BRIDGE INSPECTION MANUAL

FOR ARBICS AND PBC

EDITION 1

The Project for Strengthening of Capacity Development on Bridge Management System in the Republic of Kenya

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FOR ARBICS AND PBC
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FOREWORD

Bridges are integral elements of our road network. They perform effective linkage between two destinations thus they are critical for the economy. Despite their importance, maintenance of bridges has often not been prioritised in road network maintenance planning. This could be attributed to limited resources as well as other competing road network priorities. As a consequence, the deterioration rate of most bridges is not matched with maintenance interventions thus shortening their service life. Global warming and change in land use have made things worse as there has been a remarkable increase in surface run-off, resulting in overtopping and damage of bridges during the wet seasons. Therefore, without adequate attention, most bridges will be unsafe for use and will hinder the movement of people, goods, and services.

It is in view of the above, that there is need to put in place a framework to promote the inspection and maintenance of bridges in the road sector. This will ensure that our road assets are fit for purpose and safely provides connectivity at all times. This inspection manual is a product of a stakeholder-driven process which is intended to be a reference document to guide engineers and inspectors in carrying out bridge inspections and maintenance. The manual will be available for use for both the national government and county governments.

The objectives of this manual include assessing the current condition of the bridges and facilitating timely implementation of remedial measures, updating inventory data and carrying out performance evaluation of bridges. This will help to establish structural soundness, condition index and serviceability of the bridges to inform maintenance, improvements, design, and construction and to enable adequate planning and provision of resources essential to achieving efficient and effective bridge maintenance.

The manual addresses the most common bridge defects by outlining practical procedures for inspection and recommending appropriate tools and equipment to carry out the exercise. Defects have been discussed in detail with the help of pictures and sketches for ease of understanding. It is a comprehensive document and its implementation will be regularly monitored and reviewed to ensure it responds to emerging issues and meets desired performance.

To this end, the National Working Group (NWG) and the Sub-Working Group (SWG) have realized this important milestone for the road sector under *The Project for Strengthening of Capacity Development on Bridge Management System in the Republic of Kenya,* JICA. The implementation stage of this manual requires provision of adequate resources for the inspection and repair program and active participation by the stakeholders.

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Kenya National Highways Authority (KeNHA)
Kenya Rural Roads Authority (KeRRA)
Kenya Urban Roads Authority (KURA)
Kenya Wildlife Services (KWS)
Kenya Institute of Highways and Building Technology (KIHBT)
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ABBREVIATIONS AND ACRONYMS

AfDB	African Development Bank
AADT	Annual Average Daily Traffic
ARICS	Annual Road Inventory and Condition Survey
AC	Asphalt Concrete
ARBICS	Annual Road and Bridge Inventory and Condition Survey
BMS	Bridge management System
BI	Bridge Inspection
BICS	Bridge Inventory and Condition Survey
EBK	Engineers Board of Kenya
EDM	Electronic Distance Metre
GPR	Ground Penetrating Radar
GPS	Global Positioning System
JICA	Japan International Cooperation Agency
KeNHA	Kenya National Highways Authority
KeRRA	Kenya Rural Roads Authority
KETRB	Kenya Engineering Technology Registration Board
KURA	Kenya Urban Roads Authority
KWS	Kenya Wildlife Services
KRB	Kenya Roads Board
KIHBT	Kenya Institute of Highway and Building Technology
MoTIHUD & PW	Ministry of Transport , Infrastructure , Housing, Urban Development and Public works
MTRD	Materials Testing and Research Division
NCA	National Construction Authority
NDT	Non-Destructive Test
NWG	National Working Group
PBC	Performance Based Contracts
PC	Pre-stressed Concrete
RAs	Road Agencies
RC	Reinforced Concrete
SWG	Sub-Working Group
vpd	Vehicles per day

DEFINITIONS

Abutment	Vertical structural member located at the end of a bridge that connects the embankment portion of the approach road to the bridge. It supports the load from the superstructure and counters the earth pressure from the backfill.
ARMCO Culvert	Corrugated steel pipe culvert
Approach Slab	It is a concrete slab installed behind the abutment that acts as an intermediate bridge to avoid abrupt changes in elevation or alignment.
Back wall	The vertical wall at the ends of abutments that extends up from the bearing seat and supports the approach slabs, expansion joints and the embankment under the approach slabs.
Baseline inspection	An initial inspection conducted on a new bridge or an existing bridge to determine the primary condition in order to obtain information for BMS database and for future maintenance.
Bearing	Bearings are devices which transmit the vertical and horizontal actions from the superstructure to the substructure, and allow for movements between the superstructure and the substructure. Bearings allowing both rotation and longitudinal translation are called expansion/ movable bearings, and those, which allow rotation, only are called fixed bearings
Bridge	A structure, that can be accessed by any traffic, with the function of aiding crossing over a waterway, road or any other obstacle. In the context of this manual, it also includes box culverts, viaducts and tunnels. *NOTE: The terms bridge and structure can be used interchangeably.*
Carriageway	The part of the bridge surface which carries vehicular traffic.
Complex bridge	A complicated structure by design and construction that requires specialized maintenance intervention.
Condition Rating	This is a status indicator for bridge elements based on location, severity and element importance assigned after detailed inspection.
Contractor	An entity engaged by the Employer for the implementation of supply, maintenance and/or repair assignment.
Corrosion	The gradual deterioration of material (usually metals) by oxidation reaction forming a more stable oxide.
Damage	Defect due to external forces e.g., Flood, Vehicular load, Vehicular collision, Earth pressure, Vandalism.
Deck slab	A structural member that directly supports vehicles, pedestrians, etc. passing through a bridge and transmits loading to the main girder (main structure).

Defect	Collective term for initial flaw, damage and deterioration
Deterioration	Defects caused by changes in condition with age e.g., Carbonation, Alkali-silica reaction, Salt damage
Diaphragm	It is a bracing that connects main girders to resist lateral actions and transfer loads to the supports. It locks the girders in place and also provides support to the deck slab.
Drainage facility	A system that channels water away from the bridge deck, abutments and wing walls.
Emergency inspection	Inspection carried out after detection of abnormalities on the bridge. This may be after a natural disaster or accident to confirm safety of the bridge for use
Employer	The procuring entity responsible for the road network in Kenya and who enters into a road/bridge maintenance contract with a contractor on a certain section of the road.
Engineer	The representative of the Employer with responsibilities and obligations under the maintenance contract
Expansion gap	A gap provided to allow for expansion and contraction due to temperature changes. It can be between a bridge girder and abutment or between girders that are not continuous.
Expansion joint	It is a device installed at the expansion gap to ensure smooth expansion and contraction and to allow automobiles and other vehicles to run smoothly on the bridge. It is mainly made of steel or rubber.
Fill	Soil placed at the back of the abutment
Foundation	The part of the substructure that is in contact with the ground. Depending on the form, there are different types of foundations such as spread footing, pile foundations, and caisson foundations, etc. It transmits the loading from the substructure to the ground.
Implementers	The entity or persons directly involved in the inspections, maintenance/ repair of bridges. In maintenance of bridges, the implementers are the road agencies, engineering consultants and contractors engaged in the construction, repair and maintenance of structures/roads.
Initial Defect	Anomalies which are caused by design or occur during construction (poor workmanship) e.g Honeycomb, Cold joint.
Inspection	Diagnostic examinations on a bridge to discover any anomalies on the structural members.
Main girder/ Main structure	The main part of a superstructure that supports all the loads acting on the bridge. In general, it is called main girder in the case of girder structure, and main structure in the case of truss or arch structure.
Maintenance	The actions taken to keep the condition of a structural element to perform its level of service satisfactorily during its service life.
Obstructions	Accumulation of debris, driftwoods and stamps, rocks, silt, animals or anything that may impede free flow of water through a structure.

Ordinary bridges	Simply supported bridges with span lengths less than or equal to 30m.
PBC works	A series of works and services required for routine maintenance to bring up the bridge/road condition to the required service levels. Works and services are normally labour based works and pavement repair works
Performance	It is the level of achievement or compliance with the specified service levels.
Performance Based Contracting	A series of works and services required for routine maintenance to bring up and sustain the bridge/road condition to the specified service levels.
Periodic inspection	Inspection carried out after every five years to check soundness of bridges.
Pier	A substructure member which supports the superstructure at intermediate points, and transmits the load to the foundation.
Repair	This is the reinstatement of a damaged member or structure to its designed or as-built condition.
Road Agencies	The Agencies dealing with structures that are part of the road network which include: Kenya National Highways Authority (KeNHA), Kenya Rural Roads Authority (KeRRA), Kenya Urban Roads Authority (KURA), Kenya Wildlife Services (KWS), County Governments and any other stakeholders.
Routine inspection for ARBICS	This inspection is carried out *annually* to obtain bridge condition information for maintenance planning purposes.
Routine inspection for PBC	Inspection to confirm the serviceability of a bridge conducted *at least once a month* to check for defects with an aim of ensuring smooth traffic flow and preventing damage/hazards to third parties.
Service Level	Service level is the minimum performance standards for the level of quality for each service criteria set under various service scope of the road as defined in the specifications
Special inspection	Inspection for diagnostic study to examine the cause and extent of the damage based on findings from other inspections.
Stakeholders	Person(s) with interest in the use and operationalization of Inspection manual for bridges. They include the road agencies, engineering consultants, contractors, road users and the communities affected by the presence and usage of the bridge.
Substructure	The bridge structure that supports the superstructure and transfers loads from it to the ground or bedrock. The main components are abutments, piers, footings, and pilings.
Superstructure	The bridge structure that receives and supports traffic loads and in turn, transfers those loads to the substructure. It includes the main girder, deck slab, cross beam, lateral bracing, diaphragms. It comprises all the structural components of a bridge above the supports.

Wing wall	It is a wall adjacent to the abutment designed to retain-backfill material behind the abutment. The wing wall can be monolithic with the abutment or disjoint.

1. GENERAL

1.1 Background

Road transport is the predominant transport mode in Kenya. It carries over 90% of all passenger and freight traffic. The road assets portfolio is estimated at Kshs 3.5 trillion. The Assets comprise of over 161,000 km of classified roads and thousands of bridges.

Bridges are important elements of the road network. The road network should be looked at holistically considering the pavement itself, the alignment, drainage and crossing structures, use of the road and also, social and environmental aspects of the region being connected by the road.

It is in these considerations that there is need to improve the inspection and maintenance of the available bridges on our road network.

As new bridges are being built and old ones being replaced, the bridge inventory should be kept up-to-date to ensure that inspections being carried out continuously are properly referenced to the particular bridge.

Bridge Inspection is necessary due to the aging of bridges and changes in traffic factors. Further, due to global warming and change of land use, there has been remarkable increase in surface run-off, resulting in overtopping of some bridges during the wet seasons thus disrupting the movement of people, critical goods and services that are needed for the economy to prosper. Continuous data collection and reporting of the condition and functionality is key to ensure that there is sufficient and reliable data to justify the repair, maintenance and replacement, if need be, of the bridge in question.

1.2 Purpose

The purpose of this manual is to ensure consistency in bridge inspection, rating and evaluation across the various agencies tasked with bridge management.

This manual sets the standard rules for the data to be collected, frequency and methods to employ in bridge inspection. It is a reference book for achieving the objectives of bridge inspection.

1.3 Objectives

The objectives of implementing bridge inspection are:

(a) To facilitate collection and updating of appropriate inventory data to enable the establishment of sustainable maintenance programmes;

(b) To assess the current condition of the brdges and carry out performance evaluation, establish structural soundness, condition index and serviceability to inform maintenance, improvements, design and construction.

(c) To facilitate timely implementation of remedial measures for safe and smooth traffic flow.

(d) To enable adequate planning and provision of resources essential to achieving efficient and effective bridge maintenance.

(e) To harmonise existing procedures and practices, leveraging on international best practices to provide a standard approach to road structures inspections.

(f) To ensure safe and smooth traffic flow and prevent damage to roadside structures and third parties.

1.4 Scope of Application of the Manual

This Inspection Manual shall apply to bridges managed by Road Agencies implementing Performance Based Contracts (PBC) and Annual Road and Bridge Inventory and Conditions Survey (ARBICS) on their networks.

1.5 Reference Manuals

Reference manuals to be used are as outlined in *Table 1*.

Table 1 Reference manuals list

No	Types of Bridge Inspection	Activity	Reference Manual
1	Baseline Inspection	Detailed condition of the bridge	• Bridge Principal Inspection Procedure Manual • Structure Inventory Procedure Manual • Inspection Manual for Bridges (Principal)
2	Routine Inspection for PBC	General, Methodology, etc.	• Routine Inspection USER Manual • PBC Guideline
		Performance level	• Bridge Inspection Manual for ARBICS & PBC
		Record / Report	• Routine Inspection USER Manual
3	Routine Inspection for ARBICS	General, Methodology, etc.	• Bridge Inspection Manual for ARBICS & PBC
		Evaluation (Damage level)	• Bridge Inspection Manual for ARBICS & PBC
		Record	• Routine Inspection USER Manual
4	Periodic Inspection	General, Methodology, etc.	• Inspection Manual for Bridges (Principal)
		Evaluation (Damage level)	• Damage catalogue
		Record	• Bridge Principal Inspection Procedure Manual
5	Special Inspection		• Inspection Manual for Bridges (Principal)
6	Emergency Inspection		• Inspection Manual for Bridges (Principal)

1.6 Classification of Bridges

For the purpose of this manual, bridges are classified into "Ordinary bridges" and "Complex bridges".

Table 2 Classification of bridges

Classification	Explanation
Ordinary bridges	Simply supported bridges with span lengths less than or equal to 30m.
Complex bridge	A complicated structure by design and construction that requires specialized maintenance intervention.

Table 3 Examples of complex bridges

	Name of bridges	Type of Bridge
1.	Masalani bridge	Suspension bridge
2.	Bura bridge	Cable Stayed bridge
3.	Nyali bridge	Box Girder bridge
4.	Mtwapa bridge	
5.	Sabaki bridge	
6.	Kilifi bridge	
7.	Baricho bridge	
8.	Marigat bridge	Steel Truss bridge
9.	Galana Kulalu bridge	
10.	Endau bridge	
11.	Nginyang bridge	
12.	Wei Wei bridge	
13.	Lomut bridge	
14.	Mbita Causeway bridge	
15.	Kalobeyei River bridge	
16.	Lugards bridge	Bailey bridge
17.	Thua bridge	Steel box girder/modular
18.	Likoni floating footbridge	Steel truss/floating truss
19.	Makupa Bridge,	Pre-Stressed Conc. girder bridge
20.	Mteza Bridge	
21.	Tsunza bridge	
22.	Mwache bridge	

1.7 Bridge Inspection and Evaluation System

1.7.1 Background

Bridge inspection is an assessment of the condition and detailed investigation and evaluation of damage and/or material properties of specified bridge elements. The damage may be due to environmental impact (climate, saline soil, natural calamities, etc.), wear (insufficient maintenance), design and construction errors and overloading or similar conditions.

Inspection is the first step of maintenance where any deterioration or problems can be detected at an early stage, documented, reported and addressed before they get worse and costly.

Preservation of bridges and the safety of the road users depend largely on regular inspections and maintenance of the bridges.

The purpose of inspection is not only to identify clearly visible defects but also to anticipate the progress of minor defects and recognize where they are likely to occur and their probable causes.

Bridge inspectors should allocate sufficient time for undertaking inspection and collection of data, based on the type, size and complexity of the structure. Bridge inspection should be conducted with accuracy and thoroughness.

The data should then be evaluated to develop the bridge condition index, which informs the planning of interventions, prioritization of maintenance needs and assignment of resources.

1.7.2 Scope of Bridge Inspection

The scope of bridge inspection should include but not limited to:

1) Review of any previous inspection reports;
2) Determination and provision of equipment and resources required for the inspection including preparation of a safety plan;
3) Inspection of all relevant bridge attributes including measurements, testing and analysis as necessary to supplement the visual inspection; and
4) Identification of the probable causes and projected rate of deterioration and the effects of continued deterioration on the performance, durability and residual life of the bridge.

1.7.3 Types and Frequency of Bridge Inspection

This manual recognizes the following types of bridge inspections:

1. Baseline Inspection
2. Routine Inspection for PBC
3. Routine Inspection for ARBICS
4. Periodic Inspection
5. Special Inspection
6. Emergency Inspection

1 Baseline Inspection

Baseline inspection is the first/initial inspection after a bridge has been constructed and commissioned. It collects the baseline information for storage in a database, as a reference point for all future inspection.

2 Routine Inspection for PBC

The purpose of Daily Inspection is to detect abnormalities as early as possible for preventive maintenance consideration. Inspection of normal and special bridges shall be conducted as per the specifications in the PBC.

3 Routine Inspection for ARBICS

The purpose of Routine Inspection is to directly inspect and understand the condition of the bridges for budget preparation. Bridge Inventory and Condition Survey (BICS) shall be conducted annually. This is mainly through visual inspection with the support of binoculars, robot camera, drones and bridge checkers.

4 Periodic Inspection

Periodic inspection is for checking the soundness of bridges and shall be conducted at intervals of five (5) years. It should be conducted for all bridges to reduce maintenance and rehabilitation cost in the long term. The special bridges have many structural members to be inspected and therefore require preparation of an inspection plan which shall include safety control, materials and equipment. The Periodic Inspection shall be based on detailed visual inspection and Non-Destructive Test (NDT).

5 Special Inspection

Special Inspection is for diagnostic study to examine the cause and extent of the damage based on the findings from the previous inspection results in order to prepare a detailed plan of action. The diagnosis may involve field tests, laboratory tests and the structural performance monitoring.

6 Emergency Inspection

Emergency Inspection may be carried out upon detection of severe defect(s) on the bridge. This inspection is done after occurrence of a natural disaster or accident to ascertain the safety of the bridge for use and/or recommend appropriate remedial measures.

1.7.4 Bridge Inspection Structure

Bridge Inspection is composed of 5 layers in accordance with the objectives of the inspection. Thus, the data to be collected, methodology to be applied and preparation may differ. The inspection structure is illustrated below in *Figure 1:* Inspection structure and a summary of the gist of methodology outlined in *Table 3.*

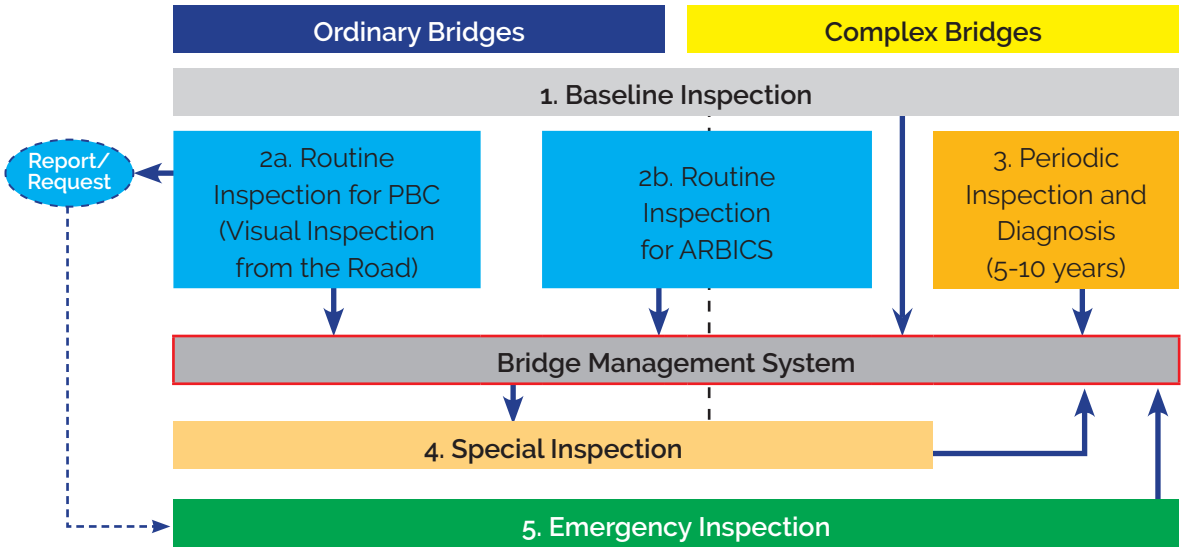


Figure 1 Inspection structure

Table 4 Types of bridge inspection

Types of Bridge Inspection	Objectives of the inspection	Methodology	Frequency	Implementer	Subject Bridge	
					Ordinary	Complex
1. Baseline Inspection	To record the initial bridge data after construction	Visual inspection and data from As Built drawings.	Once	RAs	✓	✓
2. Routine inspection for PBC	To keep smooth traffic flow, avoid third party disaster	Visually Inspecting the bridge with the naked eye to look for failure, damage, debris etc. from the road	Monthly	PBC Contractor	✓	✓
3. Routine inspection for ARBICS	To estimate budget	Visual inspection together with annual road inventory condition inspection	Annually	RAs	✓	✓
4. Periodic Inspection	To assess soundness of the bridges	Detailed visual inspection and measurement, Non-Destructive Test and equipment/technical gear	Every 5th to 10th year	RAs	✓	✓[1] Priority
5. Special Inspection	To design for repair and strengthen	Investigation using equipment/ technical gear	Whenever necessary	RAs	✓	✓
6. Emergency Inspection	To study incidents and immediate action	Following annual inspection	Whenever necessary	RAs	✓	✓

[1] **Periodic inspection** should cover all the bridges. However, due to time and cost constraints, priority should be given to complex bridges while ordinary bridges can be monitored annually under ARBICS

1.7.5 Bridge Inspection Methods

Typical bridge inspection methods conducted by qualified inspectors are shown in *Table 5*.

Table 5 Bridge inspection methods

	Method	Description
i	Visual inspection	Inspection technique that utilizes very basic tools (e.g., flashlights, sounding hammers, tape measures, plumb bob, and binoculars).
ii	Visual testing	Inspection technique where specific invasive tools such as borescopes[2] and other optical devices are used to aid visual inspection.
iii	Acoustical Techniques	This is a non-destructive technique which is performed using a chain drag or hammer to identify changes in sound pitch. The test is able to detect delamination, as well as the separation of coating or the splitting of a member into layers.
iv	Infrared / Thermal Imaging Inspection	This is also a non-destructive practice that examines changes in infrared radiation from the surface of concrete and indicates delamination.
v	Coring and Chipping	A destructive technique that uses a drilled core to create a hole in order to connect to the steel reinforcement and assess corrosion damage, and mechanical and chemical properties of the concrete.
vi	Ground Penetrating Radar (GPR)	This non-destructive test uses electromagnetic radiation to image the subsurface of the concrete and detect changes such as delamination, voids, and cracks.
vii	Half-Cell Potential Test	This non-destructive testing technique assesses the voltage between the steel reinforcement within the concrete and an electrode which is placed on the concrete's surface to map corrosion activity

1.7.6 Bridge Inspection Procedure

Bridge inspection shall adopt the following sequences and orientation for uniformity.

[2] A borescope (occasionally called a boroscope, though this spelling is nonstandard) is an *optical instrument* designed to assist *visual inspection* of narrow, difficult-to-reach *cavities*, consisting of a rigid or flexible tube with an *eyepiece* or *display* on one end, an *objective lens* or *camera* on the other, linked together by an optical or electrical system in between. The *optical system* in some instances is accompanied by (typically *fibreoptic*) *illumination* to enhance *brightness* and *contrast*. An internal image of the illuminated object is formed by the objective lens and *magnified* by the eyepiece which presents it to the viewer's eye.

