge substructures such as abutments, and piers due to settlement and tilting of substructures.

Following is the point to note in carrying out the inspections.

- Conduct measuring of the joint gaps, plumb survey, and elevation survey.

9.3.1.7 Scouring

Scouring, which is caused by swift current, exposes structures including footings and foundations of bridges constructed in a river or the sea. Due to scouring bridge foundations expose above the river bed and affects stability of the bridges.

Following is the point to note in carrying out the inspections.

- Conduct visual inspection of topographic condition of the river bank, river bed around the foundation.

9.3.2 Concrete bridges

A characteristic of concrete structures is that steel members such as reinforcing bar (hereinafter referred to as “rebar”), and pre-stressing cable (hereinafter referred to as “PC cable”) are embedded in concrete structures, so that repair works and strengthening of structures will become hard if corrosion progresses to steel members inside. Also, the quality of concrete construction may have large impact on the load-bearing capacity of the concrete structures. Environmental conditions around the bridge also have negative impacts on the progress of concrete deterioration, so that early detection of defects and deterioration along with

understanding their environment would be a key for the better maintenance of concrete facilities.

Following are typical defects and deterioration often observed during bridge inspection.

9.3.2.1 Crack

There are various influential factors causing cracks, such as those including drying shrinkage, tensile stresses, materials, construction methods, environment, designs, external working forces and so forth.

Concrete cracks allow water infiltration into the concrete and have a negative effect on the steel members in the concrete and affect life-length of the concrete structures due to loosing tensile strength of the structures. In addition, corrosion causes rebar diameter expansion which brings peeling of concrete cover and causes further corrosion of rebar. The following are the points to note in carrying out the inspections.

To identify concrete crack following inspection method is commonly implemented.

- Conduct short distance visual inspection.

9.3.2.2 Concrete Peeling, Creep

Concrete peeling is caused by the swelling of rusted rebar, concrete inner stresses and improper treatment of construction joints, causing peeling, spalling and the creep of concrete surfaces.

Peeling of concrete causes rebar exposure and develops rebar corrosion and consequently rebar loose its tensile strength.

To identify concrete peeling, creep following inspection method is commonly implemented.

- Conduct short distance visual inspection.

9.3.2.3 Rebar exposure

Rebar exposure caused by the effects of concrete peeling, creep or improper construction methods. Exposed rebar get rust and develop corrosion easily.

To identify rebar exposure following inspection method is commonly implemented.

- Observe surface of the concrete structure body, and conduct short distance visual inspection, if necessary.

9.3.2.4 Water leakage and Puddles

Water leakage and puddles occur due to rain water infiltrating through concrete joints, penetrating cracks, expansion joints and damaged drain systems. Water leakage and puddles cause rebar corrosion.

To identify water leakage and puddles following inspection method is commonly implemented.

- Observe surface of the concrete structure body together with concrete crack inspection.

9.3.2.5 Free lime

Free lime is a phenomenon causing the lime component of concrete to flow out of construction joints or out of penetrated cracks with water infiltrating into the concrete body.

To identify free lime following inspection method is commonly implemented.

- Observe surface of the concrete structure body.

9.3.2.6 Rusty fluid

Rusting of steel bars buried in the concrete progresses and flows out from concrete cracks, showing the Rusty fluid.

To identify rusty fluid following inspection method is commonly implemented.

- Observe surface of the concrete structure body.

9.3.2.7 Deterioration and Discoloration

Deterioration of concrete, which may degrade concrete performance, is caused by chemical reactions. Discoloration is a phenomenon changing concrete colour by deterioration.

- Observe surface of the concrete structure body.

9.3.2.8 Honey comb, Void

Honey combs, voids are caused by mainly poor quality control during construction stage. These defects cause rebar rusting and corrosion.

To identify honey comb and void following inspection method is commonly implemented

- Observe surface of the concrete structure body.

9.3.2.9 Chemical attacks

Following are typical chemical attacks;

a. Penetrated carbon dioxide into concrete changes concrete property from alkali to neutrality and loose protection function of rebar from rusting.

To identify neutralization depth of the concrete following inspection method is commonly implemented.

- Conduct phenolphthalein solution test on the collected core/powder of the concrete.

b. Penetrated chloride particle in the air into concrete causes rebars rusting directly.

To identify chloride penetration depth in the concrete following inspection method is commonly implemented.

- Conduct chloride contents test on the collected core/powder of the concrete.

When alkali reaction aggregates are used as concrete material often crocodile cracks are found on the surface of concrete structures which are facing high possibility of rebar rusting.

- Conduct alkali reaction test on the collected core of the concrete.

9.3.3 Steel bridges

Following are typical defects and deterioration often observed during steel bridge inspection.

9.3.3.1 Deterioration of paint

Cracks, swelling and peeling are observed on the bridge paint including corrosion due to their effects.

To identify deterioration of paint following inspection method is commonly implemented.

- Conduct short distance visual inspections which pay attention on corrosion of steel members, condition of discoloration and chalking, peeling, cracking and swelling of paint film on the steel members.

9.3.3.2 Corrosion

Concentrated corrosion is observed on the steel materials or reduction in cross section is observed on steel materials due to the effects of corrosion.

To identify corrosion following inspection method is commonly implemented.

- Conduct short distance visual inspections with scaffoldings, if necessary.

9.3.3.3 Looseness and falling of rivets and HTBs

Loosening and falling of rivets, bolt-nuts and HTBs are observed at joints.

To identify looseness and falling of rivets, bolt-nuts and HTBs following inspection method is commonly implemented.

- Conduct short distance visual inspections and hammering check with scaffoldings, if necessary.

9.3.3.4 Cracks

Steel material fatigue cracks are observed at the places where stress concentration occurs, where there are changes in steel material cross section and where welding connection area. Also, cracks are observed, which are caused by over stress due to earthquakes and vehicle collisions or high frequency of over loaded vehicle passages.

To identify cracks on the steel members following inspection method is commonly implemented.

- Conduct short distance visual inspections with scaffoldings, if necessary.
- In case exist of the crack is unclear, following tests are carried out to detect cracks;
  - Penetrant inspection
  - Magnetic particle examination
  - Ultrasonic examination

9.3.3.5 Deformation, buckling

Deformation or buckling is observed in the steel materials due to over stress caused by earthquakes and vehicle collisions or high frequency of over loaded vehicle passages.

- Pay attention on the shape of steel members during visual inspection.

9.3.3.6 Water leakage, puddles

Water infiltration is observed in the places where it is hard to treat pooled water, such as those where steel members cross each other or inside steel piers.

9.4 Focus Points of Inspection

9.4.1 Purpose of inspection

Bridge inspection are not only to detect bridge damages promptly which may lead to negative effect to durability of the bridge, but also to obtain data for strategic planning of maintenance and repair works of the bridges. The following are the points to be focused on in implementing bridge inspection.

9.4.2 Concrete superstructure

9.4.2.1 Girder

Following are the points to be focused on implementing concrete bridge girders inspection.

i. Girder end support area

Locations where the horizontal force caused by the bearing shoe reaction, earthquakes and changes in temperature. In this area following cracks observed.

- Vertical cracks on the lower side or both sides of a girder on a support.
- Diagonal cracks on the webs of a girder on a support.
- Horizontal cracks on the webs of a girder.

ii. Intermediate supporting area

Locations where negative bending moment and shear forces to be maximum values. Also, stress conditions around the locations become complicated due to the concentrated support reaction force and cracks are prone to emerge.

- Vertical cracks on the upper side of a continuous main girder near support.

iii. Span centre

Locations where bending moments show maximum values and thereby bending cracks are prone to emerge.

- Vertical cracks on the underside or both sides of a girder.
- Longitudinal cracks on the underside of a main girder.

iv. A quarter point of span

Locations where cracks emerge due to the changes in steel bar distribution. Also, improper movement of bearings causes cracks at these points.

- Vertical cracks on the underside or both sides of a girder.

v. Construction joints

Locations where cracks, peeling and water leakage may be occurring due to concrete drying shrinkage.

vi. Cracks running vertically or horizontally along the segment joints.

Similar cracks to the above arise at the segment joints during concrete casting.

- Cracks near segment joints.

vii. Anchor portions

Around the structures which anchor PC cables, cracks are prone to emerge due to the high concentration of compression stress.

- Crocodile cracks on an anchoring concrete after installing PC cable.
- Vertical or diagonal cracks near the projection of PC cable anchors.
- Cracks near PC cable anchors.
- Cracks on a anchoring concrete at joint portion of cross beams

viii. Notched section

Locations where a girder cross section changes drastically, cracks are prone to emerge due to high concentration of stress.

- Cracks near the cantilever sections where section shape changed drastically.

Focus points on concrete girder cracks inspection are summarised as **Table 9.4.1**~ **9.4.9**.

Table 9.4.1 Summary of Focus Points on Concrete Girder Crack Inspection

Inspection Points	Outlines of Inspection Points
A. Girder end support	Locations subject to the horizontal forces caused by support reaction force, earthquakes and changes in temperature
B. Central support	Locations where negative bending moment and shear forces show maximum values. Also, stress conditions around the locations become complicated due to the concentrated support reaction force and cracks are prone to emerge.
C. Centre between supports	Locations where bending moments show maximum values and thereby bending cracks are prone to emerge.
D. A quarter point between supports	Locations where cracks emerge due to the changes in steel bar distribution. Also, improper movement of bearings causes cracks at these points.
E. Concrete joints	Locations where cracks, peeling and water leakage may arise due to concrete drying shrinkage
F. Segment joints	Similar cracks to the above arise at the segment joints during concrete casting.
G. Anchor portions	Around the structures which anchor PC cables, cracks are prone to emerge due to the high concentration of tensile stress.
H. Notched section	Locations where a girder cross section changes drastically, cracks are prone to emerge due to high concentration of stress.

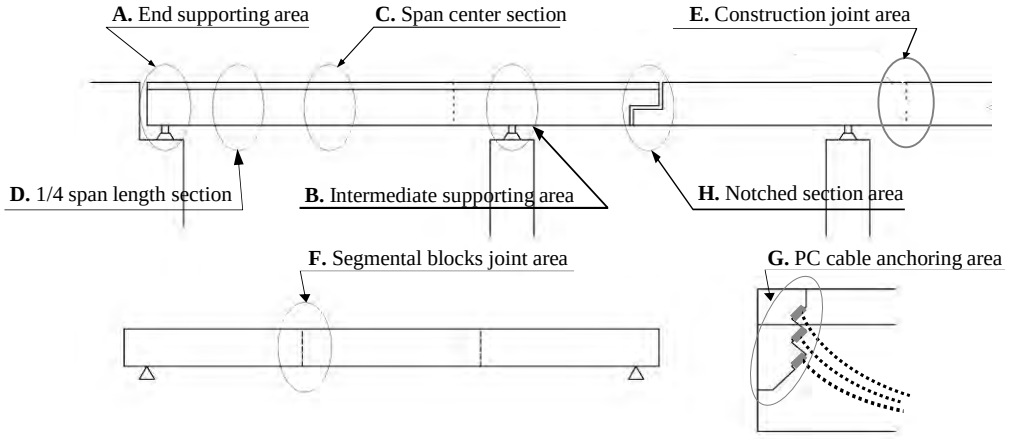


Table 9.4.2 Cracks near the Girder End Supports

Crack Pattern	Outline	Main causes of Cracks
A. Crack pattern near girder end supports	① Vertical cracks observed on the underside or both sides of a girder on a support.	Excessive concentration of stresses on a girder near a support, improper bearing functioning or earthquakes.
	② Diagonal cracks observed on the webs of a girder on a support.	Excessive concentration of stresses or shortage of shear reinforcement steel.
	③ Horizontal cracks observed on the webs of a girder.	Bearing stress around anchor.

Table 9.4.3 Crack near the Intermediate Support

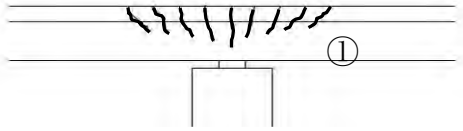
Crack Pattern	Outline	Main causes of Cracks
B. Crack pattern near intermediate support	① Vertical cracks observed on the upper side of a continuous main girder near support.	Lack of reinforcement steel against negative bending moment on the upper flange of a girder near supports.
		

Table 9.4.4 Crack near the Span Center

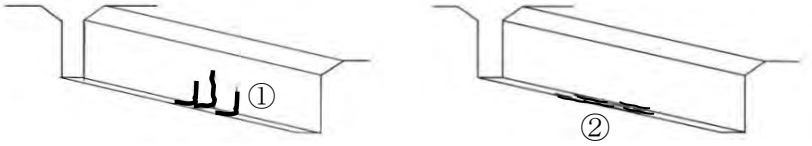
Crack Pattern	Outline	Main causes of Cracks
C. Crack pattern at the centre of the span	① Vertical cracks observed on the underside or both sides of a girder	Excessive bending moment
	② Longitudinal cracks observed on the underside of a main girder.	Lack of cross section or steel bar design volume of a main girder, salt effects or alkaline aggregate reaction.
		

Table 9.4.5 Crack near the Quarter Point of the Span

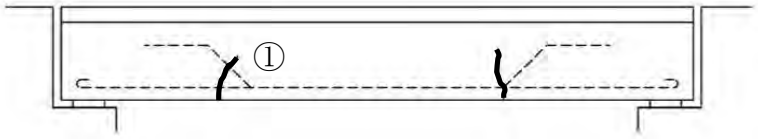
Crack Pattern	Outline	Main causes of Cracks
D. Crack patter at a quarter point of the span	① Vertical cracks observed on the underside or both sides of a girder	Lack of steel bar design volume
		

Table 9.4.6 Crack near the Construction Joints

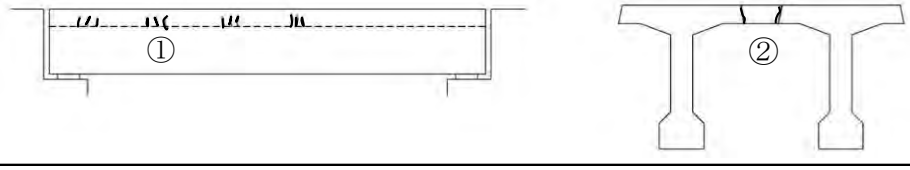
Crack Pattern	Outline	Main causes of Cracks
E. Crack pattern near construction joints	① Cracks running vertically or horizontally along construction joints	Improper concrete adhesive power at cold joints.
	② Cracks near construction joints on the girder or on the concrete slabs	Improper treatment of construction joints or lack of PC material tensile stress
		

Table 9.4.7 Crack near the Segment Joints

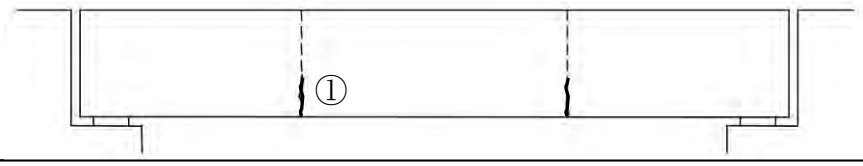
Crack Pattern	Outline	Main causes of Cracks
F. Crack pattern near segment joints	① Cracks near segment joints	Lack of PC material tensile force
		

Table 9.4.8 Crack near the PC Cable Anchors

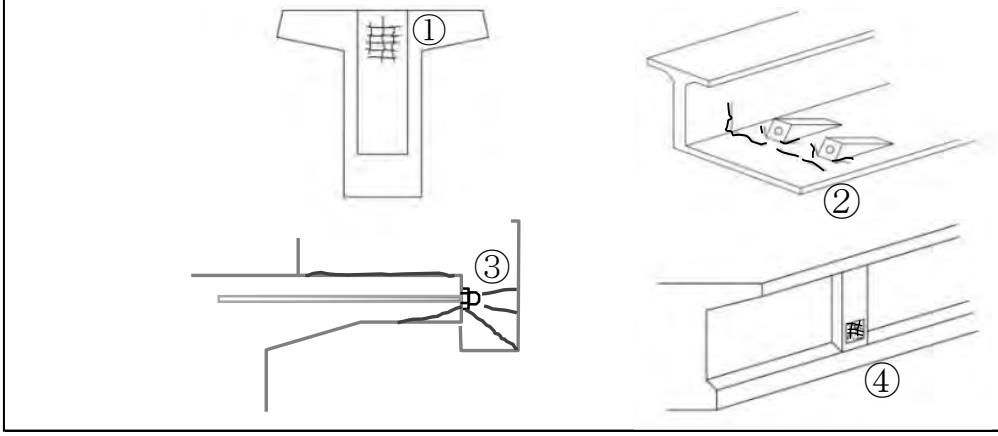
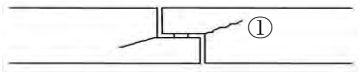
Crack Pattern	Outline	Main causes of Cracks
G. Crack pattern near PC anchors	① Crocodile cracks on an anchoring concrete after installing PC materials.	Concrete drying shrinkage, corrosion of anchor materials, improper treatment of construction joints
	② Vertical or diagonal cracks near the projection of PC material anchors	High concentration of stresses on anchor portions
	③ Cracks near PC material anchors.	Lack of concrete protective covering
	④ Cracks on a anchoring concrete at joint portion of cross beams.	Improper design of concrete, improper construction of anchoring concretes.
		

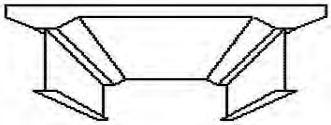
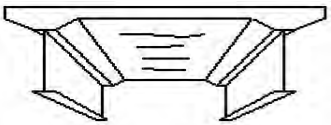
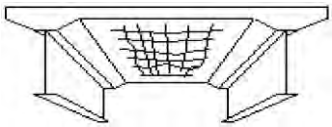
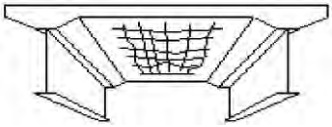
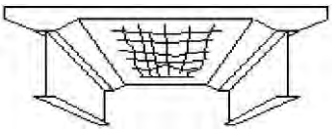
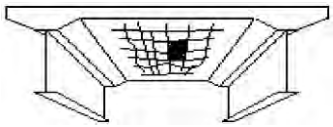
Table 9.4.9 Crack near the Notched Section

Crack Pattern	Outline	Main causes of Cracks
H. Crack pattern near the canti-lever sections	① Cracks near the canti-lever sections	Concentration of stresses due to drastic changes in cross section.
		

