



Republic of the Philippines
Department of Public Works and Highways

Bridge Management System Bridge Inspection Manual

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Version 6.0



**BRIDGE INSPECTION MANUAL
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GLOSSARY OF TERMS

AADT	Annual Average Daily Traffic
API	Agency Performance Indicator
AWP	Annual Works Program
B/C	Benefit/Cost Ratio
BOC	Bureau of Construction
BOD	Bureau of Design
BOE	Bureau of Equipment
BOM	Bureau of Maintenance



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BMC	Bridge Maintenance Costs
BMS	Bridge Management System
BNR	Bridge Needs Ratio
BRF	Bridge Route Factor
COE	Certificate of Exemption
CRF	Capital Recovery Factor
DEO	District Engineering Office
DPD	Development Planning Division
DPWH	Department of Public Works and Highways
ECC	Environmental Compliance Certificate
EMK	Equivalent Maintenance Kilometer
FAP	Foreign Assisted Project
FS	Feasibility Study
GAA	General Appropriations Act
GIS	Geographic Information System
ICC	Investment Coordination Committee
IPRSD	Infrastructure Planning Research and Statistics Division
IQL	Information Quality Level
IRR	Internal Rate of Return
JBIC	Japan Bank for International Cooperation
JICA	Japan International Cooperation Agency
KPI	Key Performance Indicator
LFP	Locally Funded Project
LRM	Locational Referencing Method
LRP	Locational Reference Point
LRS	Locational Referencing System
MIS	Monitoring & Information Service
MM	Major Maintenance
MPS	Maintenance Priority Score
MTIDP	Medium Term Infrastructure Development Plan
MTPDP	Medium Term Philippine Development Plan
MTPIP	Medium Term Public Infrastructure Plan
MVUC	Motor Vehicle User Charge
MWP	Multi-year Work Program
MYPS	Multi-Year Program and Scheduling
ND	Network Development
NMPS	Normalized Maintenance Priority Score
NPV	Net Present Value
NPV/C	Net Present Value - Cost Ratio
OIC	Officer In Charge
PMO	Project Management Office
PPI	Process Performance Indicator
PS	Planning Service
PWF	Present Worth Factor
QA	Quality Assurance
QC	Quality Control



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RBIA	Road and Bridge Information Application
RDBL	Road Diagram and Bridge List
RIMSS	Road Information and Management Support System
RMMS	Routine Maintenance Management System
RO	Regional Office
RODD	Regional Office Design Division
ROMD	Regional Office Maintenance Division
RPO	Road Program Office
SQL	Standard Query Language
SRSF	Special Road Support Fund



BRIDGE INSPECTION MANUAL

1. INTRODUCTION

1.1. Background

The Philippines has a huge stock of bridges along local and national road networks. There are about 7,600 national bridges under the responsibility of the national government thru the Department of Public Works and Highways (DPWH).

In order to effectively manage the national bridge stock, DPWH has established the Bridge Management System (BMS) in 2003 under the Road Information and Management Support System (RIMSS-CO7) Project, and was eventually institutionalized in 2004 thru Department Order No. 47.

Bridge Management System (BMS) is a computer-based system that keeps the inventory information and monitors the condition of each bridge that are utilized for identification of work programs, prioritization/ranking, and budgetary programming for major maintenance and replacement/construction.

This 2007 revised BMS Inspection Manual mainly focused on the detailed procedures in the conduct of bridge condition survey and condition rating. To provide clear definition on how to assess the condition of bridges based on their defects or damages, a more specific measurement guidelines on defects are improved and the bridge condition rating card is introduced.

The other revision in this manual is on the types of bridge inspections. The old version has seven (7) types compared to five (5) types in the revised version. The reduction was introduced to avoid overlapping activities and to simplify the required actions.

The continuing efforts for the improvement of BMS is undertaken through the DPWH Technical Working Group with the technical assistance of Mr. Hideo Nagao, the Japan International Cooperation Agency (JICA) Bridge Expert.

1.2. Scope of this Manual

The BMS relies on the availability of inventory and annual condition information on each bridge to provide reference data, to track the deterioration of bridges and hence serves as the basis in the maintenance and management of the national bridge stock. Without accurate and timely data, the BMS cannot fulfill this function.



The BMS therefore requires inventory bridge inspections to provide inventory information of each bridge and annual condition inspections to provide regular data on the condition status of each bridge. This data has to be accurate and consistent between inspection surveys to ensure efficient and consistent operation of the BMS.

Consistent and standardized bridge inspection procedures are required to ensure that consistent inspection reports are delivered from all bridge inspections.

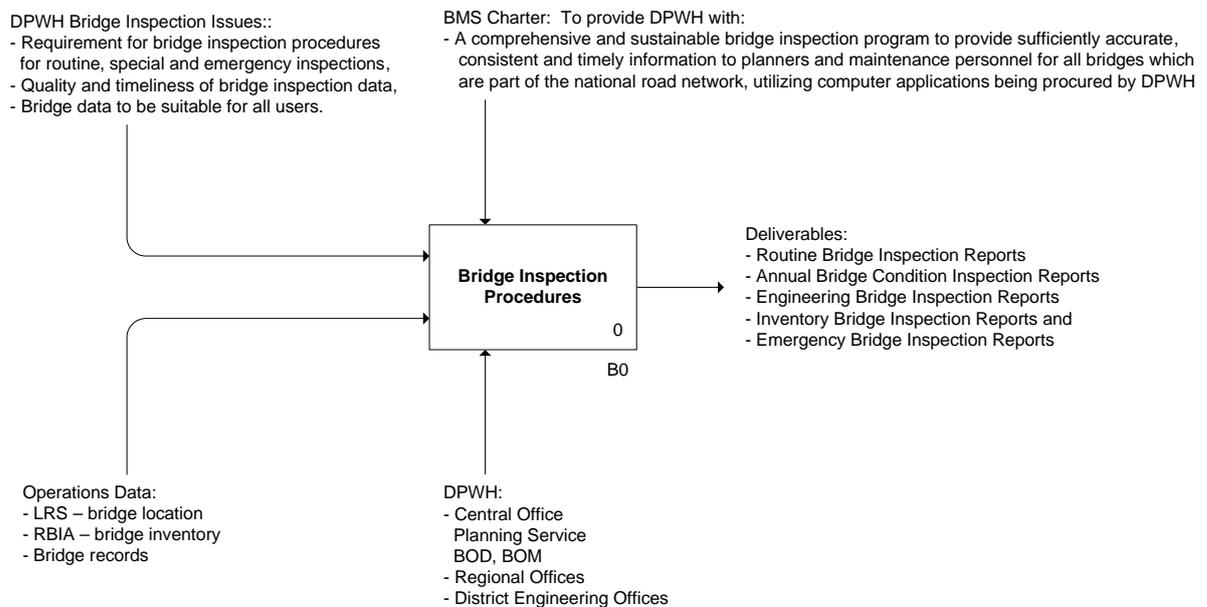
This bridge inspection manual contains requirements for all types of bridge inspection undertaken by the DPWH, and is intended to be utilized as a training guide and reference manual for DPWH bridge inspectors.

The main focus of the bridge inspection manual are bridge condition inspections (Type 2), bridge engineering inspections (Type 3) and bridge inventory inspections (Type 5), as these inspections provide the bridge data required within the RBIA for the operation of the BMS. More detailed procedures for other types of bridge inspection will be prepared separately.

1.3. Bridge Inspections Requirements

The bridge inspection procedures and requirements are shown in Figure 1-1. The bridge inspection procedures for each type of inspection have been prepared to ensure the requirements are achieved in practice.

Figure 1-1
Bridge Inspection Procedures and Requirements





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The types of bridge inspections undertaken by the DPWH are listed in Table 1.1.

Scheduled bridge inspections are those inspections required to be undertaken on a set frequency (e.g. annually) to supply data for DPWH functions.

Non-scheduled inspections are those inspections undertaken only when required because of the addition of new national bridges or calamities.

Table 1-1
Bridge Inspections Types

TYPE	NAME	FREQUENCY	PURPOSE
<i>Scheduled Bridge Inspections</i>			
1	Routine	Monthly	<ul style="list-style-type: none">- Scheduling of routine maintenance, check bridge condition to ensure safety of bridges- To detect defects of bridges at an early stage
2	Condition	Annual	<ul style="list-style-type: none">- To obtain condition data on major maintenance needs of the bridges for operation of the BMS- To assess and rate condition of the structure
<i>Non-Scheduled Bridge Inspections</i>			
3	Engineering	As Required	<ul style="list-style-type: none">- To investigate major maintenance needs of defective bridge identified by a condition inspection or other inspection- To evaluate the needs for improvement works- To decide on appropriate countermeasure- To determine safe load capacity of the bridge- To monitor progress of any damage- To test and evaluate strength or quality of materials- To evaluate structural strength and seismic vulnerability
4	Emergency	As Required	<ul style="list-style-type: none">- To determine emergency work to bridges after occurrence of calamities, ensure safety of bridges- To obtain damage information to evaluate necessity of urgent repairs- To determine severity of structural damage to bridges- To confirm safety of bridges and vehicular traffic- To evaluate structural strength
5	Inventory	As Required	<ul style="list-style-type: none">- To obtain/update bridge inventory data for the RBIA and BMS

The responsible offices to undertake specified bridge inspections are summarized in Table 1-2.

Table 1-2
Bridge Inspection Responsibility

TYPE	NAME	RESPONSIBILITY	REPORTING
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<i>Scheduled Bridge Inspections</i>			
1	Routine	District Engineering Office	Report to RO
2	Condition	District Engineering Office / Regional Office	Report to RO
<i>Non-Scheduled Bridge Inspections</i>			
3	Engineering	DEO / RO / BOD / BRS / BMS Team and other Entities	Report to CO
4	Emergency	District Engineering Office / Regional Office	Report to RO/CO
5	Inventory	District Engineering Office / Regional Office	Report to RO

The specific requirements for those personnel assigned to undertake the bridge inspections are given in Table 1-3.

Table 1-3
Requirements for Bridge Inspection Personnel

TYPE	NAME	PERSONNEL
<i>Scheduled Bridge Inspections</i>		
1	Routine	DEO Maintenance Engineer
2	Condition	Accredited Bridge Inspector
<i>Non-Scheduled Bridge Inspections</i>		
3	Engineering	Accredited bridge Inspector / Bridge Design Engineer / Materials Engineer
4	Emergency	RO Engineer / DEO Engineer
5	Inventory	Accredited Bridge Inspector

Bridge inspection types 1 and 2 do not require specialty in bridge engineering. Type 1 inspection shall be undertaken by the district engineering maintenance engineers while Type 2 inspection shall be conducted by accredited bridge inspectors.

The accredited bridge inspectors shall be engineers who have experience in the inspection, construction, design or maintenance of bridges or similar structures and who have received accreditation after successfully completing a training course in bridge inspection based on this bridge inspection manual.

The accredited bridge inspectors are trained in the assessment of the condition of structures and the evaluation of visual defects. The accredited bridge inspectors will obtain support and assistance from bridge engineers based in the Regional and District Engineering Offices to aid in decision making, to interpret visual defects or to advise on unusual structural action.

Bridge Inspection Type 3 requires a high level of bridge engineering knowledge and will be undertaken by experienced bridge design engineers with the assistance of an accredited bridge inspector and materials engineer. Type 4 inspection shall be undertaken by the regional office/district engineering office engineers.

1.4. Bridge Inspection Manual

The main purpose of the bridge inspection manual is to provide bridge inspectors and other users with guidelines and procedures to undertake effective bridge inspections.



2. GENERAL REQUIREMENTS FOR BRIDGE INSPECTIONS

2.1. Accuracy

It is important that bridge inspections be completed with accuracy and thoroughness as the primary goal.

Bridge inspectors should allow sufficient time in undertaking a bridge inspection to collect all data required by the type of inspection.

2.2. Proactive Approach to Bridge Inspections

Inspections should not be confined to searching for defects that are clearly visible in the bridges. Inspections should also include anticipating problems and recognizing where these are likely to occur, in order that deterioration of the bridges is prevented. This approach is known as preventive inspection as opposed to corrective inspection.