Table 6 Sequences for bridge inspection

Longitudinal orientation	West – East or South - North	
Transverse orientation	Left to Right	
Sequence of Bridge part inspection		
Parts/Section	**Inspection**	**Remarks**
General observation	Observation including capturing photographic images of the whole bridge structure from different views	
Road condition of approaches	Road surface condition including installations within 100m to the bridge	Both sides
Top of the bridge	Condition of the bridge installations: Guard Rails, Drainage system, road wearing course, pedestrian walkways, hand rails, lighting, furniture and expansion joints	Longitudinally
Superstructure	Deck, Girders, Bearings	Inspect each span transversely from left to right proceeding longitudinally from West – East or South – North depending on bridge orientation
Sub-Structure	Piers, abutment, embankments,	West – East or South – North depending on bridge orientation
Foundation	Piles, pads, pile caps	West – East or South – North depending on bridge orientation
Stream/River	River bed, banks	Upstream to downstream 100 m either side

1.8 Qualification of Bridge Inspection Personnel

1.8.1 Bridge Inspection Team Leader

- The Team Leader should be registered as a professional Engineer with the Engineers Board of Kenya (EBK).
- Have a Bachelor's degree in Civil Engineering or an equivalent from an accredited university.
- Have at least five years' experience in the design, supervision and maintenance of road and bridges.
- Should have successfully completed a Bridge Management course from the Kenya Institute of Highways & Building Technology (KIHBT).

1.8.2 Bridge Inspection Engineers

- Bridge inspection Engineers should be registered as graduate Engineers under the Engineers Board of Kenya (EBK).
- Have a bachelor's degree in Civil Engineering or an equivalent from an accredited university
- Have at least three years' experience in the design, supervision and maintenance of road and bridges.
- Should have successfully completed a KIHBT Bridge Management course.

1.8.3 Bridge Inspectors

- Bridge inspectors should be registered as a Technologist with the Kenya Engineering Technology Registration Board (KETRB)
- Have a higher diploma or a Diploma in Civil Engineering.
- Have at least three years' experience in the design, supervision and maintenance of bridges.
- Should have successfully completed a KIHBT Bridge Management course.

1.9 Health and Safety

1.9.1 General

During inspection, safety practices are essential and of priority for the protection and safety of inspection personnel, general public and the surrounding environment. It is therefore advisable that inspections are conducted by a team that is trained on equipment and safety prior to the inspection exercise.

All the relevant stakeholders should be notified of a scheduled inspection in advance.

Safety measures of the following categories must be considered prior to commencement of any inspection:

1) Pre-inspection safety
2) Safety during inspection

1.9.2 Pre-inspection

Work safety measures must be planned in advance. The safety measures to keep in mind are:

1) Ensure that all tools, equipment and apparatus are available and in good working condition;
2) Ensure availability of necessary safety gear such as helmets, masks, safety harnesses, footwear, gloves etc.
3) Plan and arrange for signage, road closures and suitable traffic management procedures;

4) Identify and locate all the utilities existing at site such as electricity, water, sewerage, communications, and gas lines. If any risk is foreseen, relevant authorities should be informed for action in case of any emergencies;

1.9.3 Safety during inspection

Before commencing inspection at the site ensure that:

1) All personnel are wearing reflective/high visibility vests;
2) Inspectors know where to take refuge in case of emergency;
3) Location of unsafe areas and roads are identified and shared with all personnel;
4) Inspectors do not walk on or near the road, however, if absolutely necessary ensure that proper signage and traffic management measures are in place;
5) Inspectors walk in the direction facing oncoming traffic (the vehicles should not come from behind you).
6) All the lanes are clear before crossing the roads; and
7) Inspectors do not step backwards without checking their surroundings. In a noisy environment one may not hear the sound of approaching vehicles.
8) All inspections are carried out in well-ventilated and well-lit areas. If necessary, make prior arrangements for exhaust fans and artificial lighting; and
9) No one should be under the influence of alcohol or any medication which may impair alertness or cause drowsiness while working at site or operating any mechanical equipment.

1.9.4 Health and safety Checklist (safety gear, tools and equipment)

Table 7 Health and safety checklist

No.	Items Description	Normal Condition	Special Condition*
1.	Helmet	✓	✓
2.	Gloves	✓	✓
3.	First Aid Kit	✓	✓
4.	Safety boots and gum boots	✓	✓
5.	Safety Goggles	✓	✓
6.	Reflector jackets	✓	✓
7.	Reflective cones	✓	✓
8.	Reflective tapes	✓	✓
9.	Drones		✓
10.	Flash lights	✓	✓
11.	Head lamp		✓
12.	Ladder		✓

No.	Items Description	Normal Condition	Special Condition*
13.	Life jackets		✓
14.	Dust masks		✓
15.	Smart phone with a functional inspection app	✓	✓
16.	Pole camera	✓	✓
17.	Safety harness		✓
18.	Schmidt hammer	✓	✓
19.	Tape Measure	✓	✓
20.	Digital Camera	✓	✓
21.	Inspection Forms	✓	✓
22.	Panga/spade/slasher	✓	✓
23.	Wire brush	✓	✓
24.	Insect repellent	✓	✓
25.	Field note book	✓	✓
26.	Pen/pencil/eraser	✓	✓
27.	GPS gadget	✓	✓
28.	Power bank	✓	✓
29.	Umbrella/rain coat	✓	✓
30.	Ropes		✓
31.	Boat		✓
32.	Special inspection vehicle		✓
33.	Spanner	✓	✓
34.	Compass	✓	✓
35.	Measuring tools e.g. crack gauge, EDM	✓	✓

* ***Special Condition*** refers to inspection of complex structures/environment (viaduct, sea bridges, bridge over rail, express ways, bridges crossing permanent rivers, Suspension/ floating bridge)

1.10 Condition Rating

1.10.1 Definition

Condition rating are supportable to evaluate of bridge soundness. For this session, explanation how to calculate weights assigned to the bridge components based on the inspections carried out on site to indicate the level of deterioration or damage to the bridge components and their elements. Most important point is condition rating should be objective and not subjective. In addition, inspection result should be same leveling each bridges condition rating even if inspect other inspector. Therefore, the system sets condition rating automatically. Condition rating provides information on the status of the bridge and is NOT a measure of the design deficiency. The rating is based on the observed, materials-related, physical condition of the components at the time of inspection.

Condition rating is important in Bridge Inspection as it provides the critical information that helps in planning for the necessary repairs and modifications on the bridge.

During inspection, condition rating is given depending on the type of inspection i.e Routine inspection or Initial inspection. Each inspection serves a different purpose. Whereas routine inspection serves the purpose of finding defects of elements of the bridge and evaluating their severity initial inspection is a detailed inspection that involves measurement, non-destructive test and use of equipment /technical gear to give the overall bridge condition.

The routine inspection purpose is to find any defects on the bridge elements within a short time say 10-30 minutes per bridge while the Initial inspection target is to find the overall bridge soundness through a careful inspection that may last from half-day to full-day per bridge.

1.10.2 Routine inspection condition rating

Routine inspection is a visual inspection conducted to provide information that helps in planning for the necessary bridge repairs, to inform the necessity of urgent action and to inform change of maintenance plan of a structure.

The check elements for this inspection are:

1. Road surface
2. Superstructure
3. Substructure
4. Bearings
5. Embankments

The inspector goes to site to observe the severity and the extent of the defects on the bridge, then determine the Defect Condition Level of individual defects on elements according to the BMS App.

The defects can be rated under 4 levels as shown below:

Defect Level	Description	Recommended action
N	No defect found or defect is minor	• No action nor no monitoring required
DL I	Defects to observe. Defects do not compromise the structural integrity of the structure.	• Monitoring of defects under ARBICS and Periodic inspection • Preventive measures
DL II	Defects need action. Clear defects may compromise the structural integrity of the structure if no action in few years is taken.	• Detailed inspection • Remedial measures/ preventive measures
DL III	Defects need urgent action Clear defect that has significantly compromised the structural integrity of the structure/high risk.	• Emergency inspection • Immediate action (including control of traffic)

1.10.3 Routine inspection calculation approach

A tree diagram is used to allocate points to various bridge components that are used to calculate the routine inspection rating. The tree diagram has the bridge at the top having 100% of the components donated point (DP) which is a summation of the distributed points of the elements making up the bridge.

The bridge is then subdivided into three major components i.e. Principal Structure, Non-Structural Elements (NSE) and Road Restrain Systems.

The three major components are then divided into sub-components and allocated donated points as shown in *Figure 2.*

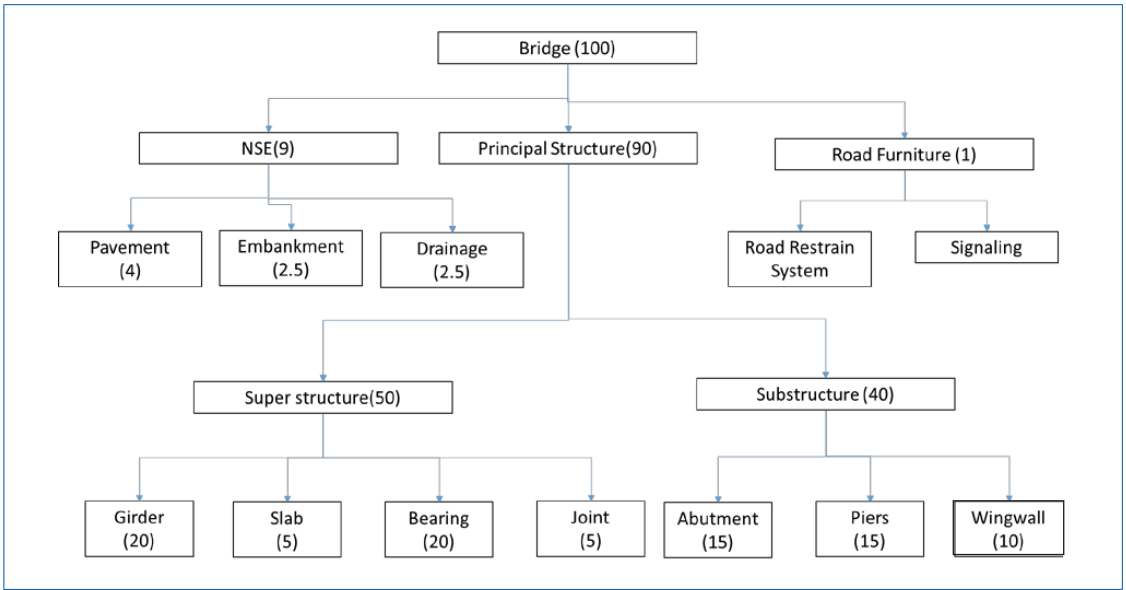


Figure 2 Bridge distribution of donated points

Using a formula, the Member Donated Points (MDP) are calculated to get the member soundness. From this data collected, and by means of different algorithms, the bridge rating is obtained. This bridge rating enables to categorize the bridge state based on five defined ranges. From N-blue, O-green, D-yellow, SD1-orange to SD2-red.

The different colour ranges from blue to red enables to prioritize the maintenance of bridges as well as to determine the need for action for each bridge.

Routine Inspection			
Defects Level on Structure elements	**Action/ Response time**		**Overall Condition Category**
N	80-100	Long – term action	N
N, DL I	60-79	Mid-long-term action	O
DL I, DL II	40-59	Mid-term action Require preventive measures	D
DL II, DL III	20-39	Short –term action (Requires prompt action)	SD1
DL III	0-19	Bridge collapsed/ Immediate urgent action (Require emergency measures)	SD2

1.10.4 Categories of Soundness Evaluation for Initial inspection

An algorithm to obtain the overall bridge rating upon completion of initial inspection has been developed where the dependency relationship between constituent parts of the bridge causes the rating to be transferred from different parts of the structure in ascending order to give the final overall bridge rating.

Condition rating evaluates each element separately; however, other deficiencies may affect the condition if they are directly related e.g. instability of an approach embankment will affect the condition of the abutment but not of the superstructure

Indicators such as extension and severity, enabling the damage assessment, are collected for each of the damages existing in a certain member of the structure. From this data, and by means of different algorithms, the bridge rating is obtained. The bridge rating enables to categorize the bridge state of conservation based on five defined ranges. This numerical value enables to prioritize the state of maintenance of a set of bridges at a specific moment as well as to determine the need for action in each bridge.

This evaluation (both from the bridge and from each of the subcomponents in which it is divided) ranges from 0, 'collapsed bridge', to 100, 'bridge in perfect condition'.

Score/Rating	Damage description	Action/Response time
80-100:	Bridge with minor durability or functional damages.	Long-term action
60-79:	Bridge with moderate durability or functional damages.	Mid / long-term action
40-59:	Bridge with minor structural damages or extended durability or functional damages.	Mid-term action Requires preventive measures
20-39:	Bridge with moderate structural damages. Serious durability or functional damages.	Short-term action (Requires prompt action)
0-19:	Collapsed bridge or bridge with high-severity structural damages.	Immediate urgent action (Require emergency measures)

An evaluation between 80 and 100 means that the bridge deteriorations do not affect the structural capacity of any of its elements but only minor durability or functional deteriorations are observed, requiring a long-term repair or not requiring any action.

An evaluation between 60 and 79 means that the bridge deteriorations do not affect the structural capacity of some of its elements and only moderate durability or functional deteriorations are observed, requiring a mid-term or long-term repair.

An evaluation between 40 and 59 means that the bridge deteriorations have minor effects on the structural capacity of some of its elements and extended durability or functional damages requiring a Mid-term action and preventive measures.

An evaluation between 20 and 39 means that the bridge deteriorations have moderate structural damages of some of its elements and serious durability or functional damages requiring short-term and prompt action.

An evaluation between 0 and 19 means that the bridge deteriorations seriously affect the structural capacity of some of its elements, requiring urgent action.

1.11 Record

The result of bridge inspection inputs on site for Bridge Management System (BMS) by mobile. For the input method of BMS, refer to Bridge Principal Inspection Procedure Manual.

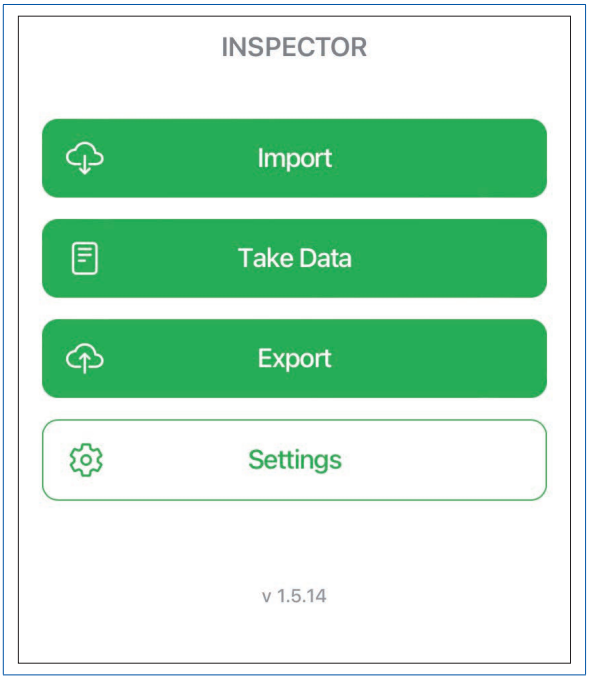


Figure 2 Bridge inspection inputs method

Table 8 Record of bridge inspection

No	Types of Bridge Inspection	Record method
1	Baseline inspection	BMS
2	Routine Inspection for PBC	PBC report form
3	Routine Inspection for ARBICS	BMS
4	Periodic Inspection	BMS
5	Special Inspection	BMS
6	Emergency Inspection	BMS

1.12 Repair Work

Appropriate measures shall be taken according to the Bridge Repair Manual.

2. ROUTINE INSPECTION FOR PBC

2.1 General

Performance based contracting (PBC) has been in use on road maintenance for several years in Kenya. Road Agencies have been implementing PBC at different scales. County Governments have also been involved in repair and maintenance of county roads since enactment of the Constitution 2010, and through the County Allocation of Revenue Bill 2019.

If well managed through costing and implementation, PBC provides means of continuously monitoring and documenting incidents and accidents on the roads. Simplified sheets are used for daily and monthly inspections for confirmation of payment due to the contractor based on the achieved level of service. Deductions are made on areas of non-compliance by the PBC contractor.

The purpose of this section of the Bridge Inspection Manual for ARBICS and PBC is to enhance the maintenance of bridges on the road network under PBC and roads being maintained under routine and periodic maintenance.

2.2 Methodology

Routine inspections shall be carried out in three phases during PBC implementation:

1. Initial Inspection
2. Daily Inspection
3. Final Inspection

1. Initial Inspection

The purpose of the initial inspection is for the contractor to grasp the conditions of the bridges and to understand the scope of work required during the PBC implementation. The items to be repaired under the scope of PBC are to be noted at this time. The defects which are outside the scope of works and cannot be repaired under PBC shall be communicated within 24 hours to the Employer.

2. Daily Inspection

The purpose of the daily inspection is to ensure that the condition of the bridge is monitored for achievement of service levels and determine effectiveness of intervention measures.

The daily inspection will be general. It is important to ensure that the critical elements of the bridges are inspected.

3. Final Inspection

The final inspection will be done at the end of the PBC project. The inventory and condition of the bridge(s) are updated in the BMS. The information that the next PBC contract needs to address will be noted. This is in the spirit of improving the service level and longevity of the bridge.

2.3 Service Levels

Service levels are the minimum requirements that the contractor needs to maintain for the optimal functioning of the road asset. If the levels fall below the set service levels, the contractor will not receive full payment and will be penalized depending on the reduction weight set at the start of the contract.

The check items for structures to be inspected are highlighted in *Table 9*.

Table 9 Bridge maintenance item under PBC

No	Check Element	Defect	Service Level
1	Concrete bridges	Structural deterioration	Concrete bridges must be in good condition and fully functional.
2	Box culvert	Obstruction due to sediments, soils and washed materials	Must be free flowing at all times.
3	Steel bridges	Structural deterioration, leaking structures	The steel bridges (e.g., Bridge and pedestrian bridge) must be clean, in good condition, free of corrosion and fully functional.
4	Bridge expansion joints	Debris impeding joint movement/damaging the joint	All expansion joints must be clean and in good condition and fully functional.
5	Guardrail / Pedestrian Rail	Deformed / Missing guardrails	Guardrails must be in good condition and fully functional.
6	Riverbeds	Obstructions due to debris or inappropriate vegetation	Riverbeds must be maintained to ensure free flow of water under the bridge and up to 50 meters upstream and downstream of the river at all times.
7	Riverbeds	Eroded river beds	Erosion around bridge abutments and piers must be controlled with all reasonable measures at all times.

Note:

1. For defects details refer to Bridge Damage Catalogue.

2.4 Service Level Inspection

Service level inspection is carried out at the end of every month jointly by the Employer and Contractor to ascertain that PBC works were carried out as specified in the contract. Based on the achieved level of service, the monthly payment is made after making the deductions for non-compliance.
Depending on the type of PBC contract under consideration, off-carriageway works or on-carriageway works or a combination of both, the scope of works the contractor should fulfil in the contract is specified.

For off-carriageway PBC works, the contractor is tasked with ensuring the off-carriageway is clean, the vegetation within the right of way is controlled as specified and that the drains and bridges are clean to ensure free flow. The off-carriageway items are mainly labour based.

For on-carriageway PBC works, the contractor is expected to repair specific items of the carriageway for example, guardrails, potholes and concrete structures. The target items are normally listed in the special specifications of the tender document.

For both the off and on carriageway PBC works, the scope will encompass the activities as explained above for off and on carriageway. The entire scope will be as listed in the special specifications of the tender document.

The road and bridges should be considered as one item during inspection. Other than the service criteria of maintenance of bridges, the contractor should, with the same zeal, focus on the following service criteria:

i. Passability.
ii. Smooth and safe traffic flow.
iii. Visibility.
iv. Traffic information.
v. Drainage capability.
vi. Vegetation control.
vii. Slope stability.
viii. Visual intrusion.
ix. Accessibility for footbridges.

The above items, if left unattended, may contribute to damage to the bridges.

Appendix 2 shows the performance standards for the four service levels established for the road network in Kenya depending on the traffic volume and road type. The service levels are:

i. Paved high {Annual Average Daily Traffic (AADT) more than 20,000 vpd}
ii. Paved standard (AADT less than 20,000 vpd)
iii. Unpaved high (AADT more than 500 vpd)
iv. Unpaved standard (AADT less than 500 vpd)

2.5 Inspection Report

It is important for the contractor regardless of the type of PBC being implemented to monitor the condition of the bridges in the contracted road section and notify the Engineer any structural damage within twenty-four (24) hours after detection.

For a detailed inspection report, you can use the Inspection Form in Appendix 3 in this manual.

3 ROUTINE INSPECTION FOR ARBICS

3.1 General

Annual Road and Bridge Inventory Condition Survey (ARBICS) is an annual data collection exercise whose objective is to update road and bridge inventory and condition database. During the survey, bridges are inspected using the BMS tool to timely monitor their condition. For purposes of differentiating the annual inspection of bridges from the well-known exercise on the roads, the annual bridge inspection shall be referred to as ARBICS.

3.2 Methodology

The ARBICS inspection shall be conducted using the BMS application. The BMS database consists of the Inventory and Inspection information.

3.3 Inspection Equipment

The list in *Table 10* consists of the recommended safety gear, tools and equipment for inspection:

Table 10 Tools and equipment

Tools & Equipment	Safety gear
Tape measure	Long sleeve shirt
Camera (Tablets and smartphones can be substituted)	Utility belt
Tablet/Smartphone (installed BMS application)	Reflector Jacket
Test hammer	Safety gloves
Ladder	Safety boots
Crack scale	Safety harness
Crack gauge	Safety cones
Pole Camera	Warning signs
Drone	Helmet
Chalk	First Aid Kit
Schmidt Hammer and Test Ambil	
Monocular/Binoculars	

Together with the tools & equipment, the Inspector should also carry the Bridge Inspection Handbook for reference during the field work.

3.4 Bridge Inventory

Inspections are conducted on various bridges for various objectives. Before starting the ARBICS inspection, it is important to grasp and study the target bridge inventory data for the particular bridge. The bridge inventory data can be obtained from the Bridge Management System database.

3.5 Inspection Items

The key inspection items for ARBICS are shown in *Table 11*. Additionally, photographs are taken and stored with inspection records.

Table 11 Inspection items for ARBICS

Category	Check Element		Check Item
Road Surface	Pavement		Siltation
			Pothole, Rut
			Crack
			Others
	Bridge Railing/Guardrail/Curb		Deformation
			Faulty lighting
			Missing Parts
			Others
	Expansion Joint		Deformation
			Misalignment
			Abnormal Sound
			Siltation
			Others
	Drainage System		Clogging
			Broken
			Others
Superstructure	Superstructure	Steel	Surface alteration
			Corrosion
			Deformation
			Crack
			Missing Parts
			Missing bolts, rivets, anchors
			Rupture
			Others
		Concrete	Honeycomb
			Spalling
			Spalling concrete showing reinforcing rods
			Crack
			Precipitate (Free lime, Rust fluid)
			Others
		Other (Masonry, Wooden, others)	Corrosion
			Deformation
			Misalignment
			Crack
			Missing Parts
			Others

Category	Check Element		Check Item
	Slab	Steel	Corrosion
			Deformation
			Crack
			Others
		Concrete	Honeycomb
			Spalling
			Spalling concrete showing reinforcing rods
			Crack
			Precipitate (Free lime, Rust fluid)
			Others
		Wooden	Corrosion-Rotting
			Deformation
			Crack
			Missing Parts
			Others
Substructure	Abutment	Concrete	Honeycomb
			Deformation (leaning)
			Spalling
			Spalling concrete showing reinforcing rods
			Crack
			Subsidence
			Scouring
			Others
		Other (Masonry, Wooden, others)	Corrosion
			Deformation (leaning)
			Crack
			Subsidence
			Scouring
			Others
	Wing wall	Concrete	Honeycomb
			Deformation (leaning)
			Spalling
			Spalling concrete showing reinforcing rods
			Crack
			Subsidence
			Scouring
			Others
		Other (Masonry, Wooden, others)	Corrosion
			Deformation (leaning)
			Crack
			Subsidence
			Scouring
			Others

Category	Check Element		Check Item
	Pier	Concrete	Honeycomb
			Deformation (leaning)
			Spalling
			Spalling concrete showing reinforcing rods
			Crack
			Subsidence
			Scouring
			Others
		Other (Masonry, Wooden, others)	Corrosion
			Deformation (leaning)
			Crack
			Subsidence
			Scouring
			Others
Bearings	Main body	Steel	Corrosion
			Deformation (leaning)
			Missing Parts
			Rupture
			Others
		Rubber	Crack
			Deformation
			Rubber breaks
			Others
	Around bearing		Corrosion
			Deformation
			Stagnant water
			Sedimentation
			Others
Embankments			Scouring
			Slope failure
			Others

3.6 Evaluation of Defects

See Appendix 1.