9.4.1.2 Concrete deck slab inspection

Table 9.4.10 shows the mechanism of crack progress on the concrete decks.

Table 9.4.10 Mechanism of Crack Progress on the Concrete Decks

Crack Damage Progress	Schematic Views
1. Initial Stage, no damage	
2. Cracks, caused by drying shrinkage, appear perpendicular to the bridge axis.	
3. Cracks progress due to traffic load, which comprise longitudinal and perpendicular cracks, forming a grid pattern.	
4. Cracks penetrate the concrete decks to the surface due to traffic load.	
5. Cracks further break down due to interaction between particles, gradually losing shear resistance force.	
6. Due to traffic load which exceeds punching sheer force of deck concrete, spalling of concrete material occurs.	

Taking above the mechanism of crack progress on the concrete deck slab into consideration, the following are the points to be focused on implementing concrete bridge deck slab inspection.

i. Bottom surface of the concrete deck slab

Crack directions, spacing of cracks, water leakage, free lime, traces of rusting, concrete peeling, range of concrete spalling, range of steel bar exposure, range of voids are to be identified through inspection on the bottom of the concrete deck slab.

To identify concrete crack on the bottom surface of main body of the concrete deck slab following inspection method is commonly applied.

- Short-distance visual inspection and hammering check standing on the scaffolding installed under the deck slab.

ii. Cantilever section of the concrete deck slab

Crack directions, spacing of cracks, free lime, traces of rusting, concrete peeling, range of concrete spalling, range of steel bar exposure, range of voids are to be identified by the inspection on the cantilever section of the concrete deck slab. These defects emerge on the bottom of the concrete deck slab of the cantilever section.

To identify concrete crack on the cantilever section of the concrete deck slab following inspection method is commonly applied.

- Short-distance visual inspection and hammering check standing on the scaffolding installed under the deck slab.

iii. Connection parts with steel girder flange

Free lime, traces of rusting, range of voids, range of concrete peeling and creep are to be identified through the inspection on the connection section between concrete deck slab and steel girder flange.

To identify concrete crack on the connection parts with the steel girder flange following inspection method is commonly applied.

- Short-distance visual inspection and hammering check standing on the scaffolding installed under the deck slab.

iv. Pavement surface

Scale of pavement, potholes and repair works in the past, direction of cracks, spacing of cracks are to be inspected. Some of these defects on the pavement are caused by defects on the concrete deck slab. Short distance visual inspection on the road surface is necessary to detect the pavement and concrete deck slab defects.

9.4.3 Steel bridge inspection

Following are the points to be focused on in implementing steel bridge inspection.

9.4.3.1 Entire steel bridge surface, members

i. Paint inspection

Inspection on paint condition of the entire of the bridge including inside of the box girder and the steel pier is to be carried out to identify paint condition of the bridge. Visual inspection is common inspection method applied for paint inspection. Following are carried out to identify detailed paint condition;

- Cut and peel check for identifying deterioration progress of the paint film on the steel members.
- Chalking progress check to confirm deterioration progress of the paint film on the steel members.
- Salt particles density check on the surface of the bridges to confirm corrosion condition of surrounding environment of the bridges.
- Impedance test to identify the steel member thickness which reduced due to progress of corrosion.

ii. Corrosion inspection

Inspection method on corrosion including rusting is almost the same with paint inspection. Rust develops to corrosion, therefore, rust inspection on rust location, rust area and rust level is carried out as parts of corrosion inspection to prepare maintenance plan including prevention plan for corrosion.

Following area are required much careful inspection due to easy corrosive/restive area.

- Water affects area such as under and surrounding area of drainage facilities.
- Bridge members and other facilities concentrated area where always keeping wet condition due to lack of sun shine and ventilation.

Iii. Deformation, buckling inspection

Visual inspection is applicable inspection method for detection of the deformation and buckling of steel

members of the bridges. When passing the bridges all ways pay attention upon deformation and buckling of the steel members which are visible from the road surface to find out the defects earlier.

9.4.3.2 Welding points

Cracks on the steel members are observed mainly following welding points:

- Welded portions of sole plates and at changes in cross sections
- Welded portions with stiffeners and gusset plates
- Welded portions on the steel deck plates and stiffness members
- Butt welded portions on the lower flanges
- Welded portions on the base of vertical members on the arch ribs
- Welding portion of the base plates with steel pier

Typical crack appearance patterns are shown in **Figure 9.4.1** through **Figure 9.4.6**.

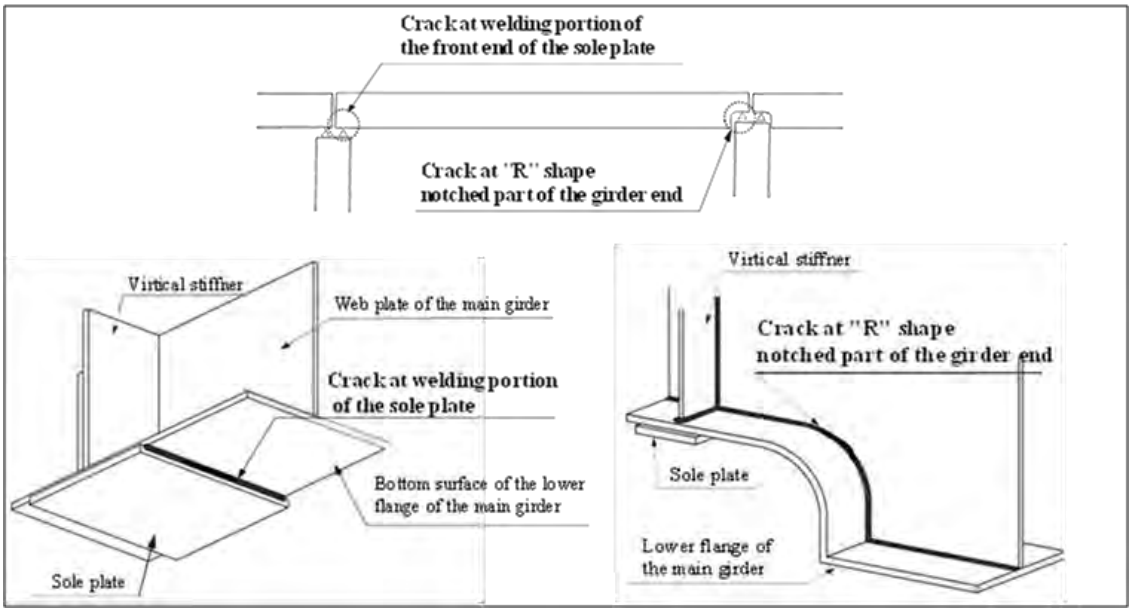


Figure 9.4.1 Crack at Welding Portion of the Front End of the Sole Plate

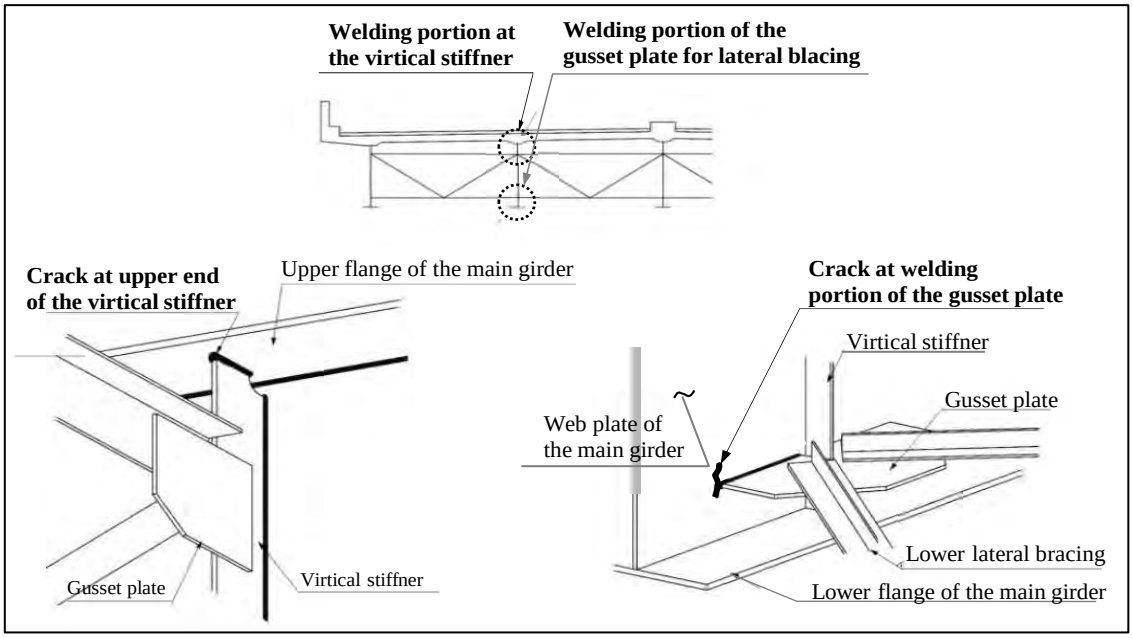


Figure 9.4.2 Crack at Welding Portion at the Vertical Stiffener

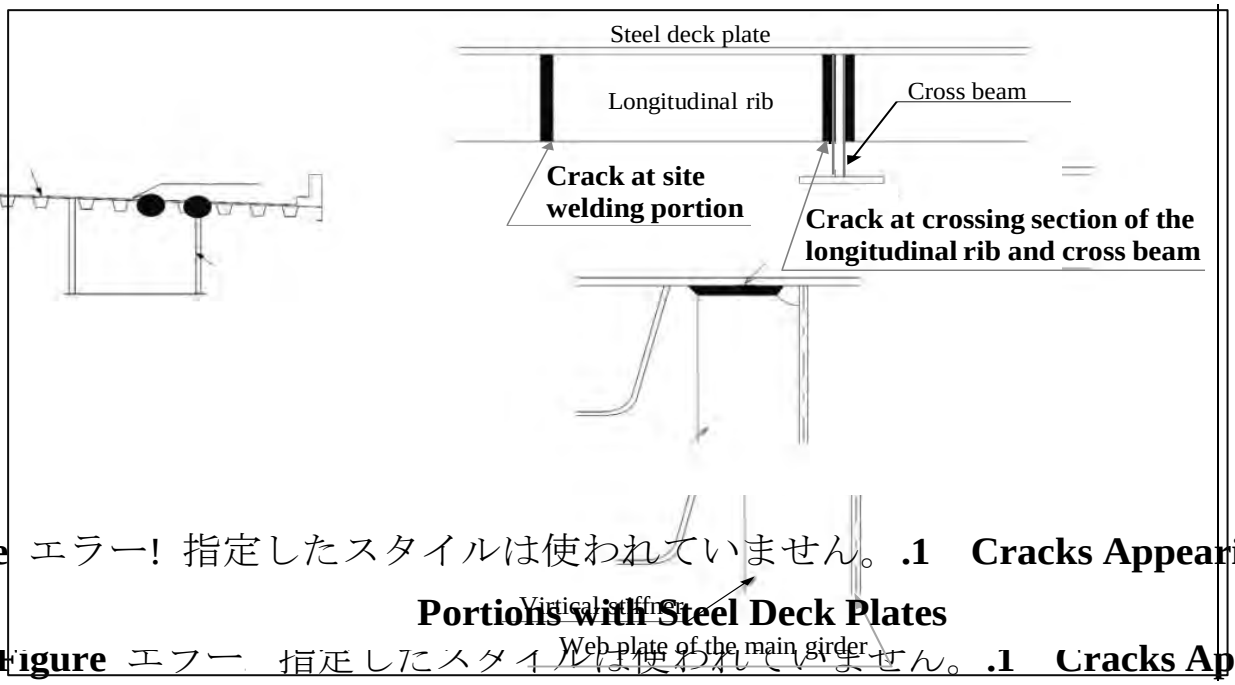


Figure エラー! 指定したスタイルは使われていません。.1 Cracks Appearing at Wel

Portions with Steel Deck Plates

Figure エラー! 指定したスタイルは使われていません。.1 Cracks Appearing at

Figure 9.4.3 Crack at Welding Portion of the Steel Deck Plate

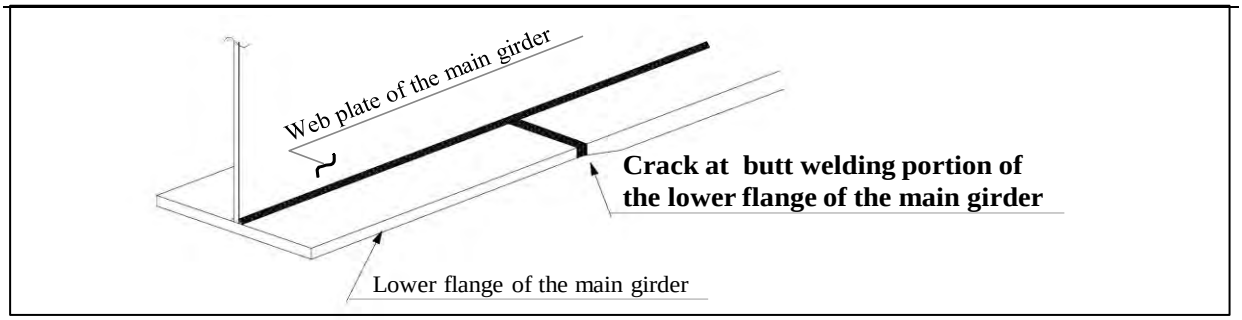


Figure 9.4.4 Crack at Butt Welding Portion of the Lower Flanges

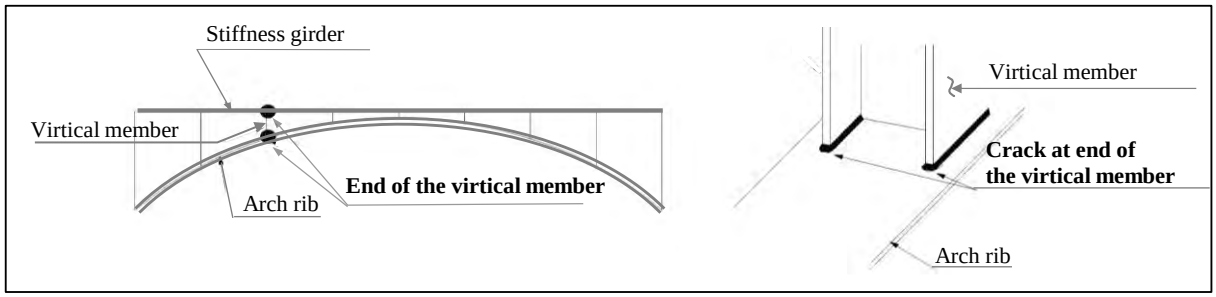


Figure 9.4.5 Crack at the Base of Vertical Members on the Arch Ribs

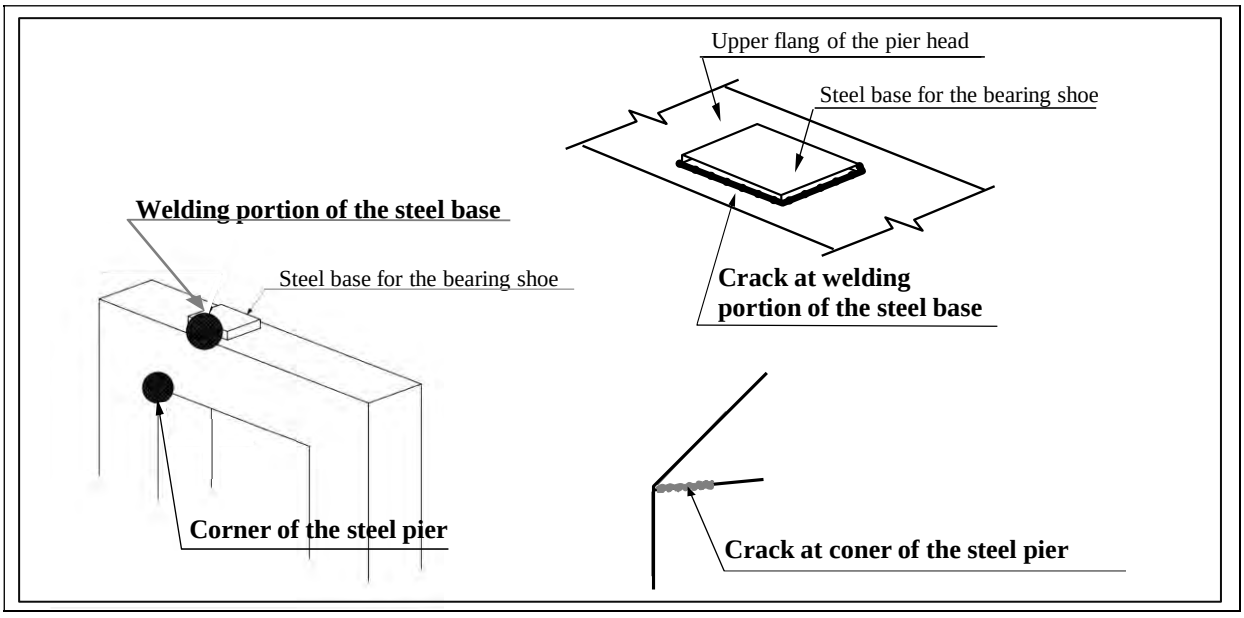


Figure 9.4.6 Crack at the Rigid-frame Piers

9.4.3.3 End of stringers

Cracks are sometimes observed at the end of stringers.