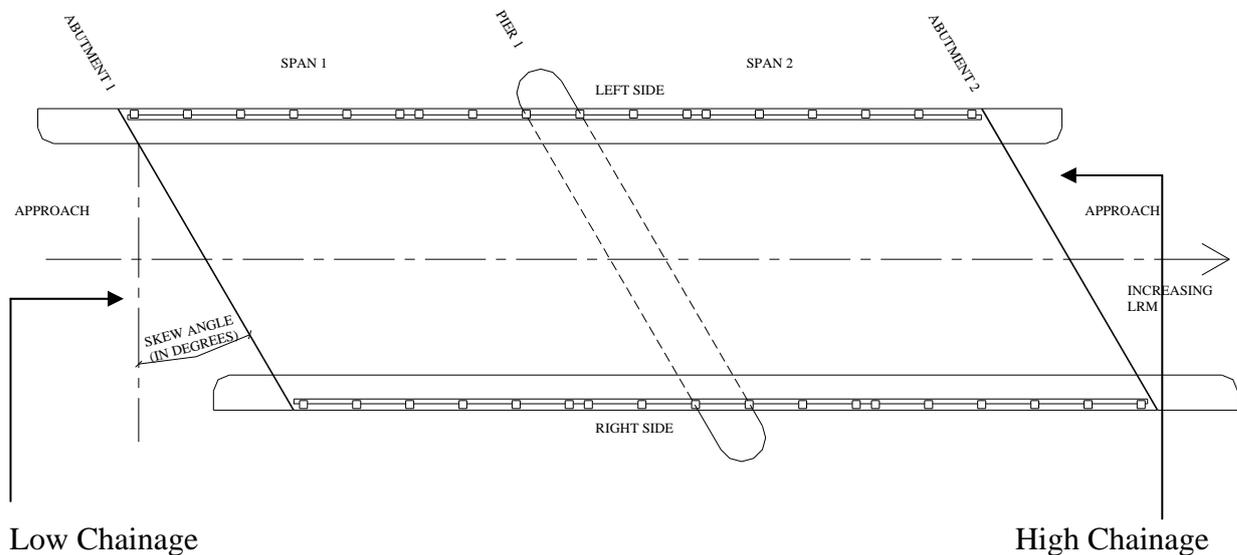
Perfunctory inspections as part of every day activities by general maintenance personnel or routine inspections of the bridges should discover any immediate conditions that may endanger life or property. All such conditions should be immediately referred to the relevant Regional or District Engineering Officer for action.

2.3. Bridge Geometry Definition

A standardized geometrical definition has been adopted for the BMS to define bridge geometry. This system is based on the LRS system used by the DPWH. The bridge is assessed in the direction of increasing chainage. Refer to Figure 2-1.



Figure 2-1
Bridge Geometry Definition



The following standard abbreviations have been adopted to describe a bridge:

S	-	span
P	-	pier
A	-	abutment
C	-	column
B	-	beam

Example, a three (3) span bridge with 4 beams in each span:

- Abutment 1 (A1) is at the low chainage end of the bridge and abutment 2 (A2) is at the high chainage end.
- Spans 1 (S1), 2 (S2) and 3 (S3) numbered from the low chainage end of the bridge.
- Piers 1 (P1) and 2 (P2) numbered from the low chainage end of the bridge.
- The first beam on the extreme right hand side (looking in increasing chainage) in Span 1 is designated as Span 1 – Beam 4 (S1 B4).
- The beam on the extreme left in span 2 is designated as Span 2 – Beam 1 (S2 B1).

Abutments 1 and 2 may be named Abutment A and B respectively in DPWH bridge drawings.

2.4. Inspection Planning

2.4.1. General

Regular and thorough inspection is essential to develop appropriate programs. Without proper preparation and facilities, however, an inspection can be severely hampered.



Careful planning is required for the smooth running of any inspection program, to enable an accurate and complete examination of the bridge structures and to ensure cost efficient inspections.

2.4.2. Inspection Program

The first step in planning inspections is to develop an inspection program. This program should list all bridges to be inspected in the region and/or engineering districts and the time period in which this is to be completed. From there, the staff and equipment requirements can be determined and the program reviewed to suit available resources. Throughout the inspection program, progress should be monitored so that budget and time constraints are met.

When developing an inspection program, careful consideration must be paid to external factors affecting the inspection.

These include:

- Traffic restrictions,
- Access difficulties, e.g. waterways, terrain, buildings, built-up areas, combined bridges,
- Safety of staff undertaking the inspection,
- Specialized equipment or personnel such as divers that may need to be called upon, and
- Seasonal or tidal restrictions.

If the officer who will undertake the inspection is not familiar with the site and possible external factors, then a familiarization visit will be beneficial.

2.4.3. Bridge Details and History

Prior to the inspection, available information on the type of bridge, its maintenance history and previous inspection reports will be reviewed by the officer who will undertake the inspection.

Copies of this information, including photographs, should be on a file for each bridge held in the regional office. It may be necessary to search further for bridge drawings, maintenance histories, consultant's reports, etc.

This information shall be reviewed prior to the inspection, so the officer who will undertake the inspection is aware of critical areas, previous problems or unusual features.

A copy of the previous inspection report and any other relevant information shall be taken to the bridge site for reference during the inspection.

The bridge files may contain helpful information that assists in the completion of inspections and should therefore be reviewed as part of the inspection. On-site conditions should be checked against the information on file and corrections and/or additions made to the file material as part of the inspection.



2.4.4. Resource Requirements

In order to perform an accurate and efficient inspection the correct equipment and manpower shall be readily at hand. A full list of the likely equipment required is included in Appendix D and this should be carefully considered prior to each inspection. It may also be necessary to arrange specialized equipment on a site-by-site basis. This might include scaffolding, bridge inspection vehicles, boats or testing equipment.

The correct level of manpower resource shall also be available and consideration given to specialized personnel who may be required. These could include laborers, security officers, divers for inspecting piles in rivers, mechanical, electrical or hydraulic specialists, testing experts or even access equipment operators.

2.4.5. RBIA

The RBIA is the main depository for inventory and condition data on bridges on national roads. The RBIA should always be interrogated for current inventory and condition reports and other relevant data by the officer who will undertake the inspection.

There are likely to be discrepancies between the data held in the RBIA and the actual bridges due to changes in the bridges (e.g. provision of alternative railings, construction of replacement bridges) and by changes in the defined national roads. The responsible regional officers shall ensure that all national bridges are included in the RBIA and that all inventory data is updated if necessary.

2.4.6. Inspection Forms

Standard inspection forms are available for each type of inspection.

The inspections forms for each inspection will be pre-printed from the RBIA to include all available relevant information for each bridge to ensure that all bridges included in the RBIA are included in each inspection cycle.

The initial data shown for each bridge shall be checked for correctness during the bridge inspections and corrections made or missing information added as necessary.

2.5. Safety

2.5.1. General

For the protection and safety of workmen, public and environment, safe work practices are essential on every work site.

The following safety aspects apply to bridge inspection work and must be considered prior to commencement of any inspection:

- Road safety
- Work safety



- Public safety

Health and safety have a high priority at all times during field operations. All statutory rules and regulations and recommended safety practices given in this manual are for general guidance in planning for safety at all the worksites. Commonsense should be used in anticipating the particular safety requirements for each and every project to be undertaken.

2.5.2. Road Safety

Working on or near roads is extremely hazardous.

The following rules must be explained to, and observed by, all personnel working on or near the roadways:

1. Before commencing inspection at the site ensure that:
 - All personnel are wearing high visibility vests;
 - Every worker knows the direction of traffic running on all the lanes;
 - Every worker knows where to take refuge if a vehicle approaches;
 - Unprotected or unsafe areas and roads are identified to all personnel.
2. Do not walk on or near the road unless absolutely necessary.
3. Always walk in the direction so that you are facing the oncoming vehicles. (The vehicles should not come from behind you.)
4. Whenever crossing roads (whether single lane or many) make sure that all the lanes are clear before crossing.
5. When operating any plant or machines on or near a road:
 - Before commencing work make yourself aware of potential hazards such as adjacent roads, overhead power lines, other workers, etc. **ALWAYS ANTICIPATE DANGER.**
 - **NEVER** step backwards without looking. Under the noise of your machine you may not hear the sound of approaching vehicles.
 - **NEVER** climb out of a machine without looking in both directions.
 - **NEVER** climb out of a machine onto a road or non-protected area.

2.5.3. Work Safety

Work safety must be planned ahead. Before commencing work, the officer undertaking the inspection shall attend to the following:

1. Be familiar with the full requirements of the inspection work including false work and access equipment.
2. Ensure that all tools, plant and equipment are available and in good working order.



3. Arrange any required safety harnesses, clothing, footwear, gloves, earmuffs, eye protection glasses, masks, helmets, welding shields, and any other items necessary for personal safety of the workers.
4. Plan and arrange road closures and suitable traffic management procedures.
5. Identify and locate all the utilities existing at site, such as water, sewerage, electricity, signals, communications, gas, etc. If any utilities are affected by inspection process take measures in advance to protect them or get them relocated as necessary through appropriate authorities. If any risk is foreseen, inform the authorities to stand by for any emergencies.
6. Ensure that first aid equipment is available at site and that at least one of the personnel at site holds a valid qualification for giving first aid.
7. All inspections are carried out in well-ventilated and well-lit areas. If necessary make prior arrangements for exhaust fans and artificial lighting.
8. Do not allow personnel under the influence of alcohol (or any medication which impairs alertness or causes drowsiness) to work at site or to operate any mechanical equipment.
9. Persons who are not qualified for carrying out a particular task or operating particular equipment must not be allowed to do that task or operate the equipment.
10. Generally, all the work should be carried out as per industry's normal standards of practice and/or in compliance with relevant Standards.

2.5.4. Public safety

There are obligations to take all necessary precautions and adequate measures for safety of public in and around the working area. The following steps should be taken to safeguard the public against any injury, loss of life or property:

1. Attend immediately to any damage and deterioration that may cause loss of strength and stability of a structure and thereby may result in injury, loss of life or damage to public property.
2. Take steps to support damaged structures against instability and collapse, as well as protect the adjacent properties, plant and utilities from possible damage.
3. Until damaged structures are made safe, close off access and prohibit their use by the public by setting up suitable fences and barriers. With the assistance of the District Engineering Office, and the police if necessary, arrange to divert the pedestrian and vehicular traffic by alternative routes. Provide warning signs and hazard lights as necessary to caution the public of danger.



4. At the completion of the inspection, clean up all dirt and debris, remove all plant, equipment and materials and restore the facility to public.

2.6. Sketches and Photographic Record

2.6.1. General

An appropriate photographic and sketch record must be compiled for Condition Inspection/ Engineering Inspection Report.

1. Mandatory inventory photographs (front view, side view, and underside).
2. Deficient components and major defects.
3. Undefined Components.

The accredited bridge inspector is required to prepare a photographic/ sketch record of each structure. All photographs and sketches must be given a reference and details of the subject matter recorded in the Bridge Inspection Report

2.6.2. Sketches Record

Sketches of the damage can be made on forms. The sketch should show the necessary plan and elevation views of the attribute to which they pertain. All damages should be located on the sketches by dimensioning their location in reference to the beginning or end of each attribute. For each damage the accredited bridge inspector should indicate dimensions showing its length, width, and depth (if applicable). Examples of sketches are attached for reference.

2.6.3. Photographic Record

The result of an inspection must be reported to the District Engineering Office. The accredited bridge inspector should photograph any major defects and append photographic prints to the report.

1. The prints should be annotated in accordance with the bridge component designations previously described.
2. Accredited Bridge Inspector must take the photo of entire condition and defects condition on the bridges exactly.
3. During the inspection, inspector must use the Blackboard as well as ribbon rods/measuring tape for getting the detailed information.
4. The blackboard must be included in the photograph.



5. The accredited inspector should take photographs to obtain as much information as possible.
6. Photograph of Defects must be taken for the worst condition rating

The photograph information required is as follows:

1. Photographic Record
2. Front View from traffic origin: One general photograph from top of deck showing alignment, width, kerbs and barriers.
3. Side View (Each span) from upstream: One photograph from side of bridge showing piers, abutments and waterway or roadway.
4. Under the bridge (Each span) from upstream: One photograph from under of bridge showing piers, abutments and waterway or roadway.
5. Representative photographs of main superstructure components (i.e. girders), from underneath or side of the structure, used in:
 - The original structure.
 - Any modifications (i.e. widening, lengthening, etc.)

These photographs are in addition to those required to show the Condition rating 2, 3 defects.

- Damage photograph must be taken for the worst condition rating such as Condition Rating 2,3 for each span of bridges.
- Damage photograph must include any information in terms of defects.
- Damage photograph must show measurement if possible by placing ribbon rod/ measuring tape beside damage points.

3. ROUTINE INSPECTION (TYPE 1)

3.1. Purpose

These inspections are essentially visual and are required to check for obvious defects.

These inspections serve also to ensure that regular planned maintenance is being properly undertaken

3.2. Process

The process for completion of routine inspections (type 1) is shown in Figure 3-1.



