

Department of Rural Roads
Ministry of Transportation
Kingdom of Thailand

Kingdom of Thailand
The Project for Bridge Master Plan and Bridge
Maintenance Ability in Rural Area

Report 2
Bridge Inspection and Evaluation Manual

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Preconditions of this Manual

1. This manual describes inspection for the purpose of data collection for long-term operation and maintenance of rural bridges.
2. Important points regarding emergency inspection after flood are added. This manual also takes the climate of Thailand into consideration, and clearly mentions that the inspection should be carried out in dry season.
3. The method to detect bridge condition is based on visual inspection.
4. As almost all of the rural bridges are concrete bridges (RC structure or PC structure) and steel bridges are few, this manual is written for concrete bridges.
5. The upper and lower structures of rural bridges in this manual are selected according to the DRR's current standard drawings. (Superstructure (4 types): Deck slab, plank girder, box girder, PC girder, Pier (4types): T-shaped pier (Circular & cross-section), rigid-frame pier, pile-bent pier, abutment (Wall)) (Note 1)
6. As a result of emergency inspection, scouring in piers, damages on the surface or behind abutments were remarkable; therefore inspection subjects related to these are established. Approach slab is also added into the inspection subjects.
7. Bearing devices made of steel (Pot bearing, Disk bearing) and bearing made of rubber (Rubber bearing pad) are also included in the manual.
8. Expansion joints (Butt joint and Undrained joint) are also included in the manual.
9. Bridge deterioration is classified into 5 ratings, which are independent with the personal judgments of each inspector.
10. Bridge inspection form is simplified to avoid the burden of data recording work.
11. Among damage class 5, the damage that may give impact on the safety of bridge can be defined as two types: Type1 is the damage needs the urgent treatment and Type 2 is the damage with a high priority of repair.

Note (1)

The concrete girder (PC/RC), pier and abutments in which listed in the standard design drawing of less than 20m span bridges (September, 2010) and less than 30m span bridges (2010) were subject to this manual.

**THE PROJECT FOR BRIDGE MASTER PLAN AND BRIDGE
MAINTENANCE ABILITY IN RURAL AREA
"BRIDGE INSPECTION AND EVALUATION MANUAL"**

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I Common

1. Application

This manual is developed to assist the periodic inspection of road bridges managed by DRR.

2. Purpose of inspection

Inspection is intended for the recording of the damage data recognizing the condition of the bridges such as the existence of remarkable deterioration in the bridges so that maintenance can be realized as planned.

3. Types of inspection

It is necessary to inspect by appropriate methods according to the purpose and the condition at the appropriate time. The types of inspection are shown as follows:

- (1) Routine inspection
- (2) Periodic inspection
- (3) Emergency inspection
- (4) Advanced inspection

Besides periodic inspection there are different types of inspection and investigation in the maintenance system. This can be schematically demonstrated in the maintenance system as follows:

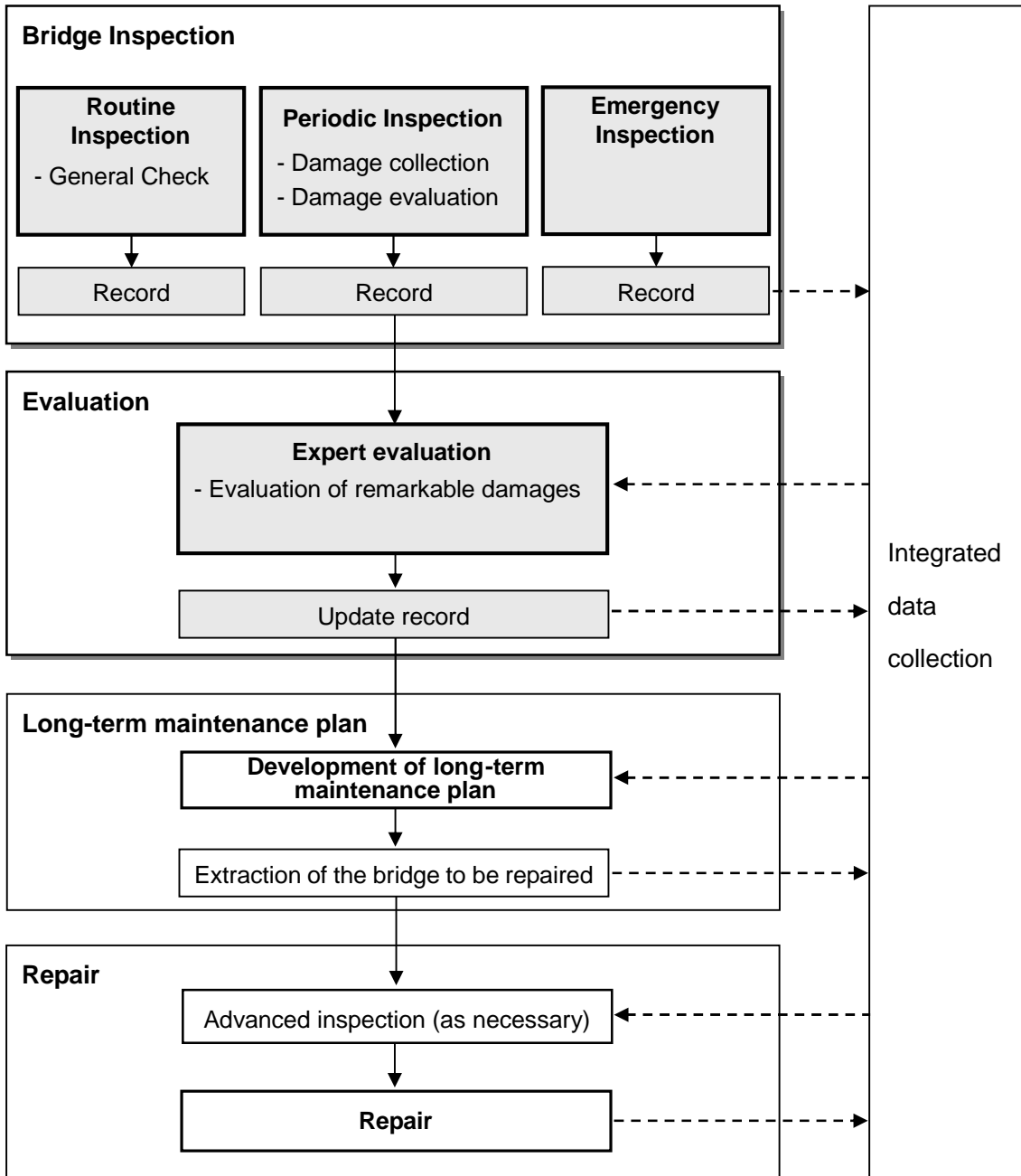


Figure 3.1: Scheme of inspection in the maintenance system

Table3.1: Types of inspection and activities

	Inspector	Frequency	Method	Remarks
Routine Inspection	Technician	Once / Year (At Least)	Visual	General check (Vehicle patrol / Foot Patrol (Optional))
Periodic Inspection	Technician Engineer	Once / 5 years	Visual (as close as possible to the structure)	
Emergency Inspection	Technician Engineer	Optional (Must be done after flood has occurred or after receiving a report of damage)	Similar to periodic inspection	In case of a disaster caused by a natural disaster (earthquake, typhoon, heavy rain, flood etc.) or the collision by car or ship, it should be checked about condition of structures.
Advanced Inspection	Professional Engineer / Consultant (in case of necessity)	Optional	Physical test (non-destructive/destructi ve), analysis, etc. (If it is appeared to be necessary according to the visual inspection result)	

3.1 Routine inspection

Routine inspection is accomplished by daily visual inspection combined with vehicle patrol in order to check structural damages, falling objects, illegal occupation, stolen appurtenances etc..

Any damage recognized from the vehicle shall be confirmed on foot as needed.

Inspection work is performed by the technician or worker in the office of Provincial Rural Road.

3.2 Periodic inspection

The periodic inspection is carried out for planned maintenance of the bridge. The condition of the structures is grasped based upon visual inspection to the structure and evaluated finally.

Inspection shall be carried out in dry season.

Inspection work is performed by the engineers, technicians and workers in the office of Provincial Rural Road.

3.3 Emergency inspection

In case of natural disasters such as earthquake, typhoon, heavy rain, flood etc. or large accidents such as collision by car or ship, emergency inspection shall be carried out. This inspection is in order to confirm the existence of fatal damages for the structural stability.

Inspection work is performed by the engineers, technicians and workers in the office of Provincial Rural Road.

3.4 Advanced inspection

If it appears to be difficult to judge the necessity of repair or the repair method after visual inspection, advanced inspection is then applied.

Advanced inspection work is performed by the professional engineers with expertise. (In case of necessity, Consultants carry out.)

II Periodic inspection

1. Inspection work

1.1 Preparation of inspection plan

To carry out inspection appropriately, an inspection plan shall be prepared before carrying out a periodic inspection. The following items are to be considered when preparing an inspection plan.

- Study of past documents and materials

Data inputted in data book, documents and materials of the past investigations or repairs, if any, shall be checked.

- Site reconnaissance

Site reconnaissance may be performed when the site condition is unknown. If performed, method shall be defined in advance.

- Method of inspection

Method of inspection appropriate for the site condition shall be decided. Necessary devices are also decided.

- Inspection personnel

Members to carry out inspection shall be appointed.

- Inspection Schedule

Schedule to carry out the inspection shall be determined.

- Consultation with administrators

Whether it is necessary to obtain prior permission from any administrator other than DRR or landowner shall be confirmed.

- Safety measures

In addition to the general measures, if there is any special condition such as heavy traffic, measures such as to place traffic controllers shall be considered.

- Traffic control and Emergency contact system

In case that it is required to control the traffic during inspection work or it is an

emergency repair work, measures related to the traffic control shall be specified in advance. This is because the inspection work may cause any harmful damages to the vehicle passengers. In addition, measures to be implemented in case of any accidents during the inspection work shall be prepared in advance.

1.2 Methods and subjects of inspection

(1) Inspection shall be based upon visual inspection. If it is difficult to close to the structures due to the structural reason or the bridge location or the condition of inspected element, to use ladder or boat or bridge inspection vehicle are recommended.

(2) The members at the girder end, the bearings and these vicinities that locations are required to be inspected shall be inspected as close as possible to the structure from the nearest abutments or piers.

(3) The condition in the place it is difficult to access shall be estimated by visual inspection with a distant view and by using the telescope, and the condition of the surrounding members. Inspection and evaluation shall be applied every span regardless of number of span. Inspection subjects, evaluation criteria and inspected area etc. are given in Table 1.1.

Note : “inspection with a close view” is defined as inspection where the inspector is close enough to touch the area being inspected.

Table 1.1: Inspection subjects, evaluation methods and location

Damage	Evaluation classification				
	Low -Damage level- High				
(1) Settlement, movement, inclination of substructures	1	-	-	-	5
(2) Unevenness of road surface	1	-	3	-	5
(3) Damages in expansion joints	1	-	3	-	5
(4) Damages in barriers	1	-	3	-	5
(5) Damages in drainages	1	-	-	-	5
(6) Damages in sidewalk	1	-	-	-	5
(7) Damages in attached facility	1	-	-	-	5
(8) Damages behind abutments	1	-	3	-	5
(9) Damages on river revetments near abutments	1	-	3	-	5
(10) Scouring riverbed around abutments & piers	1	-	3	-	5
(11) Damages at the anchorages of prestressing tendons	1	-	-	-	5
(12) Cracking, water leakage and free lime	1	2	3	4	5
(13) Pop-outs of deck	1	-	3	-	5
(14) Deck cracking	1	2	3	4	5
(15) Rebar exposure	1	2	3	-	5
(16) Functional damage of bearings	1	-	3	-	5

In case unprecedented damages such as fire signs or unusual condition related to the safety or harmful to a third person are found in the inspection according to this manual, it is important to take an appropriate countermeasure such as advanced inspection etc.

Figures 1.1 and 1.2 show the structural types for which this manual is written. Damages in a concrete girder vary in crack direction, characteristics and also its location depending upon the causes. It is necessary to confirm the whole cracking area as close as possible, since cracks such as shear cracks may give a great influence on the bridge health.

In case of prestressed concrete girder the state of prestressing gives a great influence on the bridge health. Therefore it is preferable to confirm every anchorage zone where indicates the existence of the damage in a prestressing tendon if the inspection intends to grasp the rough health.

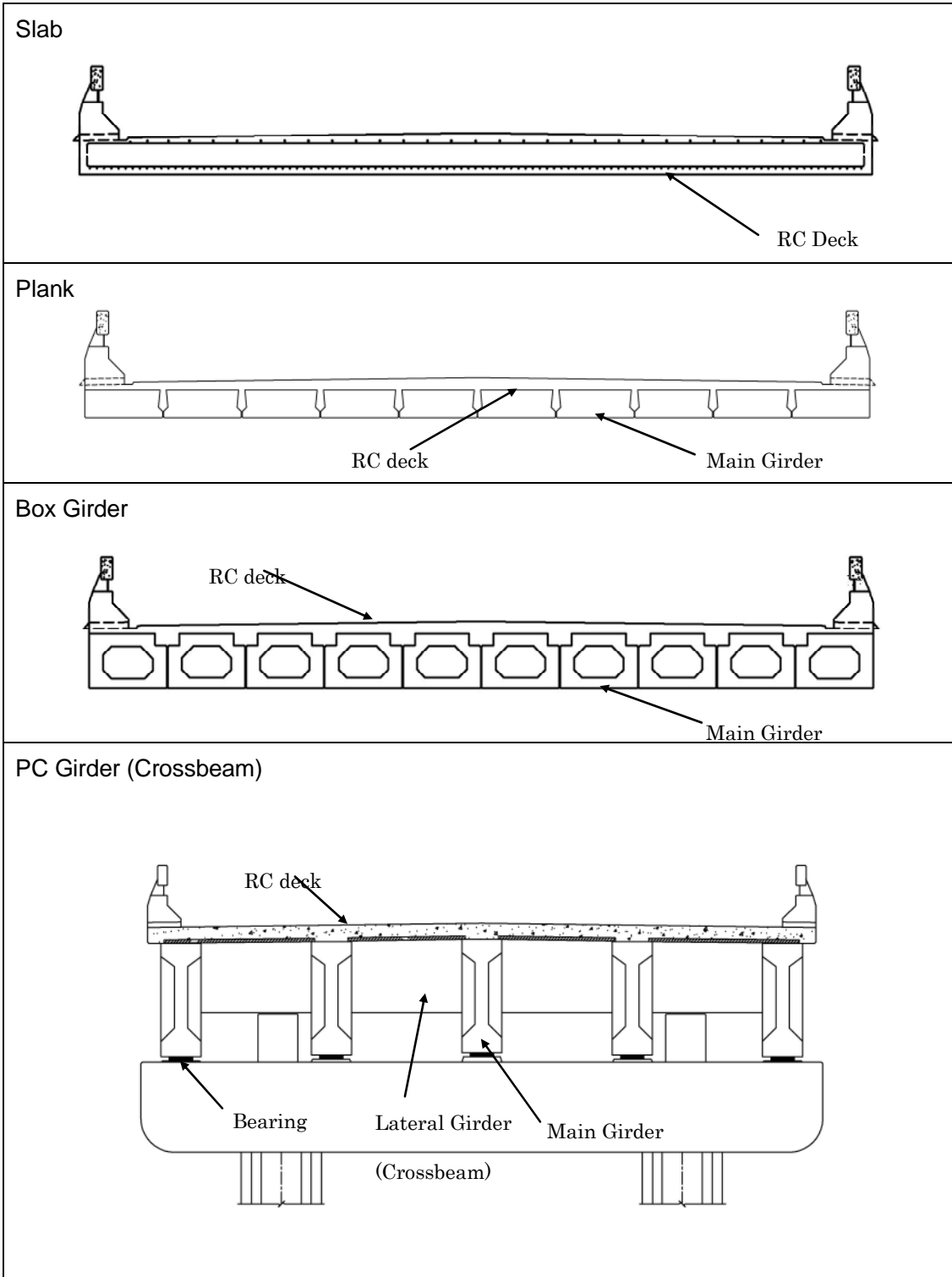


Figure 1.1: The structural types for which this manual is written (Superstructure)

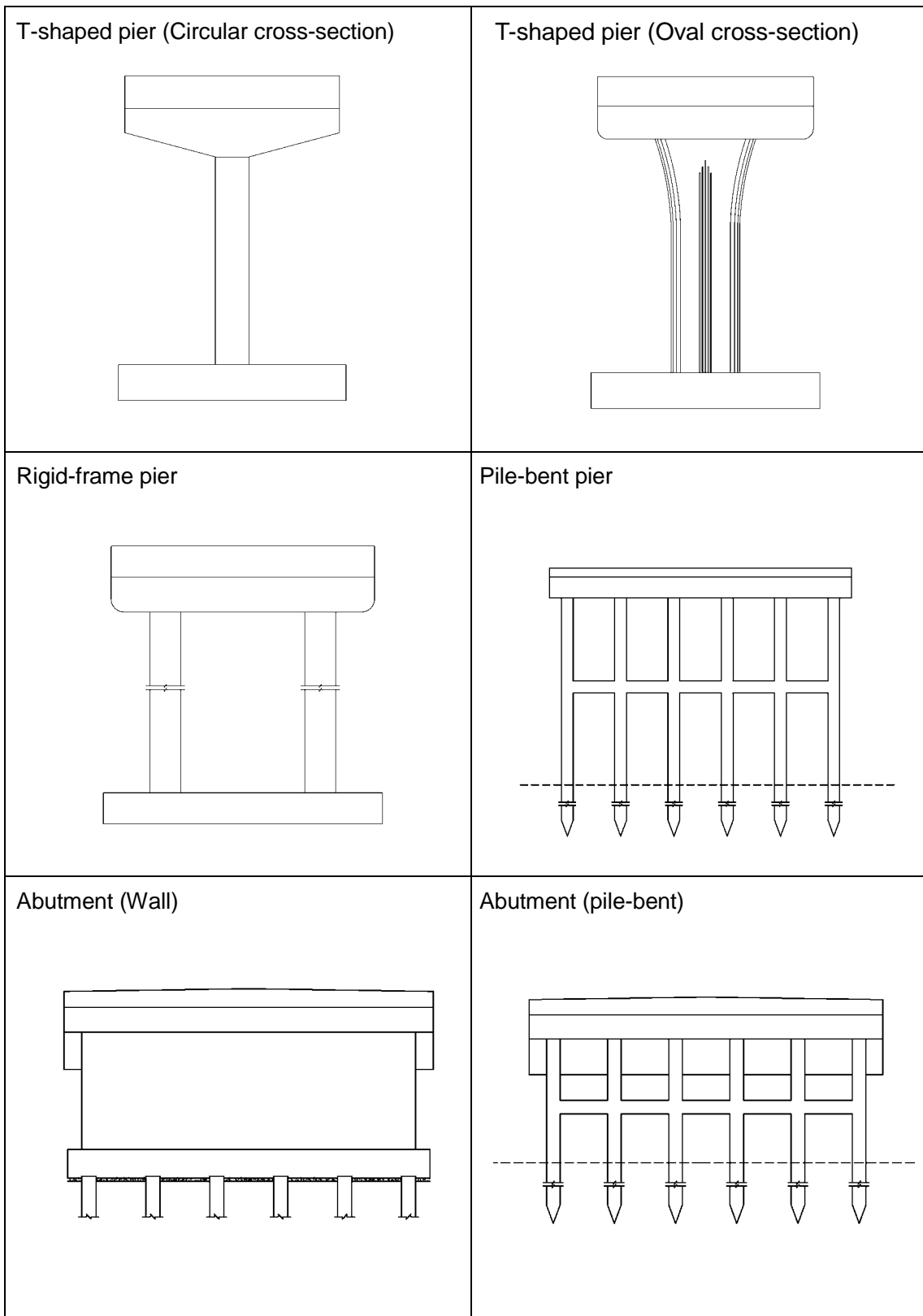


Figure 1.2: The structural types for which this manual is written (Pier and abutment)

1.3 Timing of Inspection

For the timing of inspection, dry season (drought period) is desirable. The following are the reasons.