- Pay attention on the corner of the notch for connection to other members and the end of the flange plate of the stringers

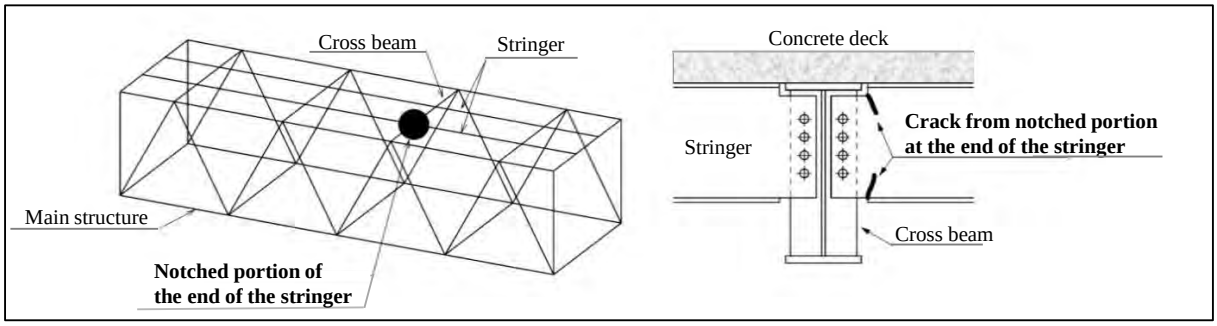


Figure 9.4.7 Crack from End of the Stringers

9.4.3.4 Connection and splicing area

Inspection on rivets, bolt-nuts and HTBs are carried out on connecting and splicing portion. In case loosen nuts found it is necessary re-tightening of the nuts. After inspection and re-tightening of bolt-nuts and HTBs, marking on nuts is necessary as parts of quality control of works. Visual inspection and hammering test is effective inspection method.

9.4.3.5 Drainage facilities

Visual inspection is applicable inspection method for detection of the water leakage and puddles. The end of the span including expansion joint area, surrounding area of the drainage facilities such as inlet and outlet of the drainage, basin, and cross points of steel materials (in particular for arch and truss bridges) are main inspection points for detecting water leakage and puddles.

9.4.4 Substructures and foundations inspection

Following are the points to be focused on in implementing substructures and foundations inspection.

9.4.4.1 Tilting, settlement, and movement

Visual inspection is applicable for detecting tilting, settlement and movement of the substructures and foundations.

Following are carried out for detect tilting, settlement and movement of the substructures and foundations as supplemental inspections, when required;

- Measuring gap space and elevation difference of the expansion joints
- Levelling survey of the substructure and foundation
- Incline survey of the stem and parapet wall by a plumb

9.4.4.2 Scouring

Scouring is caused by swift current of water which brings soil from bottom and surrounding part of the substructures and foundations constructed in a river or sea including the river edge and shore line, exposes substructures and foundations of the bridges. Scouring sometimes affects stability of the bridge seriously. Therefore, it is necessary to confirm scouring condition of the substructures and foundation of the bridges after heavy rain fall by visual inspection.

Following are carried out for detect scouring of the substructures and foundations as supplemental

inspections, when required;

- Topographic survey of the surrounding area of the substructures by measurement of the depth of water with plumbs
- Topographic survey of the surrounding area of the substructures by a bathymeter

9.4.4.3 Collision of a ship and floating objects

When ship and floating object such as logs collides with bridge, safety of the bridge such as the stability of the bridge, strength of the collided members and traffic on the bridge is often threatened. Collision of the ship and floating objects caused due to flooding, storm surge, strong wind, and improper operation of ships. When collision occurred urgent visual inspection is required to confirm exist of damages and damage level to take necessary countermeasures for ensuring safety traffic.

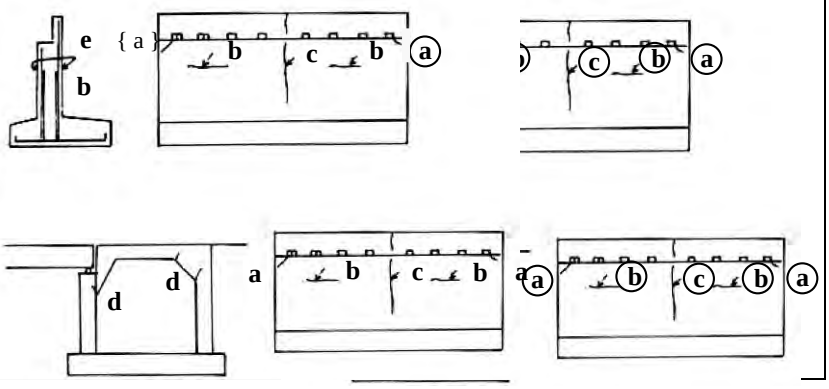
9.4.4.4 Defects of the concrete body

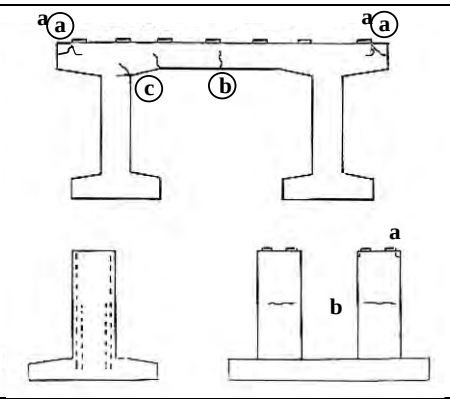
Cracks, peelings, rebar exposure, water leakage and puddling, free lime, trace of corrosion, deterioration and discoloration, honey comb and void, and chemical attacks are observed on the substructure concrete. Short distance visual inspection on the entire substructure body is carried out for the bridge substructure inspection.

- Following points have higher possibility of occurrence of concrete cracks;
  - Bearing shoe beds area
  - Rebar number changed section
  - Construction joints
  - Inside of corners of substructure bodies
  - Member section area changed parts
  - Fixing parts of cantilever members including wing walls
  - Voids under foundations and back fill at behind of stem walls

Table 9.4.11 shows inspection points of bridge substructures and foundations which are specially focused on in these inspections.

Table 9.4.11 Defects of the Concrete Body

Structure	Points to be specially focused	Figures
■ **Abutments** - Reversed T-type abutment - Rigid-frame abutment	a. Cracks b. Cracks steel ba c. Cracks joints d. Cracks sections e. Voids in	

■ **Piers** - T-type piers - Wall type piers - Rigid-frame piers - Column piers	a. Cracks near shoe bed b. Cracks on the base of cantilevered concrete c. Cracks at the corners and on the sections changing steel bar volumes.	
■ **Foundations**	a. Shortage of gaps between superstructures and substructures due to movement or leaning of substructures. b. Cracks near the base of concrete wings. c. Voids under the foundation d. Scouring and lowered river beds.	

9.4.5 Bridge accessories

9.4.5.1 Bearing shoe

Commonly, visual inspection is carried out for bearing shoe inspection.

Focus points in implementing bearing shoes inspection are as follows;

- Breakdown of bearing body
- Deterioration of rubber
- Corrosion
- Damages to attachments
- Damages to grout concrete or mortar
- Abnormal expansion gaps
- Abnormal sounds
- Piling of dust and sand

Following are major defects of the bearing shoe body and its accessories, and the points to be focused in implementing bearing shoe inspection by types;

i. Line bearing shoe

- Damages and corrosion on lower shoe
- Damages on side block
- Damages on pinch plate
- Damages on stopper for the upper shoe
- Damages and corrosion of anchor bolts
- Damages to grout concrete or mortar.

ii. Metal plate bearing shoe

- Damages and corrosion on lower shoe
- Damages on bearing plates
- Improper contact of side block and breakage of side block bolts
- Damages on the stopper for the upper shoe
- Breakage of set bolts

- Damages and corrosion of anchor bolts
- Damages to grout concrete or mortar.

iii. Multiple roller bearing shoe

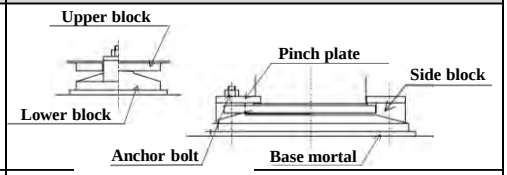
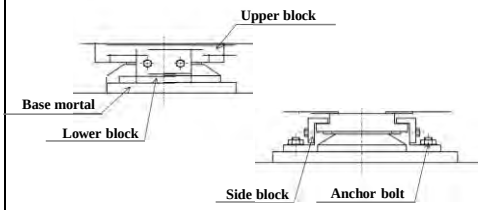
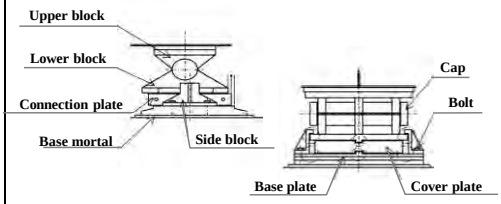
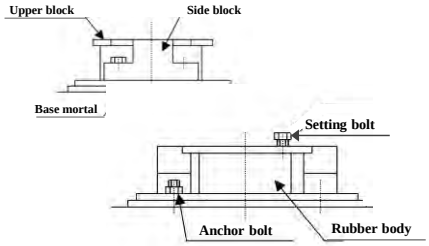
- Damages and corrosion on upper shoe, lower shoe and base plate.
- Improper contact of side block and breakage of side block bolts
- Damages to the lower shoe
- Breakage of set bolts
- Damages to pins that impact functioning
- Damages and corrosion of anchor bolts
- Damages to grout concrete or mortar
- Damages on protective cover.

iv. Rubber bearing shoe

- Damages and deterioration on rubber materials
- Displacement and deviation of rubber materials
- Bulging of rubber materials
- Abnormal space between upper shoe and rubber
- Damages on side block and breakage of set bolts
- Damages on the upper shoe stopper
- Breakage of set bolts
- Damages and corrosion of anchor bolts
- Damages on grout concrete or mortar.

Table 9.4.12 shows the focus points of bearing inspection with illustrations.

Table 9.4.12 Focus Points of Inspection on Bridge Bearings

Bearing Type	Focus points of inspection	Figures
Line Bearing shoe	● Damages and corrosion on lower shoe ● Damages on side block ● Damages on pinch plate ● Damages on stopper for the upper shoe ● Damages and corrosion of anchor bolts ● Damages to grout concrete or mortar.	
Metal bearing plate shoes	● Damages and corrosion on lower shoe ● Damages on bearing plates ● Improper contact of side block and breakage of side block bolts ● Damages on the stopper for the upper shoe ● Breakage of set bolts ● Damages and corrosion of anchor bolts ● Damages to grout concrete or mortar.	
Multiple roller shoe	● Damages and corrosion on upper shoe, lower shoe and base plate. ● Improper contact of side block and breakage of side block bolts ● Damages to the lower shoe ● Breakage of set bolts ● Damages to pins that impact functioning ● Damages and corrosion of anchor bolts ● Damages to grout concrete or mortar ● Damages on protective cover.	
Rubber shoe	● Damages and deterioration on rubber materials ● Displacement and deviation of rubber materials ● Bulging of rubber materials ● Abnormal space between upper shoe and rubber ● Damages on side block and breakage of set bolts ● Damages on the upper shoe stopper ● Breakage of set bolts ● Damages and corrosion of anchor bolts ● Damages on grout concrete or mortar.	

9.4.5.2 Expansion joint

Commonly, short distance visual inspection is carried out for expansion joint inspection.

Focus points in implementing expansion joints inspection to be carried out on all types are as follows;

- Deterioration of the face rubber material due to wearing and breakage caused by traffic, deterioration due to time passage
- Deformation of the steel members for load support
- Loosen or breakage of anchor bolt-nuts.
- Break off or breakage of a rubber drainage gutter
- Breakage of filling concrete between the expansion joint and pavement
- Elevation gap between the filling concrete and surface of the expansion joint, and the surface of the pavement
- Infiltration of soil into the expansion joint

9.4.5.3 Drainage system

Following facilities are installed on the bridge as the drainage system which facilitates drain of rain water from bridge surface and other parts of the bridge in order to avoid traffic accident due to wet condition including puddles of rain water and to prevent the bridge deterioration. Main drainage facilities on the bridge are as follows;

- Catch basin
- Drainage gutter
- Horizontal and vertical drainage pipe
- Catch drain under the expansion joint

Short distance inspection is carried out for the drainage system inspection. In order to detect defects of the drainage systems, water leakage from above facilities through inspection of wet condition of the bridge is important focus point of drainage system inspection.

9.4.5.4 Guardrail, handrail

Main cause of breakage of guardrails, guard walls and handrails is vehicles collision.

Visual inspection is common inspection method for guardrails, guard walls and handrails. Inspection of loosen and missing anchor bolt-nuts, paint condition of guardrails, handrails is carried out as part of guardrails, handrails inspection. Inspection methods, inspection frequencies and damage evaluation criteria of guardrail, handrail in principle shall follow the relevant articles of this guideline.

9.4.5.5 Traffic control facilities

Inspection methods, inspection frequencies and damage evaluation criteria of traffic control facilities in principle shall follow the relevant articles of this guideline.

9.4.5.6 Pavement

Inspection methods, inspection frequencies and damage evaluation criteria of the pavement on the bridge in principle shall follow the relevant articles of this guideline. However, many of defects of the pavement on the bridge are caused by defects of the deck slab concrete, therefore, when defects of the pavement on the bridge are found it is necessary to carry out further inspection of the deck slab concrete following the relevant articles of this guideline.

9.4.5.7 Approach road

Inspection methods, inspection frequencies and damage evaluation criteria of the approach road including the pavement, road embankment behind of the abutments, and foundation of the embankment in principle shall follow the relevant articles of this guideline. Focus points of the approach road other than the pavement are as follows;

- Settlement or deformation of the pavement due to settlement of the embankment
- Settlement of the embankment or slop failure of the embankment due to infiltration of rain water, inadequate quality control of the embankment during construction stage, or damages of the embankment slope foundation due to scouring.
- Erosion or collapse of the embankment slope due to heavy rain fall.

9.5 Inspection Points

9.5.2 Inspection points for bridges

9.5.2.1 Concrete & Steel superstructure, substructure

Road facility inspection for bridge facilities shall be implemented on the inspection points shown in **Table 9.5.1.**

Routine inspection shall be in principle implemented by vehicle-on-board visual inspection. However, when damage is detected, the inspection staff shall get off the patrol car and conduct short-distance visual inspection.

Table 9.5.1 Inspection Points for Bridge

Structures	Members	Damages	Initial inspection	Routine inspection	Periodic inspection	Emergency inspection	Detailed inspection
All bridge type	●Entire bridge structure	・Abnormal deflection /Under clearance	-----	X	X	X	As required by Routine or Periodic Inspection
		・Abnormal noise	-----	X	X	X	
		・Abnormal vibration	-----	X	X	X	
		・Abnormal expansion gaps	X	X	X	X	
		・Movement	X	-----	X	X	
		・Water leakage and puddles	X	X	X	X	
Concrete ●Super -structure ●Sub -structure	**Structure type** ● Reinforced concrete bridge ● Pre-stressed concrete bridge ●Composite bridge **Bridge type** ●I/T girder bridge ●Box girder bridge ●Slab girder bridge ●Arch bridge	・Cracks	X	-----	X	X	
		・Concrete peeling	X	X	X	X	
		・Honey comb/Voids	X	X	X	X	
		・Free lime	X	-----	X	X	
		・Deterioration /Discoloration	X	-----	X	X	
		・Rusty fluid	X	X	X	X	
		・Rebars exposure and corrosion	X	X	X	X	
		・Steel material projection	-----	X	X	X	
		・Missing of drain pipe for cylinder form	X	-----	X	X	
		・Peeling at repair part	X	X	X	X	
Steel ●Super -structure ●Sub -structure	**Bridge type** ●I girder bridge ●Box girder bridge ●Truss bridge ●Arch bridge	・(Fatigue) cracks	-----	-----	X	X	
		・Deformation /buckling	-----	-----	X	X	
		・Looseness and falling of rivets and HTBs	-----	-----	X	X	
		・Deterioration of paint	-----	-----	X	X	
		・Corrosion	-----	-----	X	X	

9.5.2.2 Bridge accessories

i. Bearing shoes

Bearing shoes inspection carried out as part of bridge inspection shall be implemented on the inspection points shown in **Table 9.5.2**.

Table 9.5.2 Inspection Points for Bearing Shoe

Structures	Members	Damages	Initial inspection	Routine inspection	Periodic inspection	Emergency inspection	Detailed Inspection
Steel Bearing Shoes ● Line bearing shoe ● Metal plate bearing shoe ●Multiple roller bearing shoe	Body	Breakage	-----	-----	X	X	As required by Routine or Periodic Inspection
		Corrosion	-----	-----	X	X	
	Accessory including anchor bolt-nuts	Breakage	-----	-----	X	X	
		Corrosion	-----	-----	X	X	
	Shoe base concrete	Breakage	-----	-----	X	X	
	Others	Abnormal gap margin	X	-----	X	X	
		Abnormal sound	-----	-----	X	X	
		Debris or soil piling	-----	-----	X	X	
Rubber Bearing Shoes	Body	Breakage	-----	-----	X	X	
		Corrosion	-----	-----	X	X	

Structures	Members	Damages	Initial inspection	Routine inspection	Periodic inspection	Emergency inspection	Detailed Inspection
	Accessory including anchor bolt-nuts	Breakage	-----	-----	X	X	
		Corrosion	-----	-----	X	X	
	Shoe base concrete	Breakage	-----	-----	X	X	
	Others	Abnormal gap margin	X	-----	X	X	
		Debris or soil piling	-----	-----	X	X	

ii. Expansion joint

Expansion joints inspection carried out as part of bridge inspection shall be implemented on the inspection points shown in **Table 9.5.3**.