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The bridge routine inspection summary report is shown in Figure 3-3.

**Figure 3-2
Bridge Routine Inspection Report**



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BRIDGE ROUTINE INSPECTION REPORT

BRIDGE DATA

Region		Province	
Eng'g District		Municipality	
Road Name			
Bridge Name			
Bridge Number		LRM	

INVENTORY DATA
(Bridge description taken from RBIA)

CONDITION DATA

Deck			
Railings and guardrails			
Painting			
Signage			
Channel			

(Circle overall condition of bridge)

No deficiencies	Good
One deficiency noted	Fair
Two deficiencies noted	Poor
More than 2 deficiencies noted	Bad

Legend:

Deck	Presence of potholes, deck unevenness, differential settlement or lack of running boards (timber decked bridges)
Railings	Presence of deteriorated, broken or missing railings and guardrails
Painting	Presence of deteriorated paint, unclean/dishvelled bridge, graffiti or posters and lush vegetation along railings or on sides at bridge approaches
Signage	Absence of proper signage – warning signs (narrow bridge, weight limit, speed limit), correct location, visibility, good condition, clear lettering.
Channel	Accumulation of debris (logs, junk, vegetation, etc) siltation, or scour to the stream channel.

ROUTINE MAINTENANCE REQUIREMENTS

Type of work		Description of required work
Cleaning bridge		
Patching concrete deck		
Repairs to steel bridge		
Repairs to Bailey bridge		
Repairs to timber bridge		
Cleaning bridge waterways		
Emergency work		

Circle level of routine maintenance required

Light
Normal
Heavy
Excessive

COMMENTS BY INSPECTOR

Accomplished by:	Checked by:	Submitted by:
------------------	-------------	---------------

Insert Name, Position, Signature and Date of Signing



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Figure 3-3
Bridge Routine Inspection Summary Sheet



Republic of the Philippines
Department of Public Works and Highways

BRIDGE ROUTINE INSPECTION SUMMARY REPORT

REGION: _____ DISTRICT: _____

DATE OF COMPLETION:

Bridge Name	Road Name	LRM	Bridge Description	Condition	Routine Maintenance Requirement	Remarks

Accomplished by:	Checked by:	Submitted by:
------------------	-------------	---------------

Insert Name, Position, Signature and Date of Signing

Page ___ of ___



4. CONDITION INSPECTION (TYPE 2)

4.1. Purpose

The purpose of this level of inspection is to monitor and rate the condition of a bridge structure as a basis for identifying current maintenance needs, and forecasting future bridge intervention requirements and estimating future funding requirements.

4.2. Scope of the Inspection

The scope of the condition inspection will include:

- Reviewing the existing inventory of the bridge structure for accuracy.
- Visually inspecting the bridge components to assess their condition using a standard condition rating system.
- Reporting the condition of each bridge component.
- Providing a general condition rating for the structure as a whole.
- Identifying bridges that require an Engineering Inspection because of the presence of attributes with a Condition State of 2 and 3.
- A photographic record of the bridge.

The bridge inspection is to be visual inspection only and to cover all parts of the bridge above ground and water level.

The individual attributes of the bridge shall be inspected from within three (3) meters of all surfaces of the attribute, or equivalent using telescopic equipment. All surfaces of the attributes shall be in good natural or artificial light during the inspection, sufficient to observe fine cracks and other defects in the surfaces.

All bearings at the abutments and piers shall be inspected, and bearings at one pier shall be inspected at eye level.

Components that need not be inspected for bridge condition inspections are:

- (i) Inside box girders (This is desirable where access is readily available)
- (ii) In areas behind abutments that are inaccessible
- (iii) Piles and foundations below ground or water.

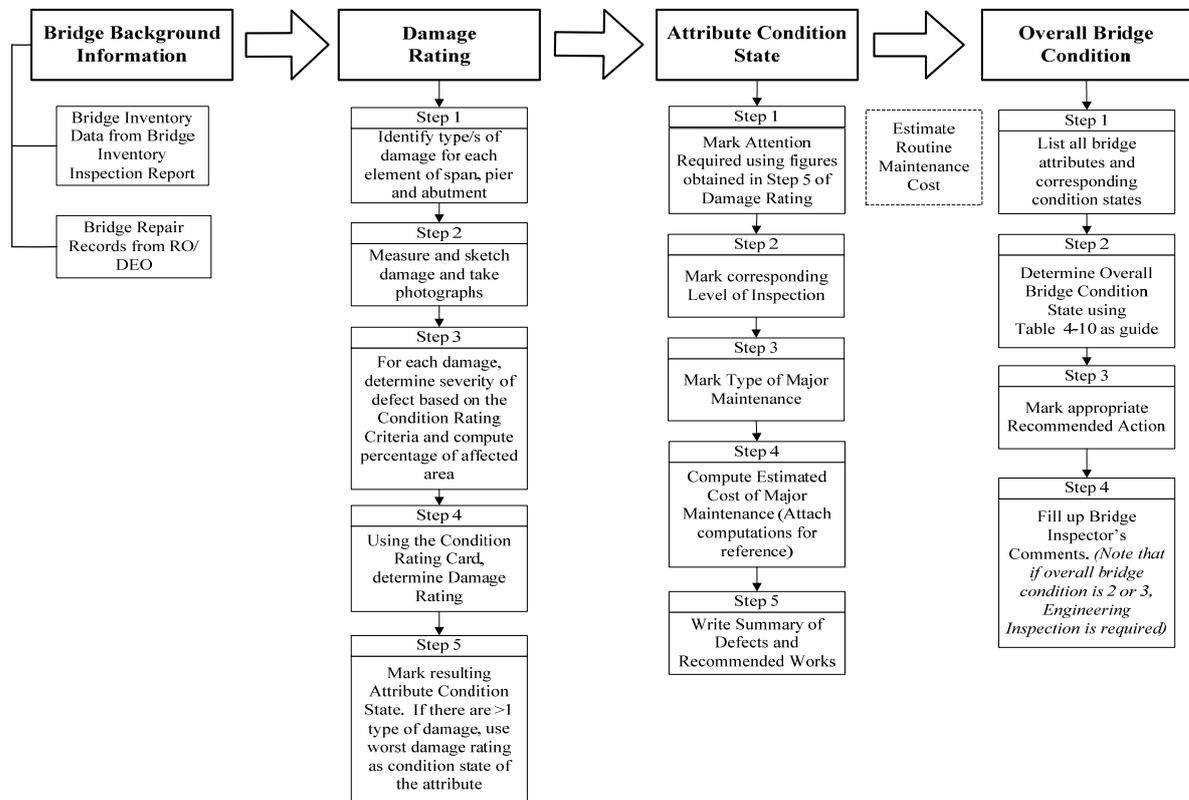
These components may be inspected as part of an Engineering Inspection if defects are located requiring further investigations.

Where an Engineering Inspection Report is available for a bridge, the conclusions of this report may be used to assist in the condition inspection though the bridge inspector shall check that these conclusions remain appropriate.



The step-by-step procedure for conducting the condition inspection is illustrated in the following flowchart.

Flowchart of Bridge Condition Inspection



4.4. Procedure

4.4.1. Condition Inspection Form

All information collected during a condition inspection is recorded or referenced on a condition inspection form (CIF). A sample CIF is included in Appendix E.

The CIF is composed of the sections shown in Table 4-1.



Table 4-1
Condition Inspection Parts

Function	Activity
Location	Identification of bridge. Review and correction of data Bridge visit photograph
Bridge Condition	Overall condition of bridge Recommended action to bridge Bridge inspector comment Type of bridge Level of Inspection Undertaken Reasons for Recommendation Estimate remaining bridge life Bridge survey
Routine Maintenance	Routine maintenance estimated costs
Major Maintenance of Bridge Attributes	Collection of bridge condition data Preparation of maintenance cost estimates Spans – 5 attributes Piers – 5 attributes Abutments – 8 attributes

The bridge inspector will complete an inventory inspection of the bridge if the bridge inventory is not included in the RBIA, or will confirm the bridge inventory against a printed bridge inventory report, as part of the condition inspection.

4.4.2. Level of Inspection

The bridge inspector shall indicate the level of inspection undertaken as shown in Table 4-2.

Table 4-2
Level of inspection

Full complete inspection	<input type="checkbox"/>
Partial inspection only as bridge inspection vehicle not available	<input type="checkbox"/>
Partial inspection for other reason	<input type="checkbox"/>

Where a complete inspection is not undertaken, a return visit to the bridge with a bridge inspection vehicle or other equipment as required. It may be practicable only to use bridge inspection vehicles one year in three for example, due to the limited number of such vehicles. A countrywide program for the use of the available bridge inspection vehicles should be implemented to ensure the maximum use of these vehicles for bridge inspections.



4.4.3. Location and Inventory Data

The bridge inspector shall inspect the bridge and review the Location data included in the CIF.

Data required are described in Table 4-3.

Table 4-3
Bridge Location Data

Data Description	Comment
Bridge ID	Unique identification number assigned by the RBIA for each bridge
Bridge Name	The name given to the bridge
Road Name	The name of the road on which the bridge is located.
Road ID	Unique identification number assigned by the RBIA for the road on which the bridge is located
Section ID	The unique identification number assigned by the RBIA to the specific road section containing the bridge
Location	The location (chainage) of the bridge within the road section based on the LRS
Region	Region in which the bridge is located
Engineering District	Engineering district which is responsible for the management and maintenance of the bridge
Province, Congressional District, Municipality and Barangay	The administrative area in which the bridge (i.e. the first abutment) is located.
River Name	The name of the stream crossed by the bridge (where appropriate)

4.4.4. Estimation of Routine Maintenance Costs

The bridge inspector is required to prepare the estimated costs of routine maintenance for the next fiscal year.

The estimated costs of routine maintenance to a bridge shall be based on a review of the actual routine maintenance costs to the bridge in the previous year adjusted based on the inspection of the bridge. The historical costs will be compiled and supplied by the District Engineering Office in which the bridge is located on request. The inspection will be used to determine if the same or different routine maintenance will be required in the next budget year. For example, if a timber-decked bridge has had the timber decking replaced in the previous year, it is unlikely that a timber deck replacement would be required in the next budget year.



The estimated costs for routine maintenance will be used in the planning of the Annual Infrastructure Program for the coming fiscal year.

The definition for routine maintenance is presented in Table 4-4.

Table 4-4
Definition of Routine Maintenance

Definition	Routine Maintenance Activities
All routine and periodic maintenance to bridges undertaken using DPWH routine maintenance funds as defined by RMMS	Works that are urgent to safeguard the bridge and the public; Works not requiring formal design and documentation; and Works that can be undertaken with a maximum MBA allocation of 10 crew days per bridge per year.

Routine maintenance covers minor works to the entire bridge, and includes cleaning, painting, minor repairs, and other minor works.

The standard routine maintenance activities are listed in Table 4-5.

Table 4-5
Routine Maintenance Activities

Act. No.	Description	Unit	Method
60.01	Sweeping and cleaning of bridge deck	sq. m	MBA/MBC
60.02	Patching concrete deck	sq. m	MBA/MBC
60.03	Repairs to concrete bridges elements	crew days	MBA
60.04	Repairs to steel bridges elements	crew days	MBA
60.05	Repairs to Bailey bridges	crew days	MBA
60.06	Repairs to timber bridges	crew days	MBA
60.07	Clearing bridge waterways	crew days	MBA

4.4.5. Repair Record

The bridge inspector is required to report the routine and major maintenance activities undertaken to a bridge after the conduct of the last condition inspection that will include the type, scope and status of maintenance activities. The bridge inspector shall also record observations whether the works undertaken are effective and sufficient.

4.4.6. Condition Data Collection

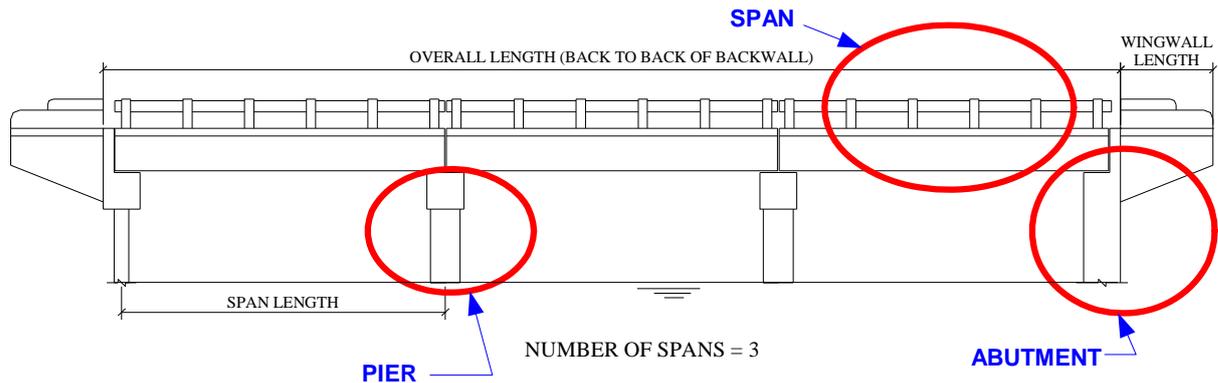
The bridge inspector will estimate the condition state of each defined attribute shown in the CIF based on a detailed visual inspection of each attribute. The affected area, length or number of components will then be roughly estimated which will be the basis in assessing the severity of defects using the Condition Rating Card (Figure 4.8) and eventually deciding the attribute condition.