- Larger inspection area

Low water level enlarges visually perceptible area of the foundation of piers and abutments, which means larger area to inspect the existence of damages.

- Easier access

Lower water level may enable under bridge access.

For the reasons above, accuracy of the inspection result is improved and effective inspection can be carried out.

1.4 Inspection personnel

Periodic inspection shall be performed by personnel with enough acknowledgement and practical skill regarding bridge.

It is preferable to determine the arrangement of inspection personnel considering the inspection contents and the site condition referring to the following. :

a) Bridge inspector : 1 person

The bridge inspector provides overall supervision of the inspection team and controls the work considering the safety and maintaining close contact with the supporting inspector.

b) Assistant inspector : 1 or 2 persons

The assistant inspector supports inspection work following the instruction of the bridge inspector. He also operates the supplementary apparatus and contacts with the traffic controller for the coordination.

c) Traffic controller : The number of personnel is determined appropriately according to the traffic condition.

The traffic controller prevents traffic disturbance during inspection and ensures the safety of the inspectors.

1.5 Equipments for inspection

For reference general carrying tools and apparatuses are shown as follows:

Type of tools	Name	Utility
Inspection tools	Binocular	When inspectors cannot approach objectives within touching distance, they can use it. (Magnification from 6 to 8 is recommended)
	Inspection hammer	To certify void inside concrete structure, inspectors hit the concrete surface by inspection hammer. (Weight 1/2 pound is recommended)
Record tools	Camera	To record photo image of the bridge condition. Use camera in a tablet PC. (In case of using cameras other than that in tablet PC, camera with 1,000,000 effective pixels or above and with GPS function is preferable.)
	Chalk, black board	To record the date and place in the photo image, they write these items on blackboard by using chalk.
	Tape measure	To measure the width and wide of damaged area (Both 5m length and 30m length are useful.)
	Tablet PC	To store bridge inspection data
Assistant tools	Flash light	To keep brightness
	Cleaning kit	To clean the objectives
	Traffic safety facility	To control traffic flow in order to keep inspectors safe
	Safety equipments	Helmet, safety-belt and safety-shoes
Approach tools	Ladder	To approach the objectives which are located higher than the inspector
	Boat	To use for the inspection from the river with a large quantity of water (Safety based on flow velocity and quantity of water is to be confirmed before use.)
	Bridge Inspection Vehicle	For inspection of damages from the top surface of bridge by

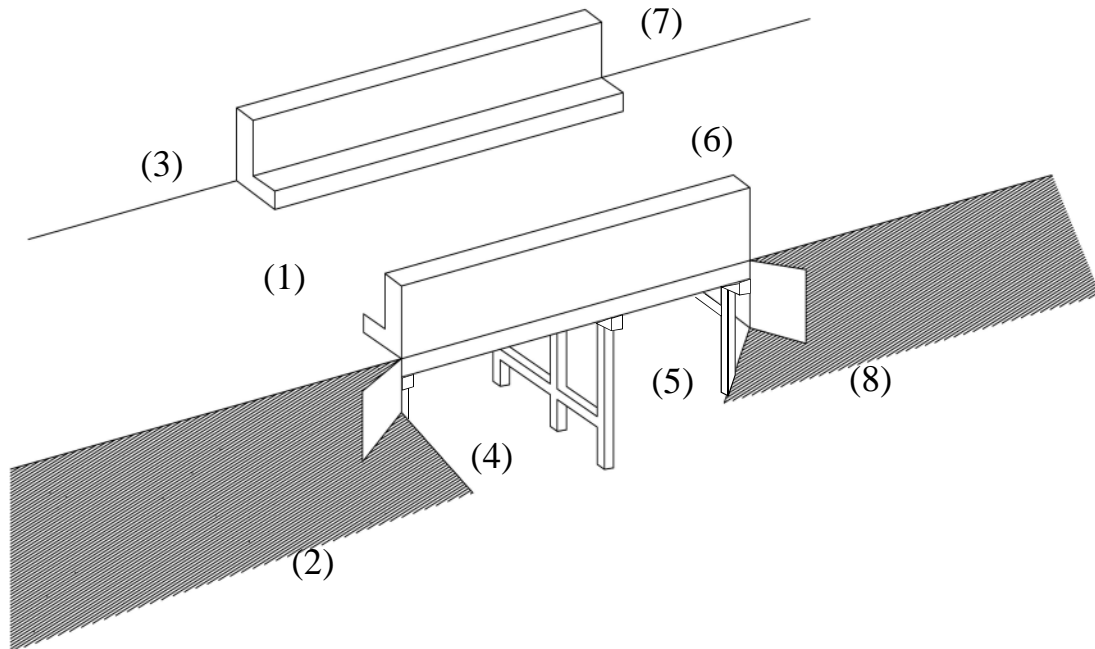
		inspecting the area under the bridge, the bottom surface of slab or girder, and the bridge pier.
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1.6 Frequency of inspection

In many example cases in different countries the frequency is defined as once per 5 years except that of 2 years in U.S.. In this manual it is defined as once per 5 years initially.

This frequency can be reconsidered in the PDCA cycle consistently with the realities of Thailand after a few year of trial practice.

1.7 Inspection Procedure



(1), (6) Near bridge, surface of bridge

Points to check: Entire bridge, surface of bridge (Road surface, expansion joints, barriers, sidewalk, drainages, attached facility), Approach road (road surface)

(2), (3), (7), (8) Slope near bridge

Points to check: Approach road (slope), behind abutment

(4), (5) Under bridge

Points to check: Side of bridge, behind bridge (bottom surface of girder, deck), around abutments and piers, river revetments near abutments

2. Grasp of damage condition and evaluation of damage

2.1 Grasp of damage condition

When damages are confirmed in periodic inspection, damage condition shall be grasped in every classification in order to obtain necessary information for the efficient maintenance.

The grasped damages classified in Section 1.2 shall be recorded in the forms shown in Section 3 according to the rules of Section 2.2.

Figure 2.1 shows the procedure regarding evaluation of damages based on inspection and evaluation of remarkable damages.

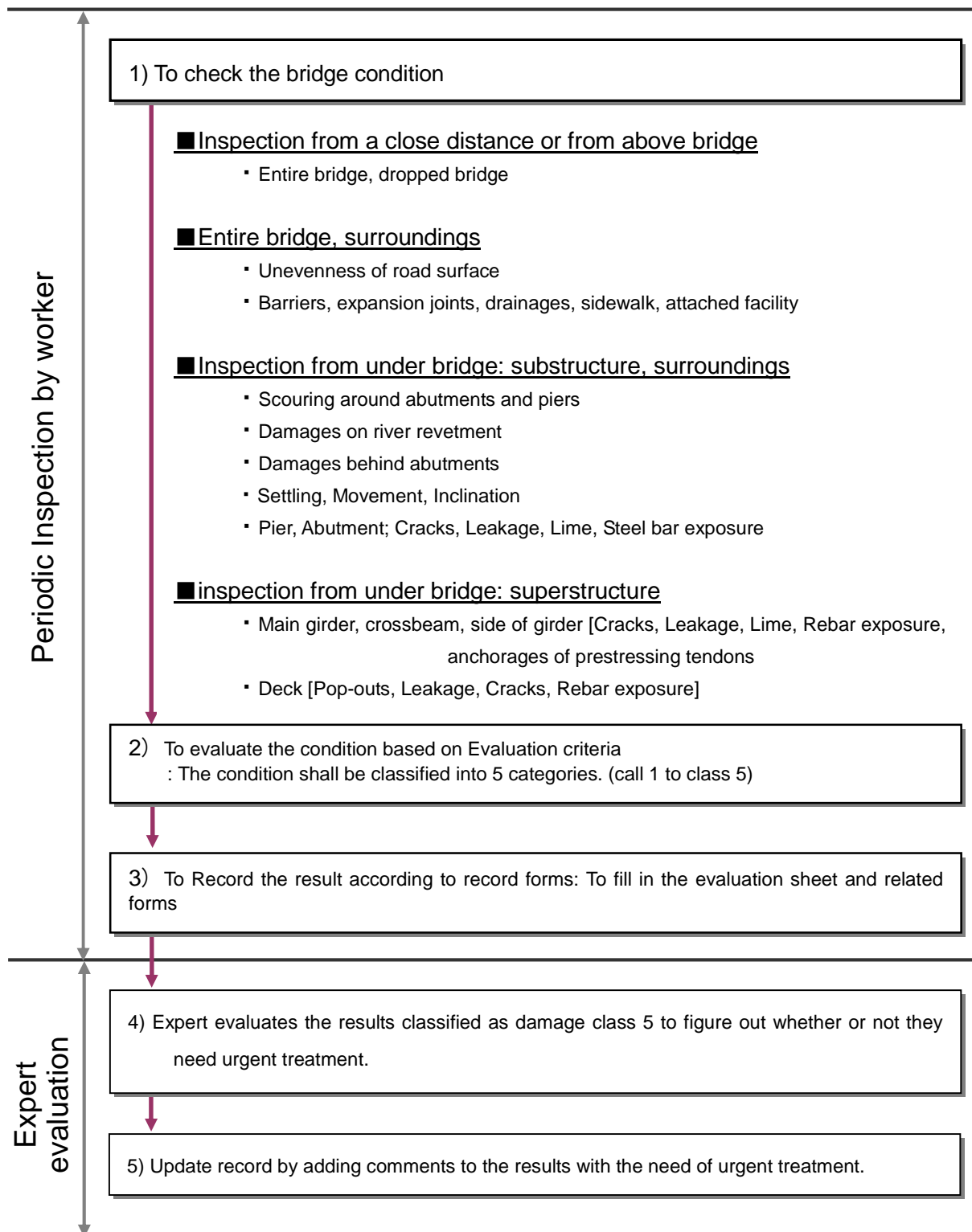


Figure 2.1 The procedure of bridge inspection and evaluation

2.2 Evaluation of damage

In this manual the condition of members is evaluated into one of several levels of classification as data according to the type of damage and member in order to grasp the influence upon the bridge health.

(1) Settlement/ movement/ inclination of substructures

(a) General description and damage characteristics

This subject covers the damage such as settlement, movement and inclination at the abutment and the piers.

(b) Relation to the other damages

Damages which are appeared on the surface of abutments and piers shall not be evaluated in this subject. These damages shall be evaluated in concrete structures.

(c) Inspection area



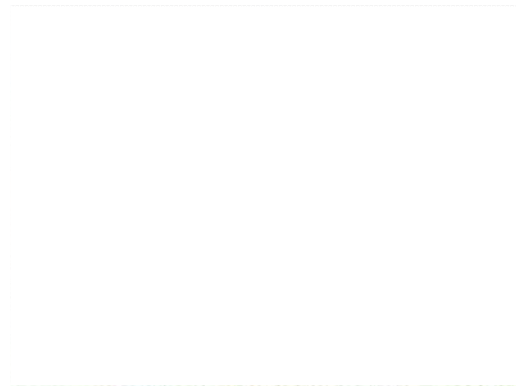


The existence of settlement, movement and inclination of within visually perceptible area shall be inspected for all substructures. In case of settlement, movement and inclination of substructures, gaps between adjacent members of superstructure would be appeared. This phenomenon would be the clue to detect this type of damages.

(d) Classification of damages

The inspected results shall be evaluated with the following classification:

Evaluation criteria	Classification
No settlement, movement, inclination	1
Settlement, movement, inclination	5

(Example)

<p>Damage level 5</p>	<p>Damage level 5</p>
 <p>Settlement/ inclination of substructure and remarkable scour of substructure</p>	 <p>Settlement of substructure and deformation on the bridge</p>
<p>Damage level 5</p>	<p>Damage level 5</p>
 <p>Collapse of bridge due to loss of substructure</p>	 <p>Remarkable inclination of substructure</p>
<p>Damage level 5</p>	<p>Damage level 5</p>
 <p>Settlement of substructure</p>	 <p>Settlement of substructure</p>

(2) Unevenness of road surface

(a) General description and damage characteristics

This subject is defined as unevenness or level difference on the road surface in the bridge longitudinal direction, which increases the shock impact caused by the traffic.

There are some cases where lack of river revetment (slope protection) behind abutment or on approach road causes loss of backfill, which leads unevenness of road surface.

(b) Relation to the other damages

- All the unevenness and the level difference in the bridge longitudinal direction shall be evaluated in this subject regardless of cause and location.
- Corrugation, pot hole and cave-in of pavement, unevenness at the expansion joint or the parapet of abutment, etc. shall be also evaluated in this subject.

(c) Inspection area




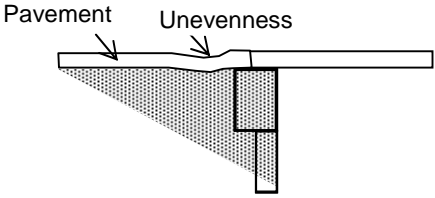

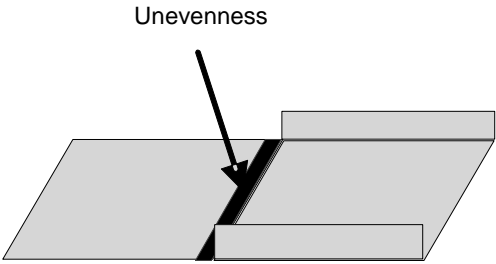
The existence of unevenness and level difference all over the road surface shall be inspected approaching closely.

(d) Classification of damages

The inspected results shall be evaluated with the following classification:

Evaluation criteria	Classification
No damage	1
Level difference < approx. 20mm (No difficulty in driving)	3
Level difference ≥ approx. 20mm (Difficulty in driving)	5

(Examples)

Damage level 3	Damage level 3
 <p>Level difference < 20mm</p>	 <p>Level difference < 20mm</p>
Damage level 5	Damage level 5
 <p>Level difference \geq 20mm (behind abutment)</p>	 <p>Pavement Unevenness</p>
Damage level 5	Damage level 5
 <p>Level difference \geq 20mm</p>	 <p>Unevenness</p>

(3) Damages in expansion joints

(a) General description and damage characteristics

This subject is defined as deformation and loss on the expansion joint due to traffic or bridge expansion.

(b) Relation to the other damages

The level difference at the expansion joint shall be evaluated as “unevenness of road surface” in the related subject.

(c) Inspection area




The existence of damages, unusual gap and water leakage downward shall be inspected for all expansions.

(d) Classification of damages

The inspected results shall be evaluated with the following classification:

Evaluation criteria	Classification
No damage	1
Local deformation or partial loss of steel or rubber etc / Excessive gap to the design value leads to the difficult traffic condition to the pedestrians and bicycles	3
Remarkable local deformation or remarkable partial loss of steel etc. / Corrosion in girders or bearings due to water leakage	5

(Examples)

Damage level 3	Damage level 3
 <p data-bbox="245 981 600 1012">Miner defects on expansion joint</p>	 <p data-bbox="799 981 1153 1012">Miner defects on expansion joint</p>
Damage level 5	
 <p data-bbox="245 1507 671 1538">Remarkable defects on expansion joint</p>	

(4) Damages in barriers

(a) General description and damage characteristics

This subject is defined as local deformation and loss of the steel or concrete barrier due to vehicle collision or poor quality when constructed, etc..

(b) Relation to the other damages

- The damages of the anchor bolts of the steel barrier such as corrosion, fracture, missing bolts, etc. shall also be evaluated in the related subjects if exist.

(c) Inspection area





The existence of deformation and loss of materials shall be inspected for all barriers.

(d) Classification of damages

The inspected results shall be evaluated with the following classification:

Evaluation criteria	Classification
No damage	1
Local deformation and partial loss of steel or concrete	3
Remarkable local deformation and remarkable partial loss of steel or concrete	5

(Examples)

Damage level 3	Damage level 3
 <p data-bbox="252 808 424 831">Minor loss of steel</p>	 <p data-bbox="799 808 1010 831">Minor loss of concrete</p>
Damage level 5	Damage level 5
 <p data-bbox="252 1279 735 1301">Breakage in large area. Dangerous traffic condition</p>	 <p data-bbox="799 1279 1246 1301">Large deformation. Dangerous traffic condition.</p>

(5) Damages in drainages

(a) General description and damage characteristics

This subject is defined as the condition in which drain function is degraded compared to normal condition. This degradation is sometimes caused with dust or other obstacles.

(b) Relation to the other damages

Water leakage from expansion joint shall be evaluated as expansion joint.

(c) Inspection area



All drain pipe of the bridge shall be inspected.

(d) Classification of damages

The inspected results shall be evaluated with the following classification:

Evaluation criteria	Classification
Drain pipe is not clogged	1
Drain pipe is clogged with obstacles	5

(Examples)

Damage level 1	Damage level 5
 <p data-bbox="248 864 584 896">No obstruction in the drain pipe</p>	 <p data-bbox="801 864 1311 896">The drain pipe is clogged with dust and gasses</p>

(6) Damages in sidewalk

(a) General description and damage characteristics

This subject is defined as occurrence of level difference that may lead difficult traffic condition to pedestrians when passing on the sidewalk.

(b) Relation to the other damages

Pop-outs of sidewalk shall be evaluated as “pop-outs of deck”. Damages to expansion joints shall be evaluated as “expansion joints” in the related subject.

(c) Inspection area



The existence of unusual condition such as level difference shall be inspected for bridges with sidewalk.

(d) Classification of damages

The inspected results shall be evaluated with the following classification:

Evaluation criteria	Classification
No unusual condition such as level difference that leads difficult traffic condition	1
Unusual condition such as level difference that lead difficult traffic condition	5

(Examples)

Damage level 1	Damage level 5
 <p data-bbox="256 981 746 1010">No unusual condition such as level difference</p>	 <p data-bbox="802 1041 1337 1126">Occurrence of level difference that leads difficult traffic condition</p>

(7) Damages in attached facility

(a) General description and damage characteristics

This subject covers unusual conditions of attached facilities such as lighting facilities and signs. This means loss of function that the facility is supposed to have such as lighting that cannot be lit and unusual condition such as damages, corrosion or robbery of light posts and electric wires.

(b) Relation to the other damages

This subject is used for the attached facilities that do not belong to other subjects.

(c) Inspection area


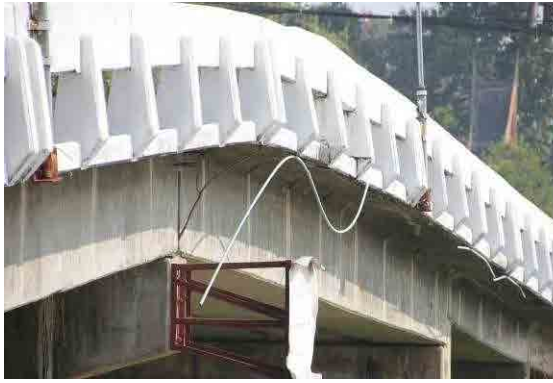
The existence of unusual conditions such as damages, corrosion or robbery shall be inspected for all attached facilities to the bridge (lighting, electric wires, etc.)

(d) Classification of damages

The inspected results shall be evaluated with the following classification:

Evaluation criteria	Classification
No unusual condition of attached facilities	1
Unusual condition of attached facilities	5

(Examples)

Damage level 1	Damage level 5
 <p data-bbox="248 864 775 954">No unusual condition of lighting equipments and signs</p>	 <p data-bbox="801 864 1356 898">Damages to piping</p>

(8) Damages behind abutments

(a) General description and damage characteristics

This subject covers the damage such as deep pothole, void under pavement, removed backfill behind abutment.

(b) Relation to the other damages

Damages which are appeared on the surface of abutments, such as cracks, corrosion, etc. shall not be evaluate in this subject. These damages shall be evaluated in concrete structures.

(c) Inspection area


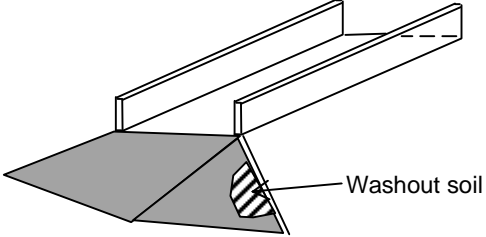

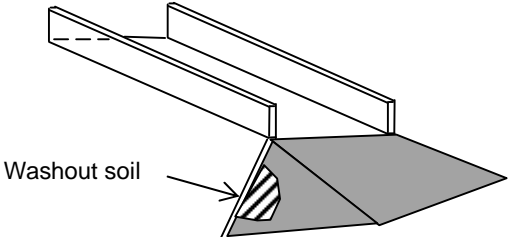


The existence of deep pothole, void under pavement, removed backfill within visually perceptible area shall be inspected for approach road.