Table 9.5.3 Inspection Points for Expansion Joint

Structures	Members	Damages	Initial inspection	Routine inspection	Periodic inspection	Emergency inspection	Detailed Inspection
Expansion joint ・ Load supporting type ・ Butting type ・ Buried type	Function Setting condition	Abnormal gap margin	X	X	X	X	As required by Routine or Periodic Inspection
		Elevation gap between face palates or pavement	-----	X	X	X	
		Abnormal noise	-----	X	X	X	
	Rubber face plate	Wearing, Breakage	-----	X	X	X	
	Steel face plate	Corrosion	-----	X	X	X	
		Breakage	-----	X	X	X	
	Anchor bolt-nuts	Corrosion	-----	-----	X	X	
		Missing of nuts	-----	X	X	X	
		Breakage	-----	X	X	X	
	Drainage gutter	Break off, Breakage	-----	X	X	X	
		Accumulation of soil	-----	-----	X	X	
	Filling concrete /Bitumen material	Elevation gap with face plate, or pavement and joint damage	-----	X	X	X	
		Peeling, Spalling	-----	X	X	X	
		Cracking, Breakage	-----	X	X	X	

9.5.3 Routine Inspection

Routine inspection shall detect bridge damages, in particular focusing on the damages causing unsafety to road traffic such as expansion gap, guardrail and handrail, deformation of bridge members above the road surface, water paddle etc.

9.5.4 Periodic Inspection

Periodic inspection shall cover not only bridge components, members, but also all facilities attached on the bridge such as traffic safety facilities, traffic control facilities, lighting systems, and pavement and approach roads including the embankment.

The chief engineer of the Inspection Team shall evaluate the results of inspection, registering data into the bridge condition database (VBMS) and preparing and submitting inspection reports to the managing agency of road facility inspection.

9.5.5 Detail Inspection

Detail inspection shall be conducted when proposed by periodic inspection or when proposed for the planning and the designing of the bridge rehabilitation and reconstruction works. Detailed inspection shall

apply advance inspection equipment and make professional judgement in finding out the causes of the damages and in planning countermeasures of the damages. The following are the typical tasks for the detailed inspection.

- Inspection on entire bridge condition
  - ✓ Survey of deflection, settlement, movement and scouring: When some deflection, settlement, movement or scouring of the bridge is found, it is necessary to conduct detailed survey with necessary survey equipment. Periodical monitoring of these abnormalities is necessary.
- Inspection on chemical attack
  - ✓ Detecting depth of penetrated salinity contents into concrete: Salinity contents test on collected concrete powder from each depth is carried out to identify penetration depth of salinity contents into the concrete.
  - ✓ Detecting depth of penetrated carbon dioxide into concrete: Phenolphthalein solution test on the collected core/powder from each depth of the concrete is conducted to identify penetration depth of carbon dioxide into the concrete.
  - ✓ Detecting effect of alkali reaction aggregate: Alkali reaction test on the collected core of the concrete is carried out. However, actual test method is different according to chemical feature of the aggregate. Therefore, chemical feature shall be clarified through laboratory test at first. After then applicable test method will be suggested by chemical researcher.
- Detecting crack on the steel member

  To confirm exist of crack on the steel member by;
  - ✓ Penetrant Inspection: It is carried out to paint Fluorescent penetrant on the surface of the steel member at first, then confirming crack by irradiated ultraviolet rays. If there is a crack on the surface of the member, the crack will be highlighted by ultraviolet ray.
  - ✓ Magnetic particle examination: It is carried out to magnetize the detecting area by electromagnet, and scattering magnetic steel particles on the detecting area, after then confirming crack by irradiated ultraviolet rays. If there is a crack on the surface of the member, the crack will be highlighted by ultraviolet ray.
  - ✓ Ultrasonic examination: It is carried out to give ultrasonic to the steel member by detector and catch echo from the steel member. If there is a crack in the steel member the crack will reflect ultrasonic and will be cached as echo.
- To make decisions on the repair work priorities.

9.6 Inspection Methods and Frequencies

Inspection methods and inspection frequencies in principle shall follow the relevant articles of this guideline. However, inspection methods and frequencies specialized for the periodic inspection and the detailed inspection for bridge facility shall follow the methods prescribed in **Table 9.6.1**.

Table 9.6.1 Inspection Methods and Frequencies

Inspection Type	Inspection Method	Inspection Frequency
Periodic inspection	● Short distance visual inspection on all parts of the bridge ● Hammering inspection for detecting concrete peeling, loosen/missing bolt-nuts etc. ● Measuring of expansion space and elevation gap	Once every 5 years
Detailed Inspection	● Surveying deflection, settlement, movement, and scouring ● Inspection on chemical attack to concrete body ● Inspection on steel member crack	Refer to Table 4.3.2

9.7 Evaluation of Inspection Results

9.7.2 Evaluation of the inspection results

Evaluation of the results of routine inspection, periodic inspection and emergency inspection shall be conducted, following the relevant articles in this Guideline. Sample evaluation criteria for bridge inspection results are shown in **ANNEX-2**. Also, particular notes for the evaluation of some damages are described below;

9.7.2.1 Damage level "D"

In this guideline, bridge damages anticipated to give large negative effects to stability of the bridge and vehicle traffic are rated as "D", such as serious girder and deck slab defects, serious deflection, settlement and movement or scouring, large expansion spacing or elevation gap, and pavement defects described in the relevant articles of this guideline.

9.7.2.2 Other defects

Other damages shall be separately inspected by patrol staff in the routine inspection and evaluated, following the relevant above articles in this guideline.

9.8 Registration of Inspection Data and Reporting

Registration of inspection data shall be conducted, following relevant articles in this guideline.

10. TUNNEL FACILITY INSPECTION

The Guideline regulates inspections on the main parts of Tunnel facilities including Inner Lining Concrete, Portal, Inner Decoration Board and Drainage Systems in the Tunnel facility.

10.1 Inspection Facilities

Inspection shall be conducted on the Tunnel facilities which include Tunnel Inner Lining, Tunnel Portals and Drainage Systems in tunnels.

10.2 Typical Damages of Tunnel Facilities

Inspection shall be conducted on the road pavement facilities which include Tunnel Inner Lining, Tunnel Portal. Expected damages to be inspected for these facilities are as follows;

10.2.1 Damages on the Tunnel Inner Lining

- Concrete cracks/corner drop
- Concrete peeling/ creep
- Improper construction joint
- Water leakage/free lime

10.2.2 Damages on the Tunnel Portal

- Cracks/ corner drop
- Peeling

- Rebar exposure
- Settlement/ movement / tilt
- Joint gap
- Scouring
- Drain/ spring water

10.2.3 Damages on the Tunnel Inner Decoration Board

- Facility damage
- Accessory damage

10.2.4 Damages on the Tunnel Drainage Systems

- Facility damage
- Debris and soil piling

10.3 Focus points of inspection

10.3.1 The inner lining concrete is deteriorated by chemical reaction working between lining concrete and chemical components in the water. Damages appear on the concrete in the forms of cracks, peeling, creeping, carbonation, water leakage and free lime.

10.3.2 Concrete cracks on the inner lining concrete are caused by tensile stress working on the Tunnel Lining, which is a deviated pressure generated by land slide occurring nearby Tunnel or changes in pressure of natural ground behind the Tunnel Lining. This deviated pressure is a main cause of tunnel damage, so that it is necessary to check carefully and conduct detailed inspection when it is found.

10.3.3 The water leakage from concrete lining is often caused by the voids in the lining concrete, causing deviated pressure on the Tunnel Lining. The water leakage leads to the damages not only to the Tunnel body, but to the pavement, creating slippery driving conditions in the tunnel.

10.3.4 Poor construction quality, including improper repair works on the concrete lining, insufficient concrete pouring into arch crown and improper concrete joint construction, often leads to cracks, peeling, corner dropping, and water leakage due to aging and earthquakes.

10.3.5 Tunnel Portals are in general constructed on the ground which has sufficient bearing capacity. However, if they are constructed on the steep slope in the mountainous area, uneven settlement of portal facility often occur due to insufficient bearing capacity of the ground, thereby causes transverse cracks on the portals and gaps at the construction joints. With this, it is necessary to inspect surrounding areas of the Tunnel Portal.

10.3.6 The damages of Tunnel Interior Decoration Board are often caused by water leakage or the material deformation given by vehicle accident, often appears in the form of corrosion on the fixing bolts.

10.3.7 Damages on the Drainage Systems in the Tunnel including deformation or break of the Drainage System are often caused by the deviated stresses working on the concrete lining.

10.3.8 Damages on the pavement in the Tunnel including cracks, depressions or swelling are often caused by external stresses originated from the deformation of Tunnel Portal and lining concrete.

10.4 Inspection Points

Road facility inspection for Tunnel facilities shall be implemented on the inspection points shown in **Table 10.4.1** for Tunnel Concrete Lining, **Table 10.4.2** for Tunnel Portal and **Table 10.4.3** for Tunnel Interior Decoration Board. Also, **Figure 10.4.1** illustrates inspection points on the Tunnel Lining and **Figure 10.4.2** inspection points on the interior facilities.

Table 10.4.1 Inspection Points (Concrete Lining)

Structure	Position	Member	Sort of damage	Initial Inspection	Daily Inspection	Periodic Inspection	Detailed Inspection
Tunnel	Concrete lining		Cracks/ corner drop	X	X	X	As required by Routine or Periodic Inspection
			Peel	X	X	X	
			Joint gap	X	X	X	
			Leakage/ free lime	X	X	X	
			Spalling, Void	X	X	X	

(Note) X15: To inspect 15~20 years after from opening to traffic.

Table 10.4.2 Inspection Points (Portal)

Structure	Position	Member	Sort of Damage	Initial Inspection	Routine Inspection	Periodic Inspection	Detailed Inspection
Tunnel	Portal /entrance		Cracks/ corner drop	X	X	X	As required by Routine or Periodic Inspection
			Peeling	X	X	X	
			Rebar exposure	X	X	X	
			Settlement/ movement / tilt	X	X	X	
			Joint gap	X	X	X	
			Scouring	X	X	X	
			Drain/ spring water	X	X	X	

(Note) X: Inspection items, but not limited.

Table 10.4.3 Inspection Points (Interior Decoration Board and Others)

Structure	Position	Member	Sort of Damage	Initial Inspection	Routine Inspection	Periodic Inspection	Detailed Inspection
Tunnel	Inner decoration board		Body damage (plate type)	-------	X	X	As required by Routine or Periodic Inspection
			Body damage (tile type)	-------	X	X	
			Accessory damage	-------	X	X	
	Drain system		Facility damage	-------	X	X	
			Debris and soil piling	-------	X	X	

(Note) X: Inspection items, but not limited.

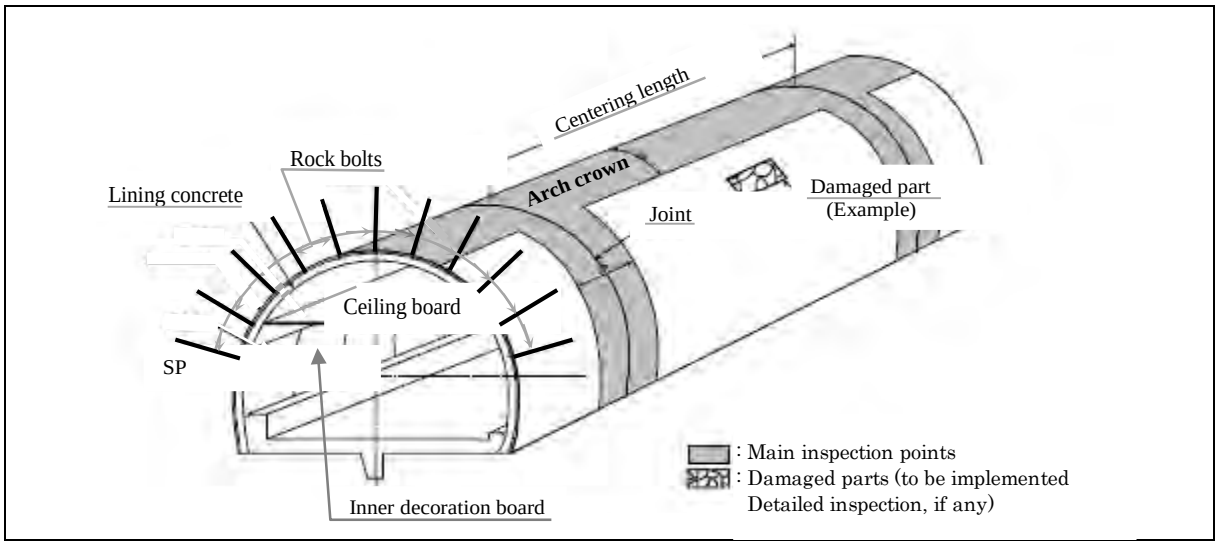


Figure 10.4.1 Inspection Points on Tunnel Lining

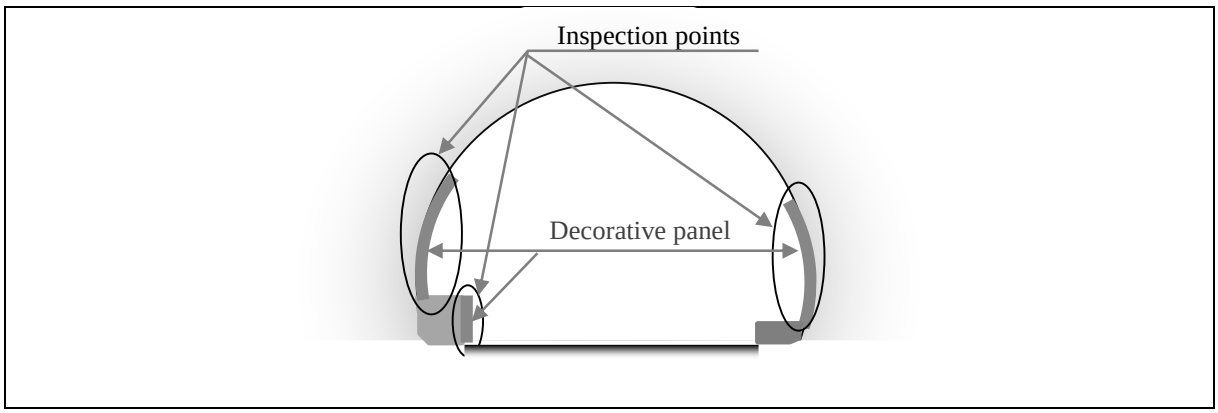


Figure 10.4.2 Inspection Points on Interior Facilities

10.5 Inspection Methods and Frequencies

Inspection methods and inspection frequencies in principle follow the Standard Inspection Methods and Standard Inspection Frequencies in this Guideline. However, inspection methods specialized for periodic inspection of Tunnel facility shall follow the methods prescribed in **Table 10.5.1**..

Table 10.5.1 Inspection Methods and Frequencies

	Inspection Method	Inspection Frequency
Periodic inspection	The following inspection methods are applied to the points where abnormalities are found. ● Short-distance visual inspection ● Hammering by test hammer	Follow the Standard Inspection Frequencies in the Guideline

(Note) **Figure 10.5.1** shows the figure of test hammer.

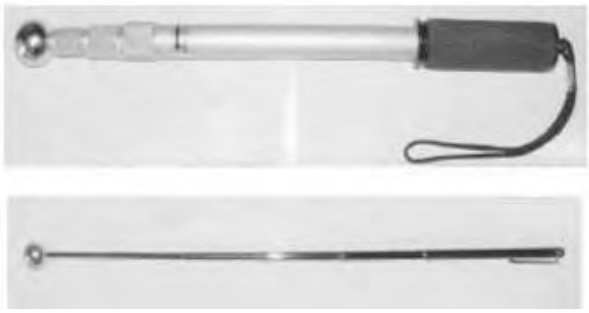


Figure 10.5.1 Test Hammer

10.6 Evaluation of Inspection Results

10.6.1 Evaluation of the results of routine inspection, periodic inspection and emergency inspection shall be conducted, following relevant articles in this Guideline. Sample evaluation criteria for Tunnel Lining are shown in ANNEX-F. Also, particular notes for the evaluation of some major damages are described below;

10.6.2 When cracks in high density are progressing rapidly or tensile cracks in wide gaps or shear cracks appear on the concrete lining, the damage is rated as "D" in this Guideline.

10.6.3 When large-scale concrete peeling or corner drops is found on the concrete lining, it leads to the fatal damages given to the lining, so that the damage is rated as "D" in this Guideline.

10.6.4 When above damages are expected to be caused by deviated pressure working on the Tunnel Lining, detailed inspection shall be conducted immediately.

10.6.5 When large-scale water leakage occurs from the Tunnel Lining, it may cause voids behind the concrete lining, thereby causing harmful pressure on the Tunnel body. Rating "D" is applied to this damage in this Guideline.

10.6.6 When concrete cracks caused by uneven settlement or movement of Tunnel Portal is found in the inspection, they will lead to fatal damages to the Tunnel Portal, the damage is rated as "D" in this Guideline.

10.6.7 When large scale damages including concrete cracks and gaps are found on the pavement and drainage facilities inside Tunnel, which are caused by lateral or uplifting pressure, massive pressure may be working on the Tunnel Lining. Rating "D" is applied to these damages in this Guideline.

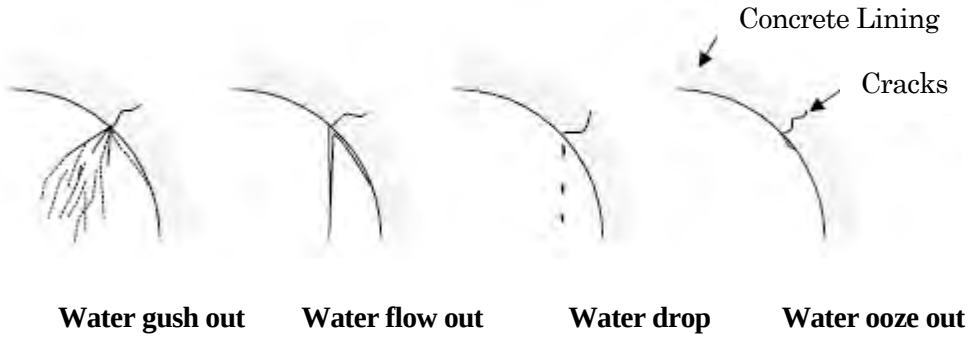


Figure 10.6.1 Water Leakage from Tunnel Lining

10.7 Data Registration and Reporting

Registration of inspection data and reporting shall be conducted, following relevant articles in this Guideline.