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Bridges are composed of span, pier and abutment elements as shown in Figure 4-2. Each element has a standard set of defined attributes that cover all the features of the element in general terms.

**Figure 4-2
Bridge Elements**



The defined attributes of a bridge are listed in Table 4-6.

**Table 4-6
Bridge Attributes**

Element	Attribute	Description
Span	Deck	The deck is the surface on which vehicle traffic and/or pedestrian move
	Main members	The structure supporting the span between the supports. The main members are the trusses in a truss bridge and the girders in a girder bridge
	Secondary members (including other members)	The secondary members are any structural members transferring the loads to the deck to the main members. In a girder bridge where the deck is supported directly on the girders, there are no structural members. In a truss bridge, the secondary members are the transverse transoms and the longitudinal stringers transferring the load on the deck to the trusses.
	Left railing	The barriers to the left side preventing vehicles and/or pedestrians falling off the bridge
	Right railing	The barriers to the right side preventing vehicles and/or pedestrians falling off the bridge
Pier	Main structure	This is the visible structure of the pier that supports the superstructure.
	Foundation	The foundation is the structure that transfers the load of the bridge to the underlying ground. In most cases the foundation may not be visible and can only be assessed based on its performance. The foundation is assumed to be in a good condition if there are no signs that the foundation is moving or other distress.
	Expansion joint	The expansion joint is the connection in the deck between the spans over the pier.
	Bearings/Restraints	The bearing and restraints support the superstructure on the pier and limit movement of the superstructure on the pier.
	Scour protection	The surrounds of the base of the pier including any work to prevent scour around the pier during flooding or other events.



Table 4-6
Bridge Attributes (Continued)

Element	Attribute	Description
Abutment	Main structure	This is the visible structure of the abutment that supports the superstructure and approach road.
	Foundation	The foundation is the structure that transfers the load of the bridge and the approach road to the underlying ground. In most cases the foundation may not be visible and can only be assessed based on its performance. The foundation is assumed to be in a good condition if there are no signs that the foundation is moving or other distress.
	Bearings/Restraints	The bearing and restraints support the superstructure on the abutment and limit movement of the superstructure on the abutment.
	Expansion joint	The expansion joint is the connection in the deck between the abutment and adjacent span that allows for movement between the superstructure and the abutment.
	Left wing wall	Any additional wall on the left side of the bridge abutment to support the approach road adjacent to the abutment. Some bridge may not have any win walls.
	Right wing wall	Any additional wall on the right side of the bridge abutment to support the approach road adjacent to the abutment. Some bridge may not have any win walls.
	Scour/Bank protection	The surrounds of the base of the abutment including any work to prevent scour or loss of material from around the abutment during flooding or other events.
	Bridge approach	The approach road structure adjacent to the bridge that is affected by the bridge abutment.

Each span, pier and abutment of a bridge will have the defined attributes listed in Table 4-6. Therefore, a single span bridge (no pier) will have 21 defined attributes, a two span bridge will have 31 defined attributes, and so on.

The bridge inspector shall inspect 100% of the exposed surface of each attribute and the assessed condition state shall be based on the surfaces that were inspected. Where it is estimated that only 50% or less of the attribute has been inspected, the assessment shall also be recorded as P on the CIF, stating the reason why it cannot be fully observed. Where an attribute has not been closely inspected at all, the assessment shall be recorded as N on the CIF. Where an attribute has only a partial or no assessment, the bridge inspector shall still nominate the condition state of the element.

As the condition inspection is a visual inspection, the inspection only applies to those attributes that can be visually inspected. Therefore, an N or a P would apply if an attribute could have been inspected in more detail if additional equipment (e.g. bridge inspection vehicle, ladder, boat, etc) were available. An N or P would indicate that a revisit should be made to the bridge to complete the inspection of incompletely inspected attributes.

Condition record photographs shall be taken at the site of all components with condition state of 2 or 3 to show the appearance of the observed defect. Photographs shall be taken within three (3) meters of the surface of the attribute showing the defect, or equivalent using a telephoto lens.



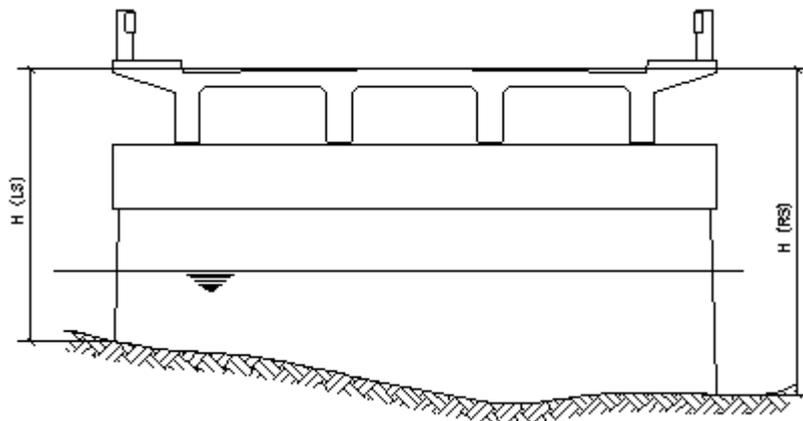
The bridge inspector shall inspect and assess the condition of each attribute using the standard condition state criteria and record the result of the assessment in the CIF.

4.4.7. Pier and Abutment Scour Check

Scour checks are made at the piers and abutments in each annual condition survey. These record the level of the ground surface at the piers and abutments. This data will be available to monitor changes in surface levels under bridges over a longer period and therefore will indicate whether erosion or accretion is taking place.

The scour check at a pier is undertaken as shown in Figure 4-3. The bridge inspector is required to measure the height from the top of the concrete deck or parapet to the ground or streambed level on each side of the bridge on the centerline of each pier.

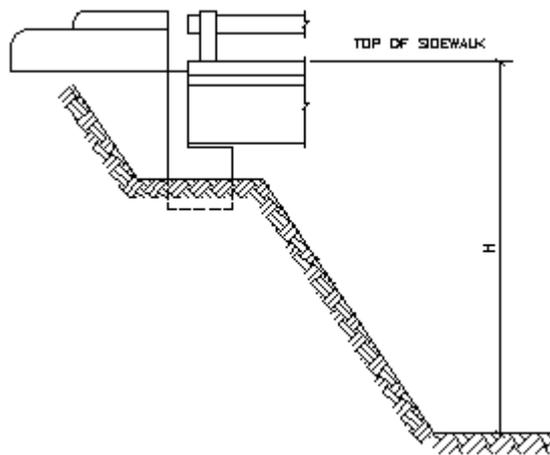
Figure 4-3
Measurement of Pier Scour Check





The scour check at an abutment is undertaken as shown in Figure 4-4. The bridge inspector is required to measure the height from the top of the concrete deck or parapet to the ground or streambed level on each side of the bridge to the natural surface immediately adjacent to the abutment.

Figure 4-4
Measurement of Abutment Scour Check



4.4.8. Condition Rating of Bridge Attributes

The material defect descriptions included in Appendix A and the component condition state rating criteria included in Appendix B will be used by the bridge inspectors to assess the defects identified in bridge elements. The descriptions cannot possibly cover every situation, and the bridge inspectors must rely on their engineering knowledge and judgment to evaluate which condition should apply to the bridge elements inspected.

The bridge inspectors shall also compare the defects observed in the component with the description photographs included in Appendix C where applicable.

Based on the type of an attribute, the damage type can be selected and evaluated using the damage rating criteria in Appendix B. The Affected area, length or number will be roughly estimated and using the Condition Rating Card shown in Figure 4-8. The damage rating can be determined. The condition state of the attribute is the worst damage rating recorded for the attribute.

The *condition states* have been developed to describe the following conditions listed in Table 4-7.

For each defined attribute in the bridge, the CIF includes a separate section covering that attribute and which is to be completed by the bridge inspector. Each section shall be completed to include:

- The condition state of the attribute (Refer Table 4-7),



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- The type of repair required to each attribute, and
- The estimated cost to undertake the required repair (major maintenance).

Some attributes may not occur as discussed in Section 4.4.9.

All repairs to attributes are classified as major maintenance to differentiate them from routine maintenance. Any work to a bridge included as routine maintenance shall not also be included as major maintenance.

The standard descriptions of major maintenance that may be undertaken to each attribute are:

- Repair damage,
- Protective measures,
- Strengthen,
- Replace and
- Other.

Only one type of maintenance can be listed for each attribute. Where two types of maintenance are required to an attribute, all work shall be listed under the type of maintenance with the highest estimated cost.

For example, a bridge may be assessed as requiring the following major maintenance to the main members of a span:

Repair damage	P345,000.00
Protective measures	P210,000.00

In this case, the attribute form would be completed as follows:

Repair damage	P555,000.00
---------------	-------------

The bridge inspector shall describe in detail the recommended works to repair each defect identified in any attribute, providing sketch drawings if necessary.



Table 4-7
Bridge Attribute Condition States

Condition State	Description	Action
0	Attribute is in good condition with little or no deterioration	No action required
1	Attribute shows deterioration of a minor nature to the primary supporting material and is showing first signs of being affected	Major maintenance is required within 10 years.
2	Attribute shows advancing deterioration and loss of protection to the supporting material, minor loss of section	Major maintenance is required within 2 years
3	Attribute shows advanced deterioration, loss of effective section to the primary supporting material, and is acting differently to design or is showing signs of overstress	Immediate major maintenance is required

The condition state of each bridge attribute will be used by the BMS to calculate the overall need of the bridge for intervention.

4.4.9. Not Applicable Attributes

There are many instances when the CIF is not completed completely or correctly due to uncertainties concerning the occurrence of some bridge attributes.

The bridge inspector may feel that an attribute cannot be completed because he cannot recognize the attribute in the bridge. The bridge inspector must not omit the data for any attribute blank for this reason. The bridge inspector must adopt one of the options described below:

1. Mark the attribute as ***not applicable***. In this case, the attribute is not included in the subsequent BMS analysis.

Assume the attribute is in good condition. In this case, the attribute is included in the BMS analysis.

The bridge inspector is only permitted to make this selection as shown in Table 4-8.

These restrictions are imposed as the BMS analysis is sensitive to the correct number of attributes being consistently selected in each bridge. The assessed attribute condition states are used to calculate the Bridge Needs Ratio (BNR) for each bridge and the calculated BNR for each bridge is used to rank the bridges with the bridge with the highest BNR given the highest ranking as it is assessed as being in the greatest need for intervention to address the observed defects in the bridge.



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The impact of these two options is discussed below in reference to the calculation of BNR (refer to the Bridge Inspection Trainees Manual).

Where the attribute is marked as *not applicable*, the attribute is not included in the analysis as $(C_i \times W_i)$ and $(C_{imax} \times W_i)$ are both made equal to zero.

Where the attribute is assumed to be in good condition, the attribute is included in the analysis as $(C_i \times W_i)$ is included as zero and $(C_{imax} \times W_i)$ is included as 3 times the weighting factor.

For example, assume a three span bridge that has 41 attributes. Three attributes are the secondary members in each span. The bridge inspector is not sure whether these occur in the bridge.

If the bridge inspector adopts the first case and assumes that the secondary members are not applicable:

$$C_i \times W_i = 0.0$$
$$C_{imax} \times W_i = 0.0$$

If the bridge inspector adopts the second case and assumes that the secondary members are applicable and are in a good condition (Condition state 0):

$$C_i \times W_i = 0.0$$
$$C_{imax} \times W_i = 54.0$$

In the first case, the overall situation for the bridge may be:

$$\text{Sum } (C_i \times W_i) = 99.5$$
$$\text{Sum } (C_{imax} \times W_i) = 294.0$$

As the $\text{BNR} = \text{Sum } (C_i \times W_i) / \text{Sum } (C_{imax} \times W_i)$, therefore:

$$\text{BNR} = 99.5 / 294.0 = 0.338$$

In the second case, the overall situation for the bridge is:

$$\text{Sum } (C_i \times W_i) = 99.5$$
$$\text{Sum } (C_{imax} \times W_i) = 348.0$$

In this case, the BNR is reduced to:

$$\text{BNR} = 99.5 / 348 = 0.286$$

In this example, the BNR has been lowered by 15% simply by including an attribute that does not occur in the bridge.