3.7 Inspection Report

See Appendix 4.

3.8 Bridge Inspection Key Points for ARBICS

3.8.1 General Areas to Check during Annual Inspection

Table 12 General inspection checklist

Main Parts		Viewpoints
(1)	General	▪ Check the entire bridge for any deformations/defects (signs of settlement of abutments, piers and approach slab, cracking, excessive deflection of girders, potholes). ▪ Is there any abnormal sound, especially during passage of heavy vehicles? ▪ What is the magnitude of vibration when vehicles are passing over?

3.8.2 Key Points of Inspection for a Concrete Bridge

3.8.2.1 Concrete Girder

The common defects on the concrete girder to check during Annual Inspection are shown in *Table 13*

Table 13 Concrete girder defects

Main Parts		Observations/Considerations
(1)	Girder-End	▪ There is often high humidity or silt deposit in narrow space. **Note**: It may be difficult to inspect the bottom surface of the girder or the top surface of substructure in case of lower bearing height. ▪ Water leakage may occur through the expansion joint. ▪ Cracks may develop because bearings are subjected to high stress.
(2)	Girder Intermediate Support	▪ Corrosion of steel rebars may occur under extreme condition such as high humidity. ▪ Check for silt deposit in narrow spaces. ▪ Cracks may develop because of the girder support conditions which are subjected to high stress.
(3)	Girder Centre	▪ Experiences high stress concentration that may lead to failure such as cracks, collapse if members develop excessive defects. ▪ Corrosion and discoloration with rust fluid may be observed on the surface.
(4)	Quarter Span	▪ Shear cracks may develop because of inadequate rebars and/or excessive loading.
(5)	Construction Joint	▪ Cracks may develop at the construction joint boundaries due to lack of continuity. ▪ Water leakage or free lime precipitation may be observed if there is penetrating crack.
(6)	PC Steel wire	▪ Noticeable corrosion in pre-stressed concrete (PC) steel wire may result in fracture of the steel if there is no grout-filling. ▪ PC steel may be visible due to release of accumulated tension if there is fracture of the PC steel. **Note:** Corrosion or partial loss of strength of steel inside concrete may be difficult to identify by visual inspection. ▪ Presence of water in PC steel duct may be the cause of water leakage from around PC steel anchorage or filling concrete or lime precipitation.
(7)	Anchorage	▪ Cracks may develop due to working stress concentration. ▪ Water may seep through the upper joint to PC steel causing corrosion. **Note:** The deterioration under the pavement cannot be seen by visual inspection. It is therefore important to understand the signs of corrosion inside the concrete from the deterioration of the concrete in and around the anchorage. Further tests can be recommended as deemed necessary.

Main Parts		Observations/Considerations
(8)	Cut-out / Gerber	▪ Cracks may develop due to stress concentration at the cut-out part of anchorage girder side due to cross section changing drastically (Gerber-hinged or cut-out parts)

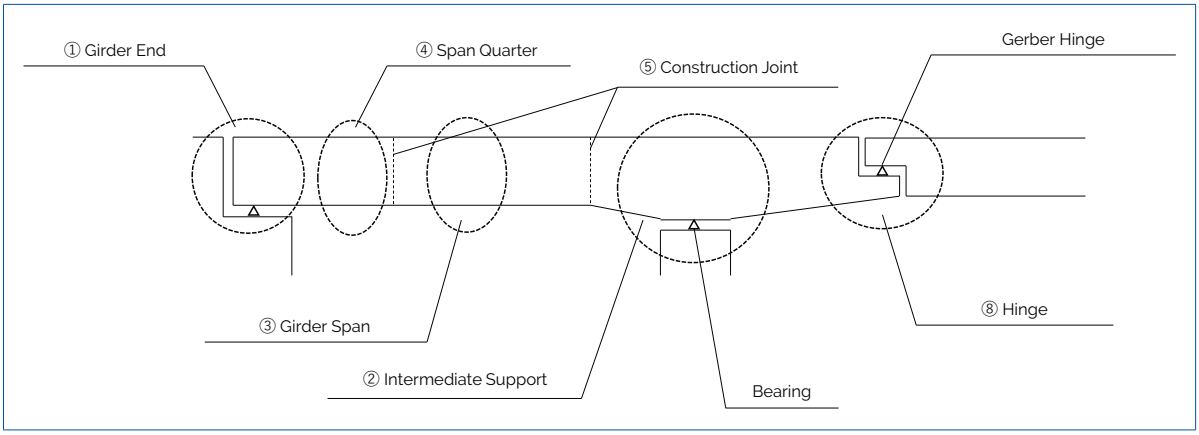


Figure 3 Concrete girder

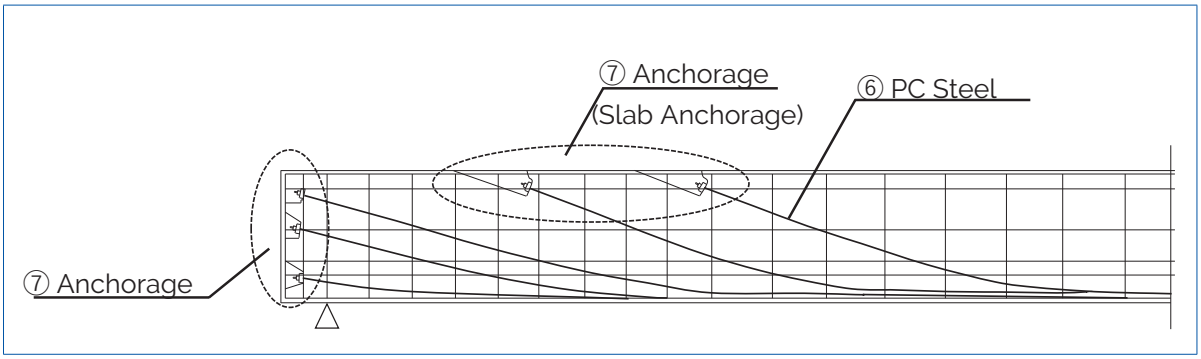


Figure 4 PC girder steel arrangement

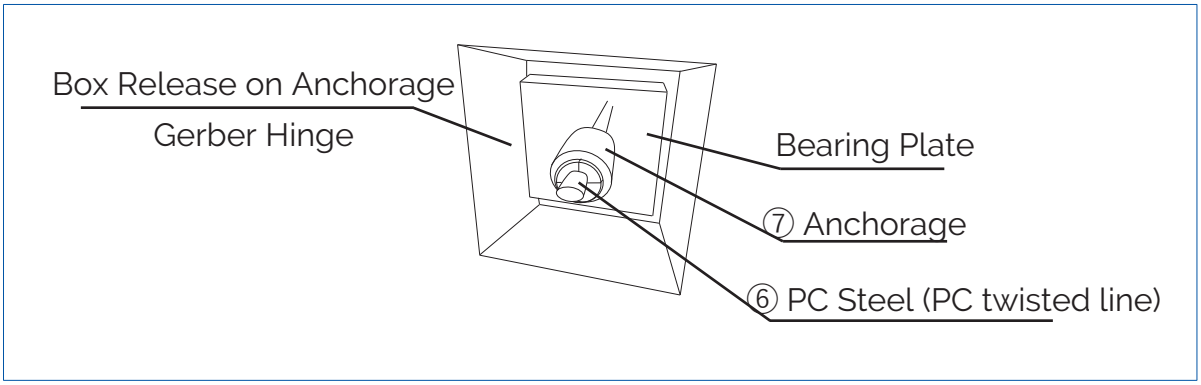


Figure 5 Anchorage on PC steel

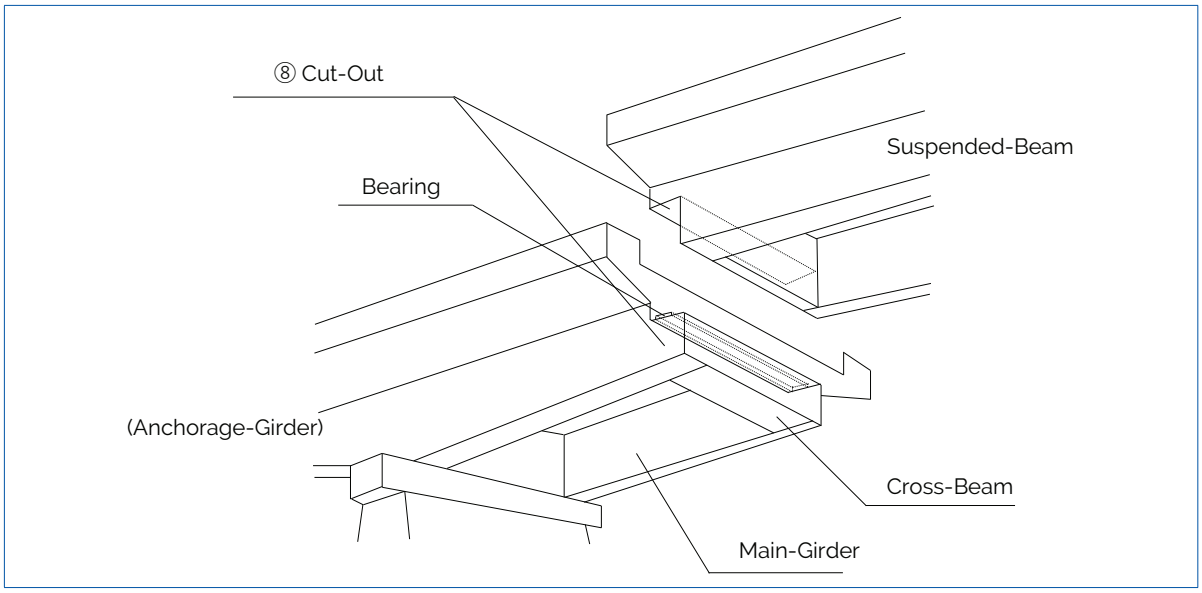


Figure 6　Gerber section

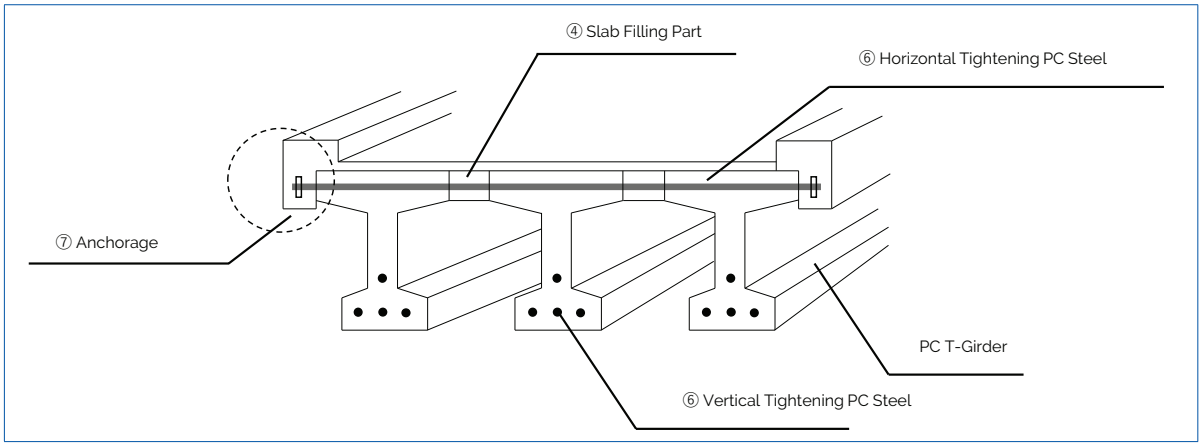


Figure 7　PC T-Girder bridge

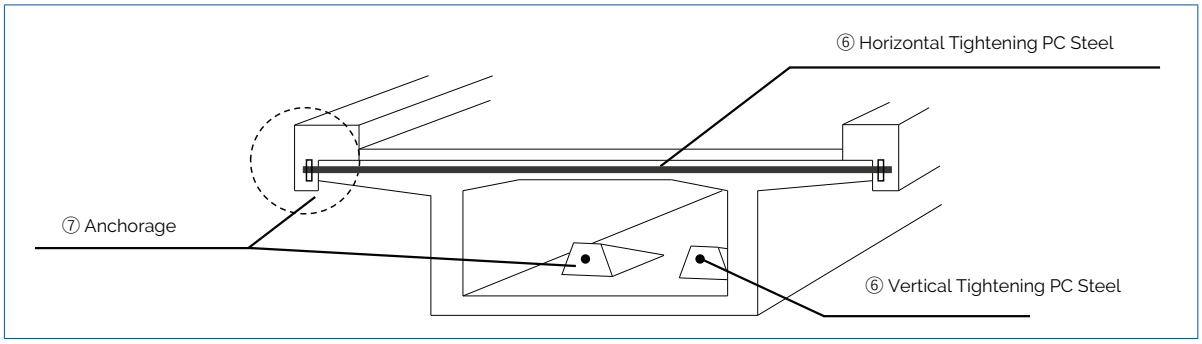


Figure 8　PC box girder bridge

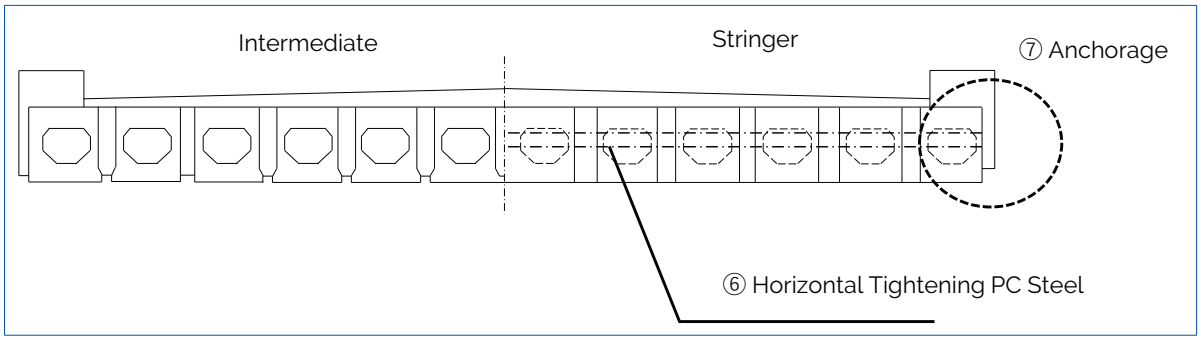


Figure 9 PC pre-tension hollow floor slab bridge

3.8.2.2 Concrete Slab Bridge

The slab bridge has no beams and therefore the points to be targeted for inspection are different from those of the girder bridge. This is because the slab bridge is composed of concrete material only and has no irregularities in the bottom surface unlike the case of girder bridge.

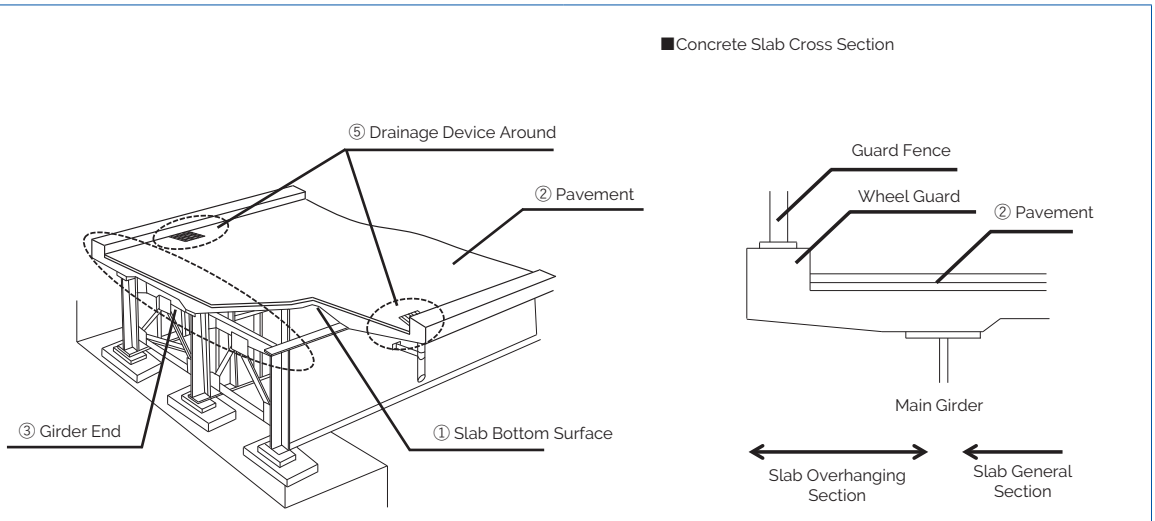
However, it is necessary to check the condition if slab bridge has a hollow cross section.

Common defects to check on a Concrete Slab Bridge during inspection are shown in *Table 14*

Table 14 Common defects on a concrete slab bridge

Main Parts		Observations / Considerations
(1)	Bottom and Top Surface on Concrete Slab	▪ Cracks may develop due to repeated loading. ▪ Lime precipitation or rust fluid may occur due to water seepage from upper surface of the slab. ▪ It is susceptible to impact force from vehicle loads due to the influence of road surface irregularities and expansion joint. ▪ Spalling of concrete cover, peeling and rebar exposure may be caused by fatigue cracks, neutralization and salt damage. ▪ Partial fall off of slab concrete may be due to deterioration of concrete if there is fatigue cracks or infiltration of rainwater to slab. ▪ Noticeable deterioration on the upper side of concrete deck slab may be identified in case there is pavement depression or tracks of cement spouting. ▪ Damages in the concrete may not be observed from the surface if steel plates, carbon fibre sheets, or peeling prevention agent are installed under deck slab. ▪ Deterioration in deck slab or joint parts of repair materials may proceed rapidly due to infiltration of water. The extent of deterioration may spread widely if the repair/reinforcement materials (such as steel plates, carbon fibre sheets, or peeling prevention agent) are installed under the deck slab.

Main Parts		Observations / Considerations
(2)	Pavement	▪ Damages to pavement may be caused by deformation of concrete slab. ▪ Poorly installed expansion joint and uneven settlement of any part of the bridge may cause level difference thus, water ponding.
(3)	Girder-End	▪ Girder-end may be damaged by impact force from passing vehicle.
(4)	Slab Filling Part of Concrete T-Girder Bridge	▪ Lime precipitation or rust fluid may be caused by water ingress from the upper slab surface through the construction joint. ▪ Filling concrete may fall off due to the loss of adhesion in the construction joint between the T-girder and the slab filling parts (see **figure 11)**.
(5)	Drainage facilities	▪ Drainage may leak water and lead to deterioration
(6)	Previous Repair/ Reinforcing Material	▪ Deterioration in the concrete may not be observed from the surface if repair/reinforcing materials are installed. ▪ Deterioration in the interface between base material and repair/ reinforcing materials may proceed rapidly due to ingress of water. The extent of deterioration may spread widely if the repair/reinforcement materials (such as steel plates, carbon fibre sheets, or peeling prevention agent) are installed.



Concrete Slab	Slab Cross Section

Figure 10 Concrete slab

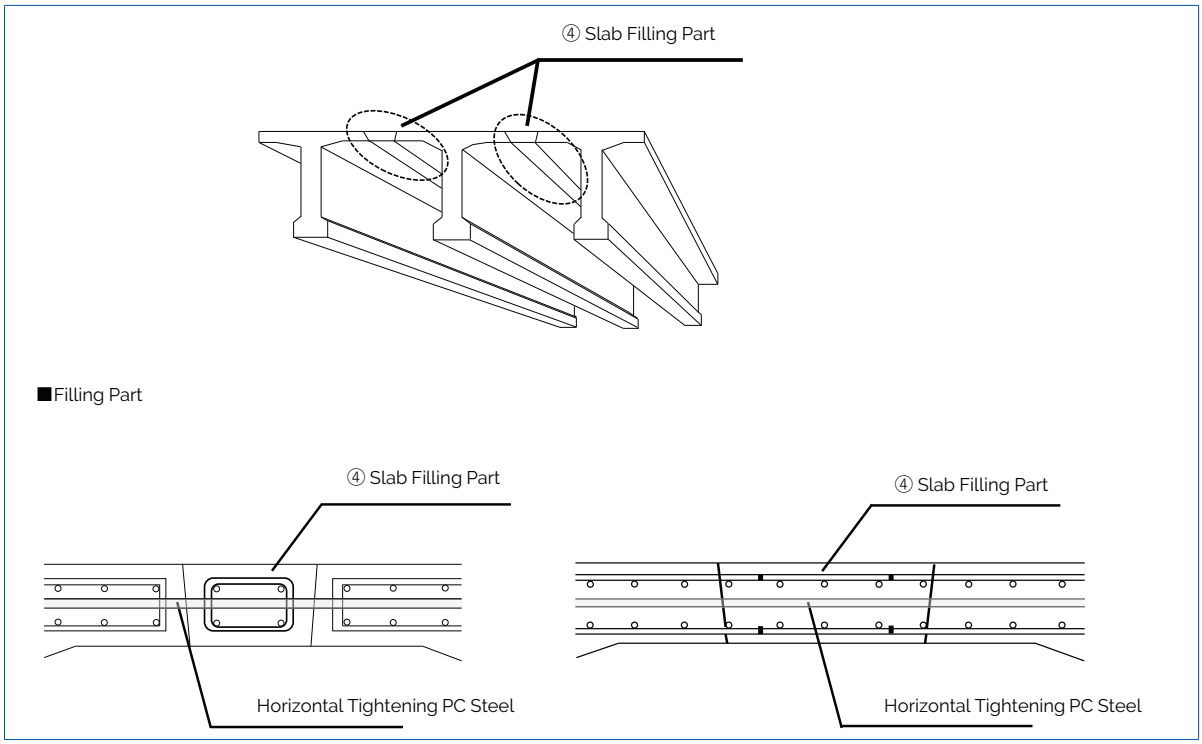


Figure 11 Example of filling part and rebar arrangement method

3.8.3 Key Points of Inspection for Steel Bridge

Common defects to check on a steel bridge during inspection are shown in *Table 15*.

Table 15 Steel bridge viewpoint

Main Parts	Observations / Considerations
1. Girder-End	▪ Localized and severe corrosion may occur under extreme condition such as high humidity or silt deposit in narrow space. ▪ Water leakage from expansion joint shall be checked. ▪ It is susceptible to impact force from vehicle loads due to the influence of road surface irregularities/unevenness and expansion joint.
2. Intermediate Support	▪ Localized and severe corrosion may occur under extreme condition such as high humidity or silt deposit in narrow spaces. ▪ As with girder ends, they are susceptible to high stresses, which can lead to cracks in the welds and damage such as deformation by differential movements.
3. Girder Centre	▪ Experiences high stress concentration that may lead to failure such as cracks, collapse if members develop excessive defects.