11. CULVERT BOX AND PIPE CULVERT INSPECTION

The Guideline regulates inspections on the main parts of Box Culvert and Pipe Culvert facilities.

11.1 Inspection Facilities

Inspection shall be conducted on the culvert facilities which include Reinforced Concrete Box Culverts, Reinforced Concrete Pipe Culverts, and Corrugated Metal Pipe Culverts.

11.2 Typical Damages of Box Culvert and Pipe Culvert Facilities

11.2.1 Damages on the Reinforced Box Culvert

- Cracks/ corner drop
- Peeling
- Rebar exposure
- Void
- Water leakage from joints/Free lime
- Settlement
- Joint Damage

11.2.2 Damages on the Reinforced Concrete Pipe Culvert

- Cracks/ corner drop
- Peeling
- Rebar exposure
- Settlement
- Connection joint damage
- Drain function

11.2.3 Damages on the Corrugated Metal Pipe Culvert

- Structure damage
- Corrosion

- Settlement
- Connection joint damage
- Drain function

11.3 Focus Points of Inspection

11.3.1 The Box Culvert does not have pile support, settlement or uneven settlement of the Box Culvert facility is caused by insufficient bearing capacity of foundation under Box Culvert facilities.

11.3.2 Damages often comes out in the form of concrete cracks and peering on the body, damages on the joints between Box Culvert segments and on the connection joints with neighbour Drainage Systems.

11.3.3 In particular, uneven settlement causes transverse concrete cracks on the Box Culvert.

11.3.4 Insufficient height clearance caused by the settlement of Box Culvert often becomes a cause of vehicle collision, so that some traffic control measures including installation of traffic signs are needed.

11.3.5 In the case of the water way Box Culvert, water leakage and scouring at the joint between Box Culvert and waterway often cause the degradation of bearing capacity under Box Culvert and provide damages to neighbouring facilities such as Retaining Wall, concrete block masonry, waterway, etc.

11.4 Inspection Points

Road facility inspection for culvert facilities shall be implemented on the inspection points shown in **Table 11.4.1** for Box Culverts and in **Table 11.4.2** for Pipe Culverts. **Figure 11.4.1** illustrates inspection points.

Table 11.4.1 Inspection Points (Box Culverts)

Facility	Member	Damage	Initial inspection	Routine inspection	Periodic inspection	Emergency inspection	Detailed Inspection
Box Culvert	Reinforced Concrete Box Culvert	Cracks/ corner drop	X	--------	X	X	As required by Routine or Periodic Inspection
		Peeling	X	--------	X	X	
		Rebar exposure	X	--------	X	X	
		Void / Honey comb	X	--------	X	X	
		Water leakage from joints/Free lime	X	--------	X	X	
		Settlement / Scoring	X	X	X	X	
		Joint Damage	X	--------	X	X	

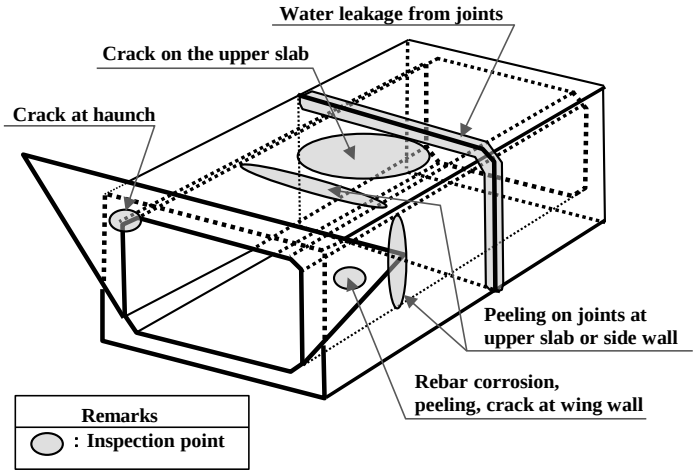


Figure 11.4.1 Box Culvert Inspection Points

Table 11.4.2 Inspection Points (Pipe Culverts)

Facility	Member	Damage	Initial inspection	Routine inspection	Periodic inspection	Emergency inspection	Detailed Inspection
Pipe Culvert	Reinforced concrete pipe culvert	Cracks/ corner drop	--------	--------	X	X	As required by Routine or Periodic Inspection
		Peeling	--------	--------	X	X	
		Rebar exposure	--------	--------	X	X	
		Settlement	--------	X	X	X	
		Connection joint damage	--------	--------	X	X	
		Drain function	--------	--------	X	X	
	Corrugated metal pipe culvert	Structure damage	--------	--------	X	X	As required by Routine or Periodic Inspection
		Corrosion	--------	--------	X	X	
		Settlement	--------	X	X	X	
		Connection joint damage	--------	--------	X	X	
		Drain function	--------	--------	X	X	

11.5 Inspection Methods and Frequencies

Inspection methods and inspection frequencies in principle shall follow the relevant articles of this Guideline.

11.6 Evaluation of Inspection Results

11.6.1 Evaluation of the results of routine inspection, periodic inspection and emergency inspection shall be conducted, following relevant articles in this Guideline. Sample evaluation criteria for Concrete Box Culverts and Pipe Culverts are shown in ANNEX-G. Also, particular notes for the evaluation of some major damages are described below;

11.6.2 The Box Culvert does not have pile support, so that culver box is in general set higher than the design height, assuming some settlement caused by consolidation of bearing layer. However, if settlement occurs larger than expected, gaps in height between approach road and the culvert becomes wider. The damage is rated as "C" in this Guideline.

11.6.3 When water leakage occurs at the end joint of culver box and infiltrates into the bearing layer of the culver box, it may degrade the bearing capacity of the culver box or scour the foundation of neighbour facilities. The damage is rated as "C" in this Guideline.

11.6.4 When damages include the opening of gaps and difference in height on the joints of pipe culver box facilities progress, it may break water-stop plate, cause water leakage and falling of water-stop plate. The damage is rated as "C" in this Guideline.

11.6.5 When drain function is degraded due to the damages at the joints of Drainage Systems or due to the piling of debris in the drain systems, thereby causing water leakage from the joints, the damage is rated as "C" in this Guideline.

11.7 Data Registration and Reporting

Registration of inspection data shall be conducted, following relevant articles in this Guideline.

12. TRAFFIC SAFETY FACILITIES INSPECTION

12.1 Classification of Traffic Safety Facility

Traffic safety facility to be covered in this Guideline includes guard rail and guard cable facilities.

12.2 Inspection Facilities

Inspection shall be conducted on the traffic safety facilities which include guard rails, guard cables, concrete wall-type guard facilities.

12.3 Typical Damages of Traffic Safety Facilities

. Expected damages to be inspected for these facilities are as follows;

12.3.1 Damages on the Guard Rail

- Main member damages; Breakage, dropout or tilting of beams, pipes, posts etc.
- Accessory damages; Breakage or dropout of mounting brackets, dropout or looseness of connection bolts, etc.
- Foundation damages; Cutting or dropout of anchor materials, or scouring around foundation which leads to the breakdown of guard facilities.

12.3.2 Damages on the Guard Cable

- Main member damages; Breakage, dropout or tilting of pipes or guard posts etc.
- Accessory damages; Breakage or dropout of mounting brackets, dropout or looseness of connection bolts, etc.
- Foundation damages; Cutting or dropout of anchor materials, or scouring around foundation

which leads to the breakdown of guard facilities.

12.3.2.1 Damages on the Concrete Wall-type Guard Facilities

- Concrete cracks or corner dropout

12.4 Focus Points of Inspection

12.4.1.1 Damages are mostly the deformation caused by the force of vehicle accident. However, damages are sometimes given to the neighboring guardrail poles or brackets, so that inspection is to be conducted on the neighboring facilities.

12.4.1.2 Regarding the guard cables, when an upper cable sinks and touches to the lower cable by the weight of inspection staff, the cable tension is deemed insufficient which needs restressing urgently.

12.4.1.3 Corrosion often degrades the strength of the guardrail facility. When serious corrosion is found on the guard posts or on the brackets during inspection, it is better to examine the thickness of the member with ultrasonic thickness meter if necessary. A past study has clarified that design strength of guard posts driven in the ground is maintained even 20 years after the installation if ground condition is good. However, care should be paid to the facilities installed where ground water level is high.

12.5 Inspection Points

Road facility inspection for traffic safety facilities shall be implemented on the inspection points shown in **Table 12.5.1**.

Table 12.5.1 Inspection Points for Traffic Safety Facilities

Structure	Position	Member	Sort of damage	Initial inspection	Routine Inspection	Periodic inspection	Detailed Inspection
Traffic safety	Guard rail	Guard rail	Main member damages	-------	X	X	As required by Routine or Periodic Inspection
			Accessory damages	-------	-------	X	
			Corrosion	-------	-------	X	
			Foundation damages	-------	-------	X	
		Guard cable	Main member damages	-------	X	X	
			Accessory damages	-------	-------	X	
			Corrosion	-------	-------	X	
			Foundation damages	-------	-------	X	
		Concrete Wall-type guard facility	Cracks/ /corner drop	-------	X	X	

(Note) X: Inspection items.

12.6 Inspection Methods and Frequencies

Inspection methods and inspection frequencies in principle follow the relevant articles stipulated in this Guideline.

12.7 Evaluation of Inspection Results

12.7.1 Evaluation of the results of routine inspection, periodic inspection and emergency inspection shall be conducted, following relevant articles in this Guideline. Sample evaluation criteria for traffic safety facilities are shown in **ANNEX-H**. Also, particular notes for the evaluation of some major damages are described below;

12.7.2 When deformation or severe damage to beams, pipes or cables or tilting of the support pole is identified, it can no longer fulfil functions of protecting vehicles and drivers on board, so that the damages are rated as "D" in this Guideline.

12.7.3 When damages are identified, such as deformation, bending and or tilting of the beams, pipes, cables and/or supporting poles, guard function is deemed slightly degraded, so that the damages are rated as "C" in this Guideline,

12.7.4 When damages are detected on the accessories of guard facilities, such as parts loss, loosening of bolts which lead the main structure damage and so forth, the damages are rated as "C" in this Guideline.

12.7.5 When severe corrosion is observed on the beam, pipe, cable and/or support pole, degradation of structural strength may occur. If the corrosion spreads wide area, it is rated as "C" in this Guideline, requesting a detailed inspection by applying detailed evaluation of the corrosion including examination of thickness measuring of main members. However, a past study has reported that guard rail facility will work together with those located in the affected area to absorb shocks given by vehicle collision. The affected area of vehicle collision is said about 20 meters, so that diagnosis needs to be made on the facilities located in the affected area, rather than focusing on some specific facilities.

12.8 Data Registration and Reporting

Registration of inspection data shall be conducted, following relevant articles in this Guideline.

13. TRAFFIC MANAGEMENT FACILITY INSPECTION

13.1 Classification of Traffic Management Facility

Traffic management facility to be covered in this Guideline is traffic signs.

13.2 Inspection Facilities

Inspection shall be conducted on the pavement facilities which include main body of traffic signs and accessories of traffic signs.

13.3 Typical Damages of Traffic Signs

13.3.1 Damages on the Main Body of Traffic Sign

- Deformation or breakage of sign boards
- Deformation, instability and breakage of sign poles
- Deterioration and stain of sign boards
- Low luminance of sign boards

13.3.2 Damages on the Accessories of Traffic Signs

- Loosening or dropout of bolts or nuts on the mounting brackets

13.4 Focus Points for Inspection

13.4.1 Traffic signs should be regularly maintained in a good condition. Inspection shall be made not only on the facility damages, but also on the visibility of signs.

13.4.2 Inspection on the facility damages shall be directed to the damages of the main body and the accessary of traffic signs including stability of sign poles against strong wind, deterioration and stain of sign board, and loosening of the bolts and nuts on the mounting brackets.

13.4.3 Inspection on the visibility of traffic signs shall be directed to the checking of visibility, lighting effect and luminance of sign boards. Night visibility is in particular important for traffic signs, so that luminance of traffic signs shall be examined by on-board visual inspection.

13.5 Inspection Points

Road facility inspection fir traffic management facilities shall be implemented on the inspection points shown in **Table 13.5.1**. **Figure 4.3.1** also illustrates inspection points for traffic sign.

Table 13.5.1 Inspection Points for Traffic Management Facilities

Structure	Position	Member	Sort of damage	Initial inspection	Daily inspection	Periodic inspection	Detailed Inspection
Traffic Management Facility	Traffic Signs	Traffic signs	Main member damages	-------	X	X	As required by Routine or Periodic Inspection
			Accessory damages	-------	-------	X	
			Corrosion	-------	-------	X	
			Foundation damages	-------	-------	X	

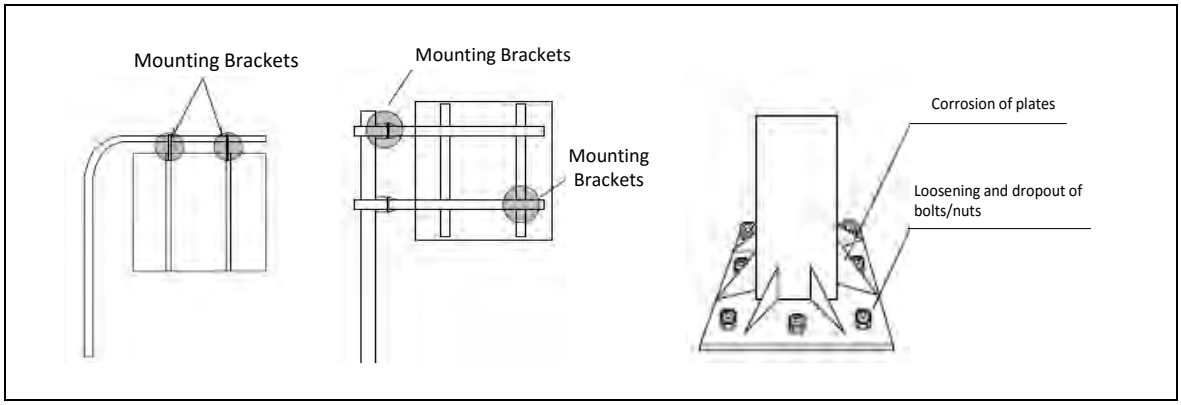


Figure 13.5.1 Inspection Points for Traffic Sign

13.6 Inspection Methods and Frequencies

Inspection methods and inspection frequencies in principle follow the relevant articles stipulated in this

Guideline.

13.7 Evaluation of Inspection Results

13.7.1 Evaluation of the results of routine inspection, periodic inspection and emergency inspection shall be conducted, following relevant articles in this Guideline. Sample evaluation criteria for traffic signs are shown in **ANNEX-I**. Also, particular notes for the evaluation of some major damages are described below;

13.7.2 For the serious damages on the traffic signs including dropout, deformation or tilting of materials, evaluation criteria for traffic safety facilities shall be applied.

13.7.3 When traffic sign is not readable due to deterioration of paints, stains of sign boards or the peering of reflection sheet, rating of "C" is applied in this Guideline.

13.7.4 For corrosion on the foundation or on the accessories of traffic signs, evaluation criteria for traffic safety facilities shall be applied.

13.8 Data Registration and Reporting

Registration of inspection data shall be conducted, following relevant articles in this Guideline.

END OF TEXT

Table Sample Evaluation Criteria for Road Slope Inspection

a. General Slope (Cut Slope & Embankment)

Facility	Member	Damage	Evaluation criteria		
			B	C	D
General slopes		Collapse		Small slope failure which has less potential of progressing	Slope failure which has high potential for expansion
		Cracks / swelling /settlement		Cracks, swelling or settlement which may not lead to slope failure	Cracks, swelling or settlement which may lead to slope failure
		surface erosion		Partial erosion which may not spread	Wide area surface erosion which has high potential of spread.
		Piling of Debris on slope steps	Small-scale pilings of debris which may not hinder the drain function on the steps.	Deposits of soil and stone which do not hinder the drainage installed on the slope steps	Deposits of soil and stone hinder the drainage installed on the slope steps.
		spring water	Spring water which is small potential for causing slope failures.	Spring water which increases in volume when rain falls, but does not have high potential of slope failures.	Spring water which increases in volume when raining and has high potential for causing slope failures.
		tree fall	Weeds which overran a wide area of slopes	Fallen or tilted trees, but do not lead to slope failures.	There are fallen or tilted trees, making holes around roots which can induce water infiltration into the slopes and cause slope failures.
		plant death	Lawn coverage more than 30% and less than 70%	Lawn coverage less than 30%	-----
		unstable stone/ rolling stone	-----	Unstable stones or rolling stones, but not so many.	Many unstable stones or rolling stones.
		Growing of hydrophilic plants and weakening of slope	-----	Slopes are weakened by spring water and covered with hydrophilic plants. Detail inspection is needed to identify underground water conditions.	Slopes weakened by spring water and covered with hydrophilic plants which have high potential of slope failures.