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Table 4-8
Assessment of Bridge Attributes

Element	Attribute	Comment
Span	Deck	All spans have decks and these must be included and assessed.
	Main members	All spans have main members and these must be included and assessed.
	Secondary members	Only some spans have secondary members. Where they occur, they must be assessed and included. Where they do not occur, they must be recorded as <i>not applicable</i> only. A bridge has no secondary members where the deck is supported directly on the main members; therefore there are no secondary members in a girder bridge. The diaphragms are not secondary members as they are not part of the load path between the main members and the deck. A steel truss bridge has secondary members; the trusses are the main members and the transoms and stringers supporting the deck are the secondary members.
	Left railing	All spans should have railings and these must be included and assessed. The case of no railings should be assessed as condition state 3.
	Right railing	All spans should have railings and these must be included and assessed. The case of no railings should be assessed as condition state 3.
Pier	Main structure	All piers have main structures and these must be included and assessed.
	Foundation	All piers have foundations and these must be included and assessed. In some cases the foundations are not visible but they must be included as condition state 0 unless there are signs (e.g. settlement) that the foundations are moving
	Expansion joint	All piers will be assessed as having expansion joints, even for those bridges where expansion joints are not included. This attribute really assesses the performance of the deck over the piers. Where there are no expansion joints and there are no signs of distress or distortion, the attribute would be assessed as condition state 0.
	Bearings/restraints	All piers must have some form of bearings and restraints though in many cases these are not apparent or visible. This attribute must always be included and assessed. Where no bearings or restraints are visible but there are no signs of poor performance such as movements, rust stains, spalling of concrete, distorting, etc, the attribute would be assessed as condition state 0.
	Scour protection	All piers have scour protection, even where no obvious scour protection works exist.



Table 4-8
Assessment of Bridge Attributes (Continued)

Abutment	Main structure	All abutments have main structures and these must be included and assessed.
	Foundation	All abutments have foundations. In some cases these are not visible but they must be included as condition state 0 unless there are signs (e.g. settlement) that the foundations are moving
	Bearings/restraints	All piers must have some form of bearings and restraints though in many cases these are not apparent or visible. This attribute must always be included and assessed. Where no bearings or restraints are visible but there are no signs of poor performance such as movements, rust stains, spalling of concrete, distorting, etc, the attribute would be assessed as condition state 0.
	Expansion joint	All piers will be assessed as having expansion joints, even for those bridges where expansion joints are not included. This attribute really assesses the performance of the deck over the piers. Where there are no expansion joints and there are no signs of distress or distortion, the attribute would be assessed as condition state 0.
	Left wing wall	Not all abutments have wing walls. Where the wing walls are not visible and therefore would have no structural purpose, it shall be assumed that no wing walls exist. In this instance, the wing walls will be recorded as <i>not applicable</i> . Where wing walls are visible, they shall be recorded and assessed.
	Right wing wall	Not all abutments have wing walls. Where the wing walls are not visible and therefore would have no structural purpose, it shall be assumed that no wing walls exist. In this instance, the wing walls will be recorded as <i>not applicable</i> . Where wing walls are visible, they shall be recorded and assessed.
Abutment	Scour/bank protection	All abutments have scour and bank protection, even where no obvious scour or bank protection works exist. A condition state of 0 applies where there is no scour/bank protection but there is no sign of loss of material around the abutment or no signs of scour.
	Bridge approach	All abutments have approach roads and this attribute shall be assessed and included. This attribute only considers damage resulting from the bridge (e.g. settlement). The attribute shall be recorded as condition state 0 if there is no sign of distress to the abutment approach (e.g. hollow under, settlement, step at abutment).

Simple rules are imposed to minimize the affect of this uncertainty:

- Attributes should not be included in the analysis if they do not occur in the bridge. That is to say, attributes that are not included in a bridge should be marked as *not applicable* in the bridge condition form.
- Care should be taken to ensure that the same number of attributes is included in the analysis in successive years. That is, the same attributes should be marked as *not applicable* in each annual bridge condition report.

Comments on each bridge attribute are given in Table 4-8.



4.4.10. Estimation of Major Maintenance Costs

The bridge inspector is required to prepare estimated costs of major maintenance to correct the defects identified in each bridge for those attributes assessed as having a condition state of 2 or 3.

The estimated costs for major maintenance costs will be used to plan programs of major maintenance, upgrading and replacement for all national bridges. It is important that reasonable accuracy cost estimates are prepared, as they will be used to assess if a bridge will be maintained, upgraded or replaced. Even where the bridge engineer is confident that the correct action is to replace a bridge, cost estimates to repair the assessed defects must be prepared. The definition for major maintenance is explained in Table 4-9.

Table 4-9
Definition of Major Maintenance

Definition	Major Maintenance
All bridge maintenance undertaken using a specific allocation of funds	All repair work to bridges that is outside the scope of work handled under routine maintenance and which requires a separate allocation of funds. This category would include all works to bridges to prevent deterioration, to address existing damage and to overcome conditions that may impact on the bridges. It would not include any work that would improve the level of service provided by the bridges.

The bridge inspector shall prepare an estimated cost for each listed major maintenance repair. Separate work sheets shall be used to give details of the recommended major maintenance and the estimated costs of this major maintenance for each defined attribute.

These cost estimates shall be prepared as follows:

- For each defect prepare a list of the major activities that will be required to make the repair. This list could include items such as scaffolding, removal of damaged concrete, excavation, traffic control, reinforced concrete construction, and the like.
- Costs are estimated for each major activity based on using the material, equipment and labor requirement costs or contract rates. The estimated cost for each activity may be a lump sum.

Each estimated cost must include a reference record on the CIF for easy access to the supporting work sheets. Reference work sheets shall be designated as R-1, R-2, etc and will be attached to the CIF.

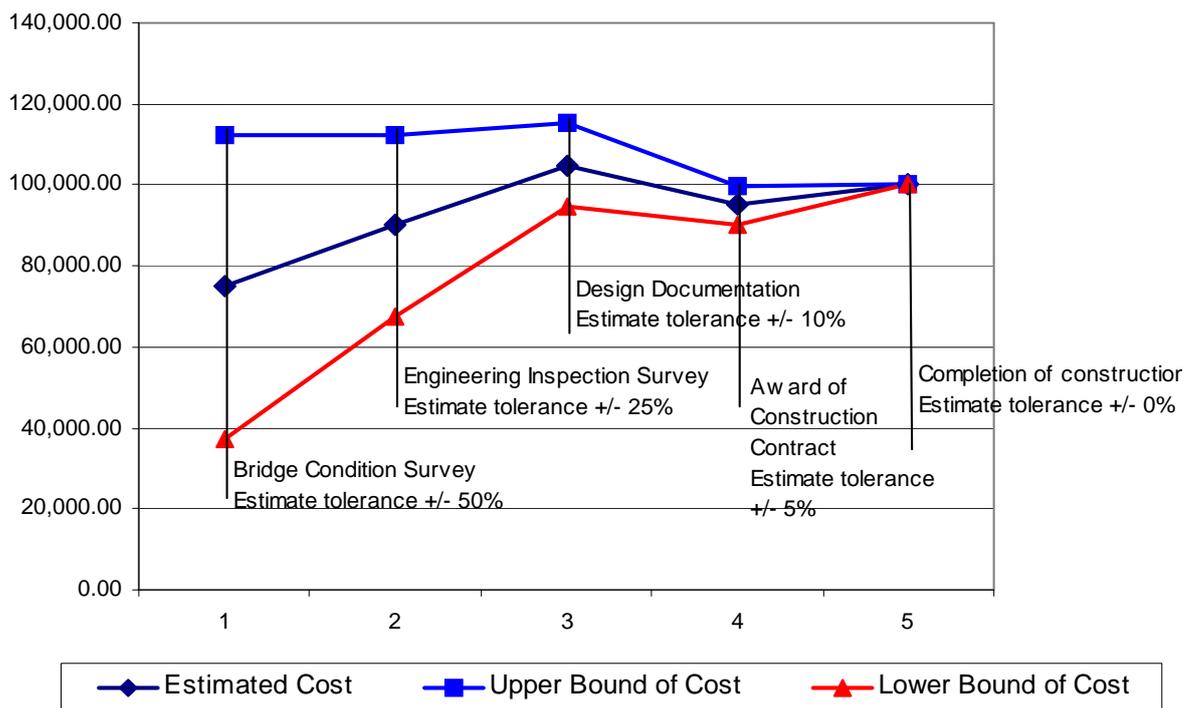
The required accuracy for the major maintenance cost estimates is only +/- 50 % as these estimates are only order-of-cost estimates and prepared based on a visual inspection of the damaged bridge attributes. The accuracy cannot be higher as the scope and extent of work has not been defined.



The requirement for accuracy of the cost estimates is illustrated in Figure 4-5.

Any bridges where the defects recorded during a bridge condition survey are such that the bridge is assessed as requiring some form of intervention, will be subject to an engineering inspection which will define the type of intervention required, determine the scope of work for the intervention, and provide a more accurate cost estimate based on estimated quantities of work.

Figure 4-5
Illustration of Estimate Accuracy



The cost of routine maintenance shall not be included in the cost of major maintenance. The bridge inspector may have to decide which work will be undertaken as routine maintenance and which works will be undertaken as major maintenance.

4.5. Sample of Attribute Inspection Forms

For example, the reinforced concrete deck slab of an RCDG bridge has 1.20mm wide cracks spaced at an average of 150mm in two directions covering an area of about 10 square meters at Span 1. Span 1 has a dimension of 7 meters width and 10meters span length. Also, Span 1 has 40cm wide water leakage.

In Figure 4-6, the CIF for damage rating of span element, the type of material for the deck attribute is concrete and the defects identified are cracking and water leakage. In Appendix B, the severity of cracking is 3-Bad since 1.20mm with an average spacing of 150mm in two directions falls under the criteria of more than 1 mm cracking in two directions spaced at less than 200 mm. The severity of water leakage is 2-Poor since 40cm is under the criteria of more than 20cm wide.



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For cracking of concrete of primary components such as deck slab, the severity of damage will be the damage rating, which in this case is **3** regardless of the size of affected area. In the CIF, the damage rating for cracking will then be **Bad**.

For water leakage where the total calculated affected area is 26%, the Condition rating Card is used to determine the damage rating. The damage rating is 2-Poor since the area affected is within 20~30% of a primary component.

When all the ratings of the observed types of defects for the deck in Span 1 are compared, the worst rating will be the condition state of the deck attribute. The attribute condition state of the deck will then be “**3**” or **Bad** since cracking has the worst rating.

Figure 4-6
Sample Attribute Form (Damage Rating)

Bridge Element: Span 1
Bridge Attribute: Deck

Type of Material: Concrete
Type of Damage: Cracking and Water Leakage

Type of Material	Type of Damage	Severity of Defect	Affected		Damage Rating	Attrib. Cond. State
			Unit	%		
DECK						
Concrete Slab	<input checked="" type="checkbox"/> Cracking	3	-	-	Bad	3
	<input type="checkbox"/> Spalling/Scaling/Disinteg.					
	<input type="checkbox"/> Rebar exposure/corrosion					
	<input type="checkbox"/> Honeycomb					
	<input checked="" type="checkbox"/> Water leakage	2	Area	26	Poor	

The attribute condition state determined will then be specified in the CIF. For example, the condition state of “3” (Attention Required – Immediate) for deck attribute can be marked as shown in Figure 4-7.