Main Parts	Observations / Considerations
4. Joint	▪ Bolted joints are prone to accumulation of rainwater and dust such as at splicing joints, gusset plate joints, which may lead to corrosion. ▪ Bolted joints are areas where the coating film is easily damaged at the corners and edges, and where it is difficult to secure the coating film thickness. Therefore, corrosion prevention function is compromised and corrosion progresses. ▪ Welded joints are prone to cracks. ▪ Missing/vandalized parts
5. Panel Points of Main Girder	▪ Localized and severe corrosion may occur under extreme condition such as high humidity or silt deposit in narrow spaces. ▪ Cracks and deformations may occur at gusset plates. **Note:** Panel points are important parts that affect the durability of the bridge.
6. Mounting point of accessories / appurtenances	▪ Depending on the connection structure of the appurtenances, it may be prone to corrosion due to stagnant water. ▪ The vibration of the appurtenances may affect the main structure of the bridge. Loosening of bolts and cracks may occur in the main structural members. ▪ If the connecting structure on the appurtenances side is damaged by corrosion or cracks, it may cause damage to third parties by falling or collapsing.
7. Drainage facilities	▪ Corrosion may occur due to leakage or splashing of rainwater caused by faulty or improperly positioned drainage facilities. ▪ Siltation and/or blockage may occur on drainage facilities causing water ponding.
8. Overpass bridge	▪ Structural damage to bridge elements may be caused by accidental impact from vehicles passing under or over the bridge.
9. Inside Box Girder or Steel Piers	▪ Water leakage from a manhole or drainage pipes may lead to water stagnation and corrosion.

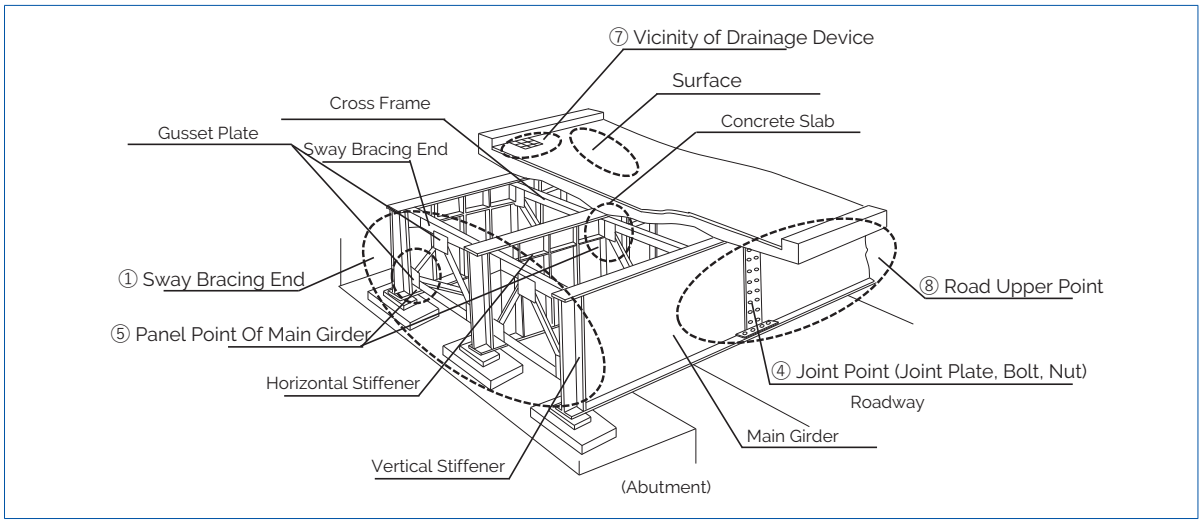


Figure 12 Steel plate girder bridge

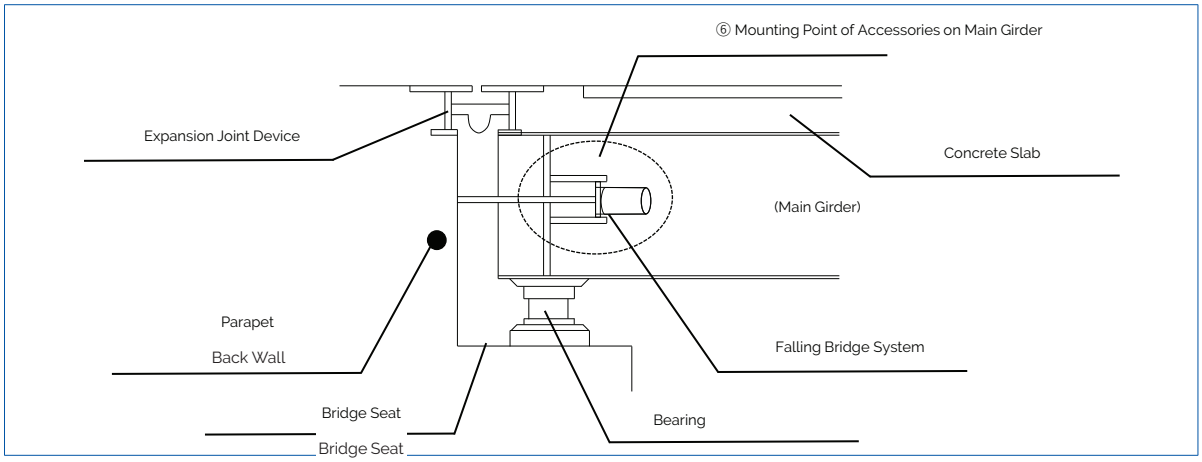


Figure 13 Girder end

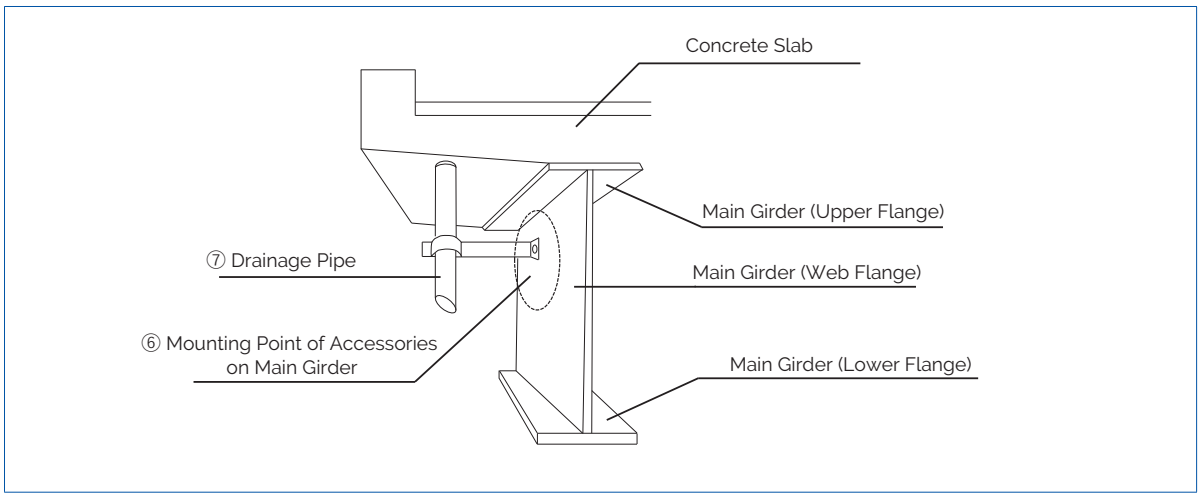


Figure 14 Vicinity of drainage device

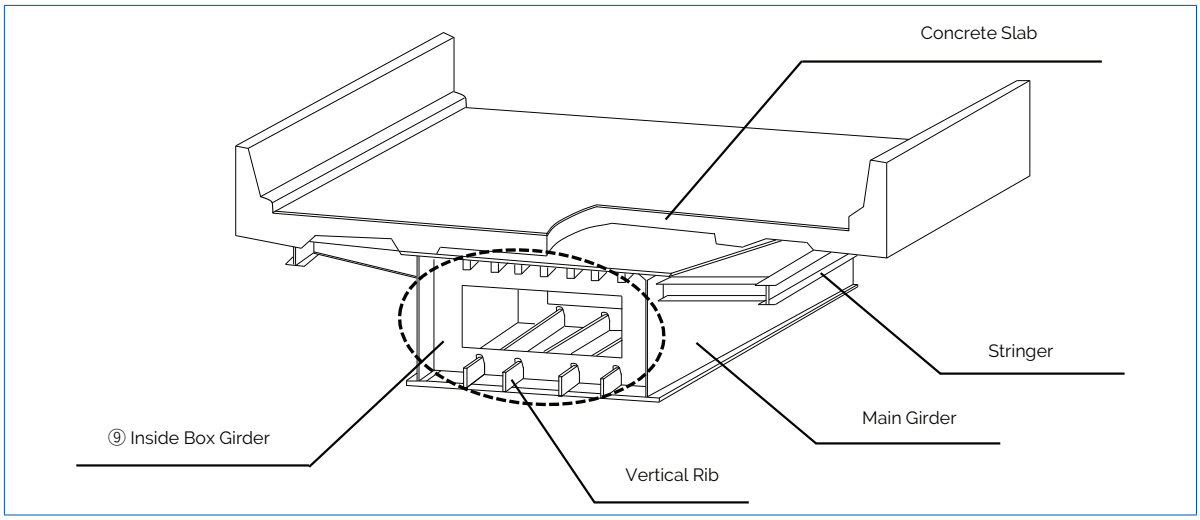


Figure 15　Steel box girder bridge

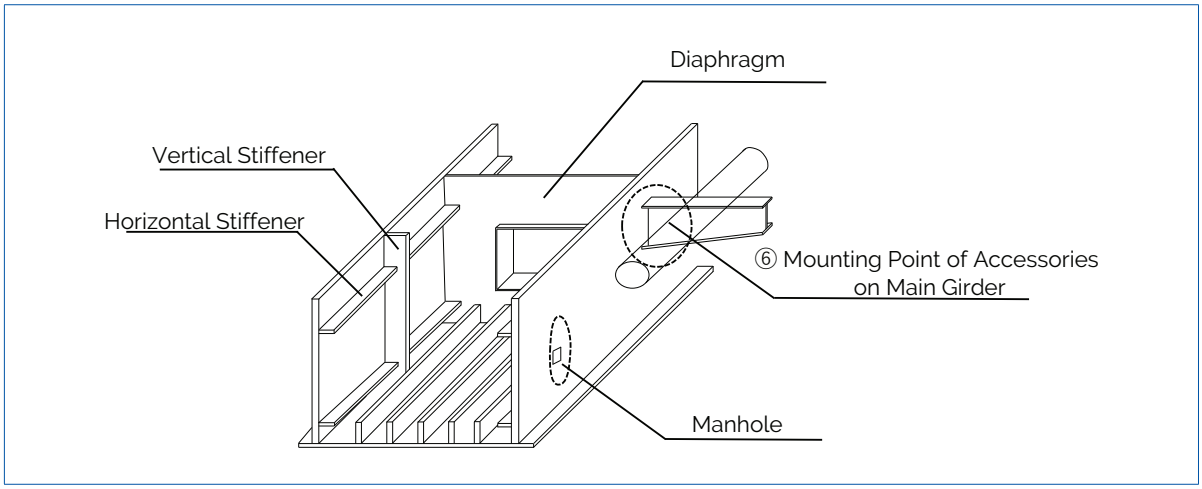


Figure 16　Inside box girder

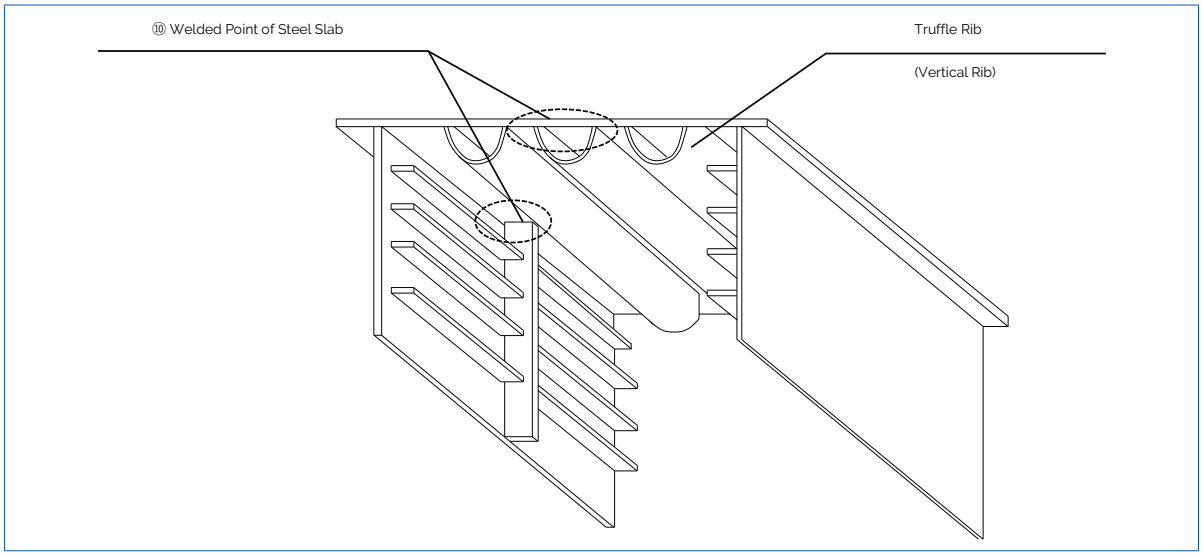


Figure 17　Steel slab

3.8.4 Key Points of Inspection for Substructure

Common defects to check on a Substructure during Inspection are shown in *Table 16*.

Table 16 Substructure

Main Parts		Observations / Considerations
(1)	Abutment	▪ Parts exposed to weather elements may develop cracks. ▪ Lime precipitation or rust fluid may occur due to water seepage from approach of abutment. ▪ Subsidence, inclination, or movement may be generated due to active pressure from backfill material. ▪ Abutment on slope may be unstable due to scour or slippage of the ground.
(2)	Pier	▪ Cantilever part that is exposed to extreme weather conditions may develop defects. ▪ Upper side of cantilever part may develop cracks because the section is exposed to high stress. ▪ Cracks may develop around bearings. ▪ Scour may occur on the pier wall due to lack of adequate protection works.
(3)	Foundation and piles	▪ Due to the structural characteristics of spread foundations and pile cap/bent, when scouring occurs, the deformation is likely to lead to instability (settlement, tilt, and general or local buckling). ▪ Scour may occur on the foundation of the pier due to lack of adequate protection works. The extent of scouring tends to increase with the width of resistance to water flow. ▪ Impact from water borne debris and boulders to piles and pile caps / bents may lead to structural damage and corrosion in the case of steel foundations. ▪ Submerged or partially submerged areas of steel piles/casings may corrode depending on conditions. It is advisable to periodically monitor the condition of the protective coating against damage. ▪ Check out for damage to corrosion protection caused by mooring (anchoring) to pile caps / bents, and corrosion from contact with different metals. **Note 1:** The condition of riverbed and scouring around pier can be often inspected by camera. **Note 2:** Condition of members or riverbed can be inspected closely and directly in dry season.

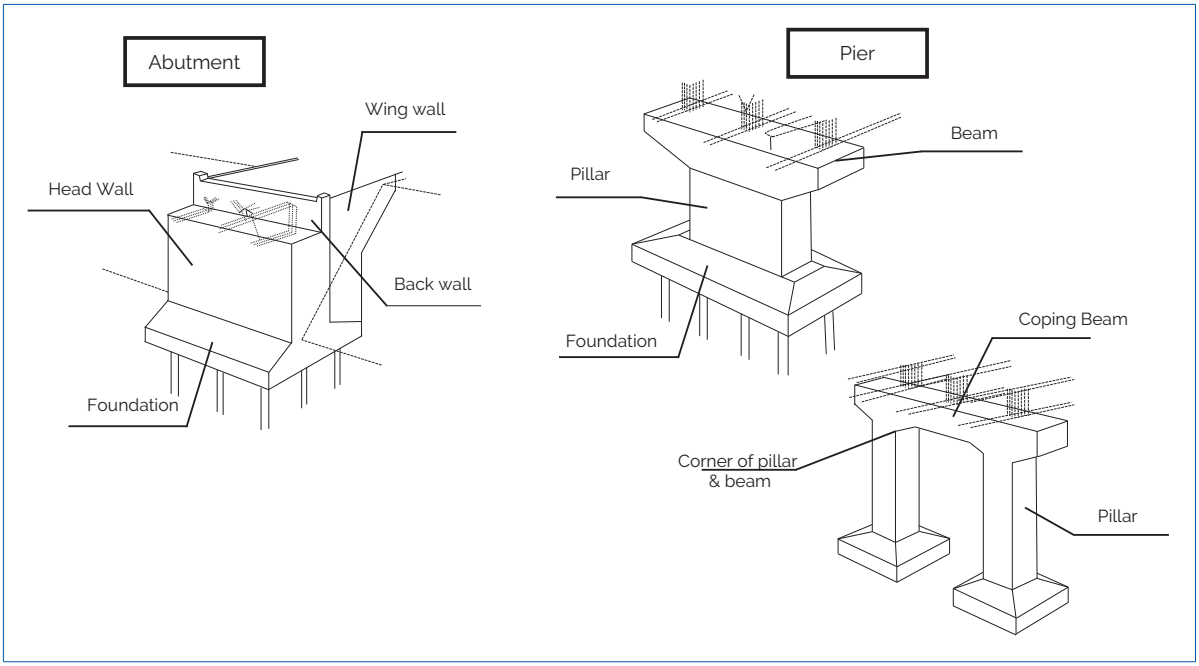


Figure 18: Abutment and pier

3.8.5 Key Points of Inspection for Bearing

Common defects to check on the bearing during inspection are shown in *Table 17.*

Table 17 Bearings

Main Parts		Observations / Considerations
(1)	Bearing	▪ It is in a narrow space, with predominantly severe corrosive environment, such as high humidity and silt accumulation leading to corrosion. ▪ Due to high stress in bearings, cracks, fractures, and defects are likely to occur. ▪ Abnormal gap is likely to occur due to excessive movement of the superstructure or the substructure. ▪ Bearings are affected by the impact force from vehicles passing on bumps or expansion joint.
(2)	Set bolt	▪ These are bolts that are used to restrain the horizontal displacement of the bearings. ▪ Due to high stress, defects e.g. fractures and deformations are likely to occur. ▪ The protective coating is easily damaged at the bolt edge. This lowers the corrosion protection function.

Main Parts		Observations / Considerations
(3)	Anchor bolt	▪ Due to high stress, defects e.g. fractures and deformations are likely to occur. ▪ The protective coating is easily damaged at bolts and nuts. This lowers the corrosion protection function.
(4)	Shoe Seat	▪ This is a high stress part, where cracks and other defects are likely to occur. ▪ Welded parts at shoe seat on steel pier are prone to fatigue cracking due to fulcrum reaction forces with impact.
(5)	Bearing Support Seat	▪ This is a part prone to high stress. cracks and other defects are likely to occur.
(6)	Horizontal clearance at the end of the girder	▪ Abnormal horizontal clearance between the girder end and back wall of abutment is likely to occur due to excessive movement of the superstructure or the substructure.

3.8.6 Key Points of Inspection for Box Culvert / Arch Culvert

Common defects to check on box culverts/ arch culverts/ARMCO culverts during inspection are shown in *Table 18*.

Table 18 Box culvert / Arch culvert /ARMCO culverts

Main Parts		Observations / Considerations
(1)	External	▪ Presence or absence of loose fill material. ▪ Scouring along the edges of the bridge. ▪ Absence/inadequate/defective protection works at culvert inlet and outlet.
(2)	Internal	▪ Presence or absence of water leakage through cracks. ▪ Check the inside of the box or the bottom slab for damage that may interfere with the flow of water. ▪ Presence or absence of longitudinal and transverse cracks on concrete surface.
(3)	Surface	▪ Unevenness of the road surface.
(4)	ARMCO	▪ Replace all ARMCO Culverts with 1200 mm diameter (minimum) concrete pipe culverts informed by the hydrological study of the location.

APPENDIX 1: GUIDELINE FOR SOUNDNESS DIAGNOSIS FOR ROUTINE INSPECTION FOR ARBICS

Guideline for Soundness Diagnosis

This is a reference for diagnosing the soundness of each member in accordance with the Bridge Inspection Manual for ARBICS and PBC. The factors to be considered in the determination of typical deteriorations are described hereinafter.

In addition, it is difficult to quantitatively judge the condition of each member because it depends on the bridge structural type and construction conditions. The condition of the target bridge should be referenced on the previous inspection. It is necessary to determine the appropriate classification of soundness diagnosis.

This section presents reference cases for some of the deteriorations as shown below. For more detailed deteriorations refer to Damage Catalog

Steel Member	Concrete Member	Others
Corrosion	Crack	Damage of bearing
Crack	Slab Crack	Others
Rupture	Others	
Others		

Table A1:.1: Below outlines the condition that lead to assignment of the various damage levels for Corrosion on a steel member

Damage of Steel Member	Corrosion	Damage Level N-III

Damage Level N	Below 10% of the element's surface is affected (there is rusting, but no section loss is found). In connections, below 10% of the length (welding) or the total number of the connection bolts or rivets is affected (there is rusting, but no section loss is found). There is no hindrance to the function of the bridge, but it is desirable to take measures from the viewpoint of preventive maintenance. (Preventive Maintenance Stage)
Damage Level I	Between 10% and 50% of the element's surface is affected (there is rusting, but no section loss is found). In connections, between 10% and 50% of the length (welding) is affected or the total number of connection bolts or rivets is affected (there is rusting, but no section loss is found). Remedial measures should be taken in early stage, because the function of the bridge may be hindered. (Early Measures Stage)
Damage Level II	Over 50% of the element surface is affected, with section loss (less than 20% of the thickness) or when over 50% of the length is affected (welding) or total number of the connection bolts or rivets is affected. Section loss is found but the element's structural or functional behaviour is not hampered. A condition in which the function of the bridge is impaired or is very likely to occur, and urgent measures should be taken. (Prompt Measures Stage)
Damage Level III	The element's surface is affected. There is section loss (over 20% of the thickness) preventing the element's proper structural or functional behaviour. A condition in which partial or total failure of the structure has occurred or is inevitable and immediate measures should be taken. (Emergency Measures Stage)

Damage of Steel Member	Corrosion	1/5

Severity: I	There is no hindrance to the function of the bridge, but it is desirable to take measures from the viewpoint of preventive maintenance. (Early Maintenance Stage)

	Although the thickness of the steel plate has hardly decreased, the corrosion-resistant coating is deteriorating over a wide area, and it is expected that serious corrosion will spread to the whole bridge if left unattended.
	There is little adverse effect on the load bearing capacity of the entire bridge, but significant corrosion is progressing locally, and if left unattended, the adverse effect can be expected to spread.
	Although it is an atmospheric corrosion weathering steel, the thickness of the main member has not been remarkably reduced, but apparent abnormal corrosion is observed, and the condition cannot deteriorate any further even if left unattended.
	Although it is a painted material, the thickness of the main material has not been significantly reduced, but if left unattended, there is a possibility of rapid deterioration of the coating and spread of corrosion due to water leakage.

Remarks

- The corrosion rate varies greatly depending on the corrosive environment (adverse effects due to salt damage, rainwater retention, water leakage, frequency of high humidity, etc.)
- This is the case when it is clearly rational to take preventive maintenance measures before the next periodic inspection.

Damage of Steel Member	Corrosion	2/5

Severity: II	Remedial measures should be taken in early stage, because the function of the bridge may be hindered. (Prompt Measures Stage)

	Significant corrosion has occurred in the main member web and lower flange, a clear reduction in plate thickness can be confirmed locally, and structural safety may be impaired if a section loss occurs.
	The main girder near the bearing and support point has significant corrosion with a clear reduction in thickness.
	An atmospheric corrosion weathering steel with apparent abnormal corrosion, resulting in a wide plate thickness reduction.
	Severe corrosion has spread to a wide range of main member due to water leaks and water retention.

Remarks

- Corrosion may reduce the plate thickness to a certain extent or more, or even locally, if a cross-section defect occurs at an important portion of the main member, the load bearing capacity of the member may be reduced.
- If water leakage or water retention occurs in the girder or inside the box cross-section member, severe corrosion may occur over a wide area. In particular, infiltration water containing an anti-freezing agent accelerates the corrosion drastically.