Table Sample Evaluation Criteria for Road Slope Inspection

b. Protected Slope

Facility	Member	Damage	Evaluation criteria		
			B	C	D
Protected Slope Inspection	Concrete block frame in situ /concrete frame	cracks/ peeling	Cracks or concrete peeling which spread over part of the area.	Cracks or concrete peeling which widespread over the area.	Severe cracks or concrete peeling, which may cause falling of concrete or collapse
		Looseness/ swelling/ settlement	-----	Looseness, swelling or settlement is seen on the facilities, but they may not lead to failures.	Serious looseness, swelling or settlement seen on the facilities which may lead to failures.
		spring water/ drain water	Spring water from facility joints or drain pipes, but they do not lead to slope failures.	-----	A large amount of spring water from facility joints and drain malfunction by drain pipes filled with soil which has high potential of causing slope failures.
	Mortar spray/ Concrete spray	cracks/ peeling	Small cracks, swelling or settlement seen over part of the area which may not lead to slope failure	Cracks, swelling or settlement which may not lead to slope failures soon, but may lead to the failure in the long run.	Severe cracks, swelling or settlement which may lead to slope failure
		loosening / swelling/ settlement	Slope edge push-out, swelling and shear gaps at construction joints, but they may not lead to slope failures.	-----	Slope edge push-out, swelling and shear gaps at construction joints which may lead to slope failures.
		Voids	A trace of soil flow-out from drain pipes after rainfalls, and hammering inspection detects the existence of voids behind the surface concrete or mortar.	-----	-----
		spring water/ drain water	Spring water from facility joints or drain pipes, but they do not lead to slope failures.	-----	A large amount of spring water from facility joints and drain malfunction by drain pipes filled with soil which has high potential of causing slope failures.

ANNEX-B

Table Sample Evaluation Criteria for Road Drainage System

Facility	Member	Damage	Evaluation criteria		
			B	C	D
Slope drainage systems	・Slope shoulder drainage/ ・Slope step drainage ・Vertical drainage ・Catch basins	Damages to drainage body	-----	Medium damages of drainage systems which hinder drain functions.	Heavy damage of drainage systems which cause water overflow and rain infiltration
		Improper drainage joints	Small water leakage which does not lead to slope failures.		Heavy damage of drainage joints which cause water leakage from joints and rain infiltration into slopes
		Debris/ soil accumulation	Limited or partial piling of soils and debris	Piling of soil and debris which hinder drain functions.	Large piling of soil and debris
		Hindrance of drain function by weeds	Small hindrance of drain functions		Heavy hindrance of drain function by weed

ANNEX-C

Table Sample Evaluation Criteria for Retaining Wall Inspection

Facility	Member	Damage	Evaluation criteria		
			B	C	D
Concrete retailing wall	RC retaining wall	Cracks/ corner failures	Small cracks running parallel with wide gaps which do not reach inner steel bars.	Small cracks running parallel with narrow gaps which reach inner steel bars.	Severe crocodile cracks which reach inner steel bars with free lime and rusty fluid.
		Concrete Peeling	Partial peeling or creep	Extensive concrete peeling or creep	
		Steel bar exposure and corrosion	Partial steel bar exposure	Severe steel bar exposure with the progress of corrosion.	
		Settlement/ movement/ tilting	Settlement, movement or tilting of facilities which does not lead to collapse.	Settlement, movement or tilting of facilities which does not need further survey	Settlement, movement or tilting of facilities which lead to collapse.
		Damages on structural joints	Joint gaps, but they do not lead to collapse.	Joint gaps which do not lead to collapse soon, but lead to collapse in the long run.	Large joint gaps which may lead to collapse.
		Scouring	Limited or partial scouring at foundations or around main bodies, but progress is not expected.	Scouring at foundations or around main bodies, which may need countermeasures in the long run.	Serious scouring at foundations or around main bodies which need urgent countermeasures.
		Drainage / spring water	Spring water from facility joints or drain malfunction by drain pipes filled with soil, but they do not lead to slope failures.	-----	A large amount of spring water from facility joints and drain malfunction by drain pipes filled with soil which has high potential of causing slope failures.

ANNEX-D-1

Table Sample Evaluation Criteria for Road Pavement Inspection

(i) Asphalt Concrete Pavement

Structure	Member	Sort of damage	Evaluation Criteria		
			B	C	D
Road Pavement	Asphalt pavement	Pot holes/ Peeling/ Depressions	-----	20 cm–40cm in diameter or 30 mm-40 mm in depth	Over 40 cm in diameter or Over 40 mm in depth.
		Crack ratio	10% - 30%	30% - 40%	Over 40 %.
		Rutting Depth	10mm - 30 mm	30mm - 40mm	Over 40 mm
		IRI	2 – 4 mm/m	4 – 6 mm/m	Over 6 mm/m
		Edge Break	-----	Surface level difference 10 mm – 30 mm	Pavement width less than design lane width or Surface level difference over 30mm.
		Bump in pavement surface	-----	10 mm - 20 mm in depth at the connection with bridges 10mm - 30mm in depth at crossing structures or cut/fill transition points	Over 20mm at the connections with bridges Over 30 mm at crossing structures or cut/fill transition points.
		Skid Resistance	-----	0.25 ì (V) - 0.3 i(V).	Over ì (V) 0.25.

(ii) Bituminous Surface Treatment

Structure	Member	Sort of damage	Evaluation Criteria		
			B	C	D
Road Pavement	Bituminous surface treatment	Pot holes/ Peeling/ Depressions	Less than 20 cm in diameter or 30 mm in depth	20 cm–40cm in diameter or 30 mm-40 mm in depth	Over 40 cm in diameter or Over 40 mm in depth.
		Crack ratio	10% - 40%	40% - 50%	Over 50 %.
		Rutting Depth	10mm - 40 mm	40mm - 50mm	Over 50 mm
		IRI	4 – 6 mm/m	6 – 8 mm/m	Over 8 mm/m
		Edge Break		Surface level difference 10 mm – 30 mm	Pavement width less than design lane width or Surface level difference over 30mm.
		Bump in pavement surface	-----	10 mm - 20 mm in depth at the connection with bridges and at joints between slabs 10mm - 30mm in depth at crossing structures or cut/fill transition points	Over 20mm at the connections with bridges and at joints between slabs. Over 30 mm at crossing structures or cut/fill transition points.
		Skid Resistance	-----	0.25 ì (V) - 0.3 i(V).	Over ì (V) 0.25.

Table Sample Evaluation Criteria for Road Pavement Inspection

(iii) Cement Concrete Pavement

Structure	Member	Sort of damage	Evaluation Criteria		
			B	C	D
Road Pavement	Concrete pavement	Crack ratio	-----	30% - 40%	Over 40 %.
		IRI	-----	-----	Over 4 mm/m
		Bump in pavement surface	-----	10 mm - 20 mm in depth at the connection with bridges 10mm - 30mm in depth at crossing structures or cut/fill transition points	Over 20mm at the connections with bridges Over 30 mm at crossing structures or cut/fill transition points.
		Slab joint seal	-----	Damaged but water infiltration is not observed	Damaged and water infiltration observed
		Skid Resistance	-----	0.25 ì (V) - 0.3 i(V).	Over ì (V) 0.25.

ANNEX E-1

Sample Evaluation Criteria for Bridge Inspection Results-1/8

	Structural Part / Kind of Damage	Estimated volume based on damage level		
		B	C	D
1	**All type of bridge**			
1.1	**Entire bridge condition**			
	Abnormal deflection	Deflection of the superstructure is observed slightly by visual inspection	Deflection of the superstructure is observed obviously by visual inspection	More than L/500 where the bridge length is over 40 meters
	Abnormal Nosie	-----	Noise arises when vehicles pass by	-----
	Abnormal vibration	-----	Vibration is identified by physical inspection or body feeling.	Serious vibration is identified by physical inspection or body feeling.
	Abnormal expansion gap	-----	Expansion gap is seen closed or open wide. Parapet & girder contacted each other.	End girder support length is not long enough. Parapet & girder contacted each other and are broken
	Settlement, Movement	-----	Superstructure or substructure moved a little.	Superstructure or substructure moved extraordinary.
	Scouring	Tendency of scouring is observed	Foundation/pile cap surface appeared due to scouring	Scouring depth reach below the bottom of foundation/pile cap
2	**Concrete bridge**			
2.1	**Concrete girder (I or T section, Box girder)**			
	Deformation, Deflection, Sag	-----	Deflection is observed slightly by visual inspection	Deflection is observed obviously by visual inspection
	Crack			
	i. Near end girder support	Small cracks extending vertically or diagonally near bearings	Large cracks extending vertically or diagonally near bearings.	Large vertical or diagonal cracks are observed near bearings with free lime or rusty fluid.
	ii. Near middle support	Small cracks are observed on upper flange or main girder web.	Large cracks are observed on upper flange or main girder web.	Large vertical cracks are observed on the upper flange of a main girder with free lime and rusty fluid.
	iii. Centre between supports	Small cracks are observed on the lower flange or the web of a main girder.	Large cracks are observed on the lower flange or the web of a main girder.	Large vertical or horizontal cracks are observed on the lower flange of a main girder with free lime and rusty fluid.
	iv. A quarter point between supports	Small vertical cracks are observed on the lower flange of a main girder.	Large vertical cracks are observed on the lower flange of a main girder,	Large vertical cracks are observed on the lower flange of a main girder with free lime and rusty fluid.
	v. Construction joints	Small cracks are observed near the construction joints.	Large cracks are observed near the construction joints.	Large cracks are observed near the construction joints with free lime or rusty fluid.
	vi. Segment junctions	-----	-----	Cracks or trace of free lime are observed near the segment joints.
	vii. Near anchors	-----	Crocodile cracks are observed near the anchorage.	Cracks are observed near the anchorage in shear direction

Sample Evaluation Criteria for Bridge Inspection Results-2/8

	Structural Part / Kind of Damage	Estimated volume based on damage level		
		B	C	D
	viii. Notch of a girder	-----	-----	Diagonal cracks are observed near the notch of a girder.
	Peeling, Spalling, Creep	Partial peeling is observed.	Wide concrete peeling is observed or peeling spreads.	Wide concrete peeling, spalling or creep with serious corroded rebar is observed
	Rebars exposure, Corrosion	Rebar exposure is observed partially	Rebar exposure is observed and rusting of rebars is progressing	-----
	Water leakage, Puddling	Water leakage or puddles is observed in rainy days.	Water leakage or puddles is observed regardless of weather.	-----
	Free lime	Free lime is observed, but no serious	Serious free lime is detected which seemingly from corroded steel members	-----
	Rusty fluid	Some rusty fluid is observed	Serious rusty fluid is observed, in particular, from rebars or PC cables.	-----
	Deterioration, Discoloration	Partial change in color is observed	Concrete changes its color on the surface near cracks	-----
	Honey comb, Void	Some of honey-combs and voids are observed, but not many	Many large honey-combs and voids are observed	-----
	Chemical attacks	Tendency of chemical attack effects is observed	Chemical attacks and serious rebars corrosion are observed	-----
2.2	**Concrete cross beam, Diaphragm**			
	Crack	Cracks at long intervals do not reached to rebar depth	Small cracks at small intervals reached to rebar depth	-----
	Peeling, Spalling, Creep	Partial peeling, spalling or creep is observed.	Wide concrete peeling, spalling or creep is observed	-----
	Rebars exposure, Corrosion	Rebar exposure is observed partially	Rebar exposure is observed and rusting of rebars progresses	-----
	Water leakage, Puddling	Water leakage or puddles is observed in rainy days.	Water leakage or puddles is observed regardless of weather.	-----
	Free lime	Free lime is observed, but not serious	Serious free lime is observed which seemingly from corroded steel members.	-----
	Rusty fluid	Some rusty fluid is observed	Serious rusty fluid is observed, in particular, from anchors of steel members or PC cables.	-----
	Deterioration, Discoloration	Partial change in concrete color is observed	Concrete changes its color on the surface near cracks	-----
	Honey comb, Void	Some of honey-combs and voids are observed, but not many	Many large honey-combs and voids are observed	-----
	Chemical attacks	Tendency of chemical attack effects is observed	Chemical attacks and serious rebars corrosion are observed	-----

Sample Evaluation Criteria for Bridge Inspection Results-3/8

	Structural Part / Kind of Damage	Estimated volume based on damage level		
		B	C	D
2.3	**Concrete deck slab**			
	Crack	Longitudinal and transverse cracks are observed	Cracks develops to crocodile cracks	Crocodile cracks cause spalling
	Peeling, Spalling, Creep	Small scale concrete peeling, spalling or creep is observed.	Wide concrete peeling, spalling or creep is observed	-----
	Rebars exposure, Corrosion	Partial rebars exposure is observed.	Rebar exposure is observed with progress of corrosion	-----
	Water leakage, Puddling	Water leakage or puddles is observed in rainy days.	Water leakage or puddles is observed regardless of weather.	-----
	Free lime	Free lime running in one direction is detected with color change	Free lime running in two directions is observed with color change.	Large extent of free lime running in two directions with color change is observed.
	Rusty fluid	Some rusty fluid is observed	Severe rusty fluid is observed.	-----
	Deterioration, Discoloration	Concrete surface has changed its color in limited areas.	Concrete surface has changed its color near cracks	-----
	Honey comb, Void	Some honey combs, voids are observed.	Large honey combs, voids are observed	Voids or holes due to crocodile crack are observed
	Chemical attacks	Tendency of chemical attack effects is observed	Chemical attacks and serious rebars corrosion are observed	-----
3	**Steel bridge**			
3.1	**Steel girder, Truss member, Arch member and Steel pier**			
	Deterioration of paint	Cracks, peeling, swollen or rust are observed in limited area.	Cracks, peeling, swelling or rust are observed over a wide area	-----
	Corrosion	There is one missing or loosen rivets or bolt-nuts observed on one connection plate	Reduction in steel plate thickness is observed due to corrosion	Corrosion on the main members develops significantly and gives significant negative impacts on strength of the structure
	Loosen and fallen of rivets, bolt-nuts, and HTBs	There is one missing or loosen rivets or bolt-nuts observed on one connection plate	More than 2 rivets or bolt-nuts are missing or loosen on one connection plate	-----
	Crack			
	i. Welding portions on sole plates	-----	Cracks appear	Cracks reached web plates
	ii. Girder end where cross section of web plate changes	-----	Cracks appear	Cracks reached web plates
	iii. Welding portions with vertical stiffeners	-----	Cracks appear	-----
	iv. Welding portions with gusset plates	-----	Paint cracks appear	Cracks progress onto web plates
	v. Butt welding portions on lower flanges	-----	Paint cracks appear	Cracks appear
	vi. Welding portions with steel deck plates	-----	Cracks appear	Cracks extend over two thirds of welding length

Sample Evaluation Criteria for Bridge Inspection Results-4/8

	Structural Part / Kind of Damage	Estimated volume based on damage level		
		B	C	D
	vii. Welding portions between vertical stiffeners and steel deck plates	-----	Cracks appear	Cracks appear on steel deck plates
	viii. End of stringers where cross section of the girder changes	-----	Cracks appear	Cracks progress on the stringer web extending in the direction that could break the stringer
	ix. Base of vertical members on the arch ribs	-----	There is potential of breaking vertical members	Cracks extend to arch chord or to the stiffeners of the girder
	x. Welding portions on shoe base plates	-----	Cracks appear	-----
	xi. Corners of steel piers	-----	Cracks appear	Cracks appear and may progress
	xii. Others	-----	Cracks appear	Other locations where large cracks are found
	Deformation and buckling	Slight deformation or buckling arises	Deformation or buckling arises and brigs a negative impacts on strength of the structure.	Significant deformation or buckling arises and bring significant negative impacts on strength of the structure.
	Water leakage, Puddling	Water leakage or puddles is sometimes seen on rainy days	Water leakage or puddle is seen anytime regardless of weather conditions	-----
3.2	**Steel Cross beam, Stringer, Diaphragm**			
	Deterioration of paint	Cracks, peeling, swollen or rust are observed in limited area.	Cracks, peeling, swelling or rust are observed over a wide area	-----
	Corrosion	Reduction in steel plate thickness is found due to corrosion	Corrosion on the members develops significantly and causes significant negative impacts on the strength of the structure	Severe rust on over 50% of length of the member
	Loosen and fallen of rivets, bolt-nuts, and HTBs	There is one missing or loosen rivets or bolt-nuts observed on one connection plate	More than 2 rivets or bolt-nuts are missing or loosen on one connection plate	
	Crack	-----	Some cracking	Severe cracking
	Deformation and buckling	-----	Slight deformation or buckling arises	Significant deformation or buckling arises and to be a significant negative impacts on strength of the structure.
	Water leakage, Puddling	Water leakage or puddles is sometimes seen on rainy days	Water leakage or puddle is seen anytime regardless of weather conditions	-----

Sample Evaluation Criteria for Bridge Inspection Results-5/8

	Structural Part / Kind of Damage	Estimated volume based on damage level		
		B	C	D
4	**Substructure**			
4.1	**Abutment and wing wall**			
	Tilting, Settlement, Movement	Partially damaged by settlement, movement or wash out	Severe damage by settlement, movement or wash out	-----
	Scouring	-----	Footing or caisson or abutment base is scoured to exposure	Footing or caisson or abutment base is scoured deeper than design
	Collision of ship / floating object		Some impact damage	Major impact damage
	Crack	Crack at long intervals do not reached to rebar depth	Small cracks at small intervals reached to rebar depth	Large crack at support end or cantilevered base is observed
	Peeling, Spalling, Creep	Small scale concrete peeling, spalling or creep is observed	Peeling, spalling or large creeping is observed	-----
	Rebars exposure, Corrosion	Partial rebar exposure is observed.	Sever exposed and corroded rebars are observed	-----
	Water leakage, Puddling	Water leakage or puddles is observed in rainy days.	Water leakage or puddles is observed regardless of weather.	-----
	Free lime	Free lime running in one direction is observed with color change	Free lime running in two directions is observed with color change.	Large extent of free lime running in two directions with color change is observed.
	Rusty fluid	Some water leakage and rusty fluid are observed	Severe rusty fluid is observed	-----
	Deterioration, Discoloration	Concrete surface has changed its color in limited areas	Concrete surface has changed its color near cracks	-----
	Honey comb, Void	Some honey combs, voids are observed	Large honey combs, voids are observed.	Large honey comb, voids with heavy corroded rebars are observed
	Chemical attacks	Tendency of chemical attack effects is observed	Chemical attacks and serious rebars corrosion are observed	-----
4.2	**Pier and pier head**			
	Tilting, Settlement, Movement	Partially damaged by settlement, movement or wash out	Severe damage by settlement, movement or wash out is observed	Damage due to settlement, movement or wash out effects on bridge stability
	Scouring	Tendency of scouring is observed	Footing or caisson or abutment base is scoured to exposure	Footing or caisson or abutment base is scoured deeper than design
	Collision of ship / floating object		Some impact damage	Major impact damage
	Crack	Crack at long intervals do not reached to rebar depth	Small cracks at small intervals reached to rebar depth	Large crack at support end or cantilevered base is observed
	Peeling, Spalling, Creep	Small scale concrete peeling, spalling or creep is observed	Peeling, spalling or large creeping is observed	-----
	Rebars exposure, Corrosion	Partial rebar exposure is observed.	Sever exposed and corroded rebars are observed	-----
	Water leakage, Puddling	Water leakage or puddles is observed in rainy days.	Water leakage or puddles is observed regardless of weather.	-----