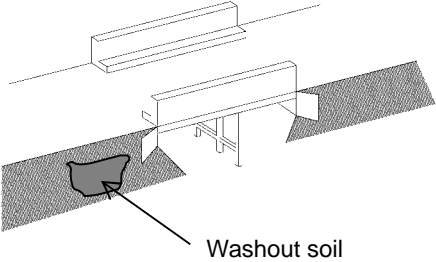

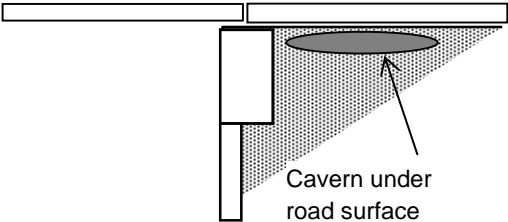

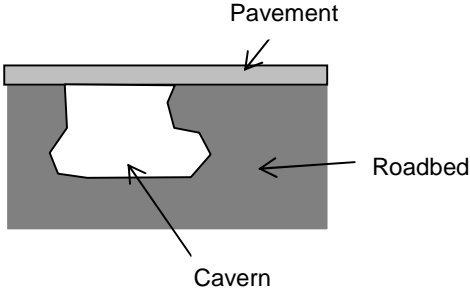
(d) Classification of damages

The inspected results shall be evaluated with the following classification:

Evaluation criteria	Classification
No pothole, void, removed backfill	1
Minor pothole, void, removed backfill	3
Remarkable pothole, void, removed backfill	5

(Examples)

Damage level 3	Damage level 3
 <p data-bbox="252 772 778 857">Deep pothole behind the abutment due to erosion/scour</p>	 <p data-bbox="1153 667 1297 696">Washout soil</p>
Damage level 3	Damage level 3
 <p data-bbox="252 1301 778 1386">Deep pothole behind the abutment due to erosion/scour</p>	 <p data-bbox="818 1205 962 1234">Washout soil</p>
Damage level 5	Damage level 5
 <p data-bbox="252 1827 778 1912">Concrete slab behind the abutment is fallen down due to erosion/scour</p>	 <p data-bbox="802 1827 1329 1912">Backfill material behind abutment is washed away due to erosion/scour</p>

<p>Damage level 5</p>	<p>Damage level 5</p>
 <p>The shoulder of approach road is wash away due to erosion/scour</p>	 <p>Washout soil</p>
<p>Damage level 5</p>	<p>Damage level 5</p>
 <p>Gap between concrete slab and bank behind abutment due to erosion/scour</p>	 <p>Cavern under road surface</p>
<p>Damage level 5</p>	<p>Damage level 5</p>
 <p>Crack appeared on the surface of pavement due to void under the pavement</p>	 <p>Pavement</p> <p>Roadbed</p> <p>Cavern</p>

(9) Damages on river revetment near abutments

(a) General description and damage characteristics

This subject covers the damage on river revetment due to the lack of backfill under the revetment near abutment. These damages are caused by erosion or loss of soil behind river revetment near abutment.

(b) Relation to the other damages

Damages which are appeared on the surface of abutments, such as cracks, corrosion, etc. shall not be evaluate in this subject. These damages shall be evaluated in concrete structures.

(c) Inspection area




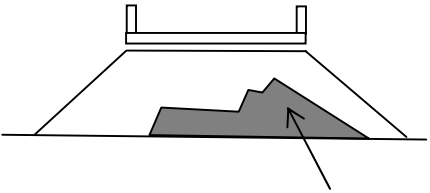

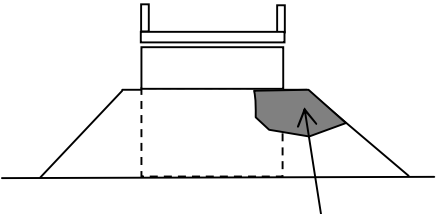
The existence of damage, settlement and collapse of river revetment within visually perceptible area shall be inspected adjacent to abutment.

(d) Classification of damages

The inspected results shall be evaluated with the following classification:

Evaluation criteria	Classification
No damage, settlement and collapse of river revetment	1
Minor damage, settlement and collapse of river revetment	3
Remarkable damage, settlement and collapse of river revetment	5

(Examples)

Damage level 3	Damage level 3
 <p data-bbox="252 779 614 813">Minor damage on river revetment</p>	 <p data-bbox="805 779 1168 813">Minor damage on river revetment</p>
Damage level 5	Damage level 5
 <p data-bbox="252 1272 782 1328">Remarkable damage on river revetment due to lack of backfill</p>	 <p data-bbox="1002 1171 1297 1205">Collapse of river revetment</p>
Damage level 5	Damage level 5
 <p data-bbox="252 1787 782 1843">Remarkable damage on river revetment due to lack of backfill</p>	 <p data-bbox="930 1720 1281 1753">Washout behind river revetment</p>

(10) Scouring riverbed around abutments and piers

(a) General description and damage characteristics

This subject covers the scouring around piers and abutments.

(b) Relation to the other damages

Damages which are appeared on the surface of abutments, such as cracks, corrosion, etc. shall not be evaluate in this subject. These damages shall be evaluated in concrete structures.

(c) Inspection area


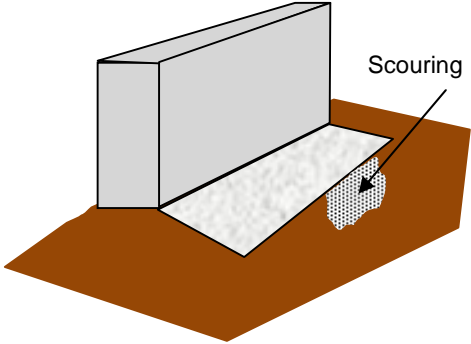

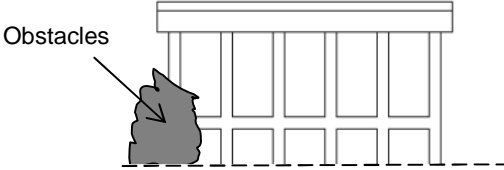

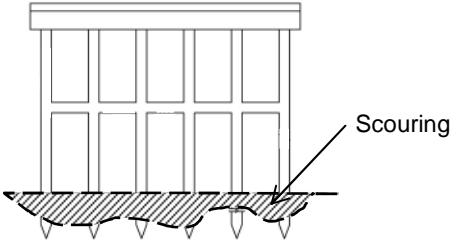
The existence of scouring around substructure within visually perceptible area shall be inspected. In addition, the existence of obstacles in the cross-section of the river shall be checked.



(d) Classification of damages

The inspected results shall be evaluated with the following classification:

Evaluation criteria	Classification
No scouring	1
Minor scouring, minor obstacles in the cross-section of the river	3
Remarkable scouring, remarkable obstacles in the cross-section of the river	5

(Examples)

Damage level 3	Damage level 3
 <p>Minor damage due to scouring</p>	 <p>Scouring</p>
Damage level 3	Damage level 3
 <p>Minor obstacles in the cross-sectional area of a river</p>	 <p>Obstacles</p>
Damage level 5	Damage level 5
 <p>Remarkable scouring around the substructure</p>	 <p>Scouring</p>

Damage level 5	Damage level 5
 <p data-bbox="248 808 687 837">Remarkable scouring around the substructure</p>	 <p data-bbox="799 808 1238 837">Remarkable scouring around the substructure</p>

(11) Damages at the anchorages of prestressing tendons

(a) General description and damage characteristics

This subject is defined as the condition in which rust stain from the cracks or spalling can be found in the concrete of the anchorage area of prestressing tendon. This includes the corrosion of prestressing tendon at the anchorage area.

(b) Relation to the other damages

The other damages such as corrosion, rebar exposure, cracking besides this damage shall be also evaluated in the related subjects if exist.

(c) Inspection area


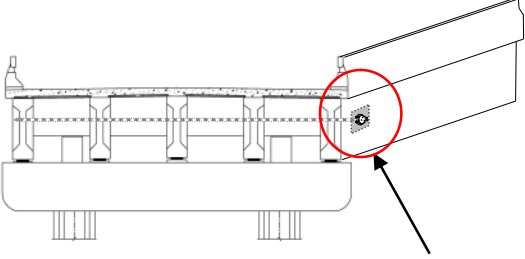

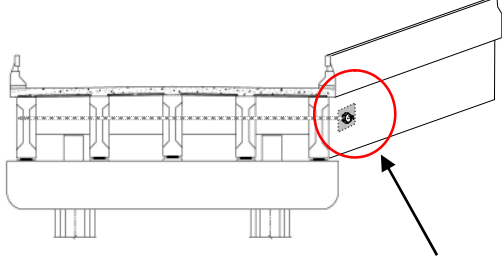
The existence of damages at all the anchorage of prestressing tendon within visually perceptible area shall be inspected.

(d) Classification of damages

The inspected results shall be evaluated with the following classification:

Evaluation criteria	Classification
No damage	1
Damages at the anchorages of prestressing tendons Damages in the prestressing tendons	5

(Examples)

Damage level 5	Damage level 5
 <p data-bbox="245 864 767 898">Spalling of the anchorage concrete and steel corrosion</p>	
Damage level 5	Damage level 5
 <p data-bbox="245 1391 767 1480">Spalling of the anchorage concrete and slip out of the PC tendon</p>	

(12) Cracking, water leakage and free lime

(a) General description and damage characteristics

This subject corresponds to the condition of concrete member in which cracking or water leakage exists on the surface.

(b) Relation to the other damages

- The other damages such as pop-outs, rebar exposure etc. shall be also evaluated in the related subjects if exist.
- Cracking occurring in bridge deck shall not be evaluated in this subject but evaluated as “Deck cracking”.

(c) Inspection area

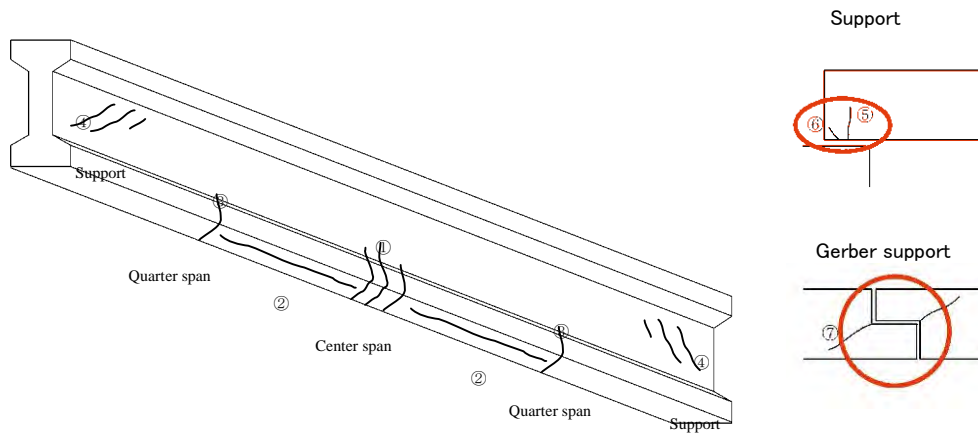
The conditions of the main members of girder and substructure shall be inspected visually approaching as close as possible.

“Cracks remarkably influential cracks upon the structures”, given in the following tables shall be evaluated separately from the other cracks.

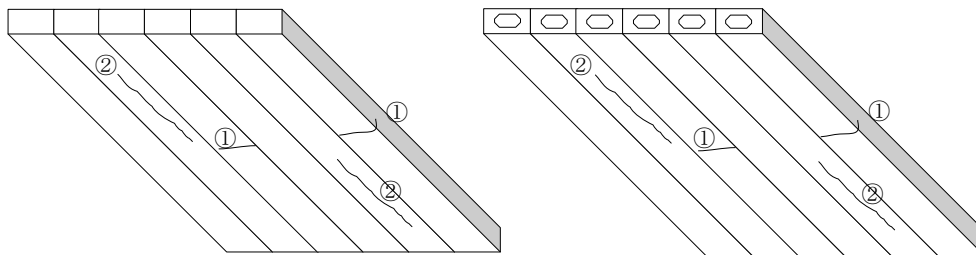
Remarkably influential cracks (Girder)

No.	Location	Crack pattern
1	Center span	Cracks in the transverse direction on the bottom surface and vertical cracks on the side surface of the girder at the center span
2		Cracks in the longitudinal direction on the bottom surface of the girder
3	Quarter span	Cracks in the transverse direction on the bottom surface and vertical cracks on the side surface of the girder at the center span
4	Support	Diagonal cracks on the side surface in the vicinity of the support
5		Cracks on the bottom surface and vertical cracks on the side surface of the girder directly above bearings
6		Diagonal cracks on the side surface of the girder directly above bearings
7	Gerber support	Cracks at Gerber supports
8	Whole PC girder	Cracks along PC sheath and PC tendon

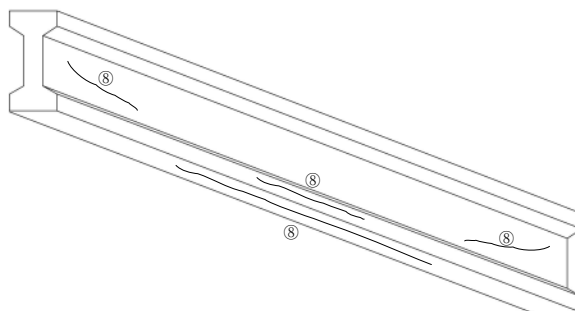
[common to PC/RC] PC: Prestressed concrete, RC: Reinforced concrete



[Plank girder, Box girder]



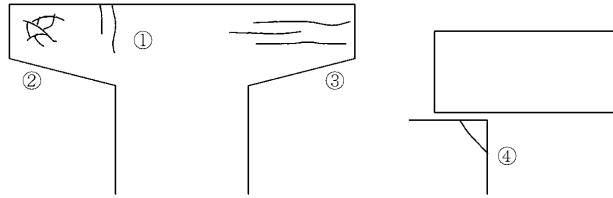
[PC girder]



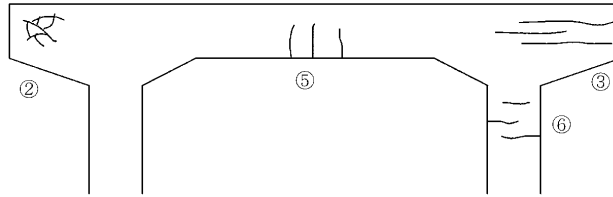
Remarkably influential cracks (Pier)

No.	Location	Crack pattern
1	T-shaped pier	Cracks at the top of the cantilever
2	Common	A number of cracks in the wide range
3		Several large cracks in the longitudinal direction
4	Beneath bearings	Cracks beneath the bearing area
5	Framed pier	Cracks on the lower chord at the beam center
6	Pile-bent pier	Cracks all around the pier

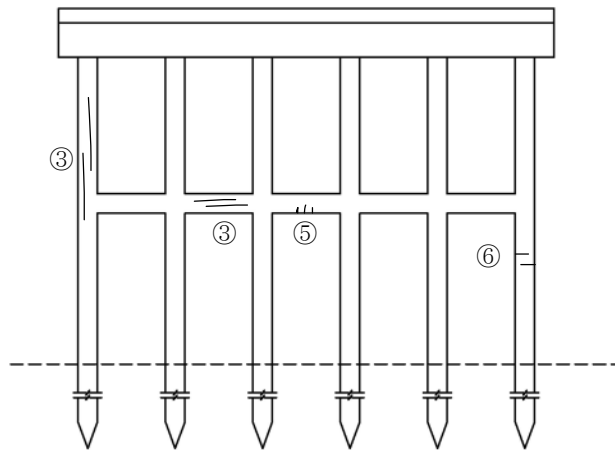
[T-shaped pier]



[Ridged frame pier]



[Pile-bent pier]







(d) Classification of damages

The inspected results shall be evaluated with the following classification:

Evaluation criteria				Classification
Existence of crack	Location of crack	Crack width*	Water leakage, free lime	
N	-	-	-	1
Y	(a) "Remarkably influential cracks"	< 0.2mm (small)	Independent of existence	3
			Crack only	3
		≥ 0.2mm (large)	Water leakage only	4
			Slight free lime	4
			Remarkable free lime, rust stain	5
	Cracks other than above (Small influence)	< 0.2mm (small)	Independent of existence	2
			Crack only	2
		≥ 0.2mm (large)	Water leakage only	3
			Slight free lime	3
			Remarkable free lime, rust stain	4

* In case crack width can not be measured due to inaccessibility etc. the easily perceptible cracks from a distant view shall be considered as "large crack width" in the evaluation.


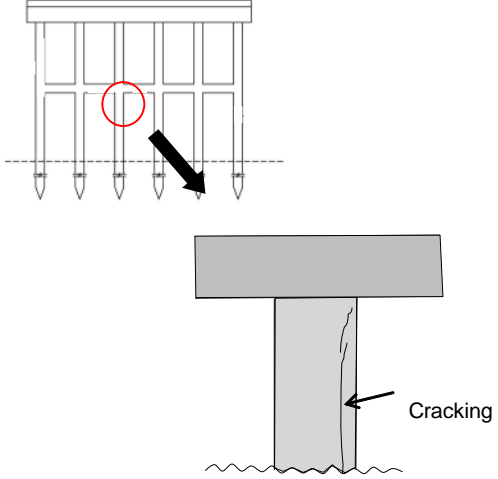

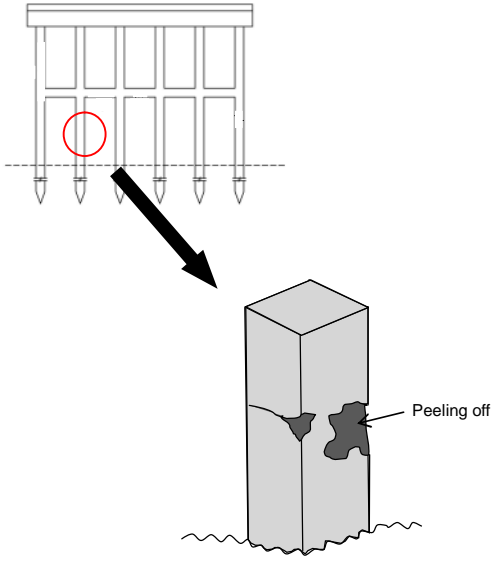
(Examples Superstructure)


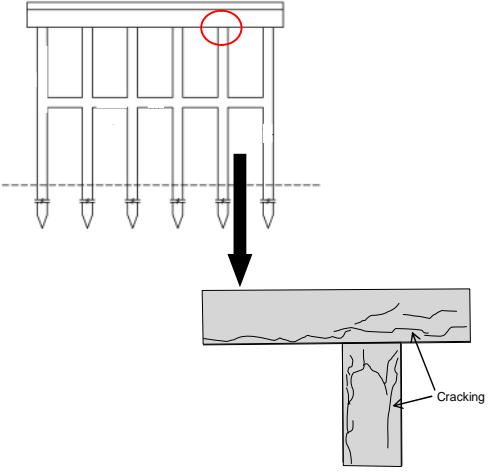

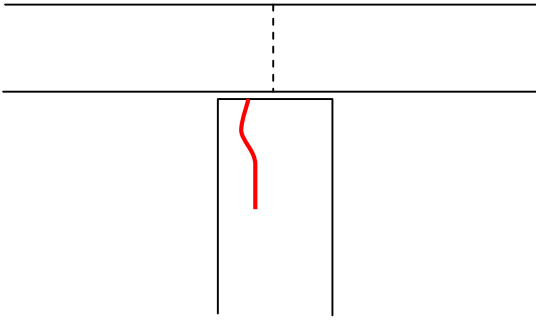
Damage level 2	Damage level 2
 <p data-bbox="248 748 679 775">Cracks of small influence (marked with chalk)</p>	 <p data-bbox="804 748 1235 775">Cracks of small influence (marked with chalk)</p>
Damage level 3	Damage level 3
 <p data-bbox="248 1218 679 1245">Cracks of large influence (marked with chalk)</p> <p data-bbox="555 1272 746 1299">Crack pattern No.1</p>	 <p data-bbox="804 1245 1225 1272">Cracks of small influence with water leakage</p>





<p>Damage level 4</p>	<p>Damage level 4</p>
 <p>Cracks of small influence with water leak age and free lime</p>	 <p>Cracks of large influence with slight water leakage and free lime</p> <p style="text-align: right;">Crack pattern No.2</p>
<p>Damage level 5</p>	<p>Damage level 5</p>
 <p>Cracks of large influence with rust stain</p> <p style="text-align: right;">Crack pattern No.8</p>	 <p>Cracks of large influence with rust stain</p> <p style="text-align: right;">Crack pattern No.8</p>

(Examples substructure)

Damage level 2	Damage level 2
 <p data-bbox="252 748 687 775">Cracks of small influence (marked with chalk)</p>	 <p data-bbox="802 748 1238 775">Cracks of small influence (marked with chalk)</p>
Damage level 3	Damage level 3
 <p data-bbox="252 1218 683 1245">Cracks of large influence (marked with chalk)</p> <p data-bbox="563 1274 759 1301">Crack pattern No.5</p>	 <p data-bbox="802 1245 1225 1272">Cracks of small influence with water leakage</p>

<p>Damage level 3</p>	<p>Damage level 3</p>
 <p>Cracks of large influence (cracks propagated along the axial direction of column)</p> <p>Crack pattern No.3</p>	
<p>Damage level 3</p>	<p>Damage level 3</p>
 <p>Cracks of large influence (cracks propagated around column)</p> <p>Crack pattern No.6</p>	

<p>Damage level 3</p>	<p>Damage level 3</p>
 <p>Cracks of large influence (cracks propagated along the axial direction of column)</p> <p>Crack pattern No.3</p>	 <p>Cracking</p>
<p>Damage level 3</p>	<p>Damage level 3</p>
 <p>Cracks of large influence (cracks propagated along the axial direction of column)</p> <p>Crack pattern No.4</p>	

<p>Damage level 4</p>	<p>Damage level 4</p>
 <p>Cracks of large influence with water leakage and free lime</p> <p style="text-align: right;">Crack pattern No.3</p>	 <p>Cracks of small influence with rust strain</p>
<p>Damage level 5</p>	<p>Damage level 5</p>
 <p>Cracks of large influence with remarkable free lime</p> <p style="text-align: right;">Crack pattern No.6</p>	 <p>Cracks of large influence with remarkable free lime</p> <p style="text-align: right;">Crack pattern No.6</p>

(13) Pop-outs of deck

(a) General description and damage characteristics

Pop-outs are conical fragments that break out of the surface of the concrete, leaving small holes in the concrete deck including cast-in-place (C.I.P) portion. In case of pop-outs lattice cracks often occur in the deck.