Figure 4-7
Sample Attribute Form (Condition)

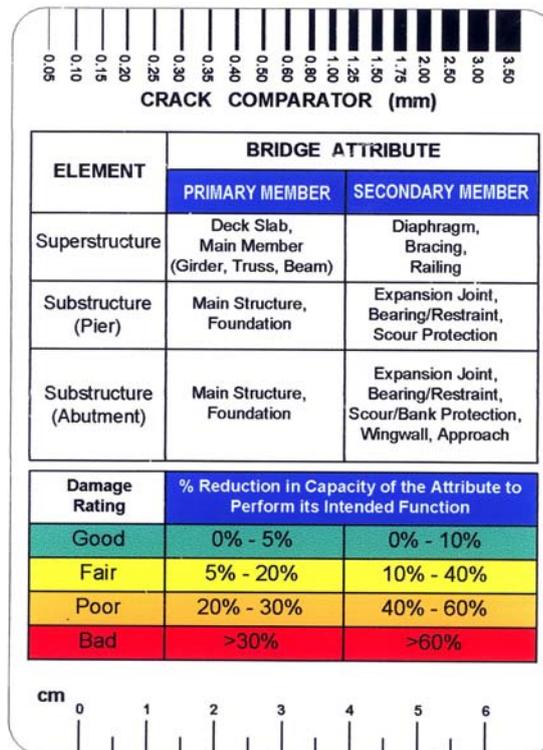
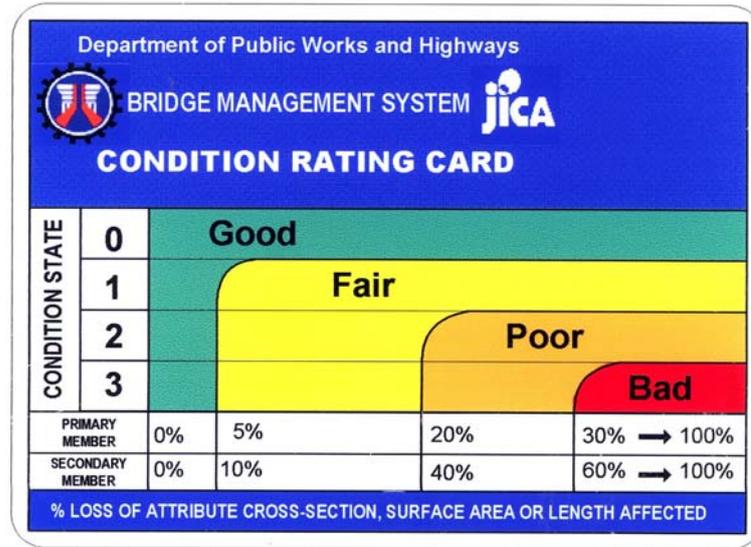
ATTRIBUTE	ATTENTION REQUIRED	LEVEL OF INSPECTION	TYPE OF MAJOR MAINTENANCE	ESTIMATED COST (P)	REFERENCE	
DECK	Immediate	3 <input checked="" type="checkbox"/>	Fully assessed <input checked="" type="checkbox"/>	Repair damage <input checked="" type="checkbox"/>	100,000.00	S1
	Within 2 years	2 <input type="checkbox"/>	assessed <input type="checkbox"/>	Protective measures <input type="checkbox"/>		
	Within 10 years	1 <input type="checkbox"/>	Partially assessed <input type="checkbox"/>	Strengthen <input type="checkbox"/>		
	None	0 <input type="checkbox"/>	assessed <input type="checkbox"/>	Replace <input type="checkbox"/>		
	Not Applicable	<input type="checkbox"/>	Not assessed <input type="checkbox"/>	Other <input type="checkbox"/>		
				Total Estimated Cost	100,000.00	
SECONDARY MEMBER	Immediate	3 <input type="checkbox"/>	Fully assessed <input type="checkbox"/>	Repair damage <input type="checkbox"/>		
	Within 2 years	2 <input type="checkbox"/>	assessed <input type="checkbox"/>	Protective measures <input type="checkbox"/>		
	Within 10 years	1 <input type="checkbox"/>	Partially assessed <input type="checkbox"/>	Strengthen <input type="checkbox"/>		
	None	0 <input type="checkbox"/>	assessed <input type="checkbox"/>	Replace <input type="checkbox"/>		
	Not Applicable	<input checked="" type="checkbox"/>	Not assessed <input type="checkbox"/>	Other <input type="checkbox"/>		
				Total Estimated Cost		



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The bridge is a concrete girder bridge with a reinforced concrete deck slab supported directly on the main members consisting of beams. In this case, there are no secondary members attribute for Span 1 therefore the box for “Not Applicable” will be marked.

Figure 4-8
Condition Rating Card





4.6. Bridge Condition Assessment

The bridge inspector is required to assess the overall condition of the bridge based on the condition of the bridge components. The summary sheet of the CIF will be completed for the overall condition of the bridge. Data needed for this section are described below:

- **Overall Condition of the Bridge** refers to the rating given by the bridge inspector to a certain bridge. The bridge can be evaluated as good, fair, poor or bad. Note that the bridge inspector must rely on his/her engineering knowledge and judgment for the evaluation of the bridges' condition.

In general, structures described as **Good** condition shall be free of defects affecting structural performance, integrity and durability; those described in **Fair** condition may have defects which affect the durability; and those described as **Poor** condition may have defects which affect the performance and structural integrity of the structure. Those structures described as **Bad** shall have major defects and are considered to be beyond repair.

The bridge inspector shall determine the overall condition of the bridge based on the result of the condition rating of the bridge primary components/attributes and secondary component/attributes that affects structural performance such as bearings/restraints. In general, the worst condition state of any primary component and secondary component that affects structural performance will be the overall condition state of the bridge. Guidelines for assistance are included in Table 4.10.

Table 4-10
Guidelines in Assessment of Bridge Condition

Bridge Condition	Assessment Indicators
	Primary Components and Secondary Components that Affects Structural Performance (Attribute Condition State)
Good	0
Fair	1
Poor	2
Bad	3

Bridge Condition	Recommended Countermeasures	Remarks
Good	Routine Maintenance	-
Fair	Major Maintenance (Repair, Protective Works, Strengthening)	Total of Bridge Component
Poor	Major Maintenance or Upgrading	Total of Bridge Component
Bad	Upgrading or Replacement	Total of Bridge Component

- **Recommended Action to the Bridge** refers to the level of rehabilitation works needed



for the bridge. The recommended measures will be generally based on the overall bridge condition as shown above.

- **Bridge Inspectors' comment on recommendation.** The bridge inspector shall indicate his comments on the recommended activity for the bridge.
- **Major reasons for recommendation.** The bridge inspector shall indicate the reason(s) for the recommended activity to the bridge. Up to three (3) reasons can be selected.
- **Estimated Remaining Bridge Life** refers to the remaining length of time for which the bridge will remain serviceable. The bridge inspector shall estimate the remaining bridge life based on his/her engineering knowledge and judgment.

Guidelines for the estimation of remaining bridge life are shown in Table 4-11.

Table 4-11
Estimation of Remaining Bridge Life

Overall Bridge Condition	Remaining Bridge Life Range (years)			
	Concrete	Steel	Timber	Demountable
Good Condition Bridge	40-50	30-40	10-15	20-30
Fair Condition Bridge	10-40	10-30	5-10	10-20
Poor Condition Bridge	5-20	5-20	2-5	5-10
Bad Condition Bridge	0-10	0-10	0-2	0-5

4.7. Deliverables

A bridge condition report is prepared following the condition inspection.

The bridge condition report shall include the following items:

- A fully completed bridge condition inspection form (CIF),
- Supporting information for proposed major maintenance,
- Cost estimates for routine maintenance and major maintenance,
- Inspection photographs (proof of visit), and
- Photographs of attributes with identified defects of Condition State 2 or 3.

A sample completed bridge condition inspection form (CIF) is included in Appendix F for reference.

The bridge condition reports shall be prepared in the offices in which the bridge inspectors are based for all bridges in each region. The reports shall be checked and reviewed in the Regional Office for completion and accuracy prior to finalization.

The data contained in the Bridge Condition Reports shall be loaded into the RBIA in the Regional Offices when the reports have been accepted as accurate and complete. The



photographs taken as part of the inspection shall also be loaded into the RBIA.

The bridge condition reports shall be retained in the Regional Offices for future reference and use.

5. ENGINEERING INSPECTIONS (TYPE 3)

5.1. Purpose

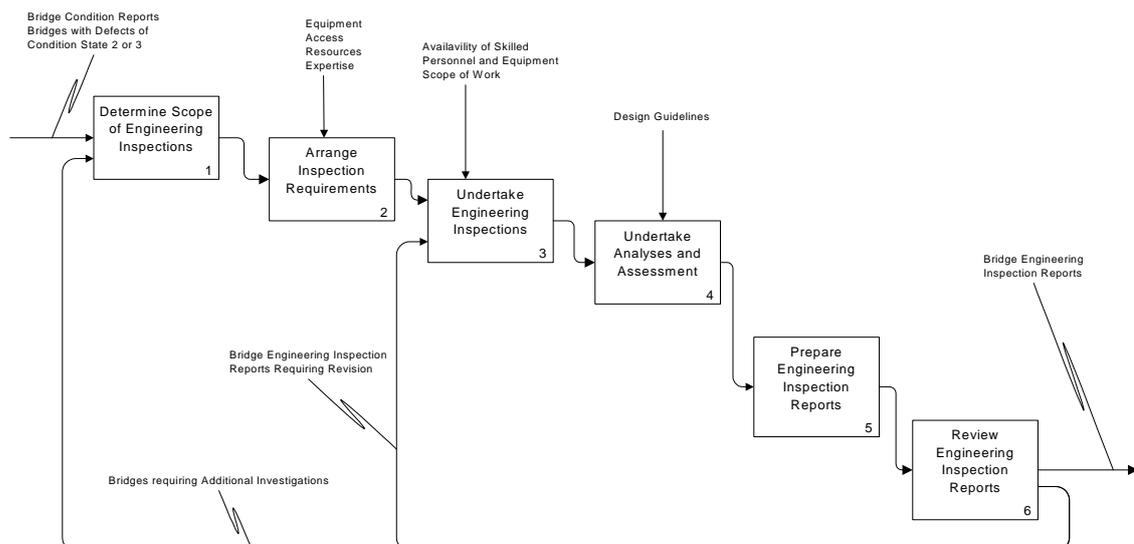
Bridge engineering inspections are undertaken as required as a follow-up to bridge condition inspections when defects with a condition state of 2 or 3 are recorded in any primary component/attribute or in any secondary component that has a detrimental effect on the structural performance of the bridge. The purposes of a bridge engineering inspection are:

- 1) To confirm the results of bridge condition inspection;
- 2) To undertake additional investigations necessary for defect evaluation including physical testing and/or structural analysis, and to document the observed defects with sufficient information for future design of required major maintenance works;
- 3) To assess the current bridge structural condition, behavior and capacity; and,
- 4) To assess the rate of deterioration and residual life expectancy.

5.2. Process

The general process for a bridge engineering inspection is shown in Figure 5-1.

Figure 5-1
Engineering Inspection





This is a generic inspection model as the scope and extent of the engineering inspection will vary depending on the nature, extent, magnitude and severity of the observed defects. This type of inspection would be undertaken by the Engineering Inspection team who would develop the appropriate scope necessary to address the identified defects and any particular bridge requirements.

The Engineering Inspection Team will consist of the BMS Team in the Planning Service, Bureau of Design, Bureau of Research and Standards, Bureau of Maintenance, BMS coordinator and BMS accredited inspector from the Regional/District Office concerned.

5.3. Scope

The scope of the Engineering Inspection will include:

- 1) Review of any previous inspection and testing reports;
- 2) Review of calculation of Load Rating;
- 3) Determination and provision of equipment and resources required for the inspection including preparation of a safety plan;
- 4) Inspection of all relevant bridge components including measurements, testing and analysis as necessary to supplement the visual inspection;
- 5) Determination of material properties and structural behavior;
- 6) Identification of components limiting the performance of the structure due to the bridge current condition and capacity or are likely to deteriorate to such a level within the next five years;
- 7) 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 structure; and,
- 8) Identification of factors which will influence the dynamic load allowance to be used in Load rating.

The engineering inspection will also be undertaken in accordance with the requirements of the BMS Operation and User manual.

The inspection would be undertaken in accordance with the Brief for Engineering Inspection. Reference would be made to the Bridge Condition Report held in the Regional Office for details of the defects reported in the bridge.

The engineering inspection will also be undertaken in accordance with the requirements of the BMS Operation and User Manual.