Sample Evaluation Criteria for Bridge Inspection Results-6/8

	Structural Part / Kind of Damage	Estimated volume based on damage level		
		B	C	D
	Free lime	Free lime running in one direction is observed with color change	Free lime running in two directions is observed with color change.	Large extent of free lime running in two directions with color change is observed.
	Rusty fluid	Some water leakage and rusty fluid are observed	Severe rusty fluid is observed	-----
	Deterioration, Discoloration	Concrete surface has changed its color in limited areas	Concrete surface has changed its color near cracks	-----
	Honey comb, Void	Some honey combs, voids are observed	Large honey combs, voids are observed.	Large honey comb, voids with heavy corroded rebars are observed
	Chemical attacks	Tendency of chemical attack effects is observed	Chemical attacks and serious rebars corrosion are observed	-----
4.3	**Foundation (Footing, Pile cap, Pile)**			
	Tilting, Settlement, Movement	Partially damaged by settlement, movement or wash out	Severe damage by settlement, movement or wash out	Damage due to settlement, movement or wash out effects on bridge stability
	Scouring	Tendency of scouring is observed	Footing or caisson or abutment base is scoured to exposure	Footing or caisson or abutment base is scoured deeper than design
	Collision of ship and floating object		Some impact damage	Major impact damage
	Crack	Crack at long intervals do not reached to rebar depth	Small cracks at small intervals reached to rebar depth	Large crack at support end or cantilevered base is observed
	Peeling, Spalling, Creep	Small scale concrete peeling, spalling or creep is observed	Peeling, spalling or large creeping is observed	-----
	Rebars exposure, Corrosion	Partial rebar exposure is observed.	Sever exposed and corroded rebars are observed	-----
	Water leakage, Puddling	Water leakage or puddles is observed in rainy days.	Water leakage or puddles is observed regardless of weather.	-----
	Free lime	Free lime running in one direction is observed with color change	Free lime running in two directions is observed with color change.	Large extent of free lime running in two directions with color change is observed.
	Rusty fluid	Some water leakage and rusty fluid are observed	Severe rusty fluid is observed	-----
	Deterioration, Discoloration	Concrete surface has changed its color in limited areas	Concrete surface has changed its color near cracks	-----
	Honey comb, Void	Some honey combs, voids are observed	Large honey combs, voids are observed.	Large honey comb, voids with heavy corroded rebars are observed
	Chemical attacks	Tendency of chemical attack effects is observed	Chemical attacks and serious rebars corrosion are observed	-----

Sample Evaluation Criteria for Bridge Inspection Results-7/8

	Structural Part / Kind of Damage	Estimated volume based on damage level		
		B	C	D
5	**Bridge accessory**			
5.1	**Bearing shoe**			
	Breakage, Crack of bearing shoe body	Movement or rotation function slight malfunction	Shoe body moves up and down due to improper friction against horizontal movement. Cracks are detected on the members supporting a vertical load.	Vertical load support function does not function well due to breakdown of shoe materials by loading
	Deterioration of rubber (Loose of elastic, deformation, spalling, blister)	No cracking, some deformed	Cracked, deformed, sagged rubber bearing	Rubber bearing excessively deformed or with severe cracking. Severe rust on steel plates
	Corrosion	Moving and rolling functions are declining due to corrosion.	Vertical load support function declines due to corrosion.	Vertical load support function does not function well due to serious corrosion.
	Displacement	Movement sometimes reaches beyond design values.	Movement reaches beyond the allowable level, like collision with stopper.	Upper and lower shoe move significantly so that vertical load supporting function does not function well.
	Damages to attachments, anchor bolt-nuts	Looseness of set bolts, side block and anchor bolt nuts.	Breakdown of set bolts and anchor bolts. Damages on side block and pinch plates.	-----
	Damages to grout concrete or mortar	-----	Some breakdown of base concrete or mortar is detected.	Vertical load supporting function does not work well due to breakdown of base concrete or mortar.
	Abnormal sounds	Shoe generated sound.	Loud crashing sound is generated.	-----
	Piling of dust and sand	-----	Shoe is filled with soil or debris	Debris or soil is piled around shoe.
	Sweating, damping on bearing the pad	Some dampness	Standing water. Dampness. Dust. Vegetation	Dampness and spalling of concrete on bearing shelf
5.2	**Expansion joint**			
	Deterioration of rubber (Wearing, spalling, crack, breakage, ageing)	*Torn* around, no crack, not splitting	*Torn* cracks, splitting around	Deep *torn* or crack, splitting and ageing
	Breakage of steel (Corrosion, crack, deformation, breakage)	Deformation, no bent	Much deformation and bent	Serious deformation, bent over the limit
	Loosen or missing of anchor bolt-nuts	Some of anchor bolt-nuts are missing	Many anchor bolt-nuts are missing	-----
	Break off or breakage of drain gutter	Drain gutter is broken partially	Drain gutter broken widely	-----
	Out of level	Tilt appeared	Tilted out of position	Tilt caused danger to traffic
	Breakage of filling concrete	Some spalling, components intact and well anchored	Severe spalling, components damaged or torn loose anchor	Severe spalling, sections of Exp. J come loose and danger to traffic
5.3	**Guardrail, Handrail**			
	Breakage, missing due to vehicle collision	Some impact damage, no repairs required	Major impact damage - repairs required	Major impact damage - major repairs/ part replacement
	Crack, deformation	Some crack, deformation, no repairs required	Major crack, deformation, repairs required	-----
	Rebar exposure and corrosion	Some loose fixings	Many loose fixings	Loose fixings leading to local deformation
	Paint damage	Some deterioration of paint or rusting	Severe rusting	Guide post faded - not visible

Sample Evaluation Criteria for Bridge Inspection Results 8/8

	Structural Part / Kind of Damage	Estimated volume based on damage level		
		B	C	D
5.4	**Approach road**			
	Settlement of road	Settlement, movement - no signs of new movements	Major settlement, movement or deformation	Settlement and deformation with scour and slip
	Spalling/ Pothole on pavement	Some spalling, no potholes	Some spalling and potholes	Major spalling, many potholes
	Crack on pavement	Some cracking	Severe localized cracking	Severe cracking all over
	Settlement of foundation (Riprap, gabion)	—	Tension crack in approach embankment slope. Some scour but embankment slope stable	Fully developed slip failure. Major scour and unstable embankment slope
5.5	**Traffic control sign board**			
	Missing pole / breakage / deformation	User Information signs missing	Traffic prohibition sign missing	Load limit for weak bridge signs missing
	Affected by impact	Some impact damage but signs intact and visible	Major damage needing part replacement	Damage needing total replacement
	Unclear/ dirty	Dirty but visible	Only partially visible	Faded or barely visible fully blocked from view
	Obscured	—	Partially blocked by vegetation	Fully blocked from view
5.6	**Lighting system**			
	Warping of Lighting- post, reinforced leaking	Some rust on post	Severe rust on or slightly bent post	Rusted or bent post likely to fall on bridge deck
	Break/ Missing lighting- post	Functioning but not adequately	Many lights not working	Dangerously low lighting or electric shocks

ANNEX-F

Sample Evaluation Criteria for Tunnel Inspection

a. Concrete Lining

Facility	Member	Damage	Evaluation criteria		
			B	C	D
Tunnel	Concrete lining	Cracks/Corner Drop	Cracks (over 0.3 mm) or corner drops, which are not progressing	Cracks (over 0.3 mm) or corner drops which are progressing	Rapid progress of dense cracks or Tensile cracks and sheer cracks
		Concrete Peeling/ Creep	Thin concrete peeling or creeping	Thick concrete peeling or creeping	Large and wide scale Peeling or creeping
		Improper Construction joint	Gaps or opening of construction joints which are not progressing	Gaps or opening of construction joints which are progressing	'-----
		Water leakage/ Free lime	Some leaks and free lime (Water ooze out)	Some leaks and free lime (Water drop)	Large-scale water leakage or free lime (Water gush out/flow out)

b. Tunnel Portal

Facility	Member	Damage	Evaluation criteria		
			B	C	D
Tunnel	Portal	Cracks/Corner Drop	Cracks (over 0.3 mm) or corner drops, which are not progressing	Cracks (over 0.3 mm) or corner drops which are progressing	Rapid progress of dense cracks or Tensile cracks and sheer cracks
		Concrete Peeling/ Creep	Partial concrete peeling	Wide concrete peeling or creeping	Large and wide scale Peeling or creeping
		Settlement/movement/ tilting	'-----	Damage identifiable by visual inspection	Damage identifiable by visual inspection with cracks on the connection with tunnel body
		Improper Construction joint	Gaps or opening of construction joints which are not progressing	Gaps or opening of construction joints which are progressing.	'-----
		Scouring	Small scouring	Large scouring	'-----
		Water leakage/ Free lime	Some leaks and free lime	Large-scale water leakage or free lime	Large-scale water leakage or free lime

c. Inner Decoration Board & Tunnel Drainage System

Facility	Member	Damage	Evaluation criteria		
			B	C	D
Tunnel	Inner decoration board	Damage on the board	'-----	Partial cracks and peeling	Large-scale cracks and peelings
		Damage on the accessories	'-----	Damages on accessories, but do not lead to the falling of decoration board	Damages on accessories which lead to the falling of decoration board
	Drainage system	Damage on the drainage system	'-----	Degradation of drain function	Heavy damage on the drain function
		Piling of debris	Small piling of debris, but no gradation of drain function	Degradation of drain function	Heavy damage on the drain function

ANNEX-G

Sample Evaluation Criteria for Culvert Facility Inspection

a. Box Culvert

Facility	Member	Damage	Evaluation criteria		
			B	C	D
Box culvert	Reinforced concrete box culverts	Cracks	Cracks at long interval do not reach rebar depth	Cracks at short intervals reach rebar depth	Serious alligator cracks
		Concrete Peeling/ Creep	Some peeling or creeping	Large scale Peeling or creeping	'-----
		Exposure of steel bars/ Corrosion	Partial rebar exposure	Severe rebar exposure and corrosion	'-----
		Concrete Voids		Settlement/ movement / tilt can be seen	'-----
		Water leakage/ Free lime	Some leaks and free lime	Severe leakage or free lime and corrosion	'-----
		Settlement/ scouring	Settlement/ movement/ tilt to disturb drainage or scouring at wing or slope	Severe settlement/ movement / tilt to cause stagnant water or a gap between the culvert and the road Severe scouring at wing or slope	'-----
		Abnormality at joints	Joint gap is not in progress	joint gap exudes seal	'-----

b. Pipe Culvert

Facility	Member	Damage	Evaluation criteria		
			B	C	D
Reinforced concrete pipe culvert		Cracks	Cracks at long intervals do not reach rebar depth	Cracks at short intervals reaches rebar depth	Alligator cracks
		Concrete Peeling	Some peeling or creeping	Large scale Peeling or creeping	'-----
		Exposure of steel bars/ Corrosion	Partial rebar exposure	Severe rebar exposure and corrosion	'-----
		Settlement	Settlement that reduces drainage function	Severe settlement that disturbs drainage function	'-----
		Joint defects	Leakage from connections	Severe leakage from connections	'-----
		Water flow obstruction	Damage that reduces the drainage	Severely damaged with stagnant water inside pipe	'-----
Colgate pipe culvert		Structural damage	Deformation or cracks in the structure	Large scale deformation or severe cracks in the structure	'-----
		Corrosion	Some corrosion	Severely corroded	'-----
		Settlement	Settlement that reduces drainage function	Severe settlement that disturbs drainage function	'-----
		Connection joint damage	Leakage from connections	Severe leakage from connections	'-----
		Drain damage	Damage to reduce the drainage	Severe damage and stagnant water inside pipe	'-----

ANNEX-H

Sample Evaluation Criteria for Traffic Safety Facility Inspection

Structure	Position	Member	Damage	Evaluation Criteria		
				B	C	D
Traffic safety facility	Guard rail	Guard rail	Main member damages	Slight damage or tilting on the guard posts, beams or pipes.	Serious damages on the guard posts, beams and pipes, but do not lead to breakdown of main members.	Serious damages, dropout or tilting on the guard posts, beams and pipes.
			Accessory damages	Slight loosening or missing bolts on the mounting brackets, which do not lead to the drop out or breakdown of main members.	-	Loosening or missing bolts on the mounting brackets, which lead to the drop out or breakdown of main members.
			Corrosion	Some corrosion	Widespread corrosion	-
			Foundation damages	Slight damages of anchor materials or scouring around foundation, but do not lead to the breakdown of main members.	-	Serious damages of anchor materials or scouring around foundation which leads to the breakdown of main members.
		Guard cable	Main member damages	Limited damage, tilt or sagging at support pole or cable	Damage, tilt or sagging at support pole or cable	Serious damages on the posts or cables including sagging of cable and tilting of guard posts.
			Accessory damages	Slight loosening	-	Loosening or missing bolts, which lead to the drop out or breakdown of main members.
			Corrosion	Partial corrosion	Widespread corrosion	
			Foundation damages	Slight damages on the mounting brackets or partial scouring around foundation.	-	Serious damages on the mounting brackets or scouring around foundation which leads to the breakdown of main members.
		Concrete wall type guard facility	Cracks/ /corner drop	Partial cracks which has not reached steel bars.	Cracks, which is not large-scale, but has reached steel bars	Serious crocodile cracks which has reached steel bars

Guard Rail & Guard Cable

ANNEX-I

Sample Evaluation Criteria for Traffic Management Facility Inspection

Traffic Sign

Structure	Position	Member	Damage	Judge		
				B	C	D
Traffic management facility	Traffic signs	Main member, accessories, foundation	Main member damages	Slight damages including deformation and breakage of sign boards or sign poles. However, information on the sign boards is still readable.	Damages including deformation, tilting and breakage of traffic signs. Also, it is hard to read information on the sign boards.	Severe damages including dropout of poles or sign boards, or deformation or tilting of traffic signs.
			Accessory damages	Slight damages including loosening of bolts or deformation of sign boards. However, they may not lead to dropout of sign boards or mounting brackets.		Damages on the mounting brackets, loosening or dropout of bolts and nuts which may cause dropout of sign boards or sign poles.
			Corrosion	Partial corrosion	Widespread corrosion	
			Foundation	Slight damages to the anchors or partial scouring around foundation.		Dropout of bolts, breakage, deformation of anchor material or scouring around foundation. Also, they may lead to serious breakdown of traffic signs.

INSPECTION DATA FORMAT SLOPE FACILITY

INSPECTION DATA FORMAT (ROAD SLOPE FACILITY)

ANNEX-I_S-1

(*1): Refer to the relevant articles in the Inspection Guideline

ID	Geographical Area	Jurisdiction	Maintenance Company	Route Number	Branch Number	Route Name	Kirometer Post					Pavement Facility damage Conditions											Damage Rating	Detailed Inspection	Selected Repair Work	Repair Work Volume	Monitoring	Note
							From (km,m)		To (km,m)		U/D	Date (yyyy/mm)		Inspection Facility (*1) General slopes Protected slope Retaining walls Slope drainage system	Damage Type (*2) Serious damages - Cracks - Deformation - Swelling/settlement - Scouring Damages on drain system	Damage Scale						Loocation Information						
																Length (m)	width (cm)	Diameter (cm)	Depth (cm)	Piece	Visual observation	Location Memo	Photo with GPS Camera	A, B, C, D, E			M / M^2 / M^3 / Piece		
NH00100	NORTHERN AREA	RMB 1	RRMC236	1	0	NATIONAL HIGHWAY 1	3	0	3	120	D	2015	9	General slope	Serious damages							2nd cut slope from roadside	NH00100-1	D	Yes	Bump repair work	120 * 0.3 * 0.08	Monitoring	Sample Data
NH00100	NORTHERN AREA	RMB 1	RRMC236	1	0	NATIONAL HIGHWAY 1	5	0	5	25	U	2015	9	Slope drainage system	Damages on drain dystem	25						1st cut slope from roadside	NH00100-1	D	-----	Drainage repair works	25 m	-----	Sample data

INSPECTION DATA FORMAT PAVEMENT FACILITY Road Condition Survey Data ANNEX-I_P-1

INSPECTION DATA FORMAT (ROAD PAVEMENT FACILITY-1)

ID	Geographical Area	Jurisdiction	Maintenance Company	Route Number	Branch Number	Route Name	Kirometer Post				Section Length (m)	Analysis Area (m2)	Structure	Intersection	Overlapping	Number of Lane		Survey Lane		Surface Type	Condition (Distress)									Note
							From (km,m)		To (km,m)							U	D	U/D	Path Lane		Date (yyyy/mm)		CrackingRatio/ Cracking Index(%／㎡/m²)				Rutting Depth(mm)		IRI (mm/m)	
																							Cracking	Patching	Pothole	Total	Max	Ave		
NH00100	NORTHERN AREA	RRMU2	RRMC236	1	0	NATIONAL HIGHWAY 1	0	10	0	100	90	340.2				2	2	D	1	AC	2012	10	0	0	0	0	31	9	10.25	

INSPECTION DATA FORMAT PAVEMENT FACILITY ANNEX-I_P-2

INSPECTION DATA FORMAT (ROAD PAVEMENT FACILITY-2)