(b) Relation to the other damages

- Although remarkable cracks occur in the deck concrete, these shall be evaluated as “Deck cracking” as long as the concrete fragment does not break out from the deck.
- In case spalling is developed remarkably and reaches through the deck, it shall be also evaluated as “Pop-outs”.

(c) Inspection area


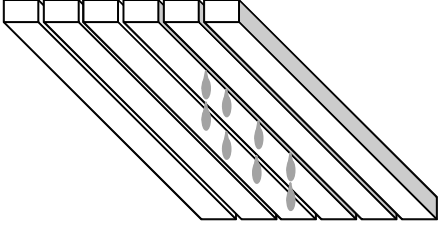

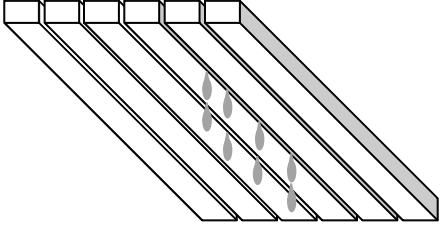
The existence of pop-outs for all the decks within visually perceptible area shall be inspected.


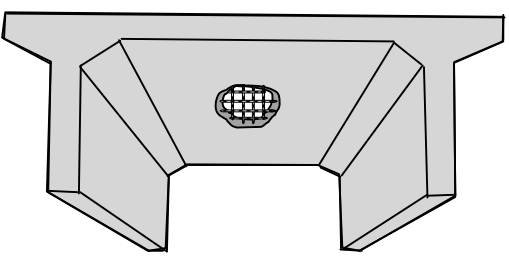

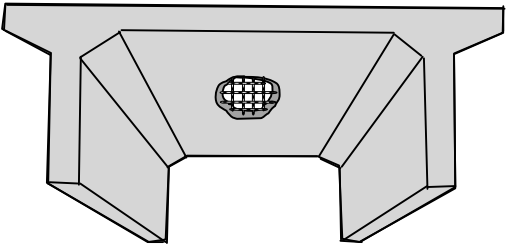
(d) Classification of damages

The inspected results shall be evaluated with the following classification:

Evaluation criteria	Classification
No damage, No leakage of water in the gaps of girders	1
Leakage of water in the gaps of girders	3
Pop-outs of concrete fragment	5

(Examples)

Damage level 3	Damage level 3
 <p data-bbox="247 1041 619 1070">Leakage of water in the gaps of girders</p>	
Damage level 3	Damage level 3
 <p data-bbox="247 1568 619 1597">Leakage of water in the gaps of girders</p>	

<p>Damage level 5</p>	<p>Damage level 5</p>
 <p>Example of pop-outs</p>	
<p>Damage level 5</p>	<p>Damage level 5</p>
 <p>Example of pop-outs</p>	

(14) Deck cracking

(a) General description and damage characteristics

Deck cracking is defined as cracks in one or two directions on the lower side of the concrete deck.

(b) Relation to the other damages

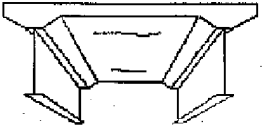



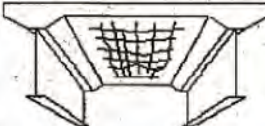
- The other damages such as rebar exposure besides deck cracking shall be also evaluated in the related subject if exists.
- The condition of water leakage, free lime and rust stain from the deck shall be evaluated in this subject.
- In case deck cracking is developed remarkably and reaches through the deck, it shall be also evaluated as “Pop-outs”.

(c) Inspection area

The crack condition in the deck within visually perceptible area shall be inspected approaching close to the girder end area. It is preferable to inspect approximately 2 panels from the girder end. In case there is no partitioning member in the deck such as diaphragms, the inspection area may be considered as the area of 10m from the support.


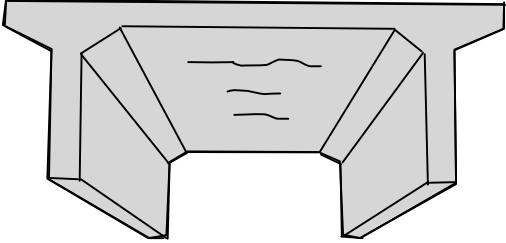

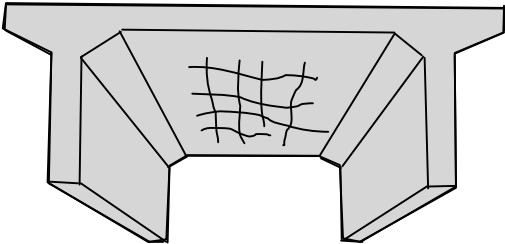

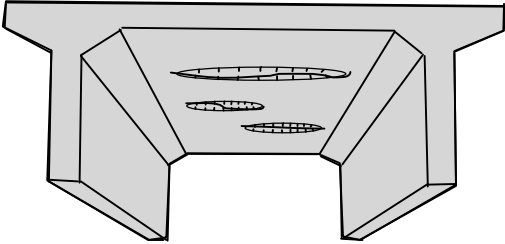
(d) Classification of damages


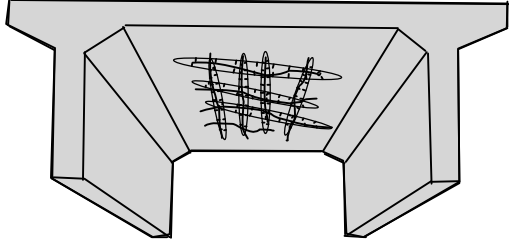

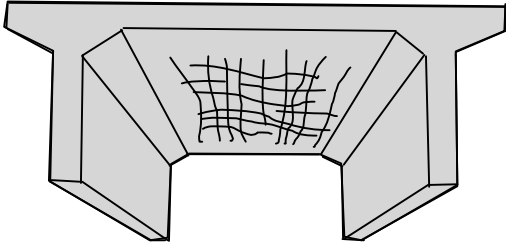
The inspected results shall be evaluated with the following classification:


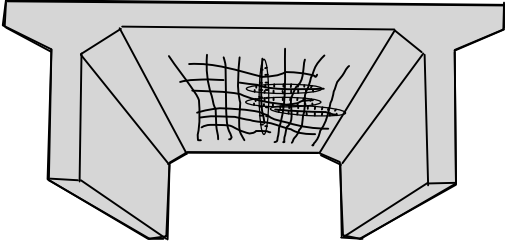

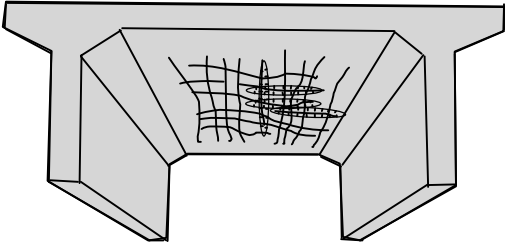
Evaluation criteria	Conceptual figure	Classification
<ul style="list-style-type: none"> - No crack or fine cracks with the width $w < 0.2\text{mm}$ and an interval of approx. 1.0m (considerably apart) - No stain of water leakage and free lime 		1
<ul style="list-style-type: none"> - Fine cracks mainly in one direction with the width $w < 0.2\text{mm}$ and an interval of approx. 0.5m (relative apart) - No stain of water leakage and free lime 		2
<ul style="list-style-type: none"> - Lattice cracks with the width of approx. 0.2mm - No stain of water leakage and free lime or - Cracks in one direction with the width of approx. 0.2mm - Stain of water leakage and free lime 		3
<ul style="list-style-type: none"> - Lattice cracks with the width of approx. 0.2mm - Stain of water leakage and free lime or - Remarkable cracks with the width $\geq 0.2\text{mm}$ and partially chipped - No stain of water leakage and free lime 		4
<ul style="list-style-type: none"> - Continuously chipped - Stain of water leakage and free lime 		5

* Crack width or interval does not necessarily require measurement. The easily perceptible cracks from a distant view shall be considered as “crack width $\geq 0.2\text{mm}$ ”.

(Examples)

Damage level 2	Damage level 2
 <p>Mainly cracks in one direction (marked with chalk)</p>	
Damage level 3	Damage level 3
 <p>Cracks in two directions (marked with chalk)</p>	
Damage level 3	Damage level 3
 <p>Cracks in one direction with free lime</p>	

<p>Damage level 4</p>	<p>Damage level 4</p>
 <p>Cracks in two directions with free lime</p>	
<p>Damage level 4</p>	<p>Damage level 4</p>
 <p>Dense cracks in two directions partially chipped (marked with chalk)</p>	

<p>Damage level 5</p>	<p>Damage level 5</p>
 <p>Continuously chipped with free lime</p>	
<p>Damage level 5</p>	<p>Damage level 5</p>
 <p>Continuously chipped with free lime</p>	

(15) Rebar exposure

(a) General description and damage characteristics

Rebar exposure is defined as the condition in which the surface of concrete member is scaled and the rebars are exposed. This is sometimes caused by the rebars installed closer to the surface than designed when constructed.

(b) Relation to the other damages

This subject includes corrosion of the exposed rebar, cracking, etc..

(c) Inspection area


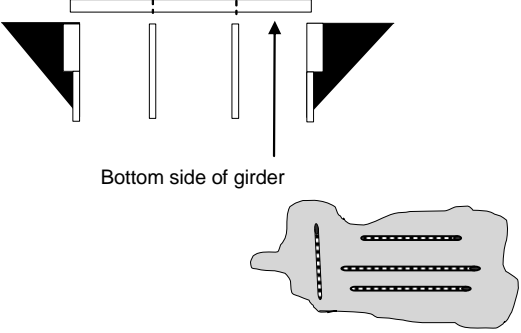

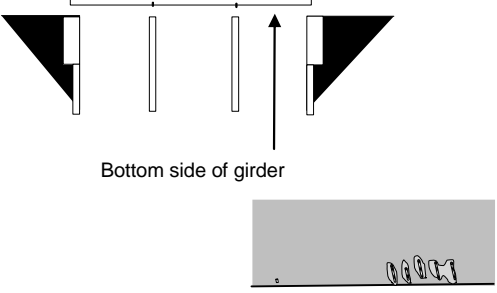

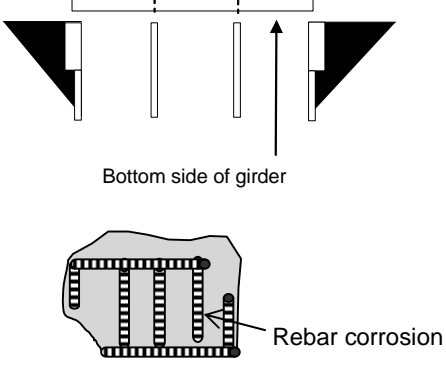
The existence of rebar exposure for all the members within visually perceptible area shall be inspected.

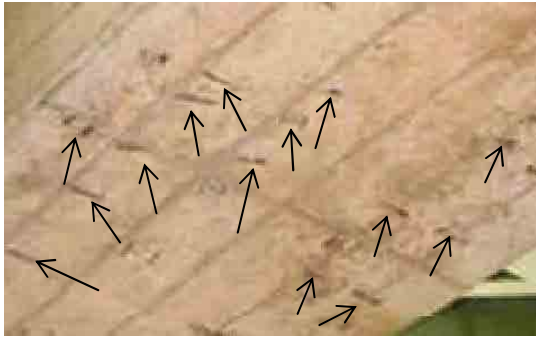
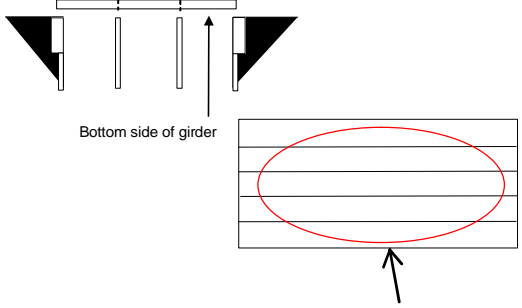

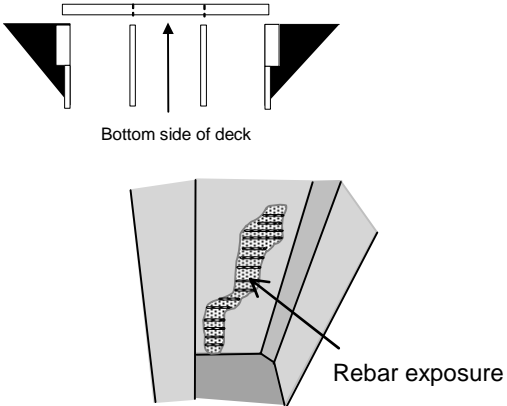

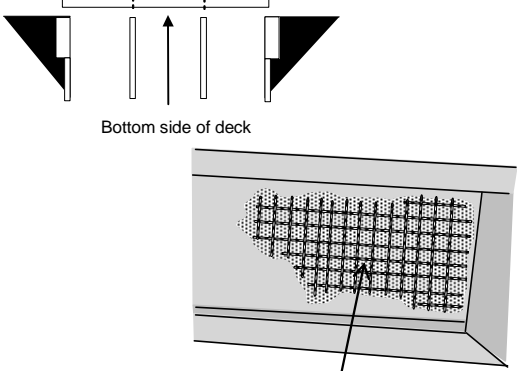
(d) Classification of damages


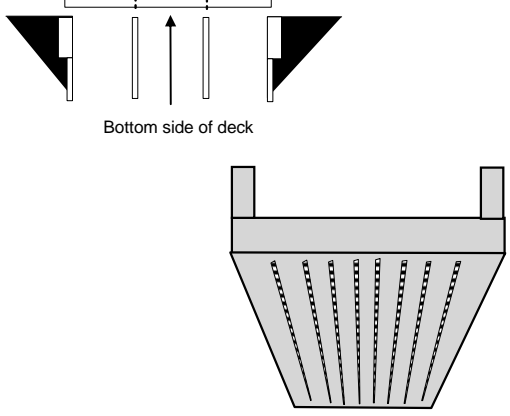
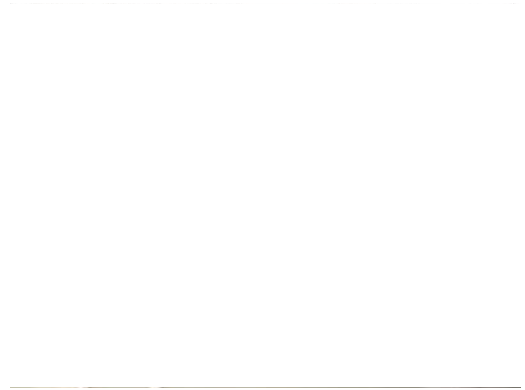
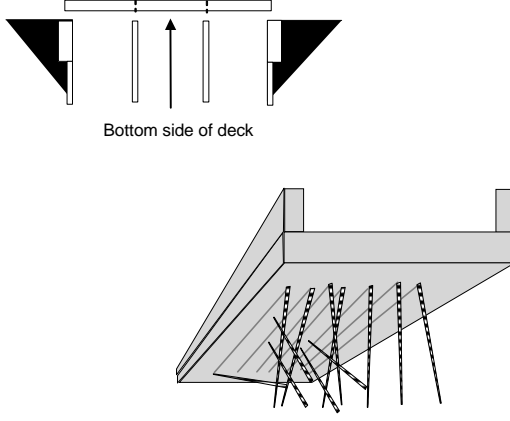
The inspected results shall be evaluated with the following classification:

Evaluation criteria			Classification
Existence of rebar exposure	Extent of corrosion	Condition of corrosion	
N	-	-	1
Y	Partial	Surface only	2
		Reduction of rebar section, remarkable expansion of rebar	3
	Global	Surface only	3
		Reduction of rebar section, remarkable expansion of rebar	5


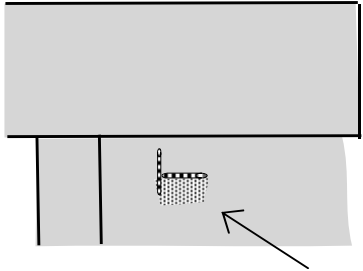

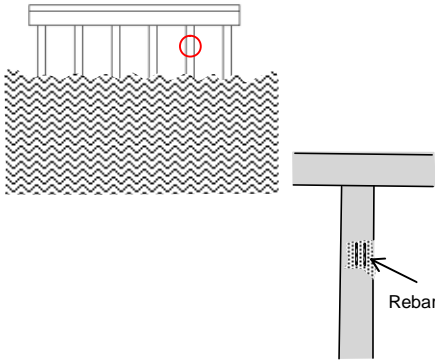

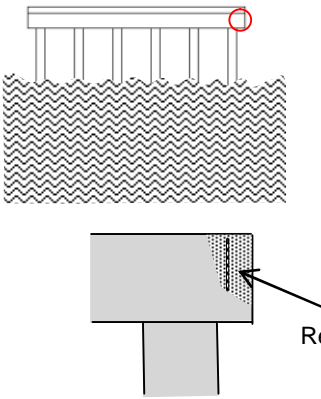
(Examples of superstructure)


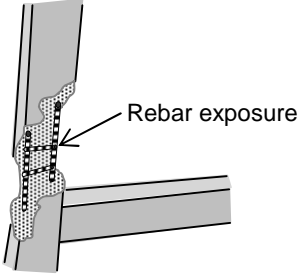

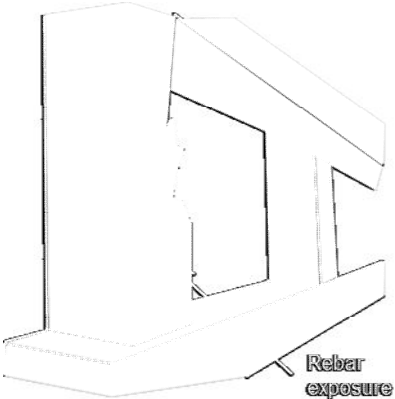
<p>Damage level 2</p>	<p>Damage level 2</p>
 <p>Partial rebar exposure</p>	 <p>Bottom side of girder</p>
<p>Damage level 2</p>	<p>Damage level 2</p>
 <p>Partial rebar exposure</p>	 <p>Bottom side of girder</p>
<p>Damage level 3</p>	<p>Damage level 3</p>
 <p>Partial rebar corrosion</p>	 <p>Bottom side of girder</p> <p>Rebar corrosion</p>

<p>Damage level 3</p>	<p>Damage level 3</p>
 <p>Superficial rebar exposure in the wide range</p>	 <p>Bottom side of girder</p> <p>Rebar exposure in the wide range</p>
<p>Damage level 3</p>	<p>Damage level 3</p>
 <p>Partial rebar corrosion</p>	 <p>Bottom side of deck</p> <p>Rebar exposure</p>
<p>Damage level 5</p>	<p>Damage level 5</p>
 <p>Rebar corrosion in the wide range</p>	 <p>Bottom side of deck</p> <p>Rebar exposure</p>

<p>Damage level 5</p>	<p>Damage level 5</p>
 <p>Rebar corrosion in the wide range</p>	 <p>Bottom side of deck</p>
<p>Damage level 5</p>	<p>Damage level 5</p>
 <p>Rebar corrosion in the wide range</p>	 <p>Bottom side of deck</p>

(Examples of substructure)

<p>Damage level 2</p>	<p>Damage level 2</p>
 <p>Partial rebar exposure</p>	 <p>Rebar exposure</p>
<p>Damage level 3</p>	<p>Damage level 3</p>
 <p>Partial rebar corrosion</p>	 <p>Rebar exposure</p>
<p>Damage level 3</p>	<p>Damage level 3</p>
 <p>Partial rebar corrosion</p>	 <p>Rebar exposure</p>

Damage level 5	Damage level 5
 <p data-bbox="252 750 592 779">Rebar corrosion around column</p>	 <p data-bbox="1011 501 1187 530">Rebar exposure</p>
Damage level 5	Damage level 5
 <p data-bbox="252 1279 592 1308">Rebar corrosion around column</p>	 <p data-bbox="1161 1227 1254 1272">Rebar exposure</p>

(16) Functional damages of bearings

(a) General description and damage characteristics

This subject is defined as the condition of the bearing in which the functions such as load supporting, displacement following function, etc. are damaged fully or partially.