Figure 5-2
Brief for Engineering Inspection

Department of Public Works and Highways
BRIEF FOR ENGINEERING INSPECTION

FISCAL YEAR: <insert budget year>
REGION: <insert region>
ENGINEERING DISTRICT: <insert engineering district>

Road ID	
Section ID	
Road Name	
Bridge ID	
Bridge Name	
Location	
Type of Bridge (Bridge Code)	

Conclusions of Current Bridge Condition Report

Overall condition of bridge	
Recommended action to bridge	
Major reason for recommendation	
Estimated remaining bridge life	

Previous Engineering Inspection Report

Prior Engineering Inspection Report Available?	
Date of prior Engineering Inspection Report	
Type of Engineering Inspection Report Required	< insert <i>new</i> or <i>review</i> >

DATE OF ISSUE: <insert date of printing from BMS>
Report BRE_01



5.4. Procedure

5.4.1. Preparation Before Inspection

- 1) Prepare a schedule for the bridge engineering inspection.
- 2) Coordinate with the Regional or District Office concerned for the scheduled inspection and request the clearing of the bridge and surrounding areas that may hamper the Engineering inspection activity. Collect and review the submitted Condition Inspection Report (CIR) and all available documents (plans, drawing and reports) of the bridge to be inspected.
- 3) Make sure all necessary materials and safety gadgets are prepared and that equipment and vehicle(s) needed for the inspection are available and in good working condition .

5.4.2. Activities During Inspection

- 1) The following should be checked to avoid mistakes in identifying the bridge:
 - a. Bridge I.D. number, if any;
 - b. Bridge Type, Length and Number of Spans;
 - c. Bridge name/river name;
 - d. Bridge Location, Road System, Road Section, Barangay, Municipality, etc.
- 2) Check information on the Condition Inspection Form (CIF).
- 3) Observe safety precaution before starting to inspect various members of the bridge.
- 4) Start inspecting various members of the bridge following the information obtained in Item No. 2. Take photographs and make sketches to highlight defects.
- 5) The following test and measurements should be carried out during the inspection:
 - a. Structural Detail Measurement
 1. Structural member dimension
 2. Crack/corrosion mapping
 3. Concrete cover, rebar size and spacing
 4. Steel thickness
 5. Pile length and size
 - b. Material Strength Measurement
 1. Concrete strength
 2. Structural Steel Strength
 3. Reinforcement bar strength
 - c. Material Deterioration Degree Measurement
 1. Reinforcement corrosion degree survey
 2. Chloride content survey, etc.
 - d. Loading Test (if required)
 1. Dynamic Test
 2. Static Test

Material properties and material and structural defects shall be determined for concrete bridges as follows:



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No.	Material Property and Material or Structural Damage	Testing Tools / Instruments
1	Compressive strength of concrete	Rebound hammer (mostly Schmidt's type) Ultrasonics
2	Detection of voids and delamination in concrete and other flaws	Ultrasonics
3	Depth of concrete cover	Magnetic field Rebar locator
4	Concrete carbonation	Phenolphthalein test
5	Chloride	Silver nitrate test Chemical analysis applied to sample obtain with rotary drill (EX; sampling, drilling, dust method)
6	Reinforcement corrosion	Half-cell potentials
7	Post-tensioning tendons corrosion or other destruction, including inadequacy of duct grouting	Ultrasonics
8	In-situ stress determination in concrete, steel reinforcement or prestressing wires	Stress relief caused by drilling

Material properties and material and structural defects shall be determined for steel bridges.

No.	Material Property and Material or Structural Defect	Testing Tools / Instruments
1	Corrosion of structural steel	Depth Gauges Micrometer
2	Depth of anti-corrosive protective coating(EX paint coating)	Thickness Gauge Magnetic tests(EX: Ultrameter)
3	Detection of cracks and abnormal in structural elements and joints, especially welded ones.	Hammer test Magnetic test Ultrasonics
4	Steel thickness	Micrometer or caliper Ultrasonic Gauges
5	In-situ stress determination	Stress relief methods with the use of gauges

Material properties and material and structural defects shall be determined for Substructure / Other bridge components as follows:

No.	Material Property and Material or Structural Defect	Testing Tools / Instruments
1	Scouring	Color Imaging Sonar
2	Load Capacity	Calculation of Load Rating Loading Test



5.4.3. Evaluation and Reporting

Complete the Engineering Inspection Report Summary Sheet and Bridge Engineering Inspection Report. The Bridge Engineering Inspection Report shall have no standard format.

5.4.4. Load Capacity Analysis

A load capacity assessment may be included in the brief to determine the repeated live load capacity for the remaining service life of the structure. The assessment shall be based on the Manual for Load Rating of Bridges (MLRB) December 2004.

5.5. Deliverables

The deliverable will be a Engineering Inspection Report. This will be an official report discussing all aspects of the engineering inspection. The report shall include recommendations such as:

- 1) Immediate remedial action
- 2) Access restrictions, including load speed limits, vehicle paths or number of lanes and detour if applicable
- 3) Further investigation, testing and structural analysis
- 4) Further inspection and monitoring regime/period
- 5) Load limit

The District Engineering Office shall consider the recommendations of the report and generally shall initiate the necessary actions.

The report will include the Engineering Inspection Report Summary Sheet, as shown in Figure 5-3 and Standard Reporting Form of Engineering Inspection Results as shown in Figure 5-4.



Figure 5-3
Engineering Inspection Report Summary Sheet

Department of Public Works and Highways
**ENGINEERING INSPECTION REPORT
SUMMARY SHEET**

BRIDGE INFORMATION

Bridge ID		Region	
Bridge Name		Engineering District	
Road Name		Province	
Road ID		Congressional District	
Section ID		Municipality	
Location		Barangay	

CONCLUSION OF ENGINEERING INSPECTION

Recommended Work:		Overall condition of bridge	
None		Estimated remaining bridge life (years)	
Major maintenance		Comment on recommended work:	
Upgrading			
Replacement			
Estimated cost of recommended work			
Urgency of recommended work			

DATE OF ISSUE: <insert date of printing from BMS>
Report BRE_02



Figure 5-4
Standard Reporting Form of Engineering Inspection Results

Measurement Items	Measurement Results
() Steel Thickness(mm)	[]Beam/Girder -Flange Min: Max: -Web Min: Max:
() Concrete Cover(mm)	[]Beam/Girder []Abutment []Deck Slab []Pier
() Steel Strength(N/mm ²)	[]Beam/Girder []Buckle Plate []Reinforcing Bar
() Concrete Strength(N/mm ²)	[]Beam/Girder []Abutment []Deck Slab []Pier
() Carbonation Depth (mm)	[]Beam/Girder []Abutment []Deck Slab []Pier
() Chloride Content (%)	[]Beam/Girder []Buckle Plate
() Reinforcement corrosion	[]Beam/Girder []Abutment []Deck Slab []Pier
() Post-tensioning tendons corrosion	[]Beam/Girder
() Painting Thickness	[]Beam/Girder []Buckle Plate
() Steel cracks	[]Beam/Girder []Buckle Plate
() Scouring	[]Abutment []Pier

Data recording will be similar to that required for Condition Inspection with additional references as to the types and locations of all testing and sampling conducted as part of inspection. Component designation and condition rating shall be identified in accordance with Condition Inspection procedures.

The data contained in the Bridge Engineering Inspection Summary Sheet shall be loaded into the RBIA in the Regional Offices when the Engineering Inspection Report has been accepted as accurate and complete.

The original Engineering Inspection Report shall be retained in the Regional Offices for future reference and use. A copy of the report shall be supplied to the BOD and PS (BMS Team) for their use.



6. EMERGENCY INSPECTION (TYPE 4)

6.1. Purpose

Emergency inspections are only undertaken in response to calamities. These inspections are required to confirm that bridges remain safe for use by traffic following a calamity or to determine the necessary work that is required to either ensure the safety of a bridge or to enable the function of the bridge to be restored.

6.2. Process

There is no general process for emergency inspections as these inspections are ad hoc inspections undertaken in difficult conditions

6.3. Procedure

No standard procedure is required for this type of inspection.

6.4. Deliverables

The deliverable will be an emergency inspection report. This will be the form appropriate for the required emergency action.

7. INVENTORY BRIDGE INSPECTIONS (TYPE 5)

7.1. Purpose

The purpose of a bridge inventory inspection is to obtain inventory data on bridges for inclusion in the RBIA. Bridge inventory data is a standardized series of data items that enables the geometry, construction and function of a bridge to be identified and described.

7.2. Process

The process for undertaking an inventory bridge inspection has not been documented as the process would depend on the bridge and is straightforward.

7.3. Procedure

All information collected during a bridge inventory inspection is recorded or referenced on an inventory inspection form (IIF). A sample IIF is included in Appendix E.



The IIF is composed of two parts:

- The location and geographical data for the bridge.
- The bridge inventory. This part is composed of the six (6) sections listed below:
 - The special requirements for inspection.
 - The general bridge data, clearances, geometry, traffic direction, type of bridge, year of construction, public utilities carried by the bridge and detail, if there is lighting provided on the bridge, the type of terrain crossed by the bridge, comments if bridge is unusual, type of construction, substructure type, deck material, wearing surface, drainage, design load and the available drawings.
 - The Bridge Modification Sheet describes the types and materials of any modifications to the bridge.
 - The span/s of the bridge.
 - The pier/s of the bridge.
 - The bridge abutments.

7.3.1. Definition of Bridge

A bridge is a structure carrying a load over a road, waterway or other feature, with a clear span along the centerline between the inside faces of supports over 6.0 meters. A bridge may have an independent deck supported on separate piers and abutments, or may have a deck constructed integral with the supports.

In some cases, there may be parallel bridges located close together. The bridge inspector will have to decide if the bridge is a single structure or if two separate bridges occur. Generally, parallel bridges will be assumed to be a single bridge if the substructures (piers and abutments) are joined together to form a single structure. Where defined as a single bridge, all inventory data shall be collected on the same inventory form. Where defined as two parallel bridges, two separate inventory forms shall be used. The two bridges will have separate identification numbers.

7.3.2. Location and Inventory Data Collection

The bridge inspector shall inspect the bridge and complete the Location and Inventory sections of the IIF. This can generally be completed by checking the appropriate box and by inserting the required names and numbers.

Several parts of the IIF can be completed even without having to go to the bridge site. **Note however, that all data shall be verified on site.**

Data needed for Location and Geographic Information are described in Table 7-1.



Table 7-1
Bridge Location Data

Data Description	Comment
Bridge ID	Unique identification number assigned by the RBIA for each bridge
Bridge Name	The name given to the bridge
Road Name	The name of the road on which the bridge is located.
Road ID	Unique identification number assigned by the RBIA for the road on which the bridge is located
Section ID	The unique identification number assigned to the specific road section containing the bridge
Location	The location of the bridge within the road section based on the LRS
Region	Region in which the bridge is located
Engineering District	Engineering district which is responsible for the management and maintenance of the bridge
Province, Congressional District, Municipality and Barangay	The administrative area in which the bridge (i.e. the first abutment) is located.
River Name	The name of the stream crossed by the bridge (where appropriate)

The bridge inspector shall take note of any particular requirements to gain access or to inspect all parts of the bridge for use in planning future bridge condition inspections. Check the appropriate boxes in *Special Inspection Requirements*, of the CIF for items such as ladders, inspection vehicles, boats, etc.

The bridge inspector will collect all the general bridge data required for the general bridge inventory as discussed in Table 7-2.

A bridge is made up of various inventory elements:

- General,
- Modifications,
- Spans,
- Piers
- Abutments.

The General Element includes all general information concerning a bridge. The Modifications Element covers nominated major changes (e.g. widening) made to a bridge. The remaining three elements describe the bridge as shown in Figure 7-1.



Figure 7-1
Bridge Elements

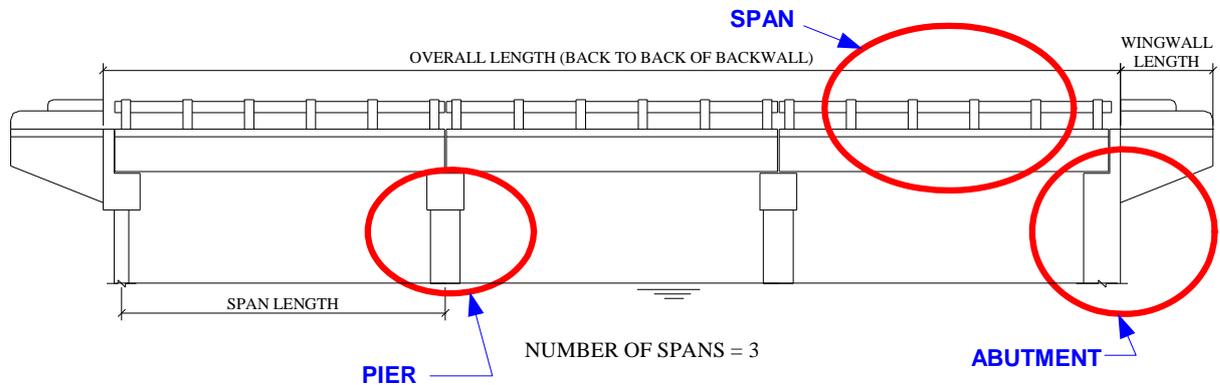


Table 7-2
General Bridge Data

Bridge Item	Description
Posted load limit	The sign posted for the bridge load capacity. Note that for some bridges the limit has been reduced by the DPWH due to structural problems.
Height clearances	Height clearances apply only to bridges that limit the height of vehicles passing over or under the bridge.
- Over	This is measured from the roadway surface to the soffit of the overhead bridge structure for traffic over the bridge. Refer to Figure 7-2.
- Under	This is measured from the roadway surface under the bridge to the soffit of the superstructure. Refer to Figure 7-2.
Maximum bridge height	The maximum height of the bridge measured from the top of the deck to the ground level. Refer to Figure 7-3.