Damage of Steel Member	Corrosion	3/5

Severity: III	A condition in which the function of the bridge is impaired or is very likely to occur, and urgent measures should be taken. (Emergency Measures Stage)

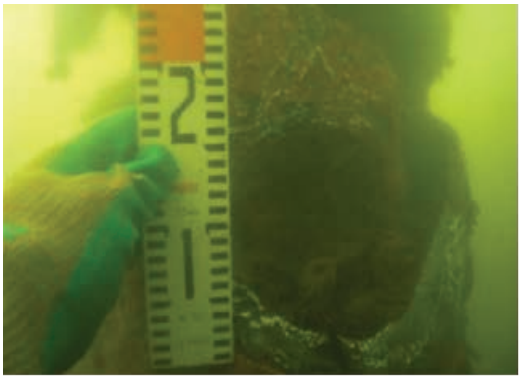
	There is a clear cross-section loss due to corrosion at the position important for the structure such as the receiving beam of the Gerber/cantilever hinged bridge structure.
	Regarding truss bridges and arch bridges, the main members, such as diagonal members, columns, suspension members, and chord members, have obvious cross-section loss and significant plate thickness reduction (Sudden rupture may also occur due to wheel load of large vehicles).
	Significant reduction in plate thickness has occurred in a wide range of main members (The required load capacity may already be lost).
	Clear cross-section defects have occurred at stress concentration areas such as support areas (There is a possibility of collapse due to large external force such as earthquake).

Remarks

- In the case of corrosion, the load bearing capacity has already decreased depending on the condition of reduction of plate thickness and cross-section loss, and the required performance cannot be exhibited against the action of large external loads such as wheel loads and earthquakes.

Damage of Steel Member	Corrosion	4/5

Severity: III	A condition in which the function of the bridge is impaired or is very likely to occur, and urgent measures should be taken. (Emergency Measures Stage)

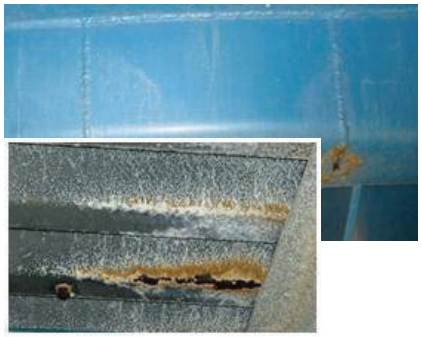
	Steel pile-bent piers have corrosion holes and a clear decrease in wall thickness (It may suddenly buckle due to effects of axial force and bending moment).
	Cross-section loss due to corrosion of steel pile-bent pier (It may suddenly buckle due to effects of axial force and bending moment).
	Corrosion locally progresses at steel pile-bent piers in submerged areas of low tide affected rivers (It may suddenly buckle due to effects of axial force and bending moment).

Remarks

- The pile-bent pier member in the underwater part may be damaged due to local corrosion, which may make the bridge uneasy with respect to the axial compressive force.

Damage of Steel Member	Corrosion	5/5

Special	The cases in the table below require detailed condition understanding.

	It is suspected that significant corrosion has progressed inside the embedded parts and members which cannot be visually confirmed (Corrosion may progress inside the embedding part to the point of rupture).
	Clear abnormal corrosion is observed in atmospheric corrosion weathering steel (The impact on load-bearing capacity may not be estimated unless detailed conditions such as thickness measurement are grasped)
	It is suspected that significant corrosion may have occurred due to water retention or water leakage in parts that are not easily visible, such as inside the girder (Significant corrosion may occur inside the girder, and serious adverse effects may occur).
	It is suspected that significant corrosion may have progressed inside the parts that cannot be visually observed (The load bearing capacity of the member may be reduced due to the reduction of the plate thickness from the inside).

Remarks

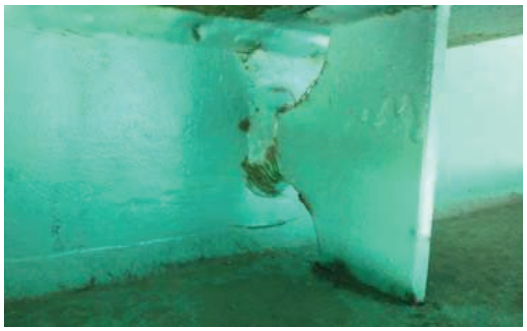
- Corrosion progresses rapidly depending on environmental conditions, so if significant corrosion is suspected inside the member or in the embedded part where the external appearance cannot be visually confirmed, it is necessary to understand the cause by grasping the detailed state. It may develop rapidly if leak or water retention is the cause.

Table A1.2 below outlines the condition that lead to assignment of the various damage levels for crack in a steel member

Damage of Steel Member	Crack	Damage Level N-III
Damage Level N	No cracks are identified on the steel structure or its members. There is no hindrance to the function of the bridge, but it is desirable to take measures from the viewpoint of preventive maintenance. (Preventive Maintenance Stage)	
Damage Level I	Cracks are identified in members (cross frame, lateral bracing) but are unlikely to reach the main members immediately. The cracks will continue to grow in the future. Remedial measures should be taken in early stage, because the function of the bridge may be hindered. (Early Measures Stage)	
Damage Level II	Identified cracks have extended to main members (deck plate, corners of steel piers, trough ribs of the steel plate floor) further propagation leads to depression and pavement damage. A condition in which the function of the bridge is impaired or is very likely to occur, and urgent measures should be taken. (Prompt Measures Stage)	
Damage Level III	Identified cracks have extended to main members (deck plate, corners of steel piers, trough ribs of the steel plate floor, gerber girder, girder flange, girder web, web of cross girders) and welded sections and may lead to breakage or collapse. A condition in which partial or total failure of the structure has occurred or is inevitable and immediate measures should be taken. (Emergency Measures Stage).	

Damage of Steel Member	Crack	1/4

Severity: I	There is no hindrance to the function of the bridge, but it is desirable to take measures from the viewpoint of preventive maintenance. (Early Maintenance Stage)

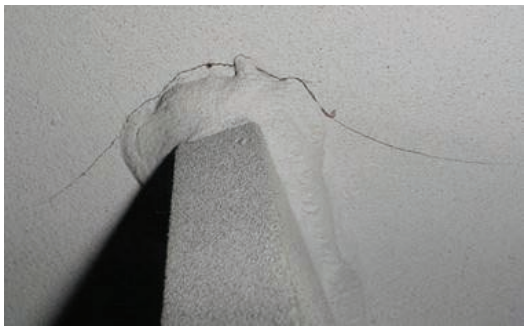
	Even if it progresses, it is unlikely that the main member will be destroyed immediately, but it is highly possible that damage will continue to progress.
	Even if it progresses, it is unlikely that the crack will reach the main member immediately, but it is expected that the crack will continue to grow in the future.
	Even if it progresses, it is unlikely that the crack will reach the main member immediately, but it is expected that the crack will continue to grow in the future.
	Clear cracks occur in the cross frame and the lateral bracing, and the crack propagates from the position and direction, it may not reach the main member immediately, but if left unattended, the member may break.

Remarks

- Depending on the location of the crack, it is considered unlikely that the crack will immediately spread to the main member and the bridge will be in a dangerous state. However, if the cracks are certainly expected to grow, it may be difficult to repair the cracks or the repair may become large-scale after the crack extended

Damage of Steel Member	Crack	2/4

Severity: II	Remedial measures should be taken in early stage, because the function of the bridge may be hindered. (Prompt Measures Stage)

	An obvious crack extends to the deck plate of the steel plate floor, and if it further develops, it is expected to lead to pavement depression and pavement damage.
	An obvious crack extends to the deck plate of the steel plate floor, and if it further develops, it is expected to lead to pavement depression and pavement damage.
	Clear cracks have occurred in the corners of the steel pier. Further progress is expected to have serious adverse effects on girders and piers (Depending on the location, it often progresses to Severity: Very high).
	Clear cracks extend to the trough ribs of the steel plate floor, and further propagation is expected to lead to road depression and pavement damage.

Remarks

- Cracks may grow suddenly and significantly and it is usually impossible to predict where they will grow in a continuous area. Therefore, cracks may develop in the main member or may spread to the main member. In that case, it is necessary to take measures early.

Damage of Steel Member	Crack	3/4

Severity: III	A condition in which the function of the bridge is impaired or is very likely to occur, and urgent measures should be taken. (Emergency Measures Stage)

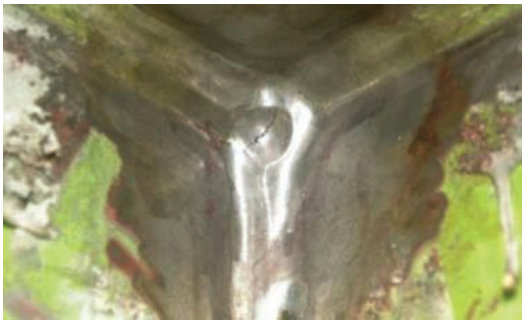
	Gerber girder plate is cracked regardless of size.
	Regardless of size, there are obvious cracks in the column members, suspension members, and chord members of arch bridges and truss bridges.
	There is a clear crack extending from the main girder flange to the web.
	Large cracks are growing in the web of main girders and cross girders.

Remarks

- It is difficult to predict the progress (progress time and degree of progress) of a crack in a part that is subjected to repeated stress, considering the size and direction of the crack, and when the performance of the main member is seriously affected, it may be possible to immediately determine that urgent measures such as traffic restrictions and accident prevention measures at the time of crack development should be taken

Damage of Steel Member	Crack	4/4

Special	The cases in the table below require detailed condition understanding.

	Although there is a clear coating film crack near the weld line, the entire crack cannot be confirmed from the appearance. (In order to make a reliable judgment of the presence or absence of cracks, it is necessary to remove the coating film and have a specialist technician grasp the detailed conditions such as non-destructive inspection and shaving.)
	Although there are cracks and rusting in the coating that may have serious cracks in the steel plate floor, it cannot be determined only by visual inspection.
	A crack has occurred or is suspected to have occurred at a corner of a steel bridge pier or a member intersection of a rigid frame bridge, and there have been other similar cracks at member intersections.
	There is rust at the lower end of the pillars of the arch bridge, and on the other hand, it is a place where fatigue cracks are prone to occur, so the possibility of fatigue cracks cannot be denied.

Remarks

- It is often the case that the cracks in steel members cannot be confirmed entirely by visual inspection due to coating or rust. In that case, it is necessary to remove the coating film and rust, and to grasp the detailed state by nondestructive inspection such as magnetic particle inspection or ultrasonic inspection

Table A1.3 below outlines the condition that lead to assignment of the various damage levels for rupture in a steel member

Damage of Steel Member	Rupture	Damage Level N-III

Damage Level N	No rupture on any members of the structure. No new rupture has occurred on members where rupture was repaired with steel plate or other means. Sound Condition. (Preventive Maintenance Stage)
Damage Level I	The rupture has occurred in members that have little effect on the load bearing capacity of the structure. New rupture has occurred on members where rupture was repaired with steel plate or other means. Remedial measures should be taken in early stage, because the function of the bridge may be hindered. (Early Measures Stage)
Damage Level II	The rupture has occurred in members with significant effect on the load bearing capacity of the structure. Failure to repair the rupture will lead to further deterioration. Remedial measures should be taken in early stage because the function of the bridge may be hindered. (Prompt Measures Stage)
Damage Level III	Rupture has occurred in critical members which may impair the function of the bridge. Vertical stiffeners at the stress concentration points have broken. Main members such as diagonal members of truss bridge have broken. The deck of a composite bridge structure is broken. A condition in which the function of the bridge is impaired or is very likely to occur, and urgent measures should be taken. (Emergency Measures Stage)

Damage of Steel Member	Rupture	1/4

Severity: I	No damages and no functional problems in a bridge. (Sound Condition)
Severity: II	There is no hindrance to the function of the bridge, but it is desirable to take measures from the viewpoint of preventive maintenance. (Preventive Maintenance Stage)
Severity: III	Remedial measures should be taken in early stage because the function of the bridge may be hindered. (Early Measures Stage)

	Severity: I The rupture was repaired with a steel plate or other means to restore function, and no new rupture occurs.
	Severity: III Ruptures have occurred in members that have little effect on the load-bearing capacity. (If structural safety may be compromised against large external forces such as earthquakes)
	Severity: III Ruptures have occurred in members that have little effect on the load-bearing capacity. (If structural safety may be compromised against large external forces such as earthquakes)

Remarks

- In case that the members other than the main member are broken, the structural safety is not significantly impaired in the normal service state. Even in such a case, it is necessary to pay attention to the fact that the performance of the bridge against a large external force such as an earthquake may have deteriorated.

Damage of Steel Member	Rupture	2/4

Severity: III	A condition in which the function of the bridge is impaired or is very likely to occur, and urgent measures should be taken. (Emergency Measures Stage)

	The vertical stiffener at the stress concentration point has broken partially, which may lead to a serious accident such as buckling of the main girder.
	Main members such as diagonal members of truss bridge have been broken, which may lead to collapse of bridge.
	The diagonal material embedded in the floor slab concrete of the truss bridge has been broken, which may lead to the collapse of the bridge.
	Example of rupture in part of truss bridge diagonal member.

Remarks

- The breakage of main member generally has a serious adverse effect not only on the damage of the member but also on the structural safety of the entire bridge.

Damage of Steel Member	Rupture	3/4

Special	The cases in the table below require detailed condition understanding.

	A part of the suspension material of the arch bridge has ruptured due to corrosion, and it is suspected that other suspension materials under the same conditions are also progressing.
	PC steel materials have ruptured due to the progress of corrosion, and it is suspected that similar corrosion also occurs at other places.
	A part of the diagonal member of the truss bridge has broken, and it is suspected that the other diagonal members under the same conditions is also being cracked or broken.
	PC steel material is protruding and colliding with the mounted facility.

Remarks

- If the cause of the breakage of the bridge member is unknown, it is necessary to identify the factor by grasping the detailed state and confirm the possibility that similar damage will occur to other members.
- When stainless steel or the like is used for the protection tube or the clasp, the steel material may be significantly corroded due to contact with different metals. In this case, it should be noted that other members having the same structure may be corroded simultaneously

Damage of Steel Member	Rupture	4/4

Special	The cases in the table below require detailed condition understanding.

	PC steel material ruptures and protrudes (Similar damage may progress in other PC steel materials).
	Concrete at the PC steel anchorage part for pre-stressing of cross beam has peeled off, and PC steel has also come out (Similar damage may progress in other PC steel materials).
	PC steel material breaks and is protruding (Similar damage may progress in other PC steel materials).
	PC steel material has ruptured, and it is suspected that other PC steel materials have deteriorated and that the deterioration of members is due to the infiltration of rainwater into the PC girders.

Remarks

- If the cause of the breakage of the bridge member is unknown, it is necessary to estimate the factor by grasping the detailed state and confirm the possibility that similar damage will occur to other members.
- If a slip-out has already been seen, it is necessary to pay attention to damage to third parties due to protrusion of other PC steel materials, and injury during periodical inspection work.

Table A1.4 below outlines the condition that lead to assignment of the various damage levels for crack in a concrete member.

Damage of Concrete Member	Crack	Damage Level N-III

Damage Level N	Fissures with no structural impact and crack width less than 0.4 mm There is no hindrance to the function of the structure, but it is desirable to take measures from the viewpoint of preventive maintenance. (Preventive maintenance stage)
Damage Level I	Fissures with structural impact (shear, bending, compression stresses) and crack width less than 0.4 mm. Another kind of cracks with a width between 0.4 mm and 1.00 mm Remedial measures should be taken in early stage, because the function of the bridge may be hindered. (Early Measures Stage)
Damage Level II	Fissures with structural impact (shear, bending, compression stresses) and crack width more than 0.4 mm. Another kind of cracks with a width more than 1.00 mm A condition in which the function of the bridge is impaired or is very likely to occur, and urgent measures should be taken. (Prompt Measures Stage)
Damage Level III	Fissures with a serious impact on the structural behavior (potential risk of total or partial collapse of the element) The element's stability cannot be ensured and an accident with serious consequences for users may occur. A condition in which partial or total failure of the structure has occurred or is inevitable and immediate measures should be taken. (Emergency Measures Stage)

Damage of Concrete Member	Crack	1/6

Severity: I	There is no hindrance to the function of the structure, but it is desirable to take measures from the viewpoint of preventive maintenance. (Preventive maintenance stage)

	There is a crack that can be easily seen by close-up visual observation, but it is unlikely to progress if for example: Position where the stress does not change repeatedly or is small Position/property that is considered to be low or not likely to cause corrosion of internal steel due to infiltration of rainwater
	There is a noticeable crack that can be easily visually recognized, and if left unattended, deterioration is expected to progress steadily due to infiltration of rainwater into the interior.
	There is a noticeable crack that can be easily visually recognized, and if left unattended, it is expected that the deterioration will certainly progress due to infiltration of rainwater into the interior.
	There is a noticeable crack that can be easily visually confirmed, and it is expected that deterioration will certainly progress due to the possibility that rainwater may enter the girder from above.

Remarks

- If cracking has occurred in a part that may have a significant impact on load bearing capacity, the progress should be carefully monitored. (For example, root of overhanging member, shear crack, suspicion of member penetration).

Damage of Concrete Member	Crack	2/6

Severity: II	Remedial measures should be taken in early stage, because the function of the bridge may be hindered. (Early Measures Stage)

	There is a crack that can be easily seen by close-up visual inspection, and the corrosion of internal reinforcing bars and PC steel material is progressing.
	A large number of cracks on the girder, concrete spalling and exposed rebars have occurred, and corrosion of the reinforcement bars has progressed extensively.
	There are many remarkable cracks in the anchorages at the girder ends of PC bridges, which may indicate corrosion of internal steel.
	There is a crack that can be easily seen by close-up visual inspection, and it is expected that deterioration will progress rapidly due to continued significant water leakage.

Remarks

- Depending on the location of cracks and the type of cracks, the load bearing capacity may be seriously affected, so detailed conditions must be grasped or evaluated as Severity level Very High (For example, there are suspected cases of cracks at the base of the cantilever member, shearing cracks, cracks penetrating the member, etc.).

Damage of Concrete Member	Crack	3/6

Severity: III	A condition in which the function of the bridge is impaired or is very likely to occur, and urgent measures should be taken. (Emergency Measures Stage)

	Significant cracks have occurred near the supporting point of the main girder, and the function of the bearing is also significantly reduced.
	Many cracks have occurred in the main members, and it is considered that the reinforcement bars have ruptured at various places.
	Significant cracks have occurred in the parts such as the receiving beams of the main members, whose destruction directly causes the collapse of the bridge.

Remarks

- If the cause of the crack or the adverse effect on the member cannot be easily determined, it is necessary to grasp the detailed condition.

Damage of Concrete Member	Crack	4/6

Severity: III	A condition in which the function of the bridge is impaired or is very likely to occur, and urgent measures should be taken. (Emergency Measures Stage)

	The pile-bent type bridge pier is significantly cracked in the axial direction, and it is suspected that the pile-bent may be destroyed due to the effect of eccentric load, and the bridge may fall down.
	The beams and columns of the substructure are markedly cracked, and it is suspected that the bridge may collapse if it progresses.

Remarks

- If the cause of the crack or the effect on the member cannot be easily determined, it is necessary to grasp the detailed condition.

Damage of Concrete Member	Crack	5/6

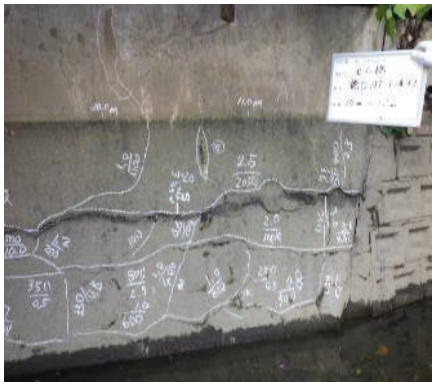
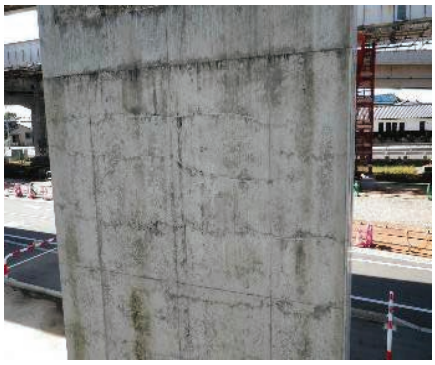
Special	The cases in the table below require detailed condition understanding.

	Cracks have developed from parts that have been repaired or reinforced in the past, and it is considered necessary to investigate the causeIn the case of cracks caused by re-deterioration, it is often impossible to determine the entire appearance of the deformation by visual inspection, and if deterioration is progressing internally, it may be in a dangerous state).
	Cracks have developed from parts that have been repaired or reinforced in the past, and it is considered necessary to investigate the cause (In the case of cracks caused by re-deterioration, it is often impossible to determine the entire appearance of the deformation by visual inspection, and if deterioration is progressing internally, it may be in a dangerous state).
	When cracks develop in the main member, it is difficult to determine whether the serious adverse impact on load bearing capacity is undeniable by only visual inspection. For example: • Support area of Gerber/cantilever hinged bridge structure • Area which supports bearing capacity of bearing • Shear crack
	Suspected to be caused by salt damage or alkaline-silica reaction.

Remarks
• If salt damage or alkali-silica reaction occurs, it will be difficult to repair and reinforce it if it becomes serious, and there is a risk of being forced to reconstruction. Therefore, if there is a possibility that salt damage or alkali-silica reaction has occurred, it is advisable to seek the advice of an expert and study the maintenance and management plan based on the investigation.

Damage of Concrete Member	Crack	6/6

Special	The cases in the table below require detailed condition understanding.

	The details of the bridge are unknown and it is difficult to grasp the cause.
	Although there are no noticeable free limes, regular cracks occur in a wide area, and it is necessary to understand the cause.
	Although there is no noticeable free lime, it is cracked irregularly in two directions (If aggregate pop-out is observed, it is suspected that an alkaline-silica reaction has occurred).
	Situation suspected of causing salt damage or alkaline-silica reaction.

Remarks

- If salt damage or alkali-silica reaction occurs, it will be difficult to repair and reinforce it if it becomes serious, and there is a risk of being forced to re-construction. Therefore, if there is a possibility that salt damage or alkali-silica reaction has occurred, it is advisable to seek the advice of an expert and study the maintenance and management plan based on the investigation.

Table A1.5 below outlines the condition that lead to assignment of the various damage levels for crack in a concrete slab.

Damage of Concrete Member	Slab Crack	Damage Level N-III

Damage Level N	Slight and local cracking <0.2mm wide (no structural impact. There is no hindrance to the function of the bridge, but it is desirable to take measures from the viewpoint of preventive maintenance. (Preventive Maintenance Stage)
Damage Level I	Cracks are within 0.2mm with no indication of water leakage. Identified in members (cross frame, lateral bracing) but are unlikely to reach the main members immediately. The cracks will continue to grow in the future. Remedial measures should be taken in early stage, because the function of the bridge may be hindered. (Early Measures Stage)
Damage Level II	Cracks within 0.2mm-0.3mm width in a uniaxial direction with water leakage that will lead structural impact and reduction of durability. A condition in which the function of the bridge is impaired or is very likely to occur, and urgent measures should be taken. (Prompt Measures Stage)
Damage Level III	Cracks more than 0.3mm wide with intervals of less than 30cm in biaxial direction together with water leakage, free lime or salt which results in reduction in loading capacity. A condition in which partial or total failure of the structure has occurred or is inevitable and immediate measures should be taken. (Emergency Measures Stage).

Damage of Concrete Member	Slab Crack	1/5

Severity: I	There is no hindrance to the function of the bridge, but it is desirable to take measures from the viewpoint of preventive maintenance. (Preventive Maintenance Stage)

	There is no noticeable water leakage, but extensive cracks in a grid pattern develop throughout the concrete slab.
	There are relatively few cracks, but there are clear penetrating cracks (water leakage, precipitation of lime).
	Rainwater is significantly infiltrating the concrete slab, and it is expected that deterioration will progress rapidly if left unattended.
	There are relatively few cracks, but there are clear penetrating cracks (water leakage, precipitation of lime).