(b) Relation to the other damages

Damages of each member of bearing area, such as those of bearing seat concrete like cracking, water leakage, free lime or rebar exposure etc. shall be also evaluated in the related subjects.

(c) Inspection area





The existence of functional damages for all bearings shall be inspected approaching closely.

(d) Classification of damages

The inspected results shall be evaluated with the following classification:

Evaluation criteria	Classification
No damage	1
Functional damages of bearings	3
Remarkable functional damages of bearings	5

(Examples)

Damage level 3	Damage level 3
 <p data-bbox="245 748 769 837">Damages appeared only on the girder (these damages shall be evaluated in cracks and rebar exposure.)</p>	 <p data-bbox="804 748 1299 837">Limited damages in bearing seat only (evaluated in cracks, water leakage, free lime or rebar exposure)</p>
Damage level 3	Damage level 3
 <p data-bbox="245 1272 737 1361">Bearing function is not restricted, even the rubber is deteriorated.</p>	 <p data-bbox="804 1272 1295 1361">Bearing function is not restricted, even the rubber is deteriorated.</p>

<p>Damage level 5</p>	<p>Damage level 5</p>
 <p>Functional damage in movement due to the accumulation of soil and dirt</p>	 <p>Bearing function is restricted by corrosion.</p>
<p>Damage level 5</p>	<p>Damage level 5</p>
 <p>Broken bearing</p>	 <p>Broken bearing</p>

3. Inspection records

The inspection results shall be recorded for each span according to the followings. Spans are numbered as 1, 2... from the beginning point numbering members for each span according to the following procedure.

3.1 Recording guide for the inspection results

(1) General View (Superstructure)

The following information should be described.

- a) Bridge name
- b) Bridge location
- c) Root number
- d) Administrator (Name of Office of Provincial Rural Road)
- e) Longitude and Latitude of the bridge location
- f) Inspection date
- g) Inspector's name
- h) General view(plain, side, cross section)
- i) member number
- j) damaged location

(2) General View (Substructure)

The following information should be described.

- a) Bridge name
- b) Bridge location
- c) Root number
- d) Administrator (the name of Office of Provincial Rural Road)
- e) Longitude and Latitude of the bridge
- f) Inspection date
- g) Inspector's name
- h) General view (plain, side, cross section)
- i) Member number
- j) Damaged location

(3) Damage photo

Corresponding photos to the inspected damages shall be attached.

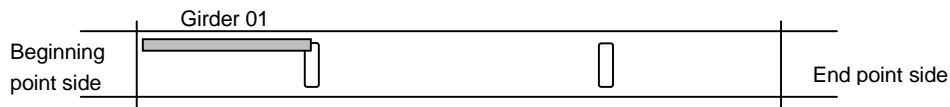
- a) Photo No.* : Corresponding No. to the photo (from left to right No.1, 2, 3 --)
- b) Span No.* : Corresponding span No. to the photo
- c) Inspection date* : The date when the photos are taken
- d) Member No.* : Girder 01, Bearing 01, etc.
- e) Damage* : Type of damage / Cracking, rebar exposure, etc.
- f) Damage level* : Classification of damage / a - e
- g) Note* : Supplementary explanation for the photos

(4) Bridge condition data

The classification of the inspected damages shall be recorded in the form.

(5) Member numbering method

Member shall be numbered from left side seeing from beginning point in principle.



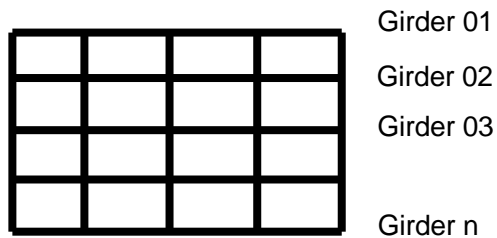
In case of special bridge type in which it is difficult to record according to the following procedure, the members shall be appropriately divided and numbered.

Member No. according to the following numbering rules shall be illustrated for each span.

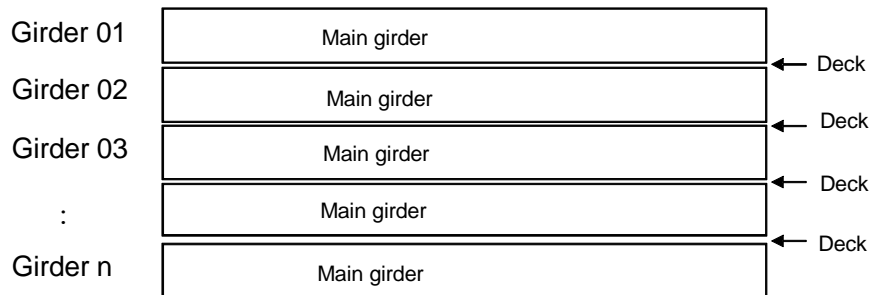
1) Girder and stringer

In principle these shall be defined in each girder.

i) Concrete I-shaped girder

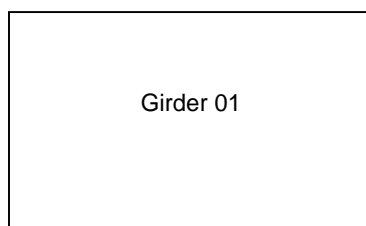


ii) Plank girder, Box girder etc.



iii) Slab bridge

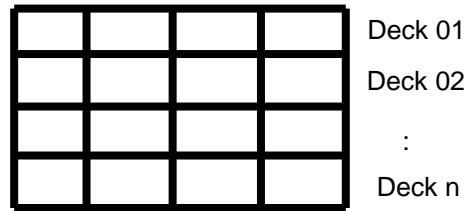
The bridges can not be divided in each girder such as a slab bridge shall be defined as “Girder 01” as a whole.



2) Deck

These shall be defined in each line between the girders.

i) Concrete I-shaped girder



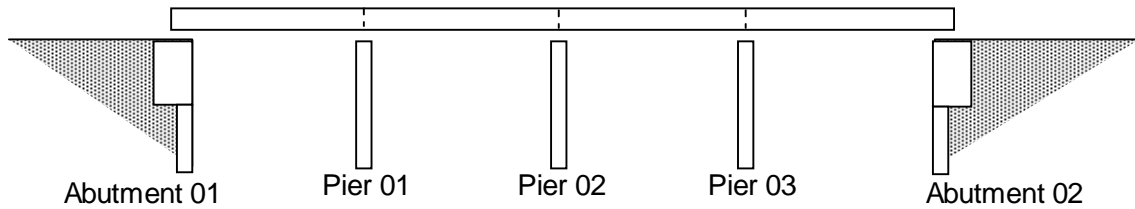
ii) Plank girder, Box girder etc.



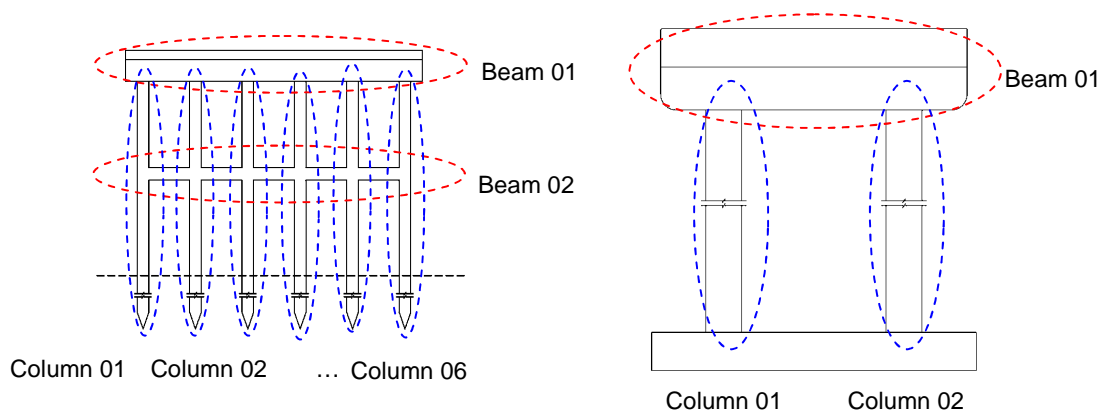
For slab bridges, plank girder bridges, Box girder bridges etc., only the cantilevered deck and the CIP-slab parts shall be defined as a deck and the other parts as a girder.

3) Substructures (pier, abutment)

These shall be defined in each pier and abutment.

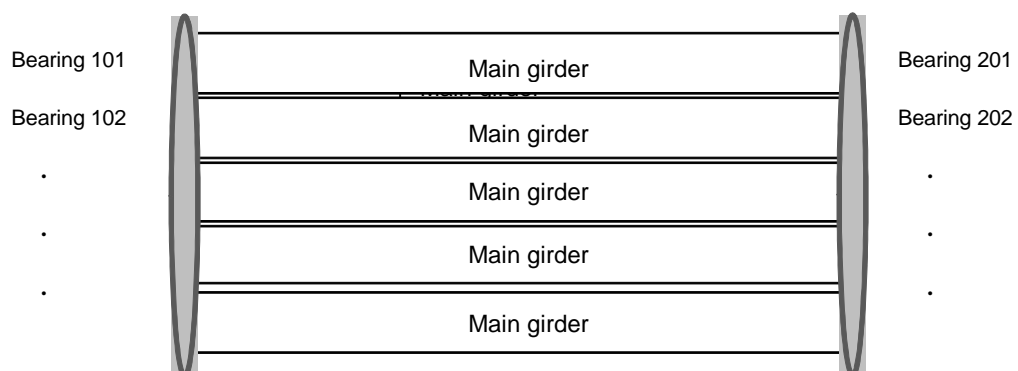


Pier shall be defined into column and beam.



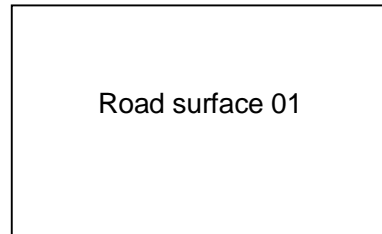
4) Bearings

These shall be defined in each span.



5) Road surface

This shall be defined in a span.



3.2 Recording forms and recorded examples

In this manual, at least 5 sheets must be needed to record the bridge conditions. In each sheet, the inspector should fill in blank, such as bridge location (bridge name, root number), date of the inspection, inspector's name.

- Sheet No.1: Inspector should describe members to be inspected from above bridge.
- Sheet No.2: Inspector should describe superstructure among the members to be inspected from under bridge.
- Sheet No.3: Inspector should describe substructure among the members to be inspected from under the bridge.

Inspector should write damage locations of substructures on side view and cross section view.

- Sheet No.4

Inspector should evaluate the damages on the bridge, which are detected by the inspector. To record the evaluation, the inspector should describe damaged locations by using photos which are taken by the inspector, photo number, Span number, etc. If needed, inspector should write comments down on this sheet.

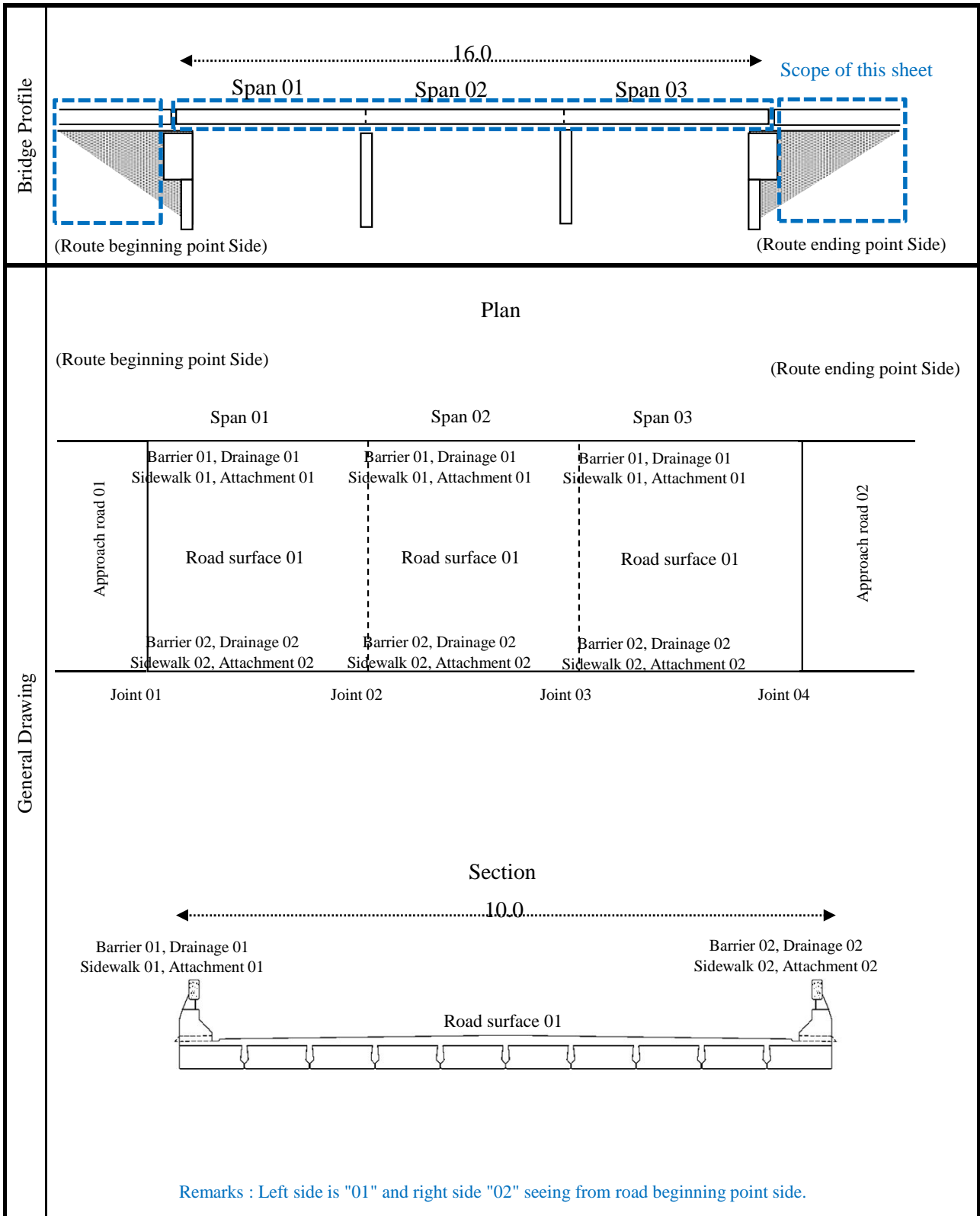
- Sheet No.5

Inspector should fill in blank to summarize bridge condition.