(*1): Refer to the relevant articles in the Inspection Guideline

ID	Geographical Area	Jurisdiction	Maintenance Company	Route Number	Branch Number	Route Name	Kirometer Post				Survey Lane		Surface Type	Pavement Facility damage Conditions										Damage Rating	Detailed Inspection	Selected Repair Work	Repair Work Volume	Monitoring	Note
							From (km,m)		To (km,m)		U/D	Path Lane		Date (yyyy/mm)		Inspection Facility (*1) AC CC Bituminous surface treatment (BST) Drainage system	Damage Type (*1) Pothole Edge Break Bump Road Surface Drainage	Damage Scale						Loocation Information						
																		Length (m)	width (cm)	Diameter (cm)	Depth (cm)	Piece	Visual observation	Location Memo	Photo with GPS Camera	A, B, C, D, E			M / M^2 / M^3 / Piece		
NH00100	NORTHERN AREA	RMB 1	RRMC236	1	0	NATIONAL HIGHWAY 1	3	0	3	120	D	1	AC	2015	9	AC	Bump		30		8			-----	NH00100-1	D	Yes	Bump repair work	120 * 0.3 * 0.08	-----	Sample Data
NH00100	NORTHERN AREA	RMB 1	RRMC236	1	0	NATIONAL HIGHWAY 1	10	0	---	---	D	1	AC	2015	9	BST	Pothole			40	3			-----	NH00100-2	D		Replacement	0.4 * 0.5 * 0.03	Monitoring	Sample Data
NH00100	NORTHERN AREA	RMB 1	RRMC236	1	0	NATIONAL HIGHWAY 1	13	20	---	---	D	1	AC	2015	9	Drainage system	Drainage	25						-----	NH00100-3	C	No	Replacement	25 m	-----	Sample Data
NH00100	NORTHERN AREA	RMB 1	RRMC236	1	0	NATIONAL HIGHWAY 1	14	15	14	80	D	1	AC	2015	9	AC	Pothole			20	1			Medien Drain	NH00100-4	B	-----	-----	-----	Monitoring	Sample Data
NH00100	NORTHERN AREA	RMB 1	RRMC236	1	0	NATIONAL HIGHWAY 1	18	25	18	275	D	1	AC	2015	9	CC	Crack	250	0.2		0.1			Shoulder Drain	NH00100-5	C	-----	-----	250 * 0.2 * 0.1	Monitoring	Sample Data

ANNEX-J_B-1

General information

Road Management/ Department of Transportation (CC):			*Bridge name: ……..……*
Company/ NH Section: ……			*Station of Bridge: ……..National Highway: ……*
Inspector: ……..			*Main Obstacle Crossed: .....*
District: ……..			*Longitude: …….. Latitude: ……*
Province/City: ……			*Load Assessment: ……*
Starting time:			*Inspector time: Date ……Month …… Year ……*
Finishing time:			*Total of pages: .....*

Result of inspection, evaluation and works requirements are noted in tables of this Sheet
Map/ Pictures of Bridges, Parts of Bridges and damage locations (supplemented at the end of report, if any)

General Remarks:

……
……
……
……
……
……

Engineer
(Sign, name)

……

Proposal of management unit:

……

The report is checked and approved by:

.....

Reference: INSPECTION DATA FORMAT (BRIDGE FACILITY-1)

Guiding for note taking: *Required to mark all the parts, the degree of damage. Where the structural parts that do not have the dash to confirm that no parts. Cases were not tested, clearly marked "Not inspection" and together with the reasons.*

Total quantity / weight: recorded total volume or quantity of the whole kind of structural parts, units as described in the Manual Guide.

Volume estimates on the extent of damage: recording volume or the number of estimated damage for each level of damaged scales A, B, C, D as classified in the Manual Guide. Total estimated volume or quantity of the four levels of damage equal to the total volume / number as in the previous column.

Description of damage: Make sure the reader test results visualize the extent and scope of damage and location. For all the damage was assessed at level C or D must have graphics and photos, to indicate the level of damage (photos included with gauge) . For structural parts such as girders,piers of the multiple spans bridge as much description should indicate the exactly piers, spans which are deteriorated, damaged . Digitized, photos and detailed description of the damaged position is documents attached to the BIS.

Estimated maintenance method: including the normal maintenance with proposed volume (including cleaning, type rust, paint, and surface sealing, crack sealing patching, straightening warped tune, apply grease, wrapped reinforced concrete, clearance ...) or promote the repair damage at high levels. If not sure the proposed repair, write "discussion with the engineer" and make sure to provide enough information to help engineers can make decisions in office.

*Priority: propose priority level at: **E** – Emergency; **H** – High*

Reference: INSPECTION DATA FORMAT (BRIDGE FACILITY-1/2)

Code	Structural Part / Kind of Damage	Unit	Total Quantity	Estimated volume based on damage level				Damage description (Damage at level C and D must be noted)	Tentative repair works	Priority level
				A	B	C	D			
1	**All type of bridge**									
1.1	**Entire bridge condition**									
	Abnormal deflection	-								
	Abnormal Nosie	-								
	Abnormal vibration	-								
	Abnormal expansion gap	-								
	Settlement, Movement	-								
	Scouring	-								
2	**Concrete bridge**									
2.1	**Concrete girder (I or T section, Box girder)**									
	Deformation, Deflection, Sag	-								
	Crack	-								
	i. Near end girder support	m/m^2								
	ii. Near middle support	m/m^2								
	iii. Centre between supports	m/m^2								
	iii. A quarter point between supports	m/m^2								
	v. Construction joints	m/m^2								
	vi. Segment junctions	m/m^2								
	vii. Near anchors	m/m^2								
	viii. Notch of a girder	m/m^2								
	Peeling, Spalling, Creep	m^2								
	Rebars exposure, Corrosion	m^2								
	Water leakage, Puddling	m^2								
	Free lime	m/m^2								
	Rusty fluid	m^2								
	Deterioration, Discoloration	m^2								
	Honey comb, Void	m^2								
	Chemical attacks	m^2								

Reference: INSPECTION DATA FORMAT (BRIDGE FACILITY-2/2)

Code	Structural Part / Kind of Damage	Unit	Total Quantity	Estimated volume based on damage level				Damage description (Damage at level C and D must be noted)	Tentative repair works	Priority level
				A	B	C	D			
2.2	**Concrete Cross beam, Diaphragm**									
	Deformation, Deflection, Sag	-								
	Crack	m/m^2								
	Peeling, Spalling, Creep	m^2								
	Rebars exposure, Corrosion	m^2								
	Water leakage, Puddling	m^2								
	Water leakage, Puddling	m2								
	Free lime	m2								
	Rusty fluid	m2								
	Deterioration, Discoloration	m2								
	Honey comb, Void	m2								
	Chemical attacks	m2								
	Free lime	m/m^2								
	Rusty fluid	m^2								
	Deterioration, Discoloration	m^2								
	Honey comb, Void	m^2								
	Chemical attacks	m^2								
2.3	**Concrete Deck slab**									
	Crack	m2								
	Peeling, Spalling, Creep	m2								
	Rebars exposure, Corrosion	m2								

ANNEX-J_B-3

Reference: INSPECTION DATA FORMAT (BRIDGE FACILITY-3)

Code	Structural Part / Kind of Damage	Unit	Total Quantity	Estimated volume based on damage level				Damage description (Damage at level C and D must be noted)	Tentative repair works	Priority level
				A	B	C	D			
3	**Steel bridge**									
3.1	**Steel girder, Truss member, Arch member and Steel pier**									
	Deterioration of paint	m^2								
	Corrosion	m^2								
	Loosen and fallen of rivets, bolt-nuts	%								
	Crack	m								
	i. Welding portions on sole plates	m								
	ii. Girder end where cross section of web plate changes	m								
	iv. Welding portions with vertical stiffeners	m								
	iv. Welding portions with gusset plates	m								
	v. Butt welding portions on lower flanges	m								
	vi. Welding portions with steel deck plates	m								
	vii. Welding portions between vertical stiffeners and steel deck plates	m								
	viii. End of stringers where cross section of the girder changes	m								
	ix. Base of vertical members on the arch ribs	m								
	x. Welding portions on shoe base plates	m								
	xi. Corners of steel piers	m								
	xii. Others	m								
	Deformation and buckling	m								
	Water leakage, Puddling	m^2								
3.2	v. **Steel Cross beam, Stringer, Diaphragm**									
	Deterioration of paint	m^2								
	Corrosion	m^2								
	Loosen and fallen of rivets, bolt-nuts, and HTBs	%								
	Crack	m								
	Deformation and buckling	m								
	Water leakage, Puddling	m^2								

Reference: INSPECTION DATA FORMAT (BRIDGE FACILITY-4)

Code	Structural Part / Kind of Damage	Unit	Total Quantity	Estimated volume based on damage level				Damage description (Damage at level C and D must be noted)	Tentative repair works	Priority level
				A	B	C	D			
4	**Substructure**	m^2								
4.1	**Abutment and Wing wall**									
	Tilting, Settlement, Movement	-								
	Scouring	-								
	Collision of ship and floating object	-								
	Crack	m/m^2								
	Peeling, Spalling, Creep	m^2								
	Rebars exposure, Corrosion	m^2								
	Water leakage, Puddling	m^2								
	Free lime	m^2								
	Rusty fluid	m^2								
	Deterioration, Discoloration	m^2								
	Honey comb, Void	m^2								
	Chemical attacks	m^2								
4.2	**Pier and Pier head**									
	Tilting, Settlement, Movement	-								
	Scouring	-								
	Collision of ship and floating object	-								
	Crack	m/m^2								
	Peeling, Spalling, Creep	m^2								
	Rebars exposure, Corrosion	m^2								
	Water leakage, Puddling	m^2								
	Free lime	m^2								
	Rusty fluid	m^2								
	Deterioration, Discoloration	m^2								
	Honey comb, Void	m^2								
	Chemical attacks	m^2								
4.3	**Foundation (Footing, Pile cap, Pile)**									
	Tilting, Settlement, Movement	-								
	Scouring	-								
	Collision of ship and floating object	-								
	Crack	m/m^2								
	Peeling, Spalling, Creep	m^2								
	Rebars exposure, Corrosion	m^2								
	Water leakage, Puddling	m^2								
	Free lime	m^2								
	Rusty fluid	m^2								
	Deterioration, Discoloration	m^2								
	Honey comb, Void	m^2								
	Chemical attacks	m^2								

Reference: INSPECTION DATA FORMAT (BRIDGE FACILITY-5)

Code	Structural Part / Kind of Damage	Unit	Total Quantity	Estimated volume based on damage level				Damage description (Damage at level C and D must be noted)	Tentative repair works	Priority level
				A	B	C	D			
5	**Bridge accessory**									
5.1	**Bearing shoe**									
	Breakage, Crack of bearing shoe body	Each								
	Deterioration of rubber (Loose of elastic, deformation, spalling, blister)	Each								
	Corrosion	Each								
	Displacement	Each								
	Damages to attachments, anchor bolt-nuts	Each								
	Damages to grout concrete or mortar	Each								
	Abnormal sounds	-								
	Piling of dust and sand	m^2								
	Sweating, damping on bearing the pad	m^2								
5.2	**Expansion joint**									
	Deterioration of rubber (Wearing, spalling, crack, breakage, ageing)	m								
	Breakage of steel (Corrosion, crack, deformation, breakage)	m								
	Loosen or missing of anchor bolt-nuts	Each								
	Break off or breakage of drain gutter	m								
	Out of level	m								
	Breakage of filling concrete	m^2								
5.3	**Guardrail, Handrail**									
	Breakage, missing due to vehicle collision	m								
	Crack, deformation	m								
	Rebar exposure and corrosion	m								
	Paint damage	m								
5.4	**Approach road**									
	Settlement of road	m^2								
	Spalling/ Pothole on pavement	m^2								
	Crack on pavement	m^2								
	Settlement of foundation (Riprap, gabion)	m								
5.5	**Traffic control sign board**									
	Missing pole/ breakage/ deformation	Each								
	Affected by impact	Each								
	Unclear/ dirty	Each								
	Obscured	Each								
5.6	**Lighting system**									
	Warping of Lighting- post, reinforced leaking	Each								
	Break/ Missing lighting- post	Each								

INSPECTION DATA FORMAT TUNNEL FACILITY

INSPECTION DATA FORMAT (TUNNEL FACILITY)

ANNEX-I_T-1

(*1): Refer to the relevant articles in the Inspection Guideline.

ID	Geographical Area	Jurisdiction	Maintenance Company	Route Number	Branch Number	Route Name	Kirometer Post					Surface Type	Pavement Facility damage Conditions											Damage Rating	Detailed Inspection	Selected Repair Work	Repair Work Volume	Monitoring	Note
							From (km,m)		To (km,m)		U/D		Date (yyyy/mm)		Inspection Facility (*1)	Damage Type (*1)	Damage Scale						Loocation Information							
															Concrete lining Tunnel portal Inner decoration board Tunnel drainage system	Serious damages - Cracks - Water leakage - Joints - Scouring Damages on drain system	Length (m)	width (cm)	Diameter (cm)	Depth (cm)	Piece	Visual observation	Location Memo	Photo with GPS Camera	A, B, C, D, E			M / M^2 / M^3 / Piece		
NH00100	NORTHERN AREA	RMB 1	RRMC236	1	0	NATIONAL HIGHWAY 1	3	0	3	120	D	AC	2015	9	Tunnel lining	Water leakage	0.2							NH00100-4	D	-----	Joint repair /Drain pipe installation	0.2 m	-----	Sample Data
NH00100	NORTHERN AREA	RMB 1	RRMC236	1	0	NATIONAL HIGHWAY 1	5	0	5	25	U	AC	2015	9	Tunnel portal	Cracks	10							NH00100-8	D	Yes	Crack seal	10		Sample data

INSPECTION DATA FORMAT CULVERT FACILITY

INSPECTION DATA FORMAT (CULVERT FACILITY)

ANNEX-I_C-1

(*1): Refer to the relevant articles in the Inspection Guideline.

ID	Geographical Area	Jurisdiction	Maintenance Company	Route Number	Branch Number	Route Name	Kirometer Post					Pavement Facility damage Conditions												Damage Rating	Detailed Inspection	Selected Repair Work	Repair Work Volume	Monitoring	Note
							From (km,m)		To (km,m)		U/D	Date (yyyy/mm)		Inspection Facility (*1)	Damage Type (*1)	Damage Scale						Loocation Information							
														Reinforced concrete box-culvert Reinforced concrete pipe culverts Corrugated metal culvert	Serious damages - Cracks - Water leakage - Joints - Scouring Damages on drain system	Length (m)	width (cm)	Diameter (cm)	Depth (cm)	Piece	Visual observation	Location Memo	Photo with GPS Camera	A, B, C, D, E			M / M^2 / M^3 / Piece		
NH00100	NORTHERN AREA	RMB 1	RRMC236	1	0	NATIONAL HIGHWAY 1	3	0	3	120	D	2015	9	Reinforced concrete box- culvert	Joint	5							NH00100-3	D	-----	Joint repair /Drain pipe installation	0.2 m	-----	Sample Data
NH00100	NORTHERN AREA	RMB 1	RRMC236	1	0	NATIONAL HIGHWAY 1	5	0	5	25	U	2015	9	Tunnel portal	Cracks	10							NH00100-4	D	Yes	Crack seal	10		Sample data

INSPECTION DATA FORMAT TRAFFIC SAFETY FACILITY

INSPECTION DATA FORMAT (TRAFFIC SAFETY FACILITY)

ANNEX-I_TS-1

(*1): Refer to the relevant articles in the Inspection Guideline

ID	Geographical Area	Jurisdiction	Maintenance Company	Route Number	Branch Number	Route Name	Kirometer Post					Pavement Facility damage Conditions										Damage Rating	Detailed Inspection	Selected Repair Work	Repair Work Volume	Monitoring	Note
							From (km,m)		To (km,m)		U/D	Date (yyyy/mm)		Inspection Facility (*1) Guardrail Guard Cable Concrete Wall-type Guard	Damage Type (*1) Main member damage Accessary damage Corrosion Foundation damage	Damage Scale					Loocation Information							
																Length (m)	width (cm)	Diameter (cm)	Depth (cm)	Piece	Visual observation	Location Memo	Photo with GPS Camera	A, B, C, D, E			M / M^2 / M^3 / Piece		
NH00100	NORTHERN AREA	RMB 1	RRMC236	1	0	NATIONAL HIGHWAY 1	3	180			D	2015	9	Guard Rail	Deformation					2	By accident		NH00100-3	D	-----	Replacement	2	-----	Sample Data
							15	250	---	---				Concrete Wall-type Guard	Cracks					1	Serious cracks		NH00100-4	D	-----	Replacement	1	-----	Sample data

INSPECTION DATA FORMAT (TRAFFIC MANAGEMENT FACILITY)

(*1): Refer to the relevant articles in the Inspection Guideline.

ID	Geographical Area	Jurisdiction	Maintenance Company	Route Number	Branch Number	Route Name	Kirometer Post					Pavement Facility damage Conditions										Damage Rating	Detailed Inspection	Selected Repair Work	Repair Work Volume	Monitoring	Note
							From (km,m)		To (km,m)		U/D	Date (yyyy/mm)		Inspection Facility (*1)	Damage Type (*1)	Damage Scale					Loocation Information							
														Traffic signs	Main member damage Accessary damage Corrosion Foundation damage	Length (m)	width (cm)	Diameter (cm)	Depth (cm)	Piece	Visual observation	Location Memo	Photo with GPS Camera	A, B, C, D, E			M / M^2 / M^3 / Piece		
NH00100	NORTHERN AREA	RMB 1	RRMC236	1	0	NATIONAL HIGHWAY 1	3	180			D	2015	9	Traffic signs	Deformation					1	By accident		NH00100-3	D	-----	Replacement	1	-----	Sample Data

ANNEX-K

PICTURE RECORDS

PHOTO NUMBER:		PHOTO NUMBER:	
ROAD ID		ROAD ID	
STATION POST		STATION POST	

PHOTO NUMBER:		PHOTO NUMBER:	
ROAD ID		ROAD ID	
STATION POST		STATION POST	