Remarks

- If the concrete slab has a through crack, it is likely that deterioration will progress rapidly if left unattended. Further, the infiltration of rainwater significantly accelerates the deterioration of the concrete slab.
- If the concrete slab has a spalling or peeling, there is a risk of falling concrete pieces.

Damage of Concrete Member	Slab Crack	2/5

Severity: II	Remedial measures should be taken in early stage, because the function of the bridge may be hindered. (Early Measures Stage)

	There is a densely developed grid-like cracks with water leakage. Or there is a large area with concentrated wet cracks on the bottom surface of the concrete slab.
	There is a densely developed grid-like cracks with water leakage. Or there is a large area with concentrated wet cracks on the bottom surface of the concrete slab.
	Rainwater has penetrated into the concrete slab, and the corrosion of steel bars is widespread.
	Significant cracks occur in the filling concrete part (The filled concrete part may fall off).

Remarks

- If the concrete slab is widely cracked, or if the corrosion of the reinforcing bars progresses due to the infiltration of rainwater, the concrete slab may fall off extensively. In addition, the wheel load may cause the concrete slab to fall down.

Damage of Concrete Member	Slab Crack	3/5

Severity: III	A condition in which the function of the bridge is impaired or is very likely to occur, and urgent measures should be taken. (Emergency Measures Stage)

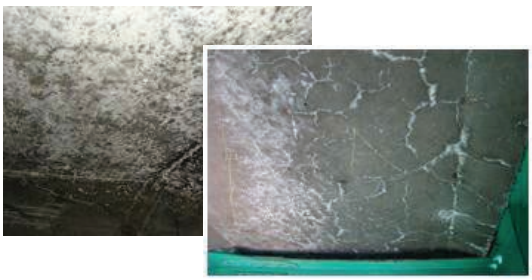
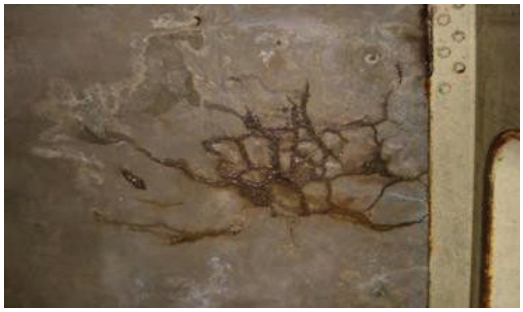
	In the case that the concrete slab loses its integrity in a certain area, it may easily fall out due to the action of wheel load.
	The concrete slab is cracked with noticeable water leakage, and there is obvious spalling or peeling on the bottom surface of the concrete slab.
	Densely developed grid-like cracks with pronounced water leakage.
	Development of white color cracks with lime deposits and discoloration due to infiltration spread on part of the bottom surface of the slab (If the pavement on the concrete slab shows a dent or a slag of cement, it is likely that the top surface of the concrete slab has turned into granulation).

Remarks

- If rainwater penetrates widely inside the concrete slab, it may cause a sudden fall-out accident due to deterioration of the concrete slab.
- If the pavement is dented or the cement component is blown out, the concrete slab may be significantly deteriorated, such as turning into granulation from the top. If this judgment is difficult, it is necessary to grasp the detailed state.

Damage of Concrete Member	Slab Crack	4/5

Special	The cases in the table below require detailed condition understanding.

	If irregular cracks develop or if the discoloration spreads over the entire surface of the concrete slab, complex deterioration such as concurrent alkali-aggregate reaction may occur.
	If there is significant spalling, peeling, or exposed reinforcing bars on the bottom surface of the concrete slab, deterioration may have progressed inside the slab.
	Part of the concrete slab shows unusual discoloration and water leakage
	Although no grid-like cracks with remarkable water leakage appeared, it was suspected that water retention had spread inside the concrete due to the spread of significant discoloration on the entire surface of the slab.

Remarks

- If the salt damage or alkali-aggregate reaction becomes serious, repair and reinforcement may become difficult and it may be necessary to re-construction. It is necessary for an expert to grasp the condition and prepare a maintenance plan.
- If cracks are not noticeable but water stains and lime deposits are widely spread, horizontal cracks may have spread inside the concrete.

Damage of Concrete Member	Slab Crack	5/5

Special	The cases in the table below require detailed condition understanding.

	There is concern about falling out of the filling concrete (the photo shows an example of falling out).
	There is concern about falling out of the filling concrete (the photo shows an example of falling out).
	Characteristic cracks and white discoloration on the pavement surface (The concrete slab under the pavement may be significantly damaged).

Remarks

- Even if the repair and reinforcement materials have been installed, tapping with a hammer or palpation may be effective.
- If repairs and reinforcements materials have been installed, it is possible that damage, existed in the past, so it is also effective to check the past repair history and background in advance.

Table A1.6 below outlines the condition that lead to assignment of the various damage levels for corrosion in bearings.

Bridge Bearing	Damage of bearing	Damage Level N-III

Damage Level N	Corrosion of the total surface area of bearing is Less than 10% with no loss of section found. There is no hindrance to the function of the bridge, but deterioration is expected to progress if left unattended. It is desirable to take measures from the viewpoint of preventive maintenance. (Preventive Maintenance Stage)
Damage Level I	Over 10-50% percentage of surface is affected with the thickness of the bearing also being reduced (section loss on the bearing is noticeable), if the corrosion continues as it is, the load bearing capacity may be reduced. Remedial measures should be taken in early stage, because the function of the bridge may be hindered. (Early Measures Stage)
Damage Level II	Over 50% of surface is affected with over 20% loss of section or when 50% of the considered area is affected. The load bearing capacity and the function of the bearing is lost and it may lead to a bridge collapse. A condition in which the function of the bridge is impaired or is very likely to occur, and urgent measures should be taken. (Prompt Measures Stage)
Damage Level III	Over 50% of surface is affected with over 50% loss of section on the bearing and its elements. The bearing capacity and function of the bearing is significantly affected interfering with its structural integrity. Abnormalities are noticed at the gap between bearing and girder and cracks within the bearing and its elements are likely to occur. A condition in which partial or total failure of the bearing or its elements has occurred or is inevitable and immediate measures should be taken. (Emergency Measures Stage).

Others	Damage of Bearing	1/4

Severity: I	There is no hindrance to the function of the bridge, but it is desirable to take measures from the viewpoint of preventive maintenance. (Preventive Maintenance Stage)

	The paint on the bearing has deteriorated, causing the base concrete to be chipped. It is expected that deterioration will progress if left unattended and it will be difficult to maintain the bearing function even if repaired.
	Corrosion is found in the bearing body, the bearing function is reduced, and it is considered that the function will be rapidly lost if left unattended.
	If the anticorrosion function of the bearing is significantly reduced and corrosion is progressing on the whole, it is expected that it will be difficult to recover its function rapidly if left unattended.
	Corrosion is progressing and bolts are loosening. If left untreated, the performance is expected to decline steadily due to the further progress of corrosion and other natural causes.
Remarks	

Others	Damage of Bearing	2/4

Severity: II	Remedial measures should be taken in early stage, because the function of the bridge may be hindered. (Early Measures Stage)

	In the case that the entire main body of the bearing is significantly corroded and the thickness of the bearing is also being reduced, if the corrosion continues as it is, the load bearing capacity may be reduced, which may cause a serious disaster such as dropping of the girder.
	Regarding the bearing and the main girder that attaches it, significant corrosion with a decrease in plate thickness is progressing
	The mounting bolt of the bearing is broken and the support function is deteriorated. If a large external force such as an earthquake occurs, it may not be possible to satisfy the required functions.
	The rubber bearing body has noticeable cracks. If a large external force such as an earthquake occurs, it may not be possible to satisfy the required functions.

Remarks

- If there is significant damage to the bearing body or mounting part, it will cause serious damage as it will function against normal traffic loads but will not perform the required functions against the effects of large-scale earthquakes, etc.

Others	Damage of Bearing	3/4

Severity: III	A condition in which the function of the bridge is impaired or is very likely to occur, urgent measures should be taken. (Emergency Measures Stage)

	If the load bearing function of the bearing is lost, such as the fall off of a roller of the bearing, there is a possibility of a dangerous state due to a step or girder fall down.
	If it is recognized that the load bearing capacity of the bearing is greatly reduced due to the damage of the pedestal mortar, there is a possibility that it will be in a dangerous state due to a step or the girder falling off.
	The bearing part, the girder of its mounting part, and the substructure main body are severely damaged. (The function of the bearing is lost, and it may lead to a bridge collapse.)
	If the bearing and its attachment to the main girder have a significant section loss, the girder ends may collapse due to the influence of wheel load or a small/medium-sized earthquake.
Remarks	

Others	Damage of Bearing	4/4

Special	The cases in the table below require detailed condition understanding.

	Abnormalities are found in the gap between the bearing and the end of the girder, so it is necessary to investigate the cause.
	Corrosion has spread to the vicinity of the bearing, and it is suspected that cracks will soon begin to occur.
	Suspected damage to the bearing body due to abnormal residual displacement after an earthquake
	Damage of bearing mounting part may affect bearing function, so load bearing capacity needs to be evaluated.

Remarks

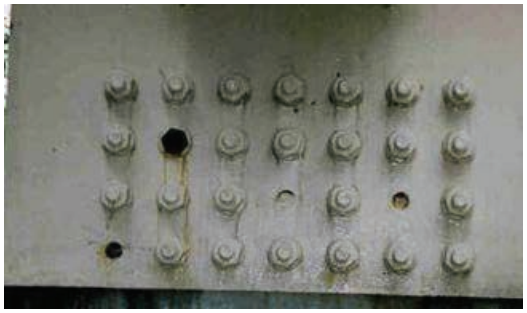
Table A1.7 below outlines the condition that lead to assignment of the various damage levels for looseness and loss of screws, rivets, anchors and bolts in steel members.

Steel Members	Looseness and Loss of screws, rivets, anchors and bolts	Damage Level N-III

Damage Level N	Below 5% of connection bolts or rivets is affected. No movements between connected parts are identified. There is no hindrance to the function of the bridge, but deterioration is expected to progress if left unattended. It is desirable to take measures from the viewpoint of preventive maintenance. (Preventive Maintenance Stage)
Damage Level I	Between 5% and 20% of connection bolts or rivets are loose or lost in secondary member joints. Movements between connected parts are identified. Remedial measures should be taken in early stage, because the function of the bridge may be hindered. (Early Measures Stage)
Damage Level II	Between 20% and 50% of connection bolts or rivets are loose or lost in secondary member joints. Movements between connected parts are detected and there is risk of an accident due to a failing element. A condition in which the function of the bridge is impaired or is very likely to occur, and urgent measures should be taken. (Prompt Measures Stage)
Damage Level III	Over 50% of connection bolts or rivets are loose or lost in Primary member joints. Movements between connected parts are detected and there is a risk of structural failure or collapse. A condition in which partial or total failure of the bearing or its elements has occurred or is inevitable and immediate measures should be taken. (Emergency Measures Stage).

Others	Looseness and Loss of Bolts	Steel

Other Conditions	The bolt is loose, and nuts, bolts, rivets, etc. have fallen off, which includes broken bolts and rivets

	Bolts are falling out (The bolts may break due to a large external force).
	Bolts are broken and lost.
	Some high strength bolts are missing.
	Loose anchor bolts and mounting bolts.

Remarks
• High-strength bolts (such as F11T) may have delayed rupture.

Others	Deterioration of Anticorrosion Function	Common

Other Conditions	Deformation is seen in the corrosion protection system of steel members (painting, plating, metal spraying, etc.). (In the case of atmospheric corrosion resisting steel material, evaluate it by corrosion)

	No rusting, but noticeable deterioration in topcoat.
	Although the rust has not spread, the deterioration of the coating film is progressing and the undercoat paint is exposed.
	Deterioration of the plating and coating surface.
	Rust on the surface of plated steel member.

Remarks

- In the case of that the coating-based anti-corrosion layer is progressively deteriorated, the risk of rusting of the base metal increases rapidly.

Table A1.8 below outlines the condition that lead to assignment of the various damage levels for spalling, peeling and rebar exposure in concrete members.

Concrete Members	Spalling, Peeling and Rebar exposure	Damage Level N-III
Damage Level N	Slight peel off which causes no negative effect or damage, rebars exposed in isolated areas without corrosion. Structural property preserved with partial loss of durability & functional properties, no risk of fragments falling off. It is desirable to take measures from the viewpoint of preventive maintenance. (Preventive Maintenance Stage)	
Damage Level I	Small range of peel off due to external forces, partial rebars exposed without corrosion which affects the durability of the element. Structural property preserved with partial loss of durability & functional properties, with risk of fragments falling off. Remedial measures should be taken in early stage, because the function of the bridge may be hindered. (Early Measures Stage)	
Damage Level II	Wide range of peel off due to rebar corrosion, partial rebars exposure with corrosion expansion leading to reduction in the bearing capacity of the member. Partial reduction of Structural property (partial reinf. Rupture), rebars exposure visible in over 50% of surface, with risk of fragments falling off. A condition in which the function of the bridge is impaired or is very likely to occur, and urgent measures should be taken. (Prompt Measures Stage)	
Damage Level III	Wide peel off which affects safe use of the structure due to possible failure, serious and wide range exposure of rebars with widespread corrosion affecting the bearing capacity of the member. Structural property is compromised (reinf. Rupture), with high risk of fragments falling off. A condition in which partial or total failure of the structure or its elements has occurred or is inevitable and immediate measures should be taken. (Emergency Measures Stage).	

Others	Spalling, Peeling, Rebar Exposure	Concrete

Other Conditions	A condition in which the surface of the concrete member has spalled or peeled. In the case ~~of~~ that the reinforcing bar is exposed at the peeling part, it is called rebar exposure. (If it is cracked, evaluate it as well)

	Concrete member with peeling and reinforcing bar exposed (Concrete pieces may fall).
	Concrete member with spalling and/or peeling (Corrosion of steel may progress internally).
	Concrete member with spalling and/or peeling (Cracks are progressing inside the member due to a large external force).
	Concrete member with spalling and/or peeling (Re-deterioration of the repaired part may cause spalling and/or peeling).
Remarks	

Table A1.9 below outlines the condition that lead to assignment of the various damage levels for water leakage and free lime in concrete members.

Concrete Members	Water leakage and free lime	Damage Levl N-III

Damage Level N	Slight and spot water leakage and free lime precipitate. The deterioration extent is below 50% of the element surface there are no any associated deteriorations (e.g., exposed reinforcements) It is desirable to take measures from the viewpoint of preventive maintenance. (Preventive Maintenance Stage)
Damage Level I	Localized or partial water leakage and free lime precipitate. The deterioration extent is over 50% of the element surface there are moderate associated deteriorations (e.g., exposed reinforcements with a section loss). Remedial measures should be taken in early stage, because the function of the bridge may be hindered. (Early Measures Stage)
Damage Level II	Serious and wide range water leakage through cracks or voids together with leaching free lime or salt leading to reduction in durability of the member. A condition in which the function of the bridge is impaired or is very likely to occur, and urgent measures should be taken. (Prompt Measures Stage)
Damage Level III	Serious and wide range water leakage through cracks or voids together with leaching free lime or salt leading to reduction in bearing capacity of the member. A condition in which partial or total failure of the structure or its elements has occurred or is inevitable and immediate measures should be taken. (Emergency Measures Stage).

Others	Water Leakage/Free Lime	Concrete

Other Conditions	Water and/or lime is seeping or leaking from the joints of concrete members. (If it is cracked, evaluate it as well)

	Water leakage around the steel member embedded in the concrete part (May be significantly corroded inside the embedded part).
	Water leakage from the concrete slab (If water leakage continues from the same location due to through cracks or the like, local deterioration may become apparent).
	Water leakage from the boundary between girder members (The filling part may deteriorate, or rainwater may penetrate into the parts and deteriorate the parts). (There may be corrosion of laterally tightened PC steel material that crosses the girders.)
	Water leakage and free lime precipitation from the joint of the precast member (Corrosion of the PC steel materials and reinforcing bars between/in the concrete members may occur, and/or corrosion may spread inside the concrete members along the steel materials).

Remarks

- If corrosion of the steel material is suspected in the part embedded in the concrete, it is better to check the condition inside the concrete by removing it by tapping sound inspection or peeling part of the concrete

Others	Water Leakage/Free Lime	Concrete

Other Conditions	Water and/or lime is seeping or leaking from the joints of concrete members. (If it is cracked, evaluate it as well)

	Precipitation of free lime has occurred from the filling part of the precast hollow slab bridge (The horizontally tightened PC steel material may have deteriorated due to infiltration of rainwater, etc.).
	Precipitation of free lime has occurred from a crack on the slab. (Corrosion of the PC steel materials and reinforcing bars between/in the concrete members may occur, and/or corrosion may spread inside the concrete members along the steel materials).

Remarks

Others	Damage of Reinforced Members	Concrete

Other Conditions	Defects have occurred in coating materials such as steel plates, sheets, and paintings that have repaired or reinforced concrete members. (Damage to concrete reinforcement is treated as damage to the main body)

	Corrosion is suspected on the reinforced steel plate on the back of the concrete slab, which is suspected of permeating rainwater into the slab (The deterioration of the concrete slab may progress inside, and it may fall out suddenly).
	Re-deterioration (corrosion, spalling) of reinforcing member (steel plate) is observed (Reinforcement effect may be lost or deterioration may have progressed inside the reinforcement member).
	Re-deterioration of repaired member (surface protection work) is observed. In this example, the concrete girder is also cracked, and "crack of concrete" is also evaluated.
	In case further deterioration of the repaired member is observed, it is possible that damage could be progressing on the inside without visible signs from the outside.
Remarks	

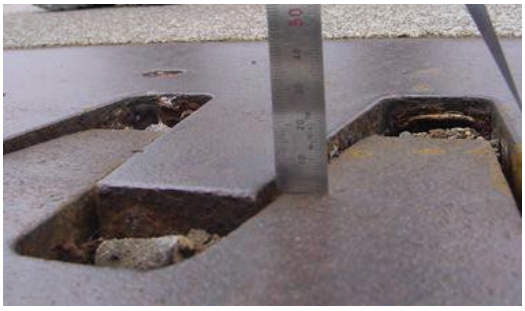
Others	Gap Error of Girder-End	Common

Other Conditions	Abnormality is found in the spacing between girder-ends and the displacement/spacing of expansion joint devices, bearings, systems for preventing bridge collapse, etc.

	The girder-end is in contact with the substructure (The substructure may be displaced).
	Spacing between expansion joint devices is abnormally narrow (The substructure may be displaced due to natural occurrences).
	Spacing between expansion joint devices is abnormally narrow (The substructure may be displaced due to the influence of an earthquake or other natural occurrences).
	The expansion joint devices are not evenly spaced (in the direction perpendicular to the bridge axis). (In addition to the displacement of the substructure due to the impact of the earthquake, abnormal horizontal displacement may occur between superstructure and substructure due to abnormalities in the superstructure and damage to the bearings.)
Remarks	

Others	Irregularities of Road Surface	Road Surface

Other Conditions	There are peculiar steps and/or irregularities on the road surface (including steps of the expansion joint devices)

	Irregularities at the boundary with the expansion joint device and bridge pavement (Partial damage may progress due to the impact load from the vehicle.)
	There is a clear step at the boundary between the approach road and the bridge surface (The step of the approach road could be as a result of settlement or due to an earthquake).
	Significant road surface irregularities at the boundary of spans (The substructure may have subsidence, inclination, or damage of bearing).
	There is a clear misalignment in the expansion joint devices This could be due to the settlement on the approach road or the bearing being destroyed).
Remarks	

Others	Abnormality of Pavement	Road Surface

Other Conditions	The pavement surface has cracks, spalling, potholes, or water or lime exudation.

	If the pavement surface shows unusual damage, the concrete slab may be significantly damaged. (Example where the top surface of the concrete slab has turned into granulation)
	If the pavement surface shows unusual damage, the concrete slab may be significantly damaged. For example: • Concrete slab has turned into granulation • Fatigue cracks in steel plate floor
	If the pavement surface shows unusual damage, the concrete slab may be significantly damaged. For example: • Concrete slab has turned into granulation • Fatigue cracks in steel plate floor
	If the pavement surface shows unusual damage, the concrete slab may be significantly damaged. (Example of cracks in the steel plate floor that penetrate the deck)
Remarks	

Others	Abnormality in the Anchorage Part	Common

Other Conditions	Abnormality is found in the fixing part of the tension steel member of PC material, the cable member, etc.

	Corrosion protection of the fixing part of the cable member is deteriorated, or rainwater may penetrate into the fixing part.
	Significant rusting is observed at the fixing part of the girder connecting device.
	Rust and lime exudation can be seen in the PC steel material fixing part in the girder (Rainwater may reach the fixing part or cable member from the road surface side such as the concrete slab top surface, and corrosion may progress).
	Horizontally tightened PC steel material is missing (In addition to the reduction in load bearing capacity, it may easily be damaged by a third party).
Remarks	

Others	Discoloration/Deterioration	Common

Other Conditions	Abnormality is seen in the color of the member such as peculiar discoloration of concrete. Material such as rubber or resin is changing.

	If a characteristic discoloration is seen on the surface of the PC bridge, the internal PC steel may be significantly corroded.
	If fire marks are seen, the strength of the member may have decreased.
	If fire marks are seen, the strength of the member may have decreased.
	If unusual discoloration is seen on the surface of the concrete member, a unique color may appear in the infiltrated state due to alteration of aggregate.
Remarks	

Others	Water Leakage/Water Retention	Common

Other Conditions	Leakage or abnormal water retention on the top surface or inside of the member, regardless of the original rain drainage mechanism such as the expansion joint device and drainage facility.

	Significant water leakage is seen between the girders (On the upper surface of the substructure, water such as water leakage may not be promptly removed, which may cause long-term water retention).
	Water has accumulated inside the member such as the box girder (If water leaks into the member due to gaps in the member or damage of the drainage facility, water may be retained).
	Water has accumulated inside the member such as the box girder (If water leaks into the member due to gaps in the member or damage of the drainage facility, water may be retained).
	Water has accumulated inside the member such as the box girder (If water leaks due to cracks or damage of drainage facilities, water may retain inside the members).
Remarks	

Others	Deformation/Defect	Common

Other Conditions	Members are locally defected or deformed due to collision of vehicles or ships.

	Large deformation or defect of structural member (Various deformations may occur in areas other than the relevant area due to vehicle collisions or interference between members).
	Large deformation or defect of main girder (In the event of a flood or tsunami, floating debris may collide and damage structural member).
	Significant deformation is seen in the upper lateral bracing (During an earthquake, a large horizontal force may cause deformation or rupture of lateral members).
	Significant deformation is seen in the vertical members of the truss bridge (The members may be deformed or ruptured as a result of being knocked by vehicles).
Remarks	

Others	Sediment Clogging	Common

Other Conditions	Sediment has accumulated on catch-basin, drainage pipes, expansion joint devices, etc.

	Sediment is deposited on the bearing (It may lead to functional impairment such as promoting corrosion of bearings).
	The expansion joint device is clogged with debris and sand.
	The catch-basin is clogged with debris, causing poor drainage on the road surface.
	Sediment is accumulated on the bridge support surface (Because of the environmental conditions of the bridge that are prone to water retention, concrete deterioration may occur).

Remarks

Others	Subsidence/Movement/Inclination	Common

Other Conditions	Peculiar subsidence, movement, and inclination occur in the foundation and substructure (In the case of a bearing, the functional impairment of the bearing is evaluated).

	Deformation can be seen on the entire bridge (The entire bridge may be in a dangerous state due to the inclination or subsidence of the substructure).
	Deformation of the entire bridge can be seen on the river bridge. (It may be in a dangerous state due to scouring or subsidence of substructure).
	There is a possibility that the substructure is displaced (If there is a deformation of the ground around the substructure, the entire bridge may be in a dangerous state.)
	Traces of earth and sand can be seen around the substructure. (If liquefaction occurs, the substructure may have subsidence or inclination). Note: It is unknown whether there are any abnormalities in the case of the photo.
Remarks	

Others	Subsidence/Movement/Inclination	Common

Other Conditions	Peculiar subsidence, movement, and inclination occur in the foundation and substructure (In the case of a bearing, the functional impairment of the bearing is evaluated).