[Recording Forms / Recorded Examples]

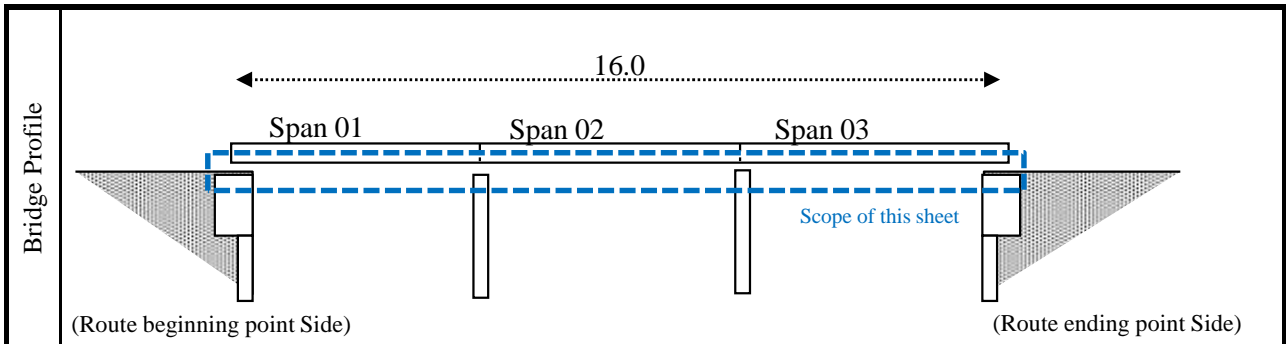
Bridge Data (Surface of bridge and approach road)

Bridge Name	Sample (Temporary number : 1030-2)	Inspection Date	26/01/2012
Location	Thalung Lek, Khok Samrong, Lop Buri	Route Number	1030
Latitude	N 15.076	Province	Lop Buri
Longitude	E 100.675	Main Inspector	(name)



Bridge Data (Under bridge [Superstructure])

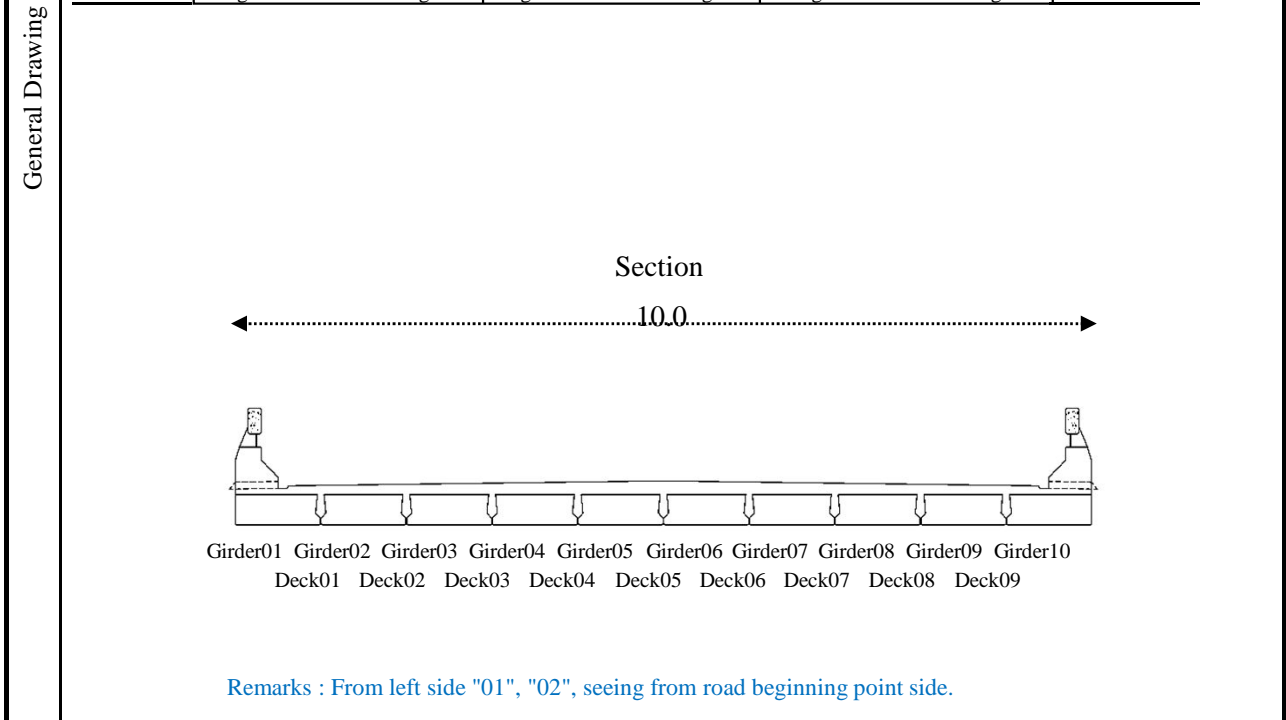
Bridge Name	Sample (Temporary number : 1030-2)	Inspection Date	26/01/2012
Location	Thalung Lek, Khok Samrong, Lop Buri	Route Number	1030
Latitude	N 15.076	Province	Lop Buri
Longitude	E 100.675	Main Inspector	(name)



Plan

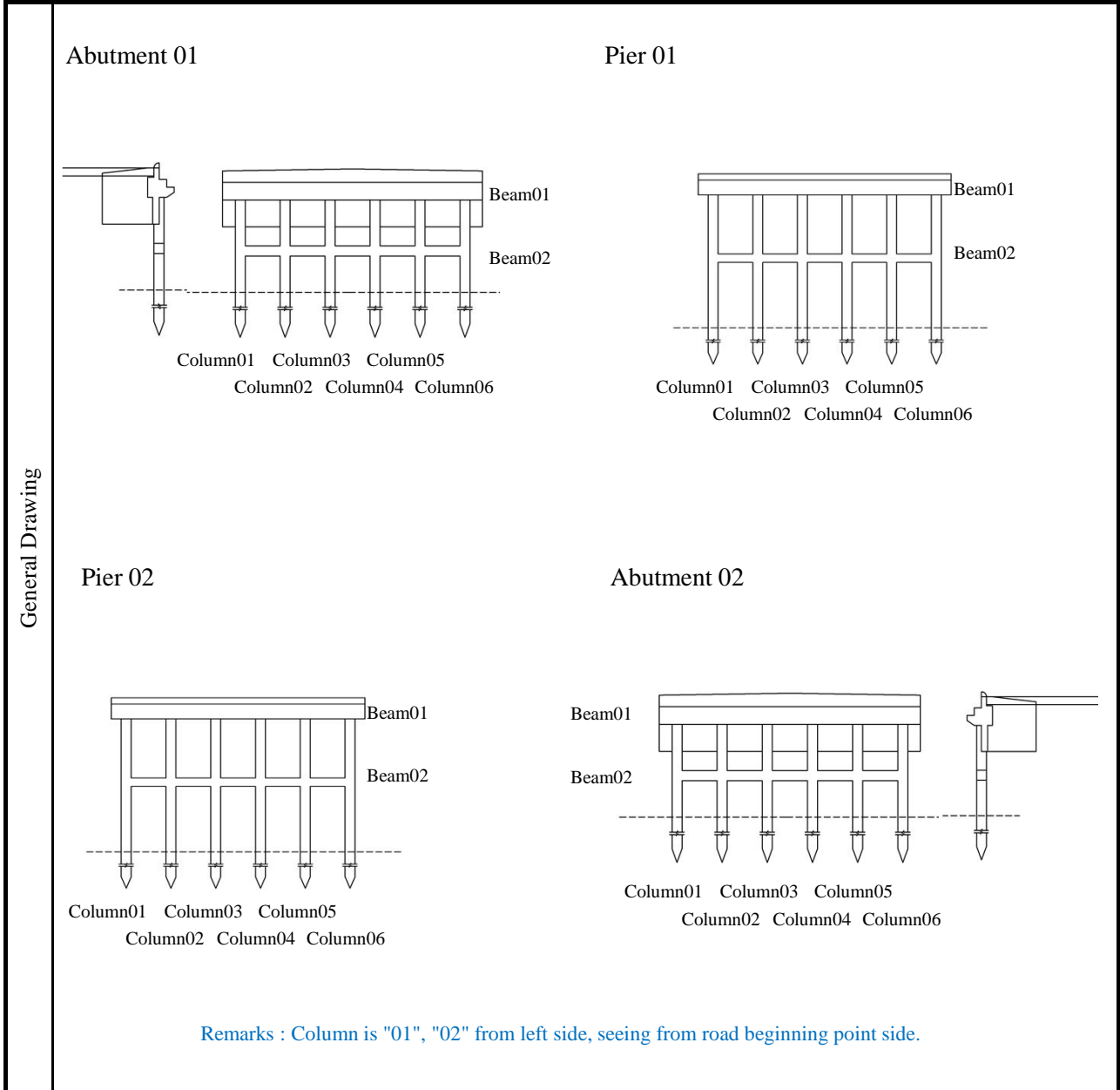
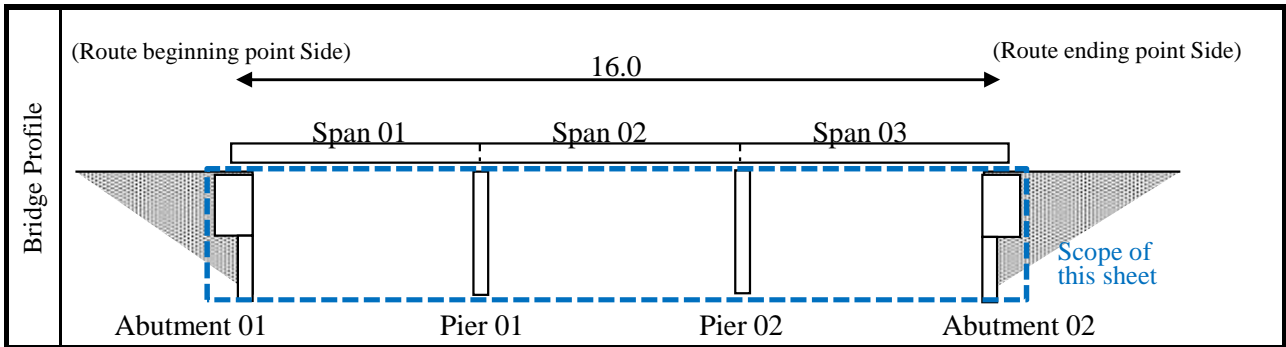
(Route beginning point Side) (Route ending point Side)

Span 01		Span 02		Span 03	
Bearing101	Girder01	Bearing201	Bearing101	Girder01	Bearing201
Bearing102	Girder02	Bearing202	Bearing102	Girder02	Bearing202
Bearing103	Girder03	Bearing203	Bearing103	Girder03	Bearing203
Bearing104	Girder04	Bearing204	Bearing104	Girder04	Bearing204
Bearing105	Girder05	Bearing205	Bearing105	Girder05	Bearing205
Bearing106	Girder06	Bearing206	Bearing106	Girder06	Bearing206
Bearing107	Girder07	Bearing207	Bearing107	Girder07	Bearing207
Bearing108	Girder08	Bearing208	Bearing108	Girder08	Bearing208
Bearing109	Girder09	Bearing209	Bearing109	Girder09	Bearing209
Bearing110	Girder10	Bearing210	Bearing110	Girder10	Bearing210



Bridge Data (Under bridge [Substructure])

Bridge Name	Sample (Temporary number : 1030-2)	Inspection Date	26/01/2012
Location	Thalung Lek, Khok Samrong, Lop Buri	Route Number	1030
Latitude	N 15.076	Province	Lop Buri
Longitude	E 100.675	Main Inspector	(name)



Bridge Data

Bridge Name	Sample (Temporary number: 1030-2)	Inspection Date	26/01/2012
Location	Thalung Lek, Khok Samrong, Lop Buri	Route Number	1030
Latitude	N 15.076	Province	Lop Buri
Longitude	E 100.675	Main Inspector	(name)

Photo No.	Span No.	Photo No.	Span No.	Photo No.	Span No.
01	01	02	02	03	03
Member name	Girder	Member name	Girder	Member name	Girder
05	05	04	04	01	01
Damage	Cracking	Damage	Rebar Exposure	Damage	Cracking
	Classification		Classification		Classification
	2		2		3
					
					
					
Photo No.	Span No.	Photo No.	Span No.	Photo No.	Span No.
01	01	01	01	01	01
Member name	Approach road	Member name	Pier	Member name	Pier
01	01	01	01	01	01
Damage	Damages behind abutments	Damage	Scouring	Damage	Rebar exposure
	Classification		Classification		Classification
	5		5		2
					
<p>Scouring is about 2.5 meters depth.</p> 					
					

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Bridge Name	Sample (Temporary number: 1030-2)		Inspection Date	26/01/2012
Location	Thalung Lek, Khok Samrong, Lop Buri		Route Number	1030
Latitude	N	15.076	Province	Lop Buri
Longitude	E	100.675	Main Inspector	(name)

Member	Span No. / Pier No.	Member No.	Settlement	Unevenness of road surface	Damages in expansion joints	Damages in barriers	Damages in drainages	Damages in sidewalk	Damages in attached facility	Damages behind abutments	Damages of river revetments near abutments	Scouring riverbed around abutment / pier	Damages at the anchorages of prestressing tendons	Cracking, Water leakage, Free lime	No.	Pop-outs of deck	Deck cracking	Rebar exposure	Functional damage of bearings
Abutment (Column)	01	01	1								1	1		1	-			1	
	01	02	1								1	1		1	-			1	
	01	03	1								1	1		1	-			1	
	01	04	1								1	1		1	-			1	
	01	05	1								1	1		1	-			1	
	01	06	1								1	1		1	-			1	
Abutment (Beam)	01	01	1								1	1		1	-			1	
	01	02	1								1	1		1	-			1	
Abutment (Column)	02	01	1								1	1		1	-			1	
	02	02	1								1	1		1	-			1	
	02	03	1								1	1		1	-			1	
	02	04	1								1	1		1	-			1	
	02	05	1								1	1		1	-			1	
	02	06	1								1	1		1	-			1	
Abutment (Beam)	02	01	1								1	1		1	-			1	
	02	02	1								1	1		1	-			1	
Pier (Column)	01	01	1									5		1	-			1	
	01	02	1									1		1	-			1	
	01	03	1									1		1	-			1	
	01	04	1									1		1	-			1	
	01	05	1									1		1	-			1	
	01	06	1									1		1	-			1	
Pier (Beam)	01	01	1									1		1	-			1	
	01	02	1									1		1	-			1	
Pier (Column)	02	01	1									1		1	-			1	
	02	02	1									1		1	-			1	
	02	03	1									1		1	-			1	
	02	04	1									1		1	-			1	
	02	05	1									1		1	-			1	
	02	06	1									1		1	-			2	
Pier (Beam)	02	01	1									1		1	-			1	
	02	02	1									1		1	-			1	
Road surface	01	01		1															
	02	01		1															
	03	01		1															
Expansion joint	01	01			1														
	02	02			1														
	03	03			1														
	03	04			1														
Barrier	01	01				1													
	01	02				1													

Bridge Name	Sample (Temporary number: 1030-2)		Inspection Date	26/01/2012
Location	Thalung Lek, Khok Samrong, Lop Buri		Route Number	1030
Latitude	N	15.076	Province	Lop Buri
Longitude	E	100.675	Main Inspector	(name)

Member	Span No. / Pier No.	Member No.	Settlement	Unevenness of road surface	Damages in expansion joints	Damages in barriers	Damages in drainages	Damages in sidewalk	Damages in attached facility	Damages behind abutments	Damages of river revetments near abutments	Scouring riverbed around abutment / pier	Damages at the anchorages of prestressing tendons	Cracking, Water leakage, Free lime	No.	Pop-outs of deck	Deck cracking	Rebar exposure	Functional damage of bearings
	02	01				1													
	02	02				1													
	03	01				1													
	03	02				1													
Drainage	01	01					1												
	01	02					1												
	02	01					1												
	02	02					1												
	03	01					1												
	03	02					1												
Sidewalk	01	01						1											
	01	02						1											
	02	01						1											
	02	02						1											
	03	01						1											
	03	02						1											
Attached facility	01	01							1										
	01	02							1										
	02	01							1										
	02	02							1										
	03	01							1										
	03	02							1										
Approach road	01	01		1		1		1	1	5									
	03	02		1		1		1	1	1									
Girder	01	01											1	1	-			1	
	01	02											1	1	-			1	
	01	03											1	1	-			1	
	01	04											1	1	-			1	
	01	05											1	2	-			1	
	01	06											1	1	-			1	
	01	07											1	1	-			1	
	01	08											1	1	-			1	
	01	09											1	1	-			1	
	01	10											1	1	-			1	
	02	01											1	1	-			1	
	02	02											1	1	-			1	
	02	03											1	1	-			1	
	02	04											1	1	-			1	
	02	05											1	1	-			1	
	02	06											1	1	-			1	
	02	07											1	1	-			1	

Bridge Name	Sample (Temporary number: 1030-2)		Inspection Date	26/01/2012
Location	Thalung Lek, Khok Samrong, Lop Buri		Route Number	1030
Latitude	N	15.076	Province	Lop Buri
Longitude	E	100.675	Main Inspector	(name)

Member	Span No. / Pier No.	Member No.	Settlement	Unevenness of road surface	Damages in expansion joints	Damages in barriers	Damages in drainages	Damages in sidewalk	Damages in attached facility	Damages behind abutments	Damages of river revetments near abutments	Scouring riverbed around abutment / pier	Damages at the anchorages of prestressing tendons	Cracking, Water leakage, Free lime	No.	Pop-outs of deck	Deck cracking	Rebar exposure	Functional damage of bearings
Member	02	08											1	1	-			1	
	02	09											1	1	-			1	
	02	10											1	1	-			1	
	03	01											1	3	6			1	
	03	02											1	1	-			1	
	03	03											1	1	-			1	
	03	04											1	1	-			1	
	03	05											1	1	-			1	
	03	06											1	1	-			1	
	03	07											1	1	-			1	
	03	08											1	1	-			1	
	03	09											1	1	-			1	
	03	10											1	1	-			1	
Deck	01	01														1	1	1	
	01	02														1	1	1	
	01	03														1	1	1	
	01	04														1	1	1	
	01	05														1	1	1	
	01	06														1	1	1	
	01	07														1	1	1	
	01	08														1	1	1	
	01	09														1	1	1	
	02	01														1	1	1	
	02	02														1	1	1	
	02	03														1	1	1	
	02	04														1	1	1	
	02	05														1	1	1	
	02	06														1	1	1	
	02	07														1	1	1	
	02	08														1	1	1	
	02	09														1	1	1	
	03	01														1	1	1	
	03	02														1	1	1	
	03	03														1	1	1	
03	04														1	1	1		
03	05														1	1	1		
03	06														1	1	1		
03	07														1	1	1		
03	08														1	1	1		
03	09														1	1	1		
Bearings	01	101																	1

Bridge Name	Sample (Temporary number: 1030-2)		Inspection Date	26/01/2012
Location	Thalung Lek, Khok Samrong, Lop Buri		Route Number	1030
Latitude	N	15.076	Province	Lop Buri
Longitude	E	100.675	Main Inspector	(name)

Member	Span No. / Pier No.	Member No.	Settlement	Unevenness of road surface	Damages in expansion joints	Damages in barriers	Damages in drainages	Damages in sidewalk	Damages in attached facility	Damages behind abutments	Damages of river revetments near abutments	Scouring riverbed around abutment / pier	Damages at the anchorages of prestressing tendons	Cracking, Water leakage, Free lime	No.	Pop-outs of deck	Deck cracking	Rebar exposure	Functional damage of bearings
	01	102																	1
	01	103																	1
	01	104																	1
	01	105																	1
	01	106																	1
	01	107																	1
	01	108																	1
	01	109																	1
	01	110																	1
	01	201																	1
	01	202																	1
	01	203																	1
	01	204																	1
	01	205																	1
	01	206																	1
	01	207																	1
	01	208																	1
	01	209																	1
	01	210																	1
	02	101																	1
	02	102																	1
	02	103																	1
	02	104																	1
	02	105																	1
	02	106																	1
	02	107																	1
	02	108																	1
	02	109																	1
	02	110																	1
	02	201																	1
	02	202																	1
	02	203																	1
	02	204																	1
	02	205																	1
	02	206																	1
	02	207																	1
	02	208																	1
	02	209																	1
	02	210																	1
	03	101																	1
	03	102																	1
	03	103																	1

Bridge Name	Sample (Temporary number: 1030-2)		Inspection Date	26/01/2012
Location	Thalung Lek, Khok Samrong, Lop Buri		Route Number	1030
Latitude	N	15.076	Province	Lop Buri
Longitude	E	100.675	Main Inspector	(name)

Member	Span No. / Pier No.	Member No.	Settlement	Unevenness of road surface	Damages in expansion joints	Damages in barriers	Damages in drainages	Damages in sidewalk	Damages in attached facility	Damages behind abutments	Damages of river revetments near abutments	Scouring riverbed around abutment / pier	Damages at the anchorages of prestressing tendons	Cracking, Water leakage, Free lime	No.	Pop-outs of deck	Deck cracking	Rebar exposure	Functional damage of bearings
	03	104																	1
	03	105																	1
	03	106																	1
	03	107																	1
	03	108																	1
	03	109																	1
	03	110																	1
	03	201																	1
	03	202																	1
	03	203																	1
	03	204																	1
	03	205																	1
	03	206																	1
	03	207																	1
	03	208																	1
	03	209																	1
	03	210																	1

Note : For "No." is that of remarkably influential cracks defined in the inspection & evaluation manual.

4. Evaluation on urgency of damage class 5

4.1 Evaluation approach to urgency of damage class 5

Once the state of damage turns out to be serious and getting worse than before through periodic inspection executed by workers, it can be classified in damage class 5 and needs to be reevaluated by expert who has a professional knowledge of that for the purpose of risk mitigation. Reevaluation can elaborate on damage class 5 and break it into three types of damage: Type 1 is the damage needs the urgent treatment; Type 2 is the damage with a high priority of repair; and Type 3 is the damage not belongs to both Type 1 and Type 2.

The kind of damage which needs evaluation usually takes place in the structural elements that may work for maintaining the stability and the serviceability of bridge, is described as following:

「Damage at anchorage of prestressing tendon」
「Cracking, water leakage, and free lime」
「Pop-outs of deck」
「Deck cracking」
「Rebar exposure」
「Functional damage of bearings」

[Type 1] Damage needs the urgent treatment

- The damage causes the difficulty of vehicle running and needs to be urgently treated and repaired in order to ensure the stability and the serviceability of bridge.
- It can be marked as E (Emergency) instead of damage class 5.

[Type 2] Damage with a high priority of repair

- ① The damage is likely to grow to be severe and get worse rapidly, such as salt damage, cracking with rust stain, and rebar exposure.
- ② The capacity of load resistance becomes significantly low and the seriousness of vehicle running problem may take place until the next periodic inspection.

- There are, for example, PC girder cracking, damage at anchorage of prestressing tendon, concrete slab deck cracking along with free lime phenomenon, rebar corrosion which causes concrete cover detachment, and level difference around bearings.
- It can be marked as R (Risk) instead of damage class 5.

[Type 3] Damage does not belong to Type 1 and 2

- This can be marked as damage class 5.

Table 4.1 Damage type definition

Type	Definition	Evaluation
Type 1	Damage needs the urgent treatment.	E
Type 2	Damage has a high priority of repair.	R
Type 3	Damage does not belong to Type 1 and 2.	Damage class 5

III Appendix

Standard design

Bureau of Location and Design, DRR, Standard Drawing for Bridges and Building Section 3
Bridge Work for Vehicles 2010

Bureau of Location and Design, Department of Rural Roads, Ministry of Transport, Bridge
Standard Drawing for Construction Work of Rural Road
September 2010

17/05/2013

Ministry of Transportation Department of Rural Roads
The Kingdom of Thailand

**THE PROJECT
FOR BRIDGE MASTER PLAN AND BRIDGE
MAINTENANCE ABILITY IN RURAL AREA
IN
THE KINGDOM OF THAILAND**

**“BRIDGE INSPECTION AND EVALUATION MANUAL “
QUICK MANUAL**

May 2013

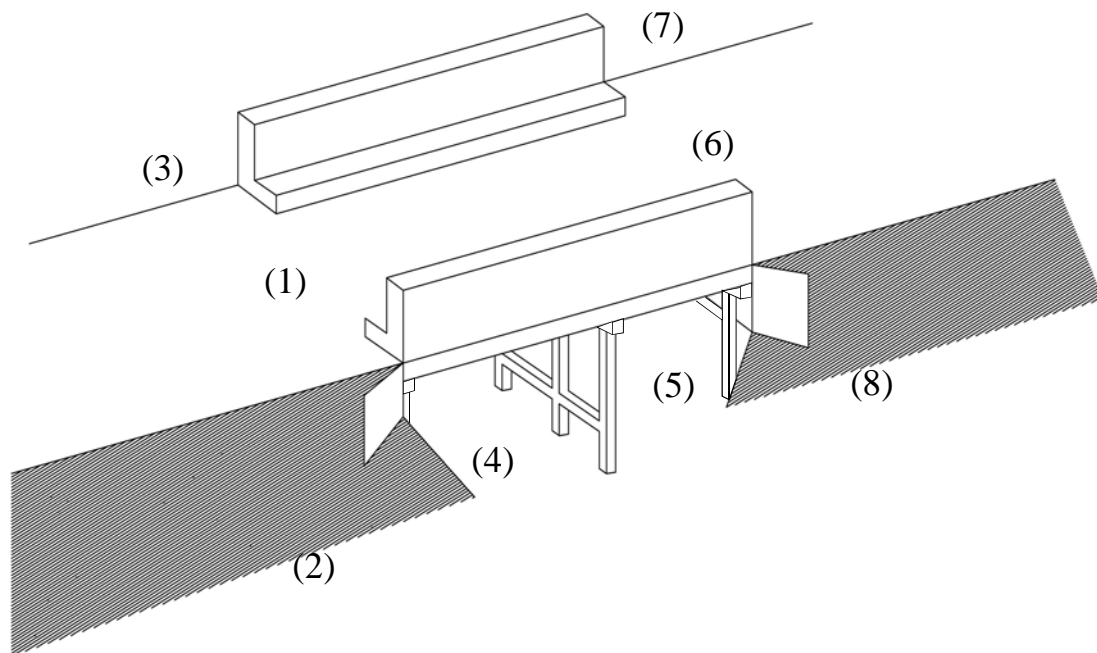
JAPAN INTERNATIONAL COOPERATION AGENCY

CHODAI CO., LTD

METROPOLITAN EXPRESSWAY COMPANY LIMITED

Remarkable point

1. Bridge collapse
2. Settlement, movement and inclination of piers and abutments
3. Washout soil
 - Approach road
 - Around abutments
 - Base of pier
4. Damage in structural members
5. Cracking
 - Surface of concrete
 - Surface of pavement
6. Rebar Exposure
 - Surface of concrete
7. Water leakage
 - Surface of concrete



The number indicates where to stand.

(1), (6) Near bridge, surface of bridge

Points to check: Entire bridge, surface of bridge (Road surface, expansion joints, barriers, sidewalk, drainages, attached facility), Approach road (road surface)

(2), (3), (7), (8) Slope near bridge

Points to check: Approach road (slope), behind abutment

(4), (5) Under bridge

Points to check: Side of bridge, behind bridge (bottom surface of girder, deck), around abutments and piers, river revetments near abutments

Damage level

Low

→

High

1

2






3

4

5




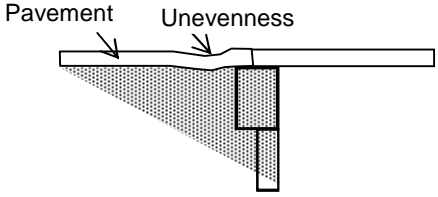

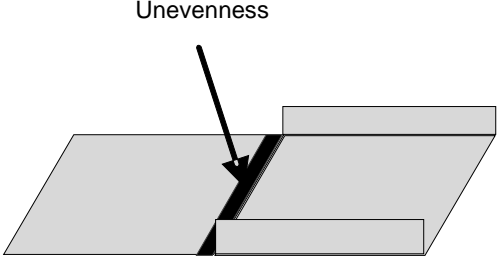
Near bridge (Entire bridge)

Settlement, movement, inclination

<p>Damage level 5</p>	<p>Damage level 5</p>
 <p>Settlement/ inclination of substructure and remarkable scour of substructure</p>	 <p>Settlement of substructure and deformation on the bridge</p>
<p>Damage level 5</p>	<p>Damage level 5</p>
 <p>Collapse of bridge due to loss of substructure</p>	 <p>Remarkable inclination of substructure</p>
<p>Damage level 5</p>	<p>Damage level 5</p>
 <p>Settlement of substructure</p>	 <p>Settlement of substructure</p>




Surface of bridge

Unevenness of road surface

<p>Damage level 3</p>	<p>Damage level 3</p>
 <p>Level difference < 20mm</p>	 <p>Level difference < 20mm</p>
<p>Damage level 5</p>	<p>Damage level 5</p>
 <p>Level difference \geq 20mm (behind abutment)</p>	
<p>Damage level 5</p>	<p>Damage level 5</p>
 <p>Level difference \geq 20mm</p>	





Surface of bridge

Damages in expansion joints

Damage level 3	Damage level 3
 <p data-bbox="245 981 596 1014">Miner defects on expansion joint</p>	 <p data-bbox="799 981 1150 1014">Miner defects on expansion joint</p>
Damage level 5	
 <p data-bbox="245 1507 667 1541">Remarkable defects on expansion joint</p>	



Surface of bridge

Damages in barriers



Damage level 3	Damage level 3
 <p data-bbox="252 808 427 831">Minor loss of steel</p>	 <p data-bbox="802 808 1015 831">Minor loss of concrete</p>
Damage level 5	Damage level 5
 <p data-bbox="252 1279 738 1301">Breakage in large area. Dangerous traffic condition</p>	 <p data-bbox="802 1279 1249 1301">Large deformation. Dangerous traffic condition.</p>

Surface of bridge

Damages in Drainage

Damage level 1	Damage level 5
 <p data-bbox="245 801 587 835">No obstruction in the drain pipe</p>	 <p data-bbox="799 801 1305 835">The drain pipe is clogged with dust and gasses</p>

Damages in sidewalk


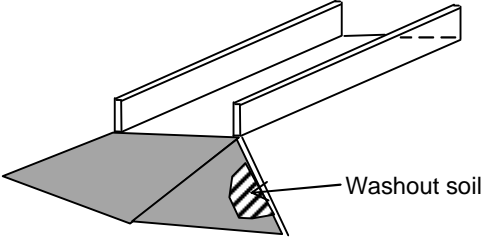

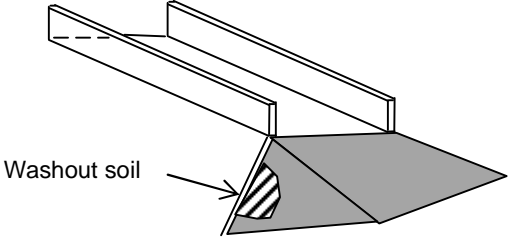


Damage level 1	Damage level 5
 <p data-bbox="252 1332 743 1361">No unusual condition such as level difference</p>	 <p data-bbox="802 1332 1337 1417">Occurrence of level difference that leads difficult traffic condition</p>

Damages in attached facility

Damage level 1	Damage level 5
 <p data-bbox="245 1906 778 1966">No unusual condition of lighting equipment and signs</p>	 <p data-bbox="799 1917 1007 1951">Damages to piping</p>


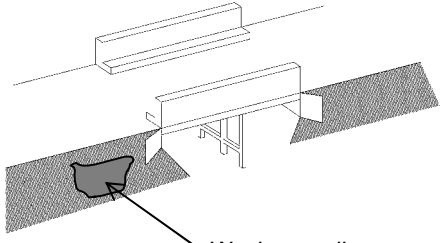

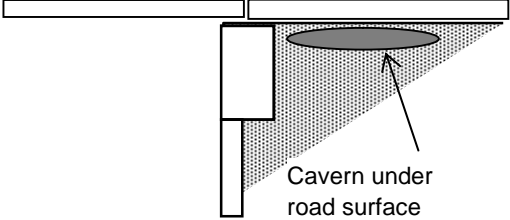

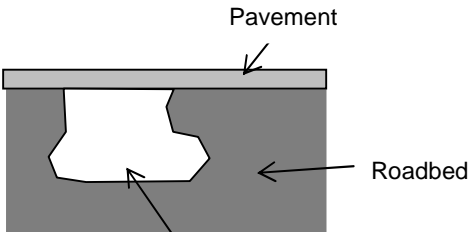
Slope near bridge

Damages behind abutment

Damage level 3	Damage level 3
 <p data-bbox="252 831 778 913">Deep pothole behind the abutment due to erosion/scour</p>	 <p data-bbox="1155 725 1295 752">Washout soil</p>
Damage level 3	Damage level 3
 <p data-bbox="252 1357 778 1440">Deep pothole behind the abutment due to erosion/scour</p>	 <p data-bbox="817 1263 957 1290">Washout soil</p>
Damage level 5	Damage level 5
 <p data-bbox="252 1883 778 1966">Concrete slab behind the abutment is fallen down due to erosion/scour</p>	 <p data-bbox="802 1883 1329 1966">Backfill material behind abutment is washed away due to erosion/scour</p>




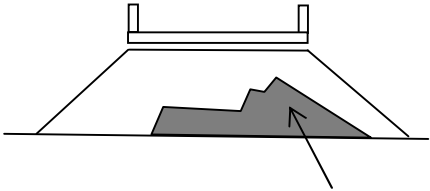

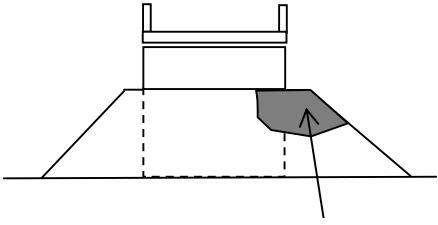
Slope near bridge

Damages behind abutment

<p>Damage level 5</p>	<p>Damage level 5</p>
 <p>The shoulder of approach road is wash away due to erosion/scour</p>	 <p>Washout soil</p>
<p>Damage level 5</p>	<p>Damage level 5</p>
 <p>Gap between concrete slab and bank behind abutment due to erosion/scour</p>	 <p>Cavern under road surface</p>
<p>Damage level 5</p>	<p>Damage level 5</p>
 <p>Crack appeared on the surface of pavement due to void under the pavement</p>	 <p>Pavement</p> <p>Roadbed</p> <p>Cavern</p>


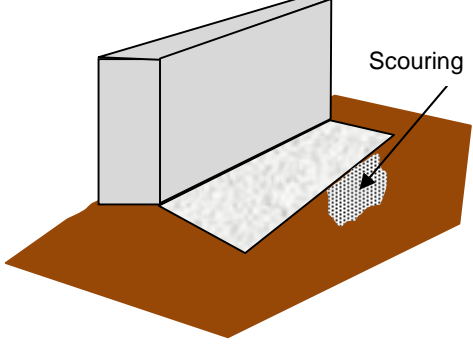

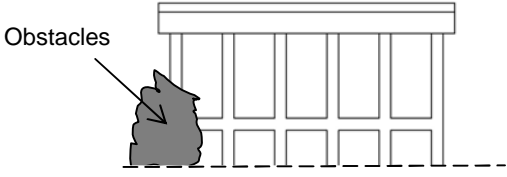

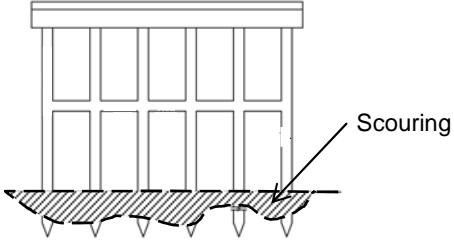
Under bridge (Bottom of pier and abutments)



Damages on river revetment near abutments

Damage level 3	Damage level 3
 <p data-bbox="252 840 609 869">Minor damage on river revetment</p>	 <p data-bbox="802 840 1160 869">Minor damage on river revetment</p>
Damage level 5	Damage level 5
 <p data-bbox="252 1330 778 1386">Remarkable damage on river revetment due to lack of backfill</p>	 <p data-bbox="995 1227 1289 1256">Collapse of river revetment</p>
Damage level 5	Damage level 5
 <p data-bbox="252 1845 778 1901">Remarkable damage on river revetment due to lack of backfill</p>	 <p data-bbox="930 1776 1278 1805">Washout behind river revetment</p>

Under bridge (Bottom of pier and abutment)


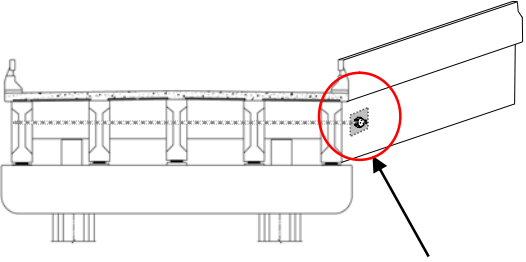

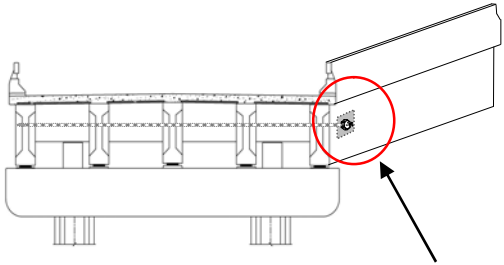
Scouring around abutments and piers

<p>Damage level 3</p>	<p>Damage level 3</p>
 <p>Minor damage due to scouring</p>	
<p>Damage level 3</p>	<p>Damage level 3</p>
 <p>Minor obstacles in the cross-sectional area of a river</p>	
<p>Damage level 5</p>	<p>Damage level 5</p>
 <p>Remarkable scouring around the substructure</p>	

Damage level 5	Damage level 5
 <p data-bbox="252 808 687 837">Remarkable scouring around the substructure</p>	 <p data-bbox="804 808 1240 837">Remarkable scouring around the substructure</p>





Under bridge (Side of bridge)

Damages at the anchorage of prestressing tendons

Damage level 5	Damage level 5
 <p data-bbox="245 864 767 893">Spalling of the anchorage concrete and steel corrosion</p>	
 <p data-bbox="245 1391 767 1476">Spalling of the anchorage concrete and slip out of the PC tendon</p>	

Under bridge (Behind bridge)

Cracking, water leakage and free lime of superstructure

Damage level 2	Damage level 2
 <p data-bbox="248 808 679 835">Cracks of small influence (marked with chalk)</p>	 <p data-bbox="804 808 1235 835">Cracks of small influence (marked with chalk)</p>
Damage level 3	Damage level 3
 <p data-bbox="248 1279 679 1305">Cracks of large influence (marked with chalk)</p> <p data-bbox="555 1335 743 1361">Crack pattern No.1</p>	 <p data-bbox="804 1305 1235 1332">Cracks of small influence with water leakage</p>


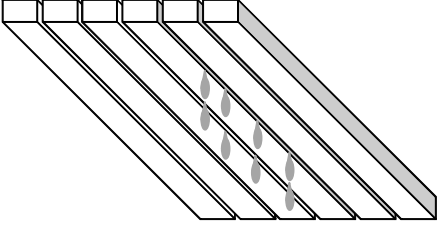

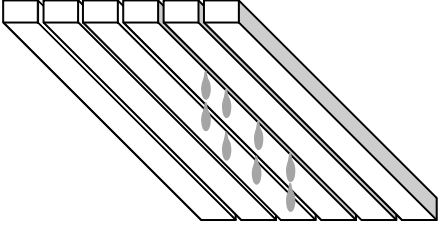
Under bridge (Behind bridge)

Cracking, water leakage and free lime of superstructure

Damage level 4	Damage level 4
 <p data-bbox="245 808 762 891">Cracks of small influence with water leak age and free lime</p>	 <p data-bbox="801 808 1318 891">Cracks of large influence with slight water leakage and free lime</p> <p data-bbox="1123 866 1318 891">Crack pattern No.2</p>
Damage level 5	Damage level 5
 <p data-bbox="245 1335 624 1359">Cracks of large influence with rust stain</p> <p data-bbox="557 1393 751 1417">Crack pattern No.8</p>	 <p data-bbox="801 1335 1177 1359">Cracks of large influence with rust stain</p> <p data-bbox="1152 1393 1347 1417">Crack pattern No.8</p>


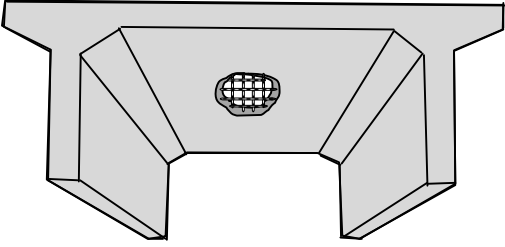

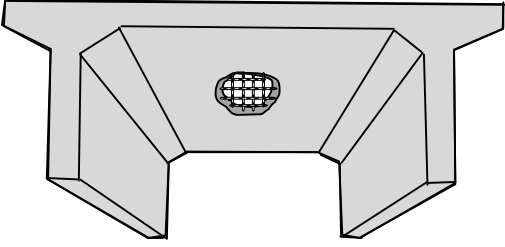
Under bridge (Behind bridge)

Pop-outs of deck

Damage level 3	Damage level 3
 <p data-bbox="247 1041 622 1070">Leakage of water in the gaps of girders</p>	
Damage level 3	Damage level 3
 <p data-bbox="247 1568 622 1597">Leakage of water in the gaps of girders</p>	


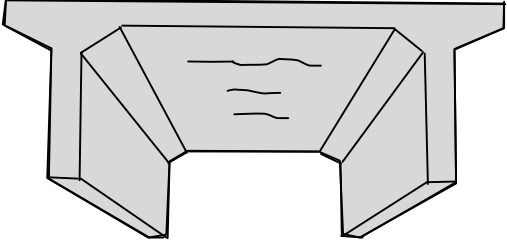

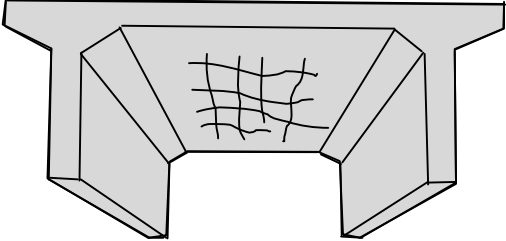

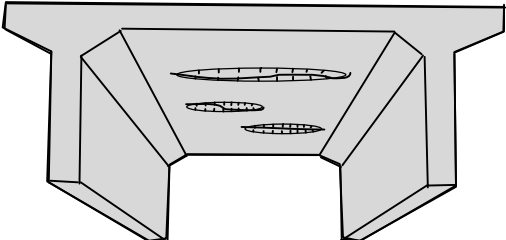
Under bridge (Behind bridge)