	Deformation of the entire bridge can be seen on the bridge. (It may be in a dangerous state due to scouring or subsidence of substructure).
	Deformation of the entire bridge can be seen on the bridge. (It may be in a dangerous state due to scouring or subsidence of substructure).
	Suspected that the abutment is subsiding, moving, or inclining due to collapse of back embankment (If there is a deformation of the ground around the substructure, the entire bridge may be in a dangerous state).
	The retaining wall which protects the substructure has subsided due to scouring.
Remarks	

Others	Subsidence/Movement/Inclination	Common

Other Conditions	The member is deformed by buckling on the pile-bent pier in the underwater.

	Buckling of steel pile-bent piers has caused subsidence of superstructure. (The stability of the substructure may be impaired and the bridge may be in a dangerous state).
	Steel pile-bent pier is buckled (There is a risk of rapid deformation).

Remarks

- In the case that it is not possible to directly check the condition of the steel pile-bent pier underwater, it may be effective to directly check with a diver or use an underwater camera.

Others	Scouring	Substructure

Other Conditions	Scour is occurring in the foundation.

	The foundation is scoured and the piles are exposed (Damage discovered after the tsunami).
	The foundation is scoured remarkably due to flowing water.
	The foundation is scoured remarkably due to flowing water.
	Scour is progressing due to flood (As scouring progresses, the pier may subside or incline).

Remarks

- In case deposits are accumulated in the scour area, it is often impossible to expect ground resistance.
- If it is not possible to directly check the condition of the foundation, it is necessary to check with a camera, etc., if required.

Others	Soil Suck-out	Substructure

Other Conditions	Sediment outflow occurs due to scouring on the foundation.

There is a possibility that cavities may occur on the bottom surface of the abutment foundation due to scouring.

The ground on the foundation of abutment is scoured and the embankment soil on the back of the abutment flowed out.

(If abnormalities appear on the pavement surface, it may be due to the erosion of the backfill).

Remarks

- If the backfill of the bridge is eroded, abnormalities such as cracks and depressions may appear on the road surface.

Others	Other Abnormalities	Common

Other Conditions	

	Significant deformation in the ground near the foundation (The entire bridge may be in a dangerous state because the stability of the substructure has been impaired).
	Large graffiti is seen (Graffiti may adversely affect anticorrosion coatings such as painting, or may hinder the formation of protective rust on atmospheric corrosion resisting steel material).
	The section is missing due to corrosion of the drainage pipe (Damage of the drainage pipe may seriously affect the bridge body due to leaking drainage).
	Girder-end collides with substructure (If there is no clearance between the girder-end and the substructure, a large force may be applied to both structure, which may lead to buckling of the girder or damage to the abutment).

Remarks

Others	Others	Steel

	The cases in the table below require detailed condition understanding.

	Case of falling bridge due to damage of gusset plate.
Remarks	

Others	Others	Cable

	The cases in the table below require detailed condition understanding.

	Crack on Coating Material Severity : I
	Crack on Coating Material Severity : II
	Peeling of Coating Material Measures must be taken to prevent water from entering the strands Severity : III
Remarks	

Others	Others	Cable

	The cases in the table below require detailed condition understanding.

	Rust/Corrosion on Strand Severity: I
	Crack on Coating Material Severity : II
Remarks	

APPENDIX 2: PBC PERFORMANCE STANDARD

Appendix 2(a) Performance Standard for Paved High Road (Road Durability)

SERVICE CRITERIA		SERVICE LEVEL	RESPONSE TIME	TOLERANCE
Element	Defect		<< x hours>> means "within x hours"	
1) Maintenance of other Structures				
1. Concrete bridges	Structural deterioration	Concrete bridges must be in good condition and fully functional.	In case of structural damage the contractor to notify the Engineer <<24 Hours>>	No tolerance permitted
Blocked culvert	Obstruction due to sediments, soils and washed materials	Must be free flowing at all times		
2. Steel bridges	Structural deterioration, leaking structures	The steel bridges (e.g. Bridge and pedestrian bridge) must be clean, in good condition, free of corrosion and fully functional	In case of structural damage the contractor to notify the Engineer <<24 Hours>>	No tolerance permitted
3. Bridge expansion joints	Debris impending joint movement /damaging the joint	All expansion joints must be clean and in good condition and fully functional	In case of any condition which threatens structural integrity of the expansion joint, the Contractor must notify the Engineer <<24 Hours>	No tolerance permitted
4. Guardrail / Pedestrian Rail	Deformed/Missing guardrails	Guardrails must be in good condition and fully functional	Damages and defects must be repaired << 1 week>>	No tolerance permitted
5. Riverbeds	Obstructions due to debris or inappropriate vegetation	Riverbeds must be maintained to ensure free flow of water under the bridge and up to 50 meters upstream and downstream of the river at all times	Any accumulation of debris >400 mm must be removed	No tolerance permitted
	Eroded river beds	Erosion around bridge abutments and piers must be controlled with all reasonable measures at all times	Causes for non- compliance must be eliminated <<2 weeks>> after water has sufficiently receded to allow working conditions	However, the damaged portion pending repairs maybe left on site with proper signs and safety arrangements.

Appendix 2(b) Performance Standard for Paved Standard Road (Road Durability)

SERVICE CRITERIA		SERVICE LEVEL	RESPONSE TIME	TOLERANCE
Element	Defect		<< x hours>> means "within x hours"	
1) Maintenance of other Structures				
1. Concrete bridges	Structural deterioration	Concrete bridges must be in good condition and fully functional.	In case of structural damage the contractor to notify the Engineer <<24 Hours>>	No tolerance permitted
Blocked culvert	Obstruction due to sediments, soils and washed materials	Must be free flowing at all times		
2. Steel bridges	Structural deterioration, leaking structures	The steel bridges (e.g. Bridge and pedestrian bridge) must be clean, in good condition, free of corrosion and fully functional	In case of structural damage the contractor to notify the Engineer <<24 Hours>>	No tolerance permitted
3. Bridge expansion joints	Debris impending joint movement/damaging the joint	All expansion joints must be clean and in good condition and fully functional	In case of any condition which threatens structural integrity of the expansion joint, the Contractor must notify the Engineer <<24 Hours>>	No tolerance permitted
4. Guardrail / Pedestrian Rail	Deformed/Missing guardrails	Guardrails must be in good condition and fully functional	Damages and defects must be repaired << 1 week>>	No tolerance permitted
5. Riverbeds	Obstructions due to debris or inappropriate vegetation	Riverbeds must be maintained to ensure free flow of water under the bridge and up to 50 meters upstream and downstream of the river at all times	Any accumulation of debris >400 mm must be removed	No tolerance permitted
	Eroded river beds	Erosion around bridge abutments and piers must be controlled with all reasonable measures at all times	Causes for non- compliance must be eliminated <<2 weeks>> after water has sufficiently receded to allow working conditions	However, the damaged portion pending repairs maybe left on site with proper signs and safety arrangements

Appendix 2(c) Performance Standard for Unpaved High Road (Road Durability)

SERVICE CRITERIA		SERVICE LEVEL	RESPONSE TIME	TOLERANCE
Element	Defect		<< x hours>> means "within x hours"	
1) Maintenance of other bridges				
1. Concrete bridges	Structural deterioration	Concrete bridges must be in good condition and fully functional.	In case of structural damage the contractor to notify the Engineer <<24 Hours>>	No tolerance permitted
Blocked culvert	Obstruction due to sediments, soils and washed materials	Must be free flowing at all times		
2. Steel bridges	Structural deterioration, leaking structures	The steel bridges (e.g. Bridge and pedestrian bridge) must be clean, in good condition, free of corrosion and fully functional	In case of structural damage the contractor to notify the Engineer <<24 Hours>>	No tolerance permitted
3. Bridge expansion joints	Debris impending joint movement/damaging the joint	All expansion joints must be clean and in good condition and fully functional	In case of any condition which threatens structural integrity of the expansion joint, the Contractor must notify the Engineer <<24 Hours>>	No tolerance permitted
4. Guardrail / Pedestrian Rail	Deformed/Missing guardrails	Guardrails must be in good condition and fully functional	Damages and defects must be repaired << 1 week>>	No tolerance permitted
5. Riverbeds	Obstructions due to debris or inappropriate vegetation	Riverbeds must be maintained to ensure free flow of water under the bridge and up to 50 meters upstream and downstream of the river at all times	Any accumulation of debris >400 mm must be removed	No tolerance permitted
	Eroded river beds	Erosion around bridge abutments and piers must be controlled with all reasonable measures at all times	Causes for non- compliance must be eliminated <<2 weeks>> after water has sufficiently receded to allow working conditions	However, the damaged portion pending repairs maybe left on site with proper signs and safety arrangements

Appendix 2(d) Performance Standard for Unpaved Standard Road (Road Durability)

SERVICE CRITERIA		SERVICE LEVEL	RESPONSE TIME	TOLERANCE
Element	**Defect**		**<< x hours>> means "within x hours"**	
1) Maintenance of other bridges				
1. Concrete bridges	Structural deterioration	Concrete bridges must be in good condition and fully functional.	In case of structural damage the contractor to notify the Engineer <<24 Hours>>	No tolerance permitted
Blocked culvert	Obstruction due to sediments, soils and washed materials	Must be free flowing at all times		
2. Steel bridges	Structural deterioration, leaking structures	The steel bridges (e.g. Bridge and pedestrian bridge) must be clean, in good condition, free of corrosion and fully functional	In case of structural damage the contractor to notify the Engineer <<24 Hours>>	No tolerance permitted
3. Bridge expansion joints	Debris impending joint movement/damaging the joint	All expansion joints must be clean and in good condition and fully functional	In case of any condition which threatens structural integrity of the expansion joint, the Contractor must notify the Engineer <<24 Hours>>	No tolerance permitted
4. Guardrail / Pedestrian Rail	Deformed/Missing guardrails	Guardrails must be in good condition and fully functional	Damages and defects must be repaired << 2 weeks>>	No tolerance permitted
5. Riverbeds	Obstructions due to debris or inappropriate vegetation	Riverbeds must be maintained to ensure free flow of water under the bridge and up to 50 meters upstream and downstream of the river at all times	Any accumulation of debris >400 mm must be removed	No tolerance permitted
	Eroded river beds	Erosion around bridge abutments and piers must be controlled with all reasonable measures at all times	Causes for non- compliance must be eliminated <<2 weeks>> after water has sufficiently receded to allow working conditions	However, the damaged portion pending repairs maybe left on site with proper signs and safety arrangements

Appendix 2(e) Payment Reduction Calculation Table (Paved Road)

Project	ABC Road PBC Maintenance Project			Contract Period	24
Road Authority	KeNHA, KURA, KeRRA, KWS	Contractor	XYZ Contractor		
Road Name/ Class/ Chainage/ (j)Length	ABC Road		Road Class	A, B, C, D, E, Unclassified, Urban Road	15.0 Km
Statement Month/ Year and Elapse of Month	September	2014	3	Standard Service Level	High, Standard

Contract Due Amount of the Month (x) 500,000 KSH

Service Level Criteria		Compliance			Reduction						
Service	Service Scope	(a) Contract Road Length (km)	(b) Required Target	(c)=(a)*(b) Target Length (km)	(d)=(a)-(c) Exemption Length (km)	(e) Non-Compliant Length (km)	(f)=(e)-(d) (>=0) Adjusted Non-Compliant Length (km)	(g)=(f)/(c) NON-Compliant Rate	(h) Reduction Weight	(i)=(g)*(h) Reduction Rate (%)	(j)=(c)x(i) Reduction Length (km)
Documentation		15.0	100%	15.0	-	-	-	1%	4%	4.0%	0.60
1. Road Usability	A) Passability	15.0	100%	15.0	0.0	2.0	2.0	13%	40%	5.3%	0.80
2. Road User Comfort	B) Smooth and safe traffic	15.0	100%	15.0	0.0	4.0	4.0	27%	40%	10.7%	1.60
3. Road Durability	C) Visibility	15.0	100%	15.0	0.0	2.0	2.0	13%	30%	4.0%	0.60
	D) Traffic information	15.0	100%	15.0	0.0	2.0	2.0	13%	30%	4.0%	0.60
	E) Drainage capability	15.0	100%	15.0	0.0	2.0	2.0	13%	20%	2.7%	0.40
	F) Vegetation Control	15.0	100%	15.0	0.0	2.0	2.0	13%	20%	2.7%	0.40
	G) Maintenance of other structures	15.0	100%	15.0	0.0	2.0	2.0	13%	10%	1.3%	0.20
	H) Slope Stability	15.0	100%	15.0	0.0	2.0	2.0	13%	6%	0.8%	0.12
									(k) Total = 200%	35.5%	5.32

Required Target			
Elapse of Month	1. Road Usability	2. Road User Comfort	3. Road Durability
1	50%	50%	50%
2	100%	75%	75%
3	100%	100%	100%
4	100%	100%	100%
5	100%	100%	100%
6	100%	100%	100%
7~	100%	100%	100%

Calculation of the Payment Amount of the Month			
Contract Due Amount of the Month	KSH	**500,000**	(x)
Reduction Rate	%	**35%**	(k)
Reduction Amount	KSH	**177,333**	(z)=(x)x(k)
Payment Amount of the Month	KSH	**322,667**	(y)=(x)-(z)

Appendix 2(f) Payment Reduction Calculation Table (Unpaved Road)

Project	ABC Road PBC Maintenance Project					Contract Period	24
Road Authority	KeNHA, KURA, KeRRA		Contractor	XYZ Contractor			
Road Name/ Class/ Chainage/ (j)Length	ABC Road		Road Class	A, B, C, D, E, Unclassified, Urban Road		15.0 Km	
Statement Month/ Year and Elapse of Month	September	2014	3	Standard Service Level	High, Standard		

Contract Due Amount of the Month (x) 500,000 KSH

Service Level Criteria		Compliance			Reduction						
Service	Service Scope	(a) Contract Road Length (km)	(b) Required Target	(c)=(a)*(b) Target Length (km)	(d)=(a)-(c) Exemption Length (km)	(e) Non-Compliant Length (km)	(f)=(e)-(d) (>=0) Adjusted Non-Compliant Length (km)	(g)=(f)/(c) NON-Compliant Rate	(h) Reduction Weight	(i)=(g)*(h) Reduction Rate (%)	(j)=(c)x(i) Reduction Length (km)
Documentation		15.0	100%	15.0	-	-	-	1%	4%	4.0%	0.60
1. Road Usability	A) Passability	15.0	100%	15.0	0.0	2.0	2.0	13%	40%	5.3%	0.80
2. Road User Comfort	B) Smooth and safe traffic	15.0	100%	15.0	0.0	4.0	4.0	13%	40%	5.3%	0.80
3. Road Durability	C) Visibility	15.0	100%	15.0	0.0	2.0	2.0	13%	30%	4.0%	0.60
	D) Traffic information	15.0	100%	15.0	0.0	2.0	2.0	13%	30%	4.0%	0.60
	E) Drainage capability	15.0	100%	15.0	0.0	2.0	2.0	13%	20%	2.7%	0.40
	F) Vegetation Control	15.0	100%	15.0	0.0	2.0	2.0	13%	20%	2.7%	0.40
	G) Maintenance of other structures	15.0	100%	15.0	0.0	0.0	0.0	0%	10%	0.0%	0.00
	H) Slope Stability	15.0	100%	15.0	0.0	2.0	2.0	13%	6%	0.8%	0.12
									(k) Total = 200%	28.8%	4.32

Required Target			
Elapse of Month	1. Road Usability	2. Road User Comfort	3. Road Durability
1	50%	50%	50%
2	100%	75%	75%
3	100%	100%	100%
4	100%	100%	100%
5	100%	100%	100%
6	100%	100%	100%
7~	100%	100%	100%

Calculation of the Payment Amount of the Month			
Contract Due Amount of the Month	KSH	**500,000**	(x)
Reduction Rate	%	**29%**	(k)
Reduction Amount	KSH	**144,000**	(z)=(x)x(k)
Payment Amount of the Month	KSH	**356,000**	(y)=(x)-(z)

Appendix 2(g) Sample Photo Image for bridge structure performance

Structural deterioration	Response Time	Image (Bad)	Image (Good)
1) Concrete Bridges			
Concrete bridges must be in good condition and fully functional.	In case of structural damage, the Contractor to notify the Engineer within 24 hours.		
Concrete bridges must be in good condition and fully functional.	In case of structural damage, the Contractor to notify the Engineer within 24 hours.		

Structural deterioration	Response Time	Image (Bad)	Image (Good)
Concrete bridges must be in good condition and fully functional.	In case of structural damage, the Contractor to notify the Engineer within 24 hours.		
2) Box Culvert			
Obstructions due to debris or inappropriate vegetation.	Any accumulation of debris <400 mm must be removed.		

Structural deterioration	Response Time	Image (Bad)	Image (Good)
Obstructions due to debris or inappropriate vegetation.	Any accumulation of debris <400 mm must be removed.		
Obstructions due to debris or inappropriate vegetation.	Any accumulation of debris <400 mm must be removed.		

Structural deterioration	Response Time	Image (Bad)	Image (Good)
Obstructions due to debris or inappropriate vegetation.	Any accumulation of debri <400 mm must be removed.		
Obstructions due to debris or inappropriate vegetation.	Any accumulation of debri <400 mm must be removed.		

Structural deterioration	Response Time	Image (Bad)	Image (Good)
Obstructions due to debris or inappropriate vegetation.	Any accumulation of debri <400 mm must be removed.		
3) Steel Bridges			
Structural deterioration, Leaking structures.	In case of structural damage, the Contractor to notify the Engineer within 24 hours.		

Structural deterioration	Response Time	Image (Bad)	Image (Good)
Structural deterioration, Leaking bridges.	In case of structural damage, the Contractor to notify the Engineer within 24 hours.		
4) Bridge expansion joints			
Debris impeding joint movement/damaging the joint.	In case of structural damage, the Contractor to notify the Engineer within 24 hours.		

Structural deterioration	Response Time	Image (Bad)	Image (Good)
Debris impeding joint movement/damaging the joint.	In case of structural damage, the Contractor to notify the Engineer within 24 hours.		
Debris impeding joint movement/damaging the joint.	In case of structural damage, the Contractor to notify the Engineer within 24 hours.		

Structural deterioration	Response Time	Image (Bad)	Image (Good)
5) Guardrail / Pedestrian Rail			
Deformed / Missing guardrails.	Damages and defects must be repaired within 2 weeks after detection.		
Deformed / Missing guardrails.	Damages and defects must be repaired within 2 weeks after detection.		

Structural deterioration	Response Time	Image (Bad)	Image (Good)
6) Riverbeds Obstructions due to debris or inappropriate vegetation			
Obstructions due to debris or inappropriate vegetation.	Any accumulation of debris <400 mm must be removed.		
Obstructions due to debris or inappropriate vegetation.	Any accumulation of debris <400 mm must be removed.		

Structural deterioration	Response Time	Image (Bad)	Image (Good)
7) Riverbeds(Eroded riverbeds)			
Eroded river beds	Erosion around bridge abutments and piers must be controlled with all reasonable measures at all times.		
8) Others			
Eroded slope protection	Must be fully functional with no serious defects that can endanger the structure		

APPENDIX 3: PBC INSPECTION FORM

Basic Information

Structure Name		Inspection Date	
Road Name	123 Road	Chainage	00+100
Road Agency	KeNHA/KeRRA/KURA/KWS	Regional office	
Contractor	ABC		
Project Name	Performance Based Maintenance Contract for the Maintenance of 123 Road		
Structure Type	Bridge/Box Culvert/Footbridge	Superstructure Material	Concrete/Steel/Masonry/ Wooden
Structure Length	100 m	Structure Width	15 m

Inspection items

Inspection Item	Inspection Sub -Item	Time		Remarks	Photo
		Detection	Removal/ Notification		
Cleanliness	Pavement				
	Slab				
	Bridge Seat				
	Sidewalk				
	Beams				
	Drainage				
	Railings / Guardrails				
Vegetation overgrowth/ control	Pavement				
	Bridge Seat				
	Sidewalk				
	Beams				
	Drainage				
Encroachment	Birds				
	Animals				
	Humans				
Vandalism	Railings/Guardrails				
	Signs				
	Lane Markers				
	Graffiti				
	Joints				
	Slope Protection				
	Structural Members				

Inspection Item	Inspection Sub -Item	Time		Remarks	Photo
		Detection	Removal/ Notification		
Damage to Members	Railings/Guardrails				
	Signs				
	Pavement			ex. Rutting, Cracks, Pothole, Damage on Expansion Joint and Kerb	
	Slab			ex. Cracks, Spalling, Rebar Exposure, Rusting, Honeycombs, Delamination	
	Superstructure			ex. Cracks, Spalling, Rebar Exposure, Corrosion, Honeycombs, Delamination, Paint Peel-off, Loose Bolts	
	Abutment			ex. Cracks, Spalling, Rebar Exposure, Corrosion, Honeycombs, Deformation, Settlement	
	Piers			ex. Cracks, Spalling, Rebar Exposure, Rusting, Honeycombs, Deformation, Settlement	
	Bearings			ex. Sedimentation, Corrosion, Functional Impairment, Slipping Out	
	Slope protection				
	Lighting				
	Expansion Joint				
	Foundations			ex. Scouring, Settlement, Exposure	

APPENDIX 4: ROUTINE INSPECTION FORM

Road Authority				
Project/Road				
Bridge Name		Chainage		
Road Class		Standard Service Level		
Bridge Classification		Bridge Type		
From		To		
Inspected By		Sign:		Date:

Category	Element	Material	Deterioration	Severity	Indicator
Road surface	Pavement		Siltation	N	Not observed or very limited
				III	Special case
				II	Above 50 mm thickness, narrow carriageway and drainage facilities clogging
				I	Less 50mm thickness,partial loss of function of carriageway
			Crack	N	Not observed or very limited
				III	Arrigator cracks (partial with depression) reflectction from bridge slab deformation
				II	Arrigator cracks (local, without depression)
				I	Only partial linier cracks
			Potholes	N	Not observed or very limited
				III	Above 50% of pavement
				II	25-50% of pavement
				I	Below 25% of pavement
			Others	N	Not observed or very limited
				III	Urgent action

Category	Element	Material	Deterioration	Severity	Indicator
				II	Mid-term action
				I	Partialy damaged but maintain function
	Bridge Railing/ Guardrail/Curb		Deformation	N	Not observed or very limited
				III	Completely deformed or removed and lost function completely
				II	Deformed and lost function partialy
				I	Partialy deformed but maintain function
			Faulty lighting	N	Not observed or very limited
				III	>50 % - if there is Accident Risk
				II	10-50%-if no accident Risk resulting from loss of Visibility
				I	< 10% -No accident Risk
			Missing parts	N	Not observed or very limited
				III	The part loss has a serious impact on the element's structural behavior.
				II	The missing has a moderate impact on the element's structural behavior.
				I	The missing part has a minor impact on the element's structural behavior.
			Others	N	Not observed or very limited
				III	Urgent action
				II	Mid-term action
				I	Partialy damaged but maintain function
	Expansion joints		Deformation	N	Not observed or very limited
				III	above 2cm and presence of structural instability
				II	displacement 1cm to 2cm
				I	displacement less 1cm
			Misalignment	N	Not observed or very limited
				III	Element has completely lost its functional properties
				II	Element loses part of its functional properties
				I	Element preserves its functional properties