Pop-outs of deck

Damage level 5	Damage level 5
 <p data-bbox="248 869 448 898">Example of pop-outs</p>	
Damage level 5	Damage level 5
 <p data-bbox="248 1393 448 1422">Example of pop-outs</p>	


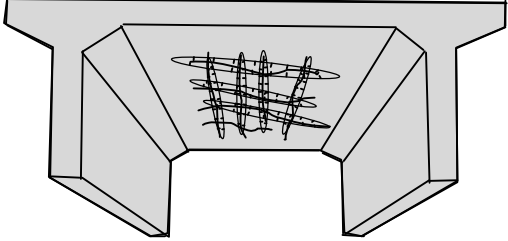

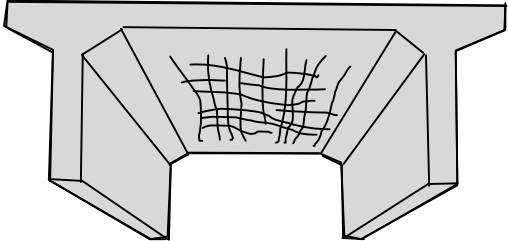
Under bridge (Behind bridge)

Deck cracking

Damage level 2	Damage level 2
 <p>Mainly cracks in one direction (marked with chalk)</p>	
Damage level 3	Damage level 3
 <p>Cracks in two directions (marked with chalk)</p>	
Damage level 3	Damage level 3
 <p>Cracks in one direction with free lime</p>	


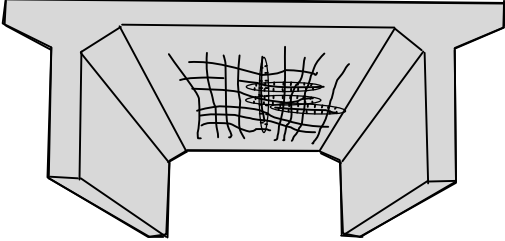
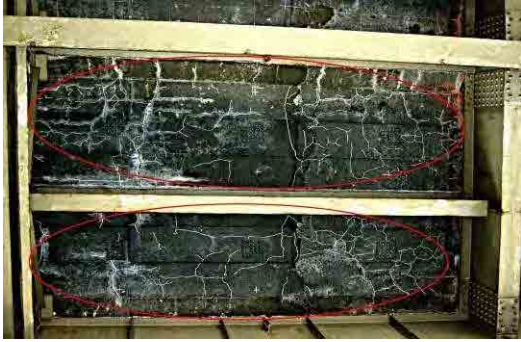
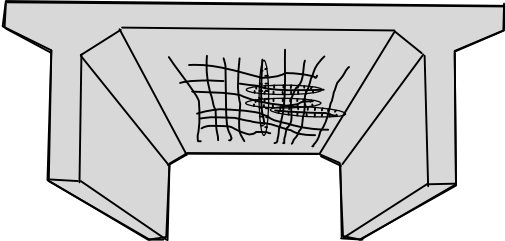
Under bridge (Behind bridge)

Deck cracking

Damage level 4	Damage level 4
 <p data-bbox="240 804 603 835">Cracks in two directions with free lime</p>	
Damage level 4	Damage level 4
 <p data-bbox="240 1274 778 1361">Dense cracks in two directions partially chipped (marked with chalk)</p>	


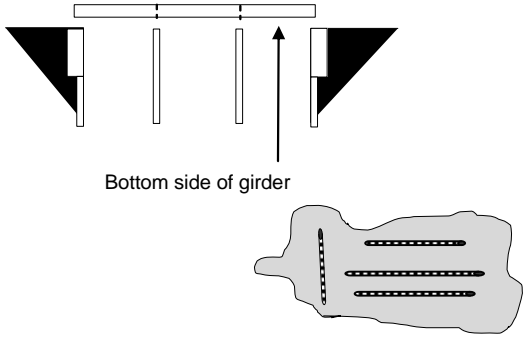

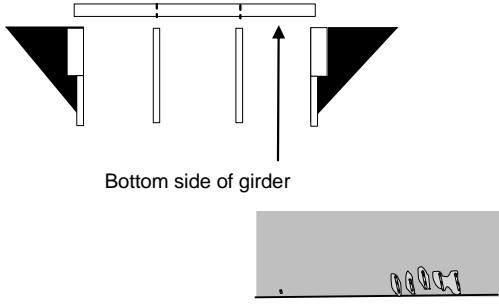

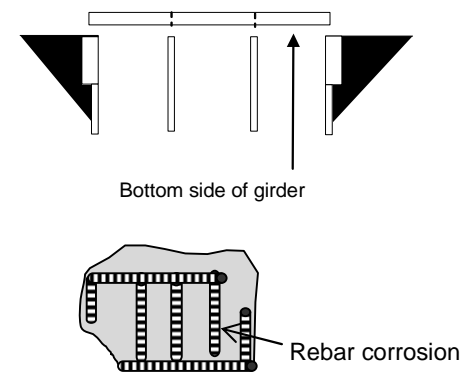
Under bridge (Behind bridge)

Deck cracking

Damage level 5	Damage level 5
 <p data-bbox="240 808 580 835">Continuously chipped with free lime</p>	
 <p data-bbox="240 1279 580 1305">Continuously chipped with free lime</p>	

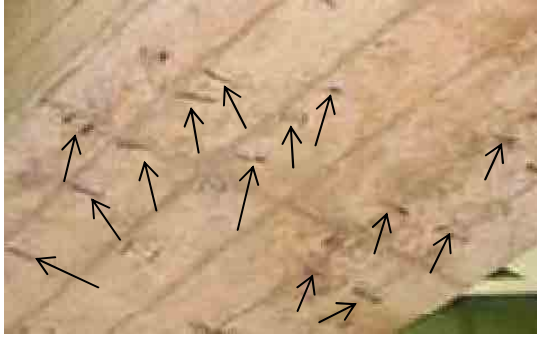
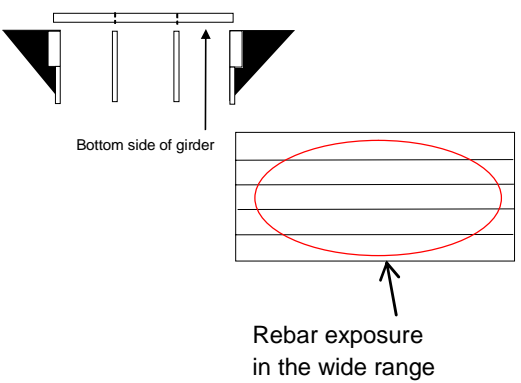

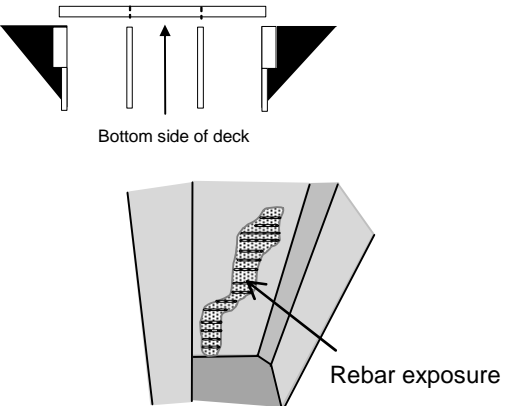

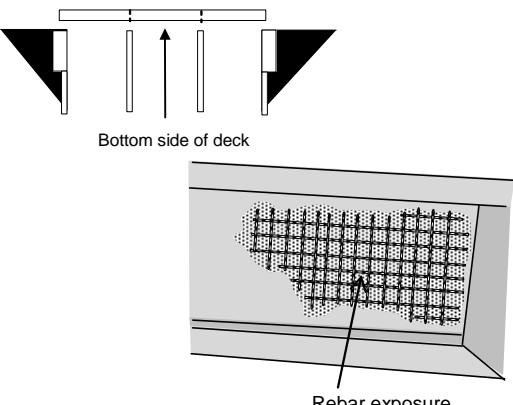
Under bridge (Behind bridge)

Rebar exposure of superstructure

<p>Damage level 2</p>	<p>Damage level 2</p>
 <p>Partial rebar exposure</p>	 <p>Bottom side of girder</p>
<p>Damage level 2</p>	<p>Damage level 2</p>
 <p>Partial rebar exposure</p>	 <p>Bottom side of girder</p>
<p>Damage level 3</p>	<p>Damage level 3</p>
 <p>Partial rebar corrosion</p>	 <p>Bottom side of girder</p> <p>Rebar corrosion</p>


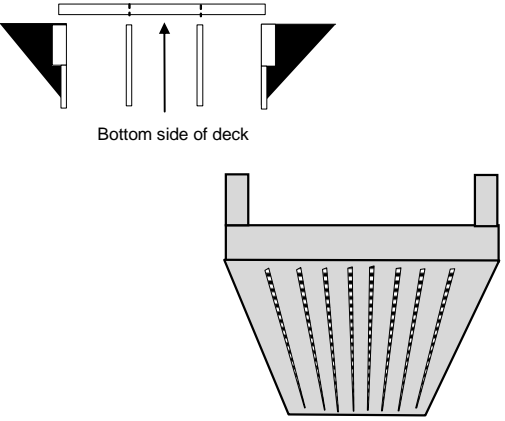

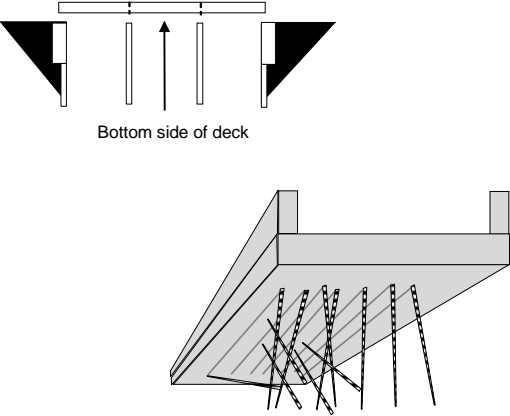
Under bridge (Behind bridge)

Rebar exposure of superstructure

<p>Damage level 3</p>	<p>Damage level 3</p>
 <p>Superficial rebar exposure in the wide range</p>	 <p>Bottom side of girder</p> <p>Rebar exposure in the wide range</p>
<p>Damage level 3</p>	<p>Damage level 3</p>
 <p>Partial rebar corrosion</p>	 <p>Bottom side of deck</p> <p>Rebar exposure</p>
<p>Damage level 5</p>	<p>Damage level 5</p>
 <p>Rebar corrosion in the wide range</p>	 <p>Bottom side of deck</p> <p>Rebar exposure</p>





Under bridge (Behind bridge)

Rebar exposure of superstructure

Damage level 5	Damage level 5
 <p>Rebar corrosion in the wide range</p>	 <p>Bottom side of deck</p>
 <p>Rebar corrosion in the wide range</p>	 <p>Bottom side of deck</p>

Under bridge (Pier)

Cracking, water leakage and free lime of substructure

Damage level 2	Damage level 2
 <p data-bbox="252 808 687 835">Cracks of small influence (marked with chalk)</p>	 <p data-bbox="802 808 1238 835">Cracks of small influence (marked with chalk)</p>
Damage level 3	Damage level 3
 <p data-bbox="252 1279 687 1305">Cracks of large influence (marked with chalk)</p> <p data-bbox="563 1335 759 1361">Crack pattern No.5</p>	 <p data-bbox="802 1305 1238 1332">Cracks of small influence with water leakage</p>

Under bridge (Pier)

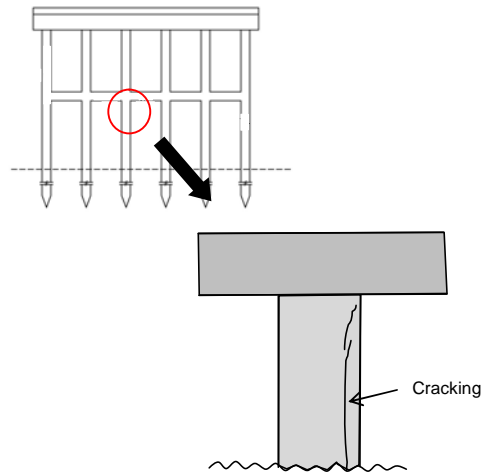
Cracking of pier

Damage level 3



Cracks of large influence (cracks propagated along the axial direction of column)

Crack pattern No.3

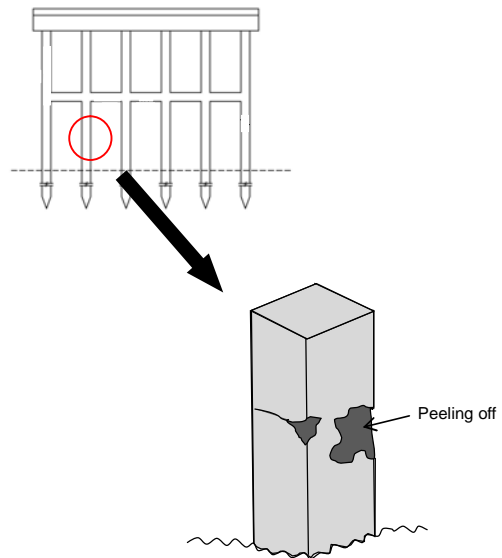


Damage level 3



Cracks of large influence (cracks propagated around column)

Crack pattern No.6



Under bridge (Pier)

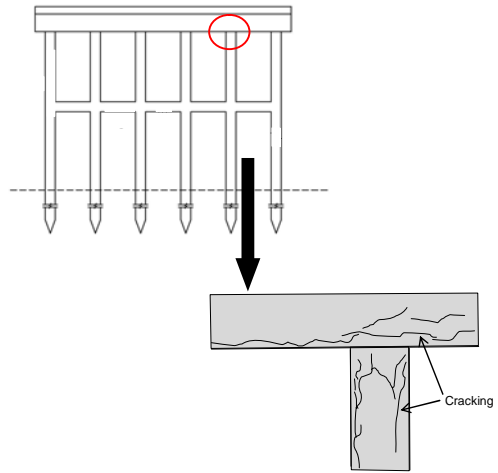
Cracking of pier

Damage level 3



Cracks of large influence (cracks propagated along the axial direction of column)

Crack pattern No.3

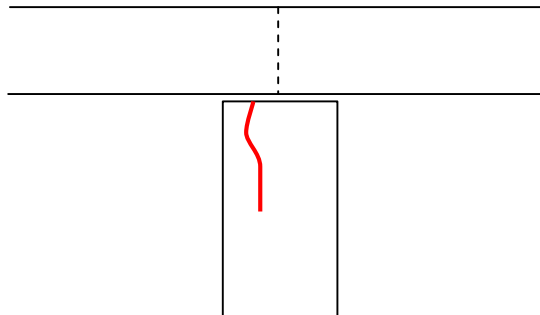


Damage level 3







Cracks of large influence (cracks propagated along the axial direction of column)

Crack pattern No.4




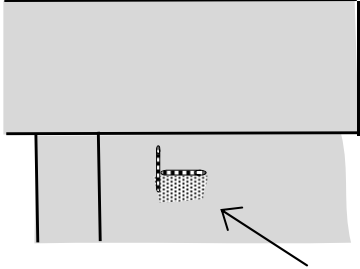

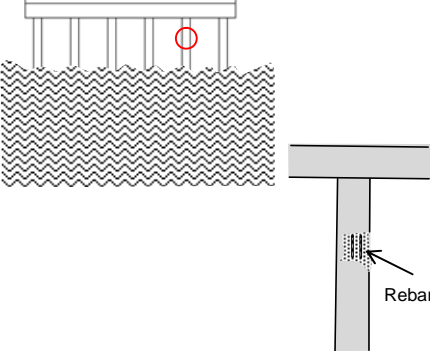

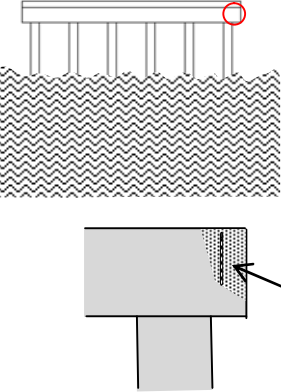
Under bridge (Pier)

Cracking, water leakage and free lime of substructure

Damage level 4	Damage level 4
 <p data-bbox="252 808 767 891">Cracks of large influence with water leakage and free lime</p> <p data-bbox="571 864 767 891">Crack pattern No.3</p>	 <p data-bbox="802 837 1185 864">Cracks of small influence with rust strain</p>
Damage level 5	Damage level 5
 <p data-bbox="252 1335 767 1361">Cracks of large influence with remarkable free lime</p> <p data-bbox="571 1395 767 1422">Crack pattern No.6</p>	 <p data-bbox="802 1335 1297 1361">Cracks of large influence with remarkable free lime</p> <p data-bbox="1102 1395 1299 1422">Crack pattern No.6</p>


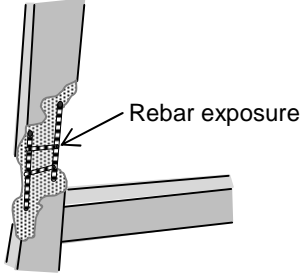

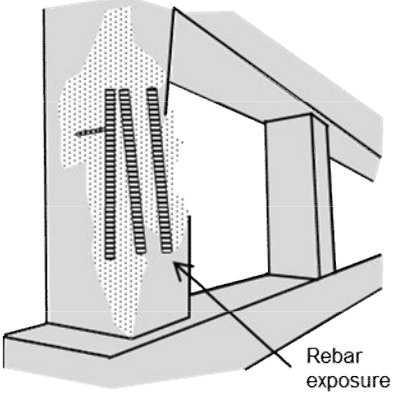
Under bridge (Pier)

Rebar exposure

Damage level 2	Damage level 2
 <p data-bbox="252 864 491 898">Partial rebar exposure</p>	 <p data-bbox="1145 819 1302 853">Rebar exposure</p>
Damage level 3	Damage level 3
 <p data-bbox="252 1395 491 1429">Partial rebar corrosion</p>	 <p data-bbox="1209 1339 1347 1373">Rebar exposure</p>
Damage level 3	Damage level 3
 <p data-bbox="252 1921 491 1955">Partial rebar corrosion</p>	 <p data-bbox="1129 1843 1302 1877">Rebar exposure</p>





Under bridge (Pier)

Rebar exposure

Damage level 5	Damage level 5
 <p data-bbox="252 869 593 900">Rebar corrosion around column</p>	 <p data-bbox="1011 618 1187 649">Rebar exposure</p>
Damage level 5	Damage level 5
 <p data-bbox="252 1393 593 1424">Rebar corrosion around column</p>	 <p data-bbox="1161 1346 1257 1391">Rebar exposure</p>

Under bridge (Top of pier and abutments)

Functional damages of bearings

Damage level 3	Damage level 3
 <p data-bbox="244 808 770 891">Damages appeared only on the girder (these damages shall be evaluated in cracks and rebar exposure.)</p>	 <p data-bbox="802 808 1297 891">Limited damages in bearing seat only (evaluated in cracks, water leakage, free lime or rebar exposure)</p>
Damage level 3	Damage level 3
 <p data-bbox="244 1335 738 1417">Bearing function is not restricted, even the rubber is deteriorated.</p>	 <p data-bbox="802 1335 1297 1417">Bearing function is not restricted, even the rubber is deteriorated.</p>

Under bridge (Top of pier and abutments)

Functional damages of bearings

Damage level 5	Damage level 5
 <p data-bbox="247 806 662 891">Functional damage in movement due to the accumulation of soil and dirt</p>	 <p data-bbox="801 835 1204 862">Bearing function is restricted by corrosion.</p>
Damage level 5	Damage level 5
 <p data-bbox="247 1332 391 1359">Broken bearing</p>	 <p data-bbox="801 1332 944 1359">Broken bearing</p>