Category	Element	Material	Deterioration	Severity	Indicator
			Abnormal Spacing	N	Not observed or very limited
				III	Completely No space and unbalanced(too wide space on the other end)
				II	Spacing is maintained but abnormaly small or large
				I	Silted but spacing is properly maintained at both ends
			Abnormal Sound	N	Not observed or very limited
				III	Abnormal sound when vehicles pass on joints and effects to other elements
				II	Abnormal sound when vehicles pass on joints
				I	Small abnormal sound when vehicles pass on joints
			Others	N	Not observed or very limited
				III	Urgent action
				II	Mid-term action
				I	Partialy damaged but maintain function
	Drainage system		Clogging	N	Not observed or very limited
				III	Over 75% of structure's free section is blocked
				II	50% - 75% of structure's free section is blocked
				I	25% - 50% of structure's free section is blocked
			Broken	N	Not observed or very limited
				III	Few drinage systems are broken and necessary to exchange new drinage
				II	Few drinage systems are broken
				I	A drinage system is broken and easy repair
			Others	N	Not observed or very limited
				III	Urgent action
				II	Mid-term action
				I	Partialy damaged but maintain function
Superstructure	Superstructure	Steel	Surface alteration	N	Not observed or very limited
				III	Abnormal alteration observed (special investigation proposed)

Category	Element	Material	Deterioration	Severity	Indicator
Superstructure	Superstructure	Steel		II	The alteration has a functional impact and could cause an accident
				I	The alteration has only an esthetic impact
			Corrosion	N	Below 10% of the element's surface is affected
				III	The element's surface is entirely affected. There is section loss (over 20% of the thickness)
				II	Over 50% of the element surface is affected, with section loss (less than 20% of the thickness)
				I	Between 10% and 50% of the element's surface is affected
			Deformation	N	Not observed or very limited
				III	Clear deformation of entire components and hampers the proper functional or a serious accident.
				II	The deformation is noticeable at entire components of the structure and affecting other components.
				I	The partial deformation, sectional loss, lateral buckling observed.
			Crack	N	Not observed or very limited
				III	Identified cracks have extended to main components and may lead to breakage or collapse.
				II	Identified cracks have extended to main components further propagation leads to depression and pavement damage.
				I	Cracks are identified in elements but are unlikely to reach the main components immediately.
			Missing parts	N	Not observed or very limited
				III	The part loss has a serious impact on the element's structural behavior.
				II	The missing has a moderate impact on the element's structural behavior.
				I	The missing part has a minor impact on the element's structural behavior.
			Missing screws, rivets, anchors	N	Not observed or very limited
				III	The bolts are missing/broken or the support function is deteriorated
				II	The bolts are missing/broken

Category	Element	Material	Deterioration	Severity	Indicator
Superstructure	Superstructure	Steel		I	Bolts are loosening
			Rupture	N	Not observed or very limited
				III	Rupture has occurred in critical components which may impair the function of the bridge.
				II	The rupture has occourred in components with significant effect on the load bearing capacity of the structure.
				I	The rupture has occurred in components that have little effect on the load bearing capacity of the structure.
			Others	N	Not observed or very limited
				III	Urgent action
				II	Mid-term action
				I	Partialy damaged but maintain function
Superstructure	Superstructure	Concrete	Honeycomb	N	Not observed or very limited
				III	<25mm deep without Reinf. Expossure (>50% surface)
				II	0-5mm deep (<50% of surface)
				I	Partially observed
			Spalling	N	Not observed or very limited
				III	The spalling depth is over 100mm and wide area
				II	Partially depth is over 100 mm.
				I	Partially depth is between 10 and 100 mm.
			Spalling concrete showing reinforcing bars	N	Not observed or very limited
				III	The spalling observed of components and corrosion/rupture of reinforcing bars widely.
				II	The spalling observed of components and corrosion of reinforcing bars limited.
				I	The spalling observed partially and limited to find no corrosion of reinforcing bars.
			Crack	N	Not observed or very limited and crack width less than 0.4 mm
				III	Serious impact on the structural behavior or cracks with a width more than 2.0mm

Category	Element	Material	Deterioration	Severity	Indicator
Superstructure	Superstructure	Concrete		II	Fissures with structural impact and crack width less than 0.4mm, or cracks with a width more than 1.0mm
				I	Fissures with structural impact and crack width less than 0.4mm, or cracks with a width between 0.4-1.0mm
			Precipitate (Freelime, Rust fluid)	N	Not observed or very limited
				III	The deterioration extent is over 50% of the element surface or there are other associated moderate or high severity deteriorations
				II	The deterioration extent is below 50% of the element surface or there are not any associated moderate or high severity deteriorations
				I	Partially observed.
			Others	N	Not observed or very limited
				III	Urgent action
				II	Mid-term action
				I	Partialy damaged but maintain function
Superstructure	Superstructure	Other (masonry, Wooden)	Corrosion	N	Below 10% of the element's surface is affected
				III	The element's surface is entirely affected. There is section loss (over 20% of the thickness)
				II	Over 50% of the element surface is affected, with section loss (less than 20% of the thickness)
				I	Between 10% and 50% of the element's surface is affected
			Deformation	N	Not observed or very limited
				III	Clear deformation of entire components and hampers the proper functional or a serious accident.
				II	The deformation is noticeable at entire components of the structure and affecting to other components.
				I	The partial deformation, sectional loss, lateral buckling observed.
			Misalignment	N	Not observed or very limited
				III	Element has completely lost its functional properties

Category	Element	Material	Deterioration	Severity	Indicator
Superstructure	Superstructure			II	Element loses part of its functional properties. Found abnormal behavior.
				I	Element loses part of its functional properties. Not found abnormal behavior.
			Crack	N	Not observed or very limited and crack width less than 0.4mm
				III	Serious impact on the structural behavior or cracks with a width more than 2.0mm
				II	Fissures with structural impact and crack width less than 0.4mm, or cracks with a width more than 1.0mm
				I	Fissures with structural impact and crack width less than 0.4mm, or cracks with a width between 0.4-1.0mm
			Missing parts	N	Not observed or very limited
				III	Relative movements between parts have been detected and there are loose parts with a falling risk.
				II	All mortar joint is missing
				I	Partial loss of the mortar joint
			Others	N	Not observed or very limited
				III	Urgent action
				II	Mid-term action
				I	Partialy damaged but maintain function
Superstructure	Slab	Steel	Corrosion	N	Below 10% of the element's surface is affected
				III	The element's surface is entirely affected. There is section loss (over 20% of the thickness)
				II	Over 50% of the element surface is affected, with section loss (less than 20% of the thickness)
				I	Between 10% and 50% of the element's surface is affected
			Deformation	N	Not observed or very limited
				III	Deformation very noticeable and severe consequences on structural/ functional behavior.
				II	Deformation noticeable and consequences on structural/functional behavior.
				I	Deformation noticeable (above 1mm)

Category	Element	Material	Deterioration	Severity	Indicator
Superstructure	Superstructure	Steel	Crack	N	Not observed or very limited
				III	Identified cracks have extended to main components and may lead to breakage or collapse.
				II	Identified cracks have extended to main components further propagation leads to depression and pavement damage.
				I	Cracks are identified in elements but are unlikely to reach the main components immediately.
			Others	N	Not observed or very limited
				III	Urgent action
				II	Mid-term action
				I	Partialy damaged but maintain function
	Slab	Concrete	Honeycomb	N	Not observed or very limited
				III	<25mm deep without Reinf. Expossure (>50% surface)
				II	0-5mm deep (<50% of surface)
				I	Partially observed
			Deformation (leaning)	N	Not observed or very limited
				III	Deformation of slab is observed clearly
				II	Suspected deformation of slab is observed
				I	Non-active process without consequence on structural and functional properties, deformation of slab is hardly detectable visually < 10 mm
			Spalling	N	Not observed or very limited
				III	The spalling depth is over 100 mm and wide area
				II	Partially depth is over 100 mm.
				I	Partially depth is between 10 and 100 mm.
			Spalling concrete showing reinforcing bars	N	Not observed or very limited
				III	The spalling observed of components and corrosion/rupture of reinforcing bars widely.
				II	The spalling observed of components and corrosion of reinforcing bars limited.
				I	The spalling observed partially and limited to find no corrosion of reinforcing bars.

Category	Element	Material	Deterioration	Severity	Indicator
Superstructure	Slab	Concrete	Crack	N	Not observed or very limited and crack width less than 0.2mm
				III	Cracks more than 0.3 mm wide with intervals of less than 30cm in biaxial direction togher with water leakage, free lime
				II	Cracks within 0.2-0.3 mm width in a uniaxial direction with water leakage
				I	Cracks are within 0.2 mm with no indication of water leakage.
			Precipitate (Freelime, Rust fluid)	N	Not observed or very limited
				III	The deterioration extent is over 50% of the element surface or there are other associated moderate or high severity deteriorations
				II	The deterioration extent is below 50% of the element surface or there are not any associated moderate or high severity deteriorations
				I	Partially observed.
			Others	N	Not observed or very limited
				III	Urgent action
				II	Mid-term action
				I	Partialy damaged but maintain function
Superstructure	Slab	Slab (Wooden)	Corrosion-Rotting	N	Below 10% of the element's surface is affected
				III	The element's surface is entirely affected. There is section loss (over 20% of the thickness)
				II	Over 50% of the element surface is affected, with section loss (less than 20% of the thickness)
				I	Between 10% and 50% of the element's surface is affected
			Deformation	N	Not observed or very limited
				III	Relative movements between parts have been detected and there are loose parts with a falling risk that may cause a serious accident.
				II	All mortar joint is missing
				I	Partial mortar joint is missing

Category	Element	Material	Deterioration	Severity	Indicator
Superstructure	Slab	Others	Crack	N	Not observed or very limited
				III	Serious crack and water leakage, concrete falls off due to the action of wheel load
				II	Latticed crack and water leakage
				I	Crack limited of the part or water leakage from penetrated crack
			Missing parts	N	Not observed or very limited
				III	The part loss has a serious impact on the element's structural behavior.
				II	The missing has a moderate impact on the element's structural behavior.
				I	The missing part has a minor impact on the element's structural behavior.
			Others	N	Not observed or very limited
				III	Urgent action
				II	Mid-term action
				I	Partialy damaged but maintain function
Sub-structure	Abutment	Concrete	Honeycomb	N	Not observed or very limited
				III	<25mm deep without Reinf. Expossure (>50% surface)
				II	0-5mm deep (<50% of surface)
				I	Partially observed
			Deformation (Leaning)	N	Not observed or very limited
				III	Leaning of abutment is observed clearly
				II	Suspected leaning of abutment observed.
				I	Non-active process without consequence on structural & functional properties. Leaning of abutment is hardly detectable visually <10mm
			Spalling	N	Not observed or very limited
				III	The spalling depth is over 100mm and wide area
				II	Spalling depth is over 100 mm.
				I	Spalling depth is between 10 and 100 mm.

Category	Element	Material	Deterioration	Severity	Indicator
Sub-structure	Abutment	Concrete	Spalling concrete showing reinforcing bars	N	Not observed or very limited
				III	The spalling observed of components and corrosion/rupture of reinforcing bars widely.
				II	The spalling observed of components and corrosion of reinforcing bars limited.
				I	The spalling observed partially and limited to find no corrosion of reinforcing bars.
			Crack	N	Not observed or very limited and longitudinal crack width less than 0.4mm
				III	Serious crack and water leakage, concrete falls off due to the action
				II	Longitudinal/transvere crack width more than 1.0mm, or latticed crack with water leakage/freelime
				I	Longitudinal/transvere crack width between 0.4-1.0mm, or crack limited
			Subsidence	N	Not observed or very limited
				III	Any subsidence observed and serious damage
				II	Any subsidence observed and damage
				I	Any subsidence observed and damage limited
			Scouring	N	Not observed or very limited
				III	Embankment/river banks/bed errosion (>50% surface) in contact with risk to structural element stability
				II	Embankment/river banks/bed errosion (25%-50% surface) in contact with structural element with impact on stability
				I	Embankment/river banks/bed errosion (>25% surface) in contact with wingwalls and foundation
			Others	N	Not observed or very limited
				III	Urgent action
				II	Mid-term action
				I	Partialy damaged but maintain function
Sub-structure	Abutment	Other (Masonry, Wooden, others)	Corrosion	N	Below 10% of the element's surface is affected
				III	The element's surface is entirely affected. There is section loss (over 20% of the thickness)
				II	Over 50% of the element surface is affected, with section loss (less than 20% of the thickness)

Category	Element	Material	Deterioration	Severity	Indicator
Sub-structure	Abutment	Other (Masonry, Wooden, others)		I	Between 10% and 50% of the element's surface is affected
			Deformation (leaning)	N	Not observed or very limited
				III	damage level 4 is not allowed since it may result to failure
				II	1% and above of the element's magnitude is affected
				I	0.10%-1% of the element's magnitude is affected
			Crack	N	Not observed or very limited and longitudinal crack width less than 0.4mm
				III	Serious crack and water leakage, concrete falls off due to the action
				II	Longitudinal/transvere crack width more than 1.0mm, or latticed crack with water leakage/freelime
				I	Longitudinal/transvere crack width between 0.4-1.0mm, or crack limited
			Subsidence	N	Not observed or very limited
				III	Any subsidence observed and serious damage
				II	Any subsidence observed and damage
				I	Any subsidence observed and damage limited
			Scouring	N	Not observed or very limited
				III	Embankment/river banks/bed errosion (>50% surface) in contact with risk to structural element stability
				II	Embankment/river banks/bed errosion (25%-50% surface) in contact with structural element with impact on stability
				I	Embankment/river banks/bed errosion (>25% surface) in contact with wingwalls and foundation
			Others	N	Not observed or very limited
				III	Urgent action
				II	Mid-term action
				I	Partialy damaged but maintain function

Category	Element	Material	Deterioration	Severity	Indicator
Sub-structure	Wing wall	Concrete	Honeycomb	N	Not observed or very limited
				III	<25mm deep without Reinf. Expossure (>50% surface)
				II	0-5mm deep (<50% of surface)
				I	Partially observed
			Deformation	N	Not observed or very limited
				III	Deformation hampers functional/structural properties and results in serious accidents
				II	Active process with consequence on structural & functional properties, detectable visually, deformation >1% of abutment length, >5mm/m buckling
				I	Non-active process without consequence on structural & functional properties, hardly detectable visually <10mm
			Spalling	N	Not observed or very limited
				III	The spalling depth is over 100mm and wide area
				II	Spalling depth is over 100 mm.
				I	Spalling depth is between 10 and 100 mm.
			Spalling concrete showing reinforcing bars	N	Not observed or very limited
				III	The spalling observed of components and corrosion/rupture of reinforcing bars widely.
				II	The spalling observed of components and corrosion of reinforcing bars limited.
				I	The spalling observed partially and limited to find no corrosion of reinforcing bars.
			Crack	N	Not observed or very limited and longitudinal crack width less than 0.4mm
				III	Serious crack and water leakage, concrete falls off due to the action
				II	Longitudinal/transvere crack width more than 1.0mm, or latticed crack with water leakage/freelime
				I	Longitudinal/transvere crack width between 0.4-1.0mm, or crack limited
			Subsidence	N	Not observed or very limited
				III	Any subsidence observed and serious damage
				II	Any subsidence observed and damage
				I	Any subsidence observed and damage limited

Category	Element	Material	Deterioration	Severity	Indicator
Sub-structure	Wing wall	Concrete	Scouring	N	Not observed or very limited
				III	Embankment/river banks/bed errosion (>50% surface) in contact with risk to structural element stability
				II	Embankment/river banks/bed errosion (25%-50% surface) in contact with structural element with impact on stability
				I	Embankment/river banks/bed errosion (>25% surface) in contact with wingwalls and foundation
			Others	N	Not observed or very limited
				III	Urgent action
				II	Mid-term action
				I	Partialy damaged but maintain function
Sub-structure	Wing wall	(Other (Masonry, Wooden, Others))	Corrosion	N	Below 10% of the element's surface is affected
				III	The element's surface is entirely affected. There is section loss (over 20% of the thickness)
				II	Over 50% of the element surface is affected, with section loss (less than 20% of the thickness)
				I	Between 10% and 50% of the element's surface is affected
			Deformation (leaning)	N	Not observed or very limited
				III	Deformation hampers functional/structural properties and results in serious accidents
				II	Active process with consequence on structural & functional properties, detectable visually, deformation >1% of abutment length, >5mm/m buckling
				I	Non-active process without consequence on structural & functional properties, hardly detectable visually <10mm
			Crack	N	Not observed or very limited and longitudinal crack width less than 0.4mm
				III	Serious crack and water leakage, concrete falls off due to the action
				II	Longitudinal/transvere crack width more than 1.0mm, or latticed crack with water leakage/freelime
				I	Longitudinal/transvere crack width between 0.4-1.0mm, or crack limited

Category	Element	Material	Deterioration	Severity	Indicator
Sub-structure	Wing wall pier	Others	Subsidence	N	Not observed or very limited
				III	Any subsedence observed and serious damage
				II	Any subsedence observed and damage
				I	Any subsedence observed and damage limited
			Scouring	N	Not observed or very limited
				III	Embankment/river banks/bed errosion (>50% surface) in contact with risk to structural element stability
				II	Embankment/river banks/bed errosion (25%-50% surface) in contact with structural element with impact on stability
				I	Embankment/river banks/bed errosion (>25% surface) in contact with wingwalls and foundation
			Others	N	Not observed or very limited
				III	Urgent action
				II	Mid-term action
				I	Partialy damaged but maintain function
Sub-structure	Pier	Concrete	Honeycomb	N	Not observed or very limited
				III	<25mm deep without Reinf. Expossure (>50% surface)
				II	0-5mm deep (<50% of surface)
				I	Partially observed
			Deformation (leaning)	N	Not observed or very limited
				III	Deformation hampers functional/structural properties and results in serious accidents
				II	Active process with consequence on structural & functional properties, detectable visually, deformation >1% of abutment length, >5mm/m buckling
				I	Non-active process without consequence on structural & functional properties, hardly detectable visually <10mm
			Spalling	N	Not observed or very limited
				III	The spalling depth is over 100mm and wide area
				II	Partially depth is over 100 mm.
				I	Partially depth is between 10 and 100 mm.

Category	Element	Material	Deterioration	Severity	Indicator
Sub-structure	Pier	Conrete	Spalling concrete showing reinforcing bars	N	Not observed or very limited
				III	The spalling observed of components and corrosion/rupture of reinforcing bars widely.
				II	The spalling observed of components and corrosion of reinforcing bars limited.
				I	The spalling observed partially and limited to find no corrosion of reinforcing bars.
			Crack	N	Not observed or very limited and longitudinal crack width less than 0.4mm
				III	Serious crack and water leakage, concrete falls off due to the action
				II	Longitudinal/transvere crack width more than 1.0mm, or latticed crack with water leakage/freelime
				I	Longitudinal/transvere crack width between 0.4-1.0mm, or crack limited
			Subsidence	N	Not observed or very limited
				III	Any subsedence observed and serious damage
				II	Any subsedence observed and damage
				I	Any subsedence observed and damage limited
			Scouring	N	Not observed or very limited
				III	Embankment/river banks/bed errosion (>50% surface) in contact with risk to structural element stability
				II	Embankment/river banks/bed errosion (25%-50% surface) in contact with structural element with impact on stability
				I	Embankment/river banks/bed errosion (>25% surface) in contact with wingwalls and foundation
			Others	N	Not observed or very limited
				III	Urgent action
				II	Mid-term action
				I	Partialy damaged but maintain function

Category	Element	Material	Deterioration	Severity	Indicator
Sub-structure	Pier	(Other (Masonry, Wooden, others))	Corrosion	N	Below 10% of the element's surface is affected
				III	The element's surface is entirely affected. There is section loss (over 20% of the thickness)
				II	Over 50% of the element surface is affected, with section loss (less than 20% of the thickness)
				I	Between 10% and 50% of the element's surface is affected
			Deformation	N	Not observed or very limited
				III	Damage level 4 is not allowed since it may result to failure
				II	1% and above of the element's magnitude is affected
				I	0.10%-1% of the element's magnitude is affected
			Crack	N	Not observed or very limited and longitudinal crack width less than 0.4mm
				III	Serious crack and water leakage, concrete falls off due to the action
				II	Longitudinal/transvere crack width more than 1.0mm, or latticed crack with water leakage/freelime
				I	Longitudinal/transvere crack width between 0.4-1.0mm, or crack limited
			Subsidence	N	Not observed or very limited
				III	Any subsedence observed and serious damage
				II	Any subsedence observed and damage
				I	Any subsedence observed and damage limited
			Scouring	N	Not observed or very limited
				III	Embankment/river banks/bed errosion (>50% surface) in contact with risk to structural element stability
				II	Embankment/river banks/bed errosion (25%-50% surface) in contact with structural element with impact on stability
				I	Embankment/river banks/bed errosion (>25% surface) in contact with wingwalls and foundation
			Others	N	Not observed or very limited
				III	Urgent action
				II	Mid-term action
				I	Partialy damaged but maintain function

Category	Element	Material	Deterioration	Severity	Indicator
Bearing	Bearing	Main body(Steel)	Corrosion	N	Not observed or very limited
				III	The bearing and its attachment, the girder ends may collapse
				II	Significant corrosion with a decrease in plate thickness is progressing
				I	Corrosion is found in the bearing body, the bearing functions is reducted
			Deformation	N	Not observed or very limited
				III	The bearing body seriously damaged
				II	The bearing body damaged
				I	The paint on the bearing has deteriorated, and the pedestal concrete is spalling.
			Missing parts	N	Not observed or very limited
				III	The mounting bolt of the bearing is missed/broken or the support function is deteriorated
				II	The mounting bolt of the bearing is missed/broken
				I	Bolts are loosening.
			Rupture	N	Not observed or very limited
				III	Deformation/ mising parts found
				II	NA
				I	NA
			Others	N	Not observed or very limited
				III	Urgent action
				II	Mid-term action
				I	Partialy damaged but maintain function
		Main body (Rubber)	Crack	N	Not observed or very limited
				III	NA
				II	The rubber bearing body has noticeable cracks
				I	NA

Category	Element	Material	Deterioration	Severity	Indicator
Bearing	Bearing	Main body (Rubber)	Deformation	N	Not observed or very limited
				III	The bearing body seriously damaged
				II	The bearing body damaged
				I	The paint on the bearing has deteriorated, and the pedestal concrete is spalling.
			Rubber breaks	N	Not observed or very limited
				III	Over 50% loss of surface has occurred preventing the structural behavoiur of the element
				II	Over 50% surface affected with over 20% loss of section or when 50% of the sonsidered area is affected but the elements structural behavoiur is not hampered
				I	10-50% percentage of sufrace affected with no loss of section found
			Others	N	Not observed or very limited
				III	Urgent action
				II	Mid-term action
				I	Partialy damaged but maintain function
Bearing	Around bearing		Corrosion	N	Not observed or very limited
				III	The element's surface is entirely affected. There is section loss (over 20% of the thickness)
				II	Over 50% of the element surface is affected, with section loss (less than 20% of the thickness)
				I	The base concret to be chipped
			Deformation	N	Not observed or very limited
				III	The bearing body seriously damaged
				II	The bearing body damaged
				I	The paint on the bearing has deteriorated, and the pedestal concrete is spalling.
			Stagnant Water	N	Not observed or very limited
				III	Always wet condition at bearing, water mark (penetrating surrounding area)
				II	Wet debris (entire location)
				I	parially water stagnant or observe mark of water stagnant. Soil or debris

Category	Element	Material	Deterioration	Severity	Indicator
Bearing	Around bearing		Sedimentation	N	Not observed or very limited
				III	Fully sedimented and wet
				II	Fully sedimented
				I	Sedimentation partial
			Others	N	Not observed or very limited
				III	Urgent action
				II	Mid-term action
				I	Partialy damaged but maintain function
Embankments			Scouring	N	Not observed or very limited
				III	Urgent action
				II	Mid-term action
				I	Partialy damaged but maintain function
			Slope failure	N	Not observed or very limited
				III	Urgent action
				II	Mid-term action
				I	Partialy damaged but maintain function
			Others	N	Not observed or very limited
				III	Urgent action
				II	Mid-term action
				I	Partialy damaged but maintain function