Figure 7-2
Bridge Clearance Definition

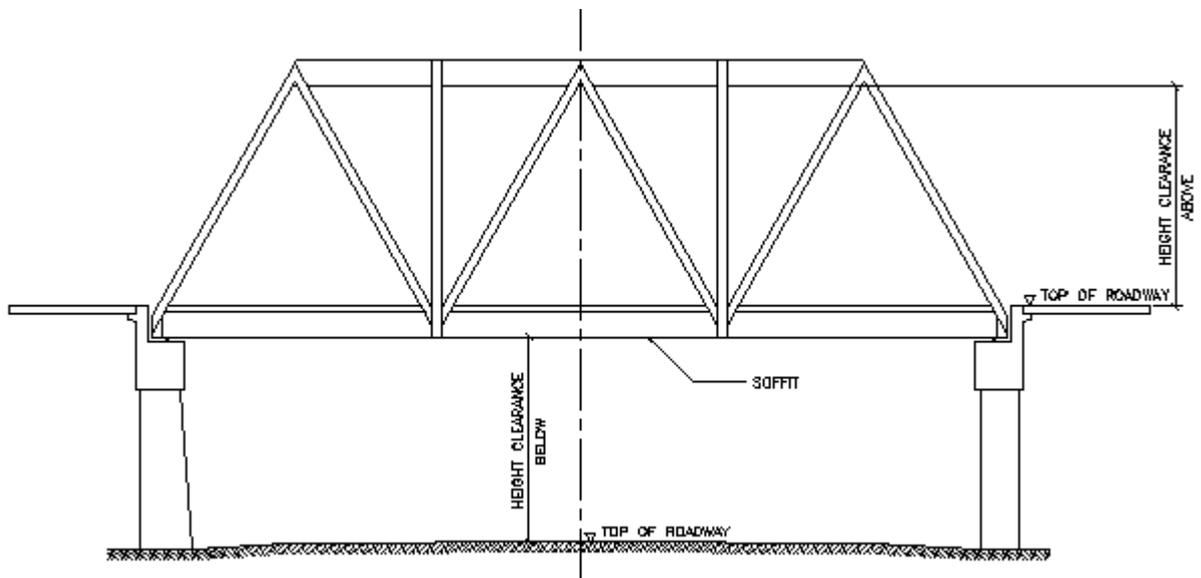


Table 7-3
Navigation Clearances

Navigation Clearances	Navigation clearances are important for those bridges constructed over navigable channels. The RBIA allows for a single navigable channel under a bridge. Refer to Figure 7-4.
- Horizontal	The width of the navigable channel under the bridge as measured between lateral controls such as the edges of piers, abutments, banks or other controls.
- Vertical	The minimum vertical distance between the soffit of the superstructure and the normal water level or normal high water mark for tidal waters.



Figure 7-3
Maximum Bridge Height

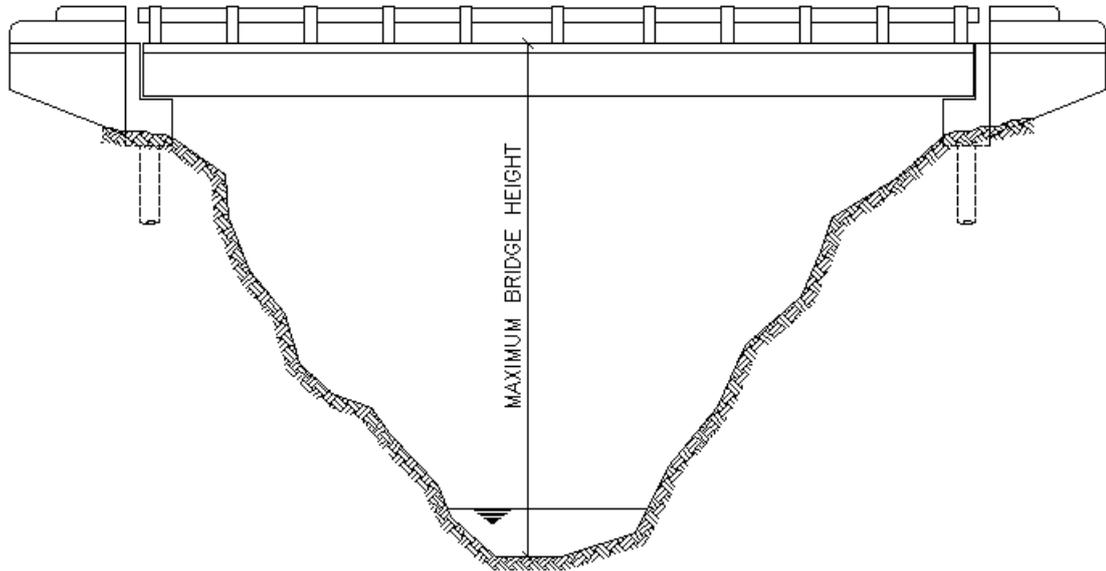


Figure 7-4
Navigation Clearances

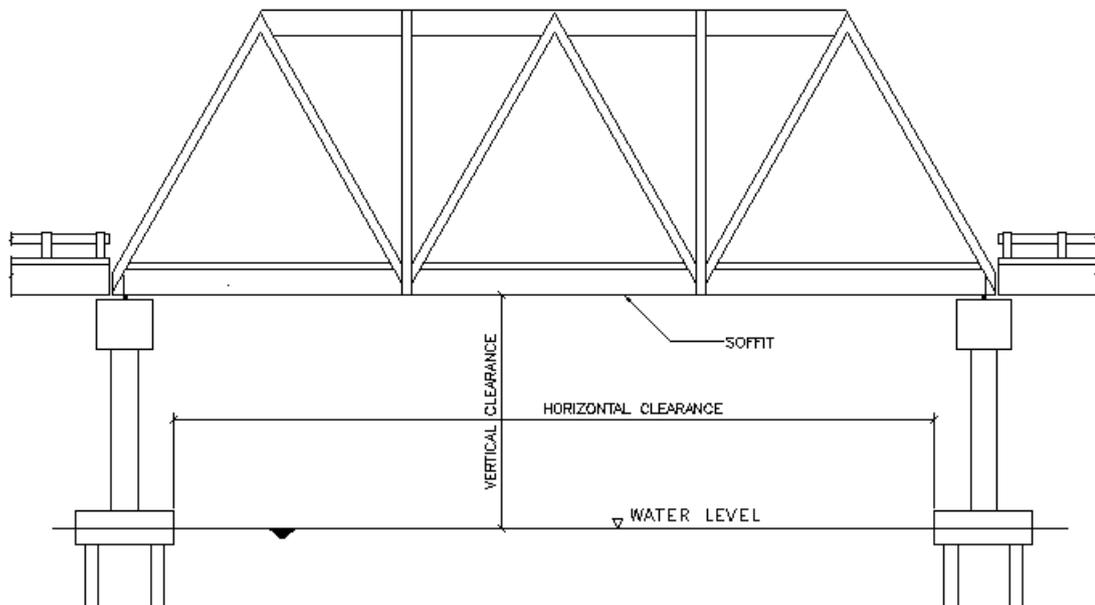




Table 7-4
Bridge Geometry

Overall length	The total length of the bridge measured between the back of the backwalls at the abutments or between the ends of the deck if there is no backwall. Refer to Figure 7-5.
Overall width	The total width of the bridge is measured between the outermost parts of the superstructure including any structural protrusions (e.g. the transoms of Bailey type bridges). Refer to Figure 7-7
Number of lanes	The number of traffic lanes marked on the bridge carriageway and not including the shoulder.
Number of spans	The number of spans of the bridge. Note that for a bridge where the superstructure is cantilevered behind a supporting pier with no abutment support, the cantilever portion is considered a span. Therefore, a bridge supported on two piers only with superstructure cantilevers on both ends, will be recorded as a three (3) span bridge. Refer to Figure 7-5.
Width of carriageway	The distance measured between the inner faces of the external bridge curbs (wheel guards) excluding any islands or shoulders. Refer to Figure 7-7 and Figure 7-9.
Width of island(s)	Many bridges have islands in the center of the carriageway to isolate traffic flowing in opposite directions. The width of island is defined as the total width of the island(s). If there is no island, the width of island shall be recorded as 0. Refer to Figure 7-9.
Width of shoulder(s)	Some bridges have been provided with shoulders for increased safety of vehicles and as a breakdown zone. This is defined as the total width of the shoulders between the sidewalks, curbs or barriers and the marked traffic lanes. Refer to Figure 7-9.
Left sidewalk width and right sidewalk width	The width of the sidewalk from the inner face of the railing to the inner upper edge of the sidewalk. Refer to Figure 7-7.
Traffic direction	Information on whether the bridge carries one way or two way traffic and to give the traffic direction.



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Table 7-5
Other Bridge General Data

Type of bridge	This is used to indicate whether the bridge is a standard bridge and can be fully described by the inventory data held in the RBIA or is a special bridge outside the scope of the RBIA. Special bridges are major or complex structures (e.g. cable stayed bridge) and are required to have separate inventory material maintained outside the RBIA in the form of drawings linked to the RBIA. The RBIA would contain summary inventory data of such bridges.
Year of construction	The year when the bridge was built. If there is no available data, the bridge inspectors shall interview local residents or provide the approximate period of construction.
Public utilities carried by the bridge and details	The location and detail of all utilities supported on the bridge shall be noted. The RBIA allows for up to six utilities to be recorded. Where more than six utilities exist, the utilities may be bundled as appropriate. Each utility shall be identified by a number from 1 to 6. The first section indicates the type of utility (e.g. water) for each identified utility. The second section provides space for a description of the utility (e.g. 600 mm diameter steel pipeline) and indicated the location of the utility on the bridge. Transverse utilities would be described in the description, e.g. <i>450mm steel water pipe crossing bridge under span 1, suspended from girders.</i>
Lighting	The bridge inspector shall note if there is lighting provided on the bridge.
Interval of light poles	Refers to the distance measured in meters, between two light poles.
Terrain crossed	Refers to the ground feature or structure, over which the bridge passes and may be the main reason(s) for the construction of the bridge. Three (3) types of terrain may be selected. For example, a bridge may pass over a river, road and railway.
Bridge comments	Insert comments on special or unusual bridges. for example, the bridge may be of historical importance and this should be recorded here.



Table 7-6
Bridge Construction Details

Bridge type of construction	<p>The RBIA can record the type of construction of the superstructure of the bridge for up to three types of construction. The type of construction would be listed in order of importance and the importance is normally based on span length. For example, a bridge may consist of the following types of construction:</p> <ul style="list-style-type: none">- An approach viaduct of 10 No. 20.0 meter long concrete girder spans,- A main span of a single 50.0 meter long steel truss, and- An approach span of 2 No. 10.0 meter long voided slabs. <p>Construction Identification No. 1 would be truss Construction Identification No. 2 would be girder Construction Identification No. 3 would be voided slab</p> <p>The type of construction does not refer to the number of spans, i.e., a bridge of uniform construction throughout would only be allocated a single type of construction.</p>
Main member material	<p>The material of construction of the main members of the types of construction identified above.</p> <p>For the example given above:</p> <p>The material for Construction Identification No. 1 would be steel The material for Construction Identification No. 2 would be concrete The material for Construction Identification No. 3 would be concrete</p>
Substructure type	<p>Refers to the major material used in the construction of abutments and piers.</p>
Deck material	<p>The material used for the construction of the bridge deck.</p>
Deck wearing surface	<p>Refers to the surface of the carriageway.</p>
Deck drainage	<p>Refers to the drainage provided to the deck.</p>
Design Load	<p>Refers to the design load to which the bridge was designed, as a percentage of the standard design live loading of MS18.</p>
Design Drawings	<p>The set of drawings done during the detailed engineering design of the bridge.</p>
As-built Drawings	<p>The set of drawings prepared after the construction of the bridge showing the as-built details.</p>



Figure 7-5
Bridge Length Definition and No. of Spans

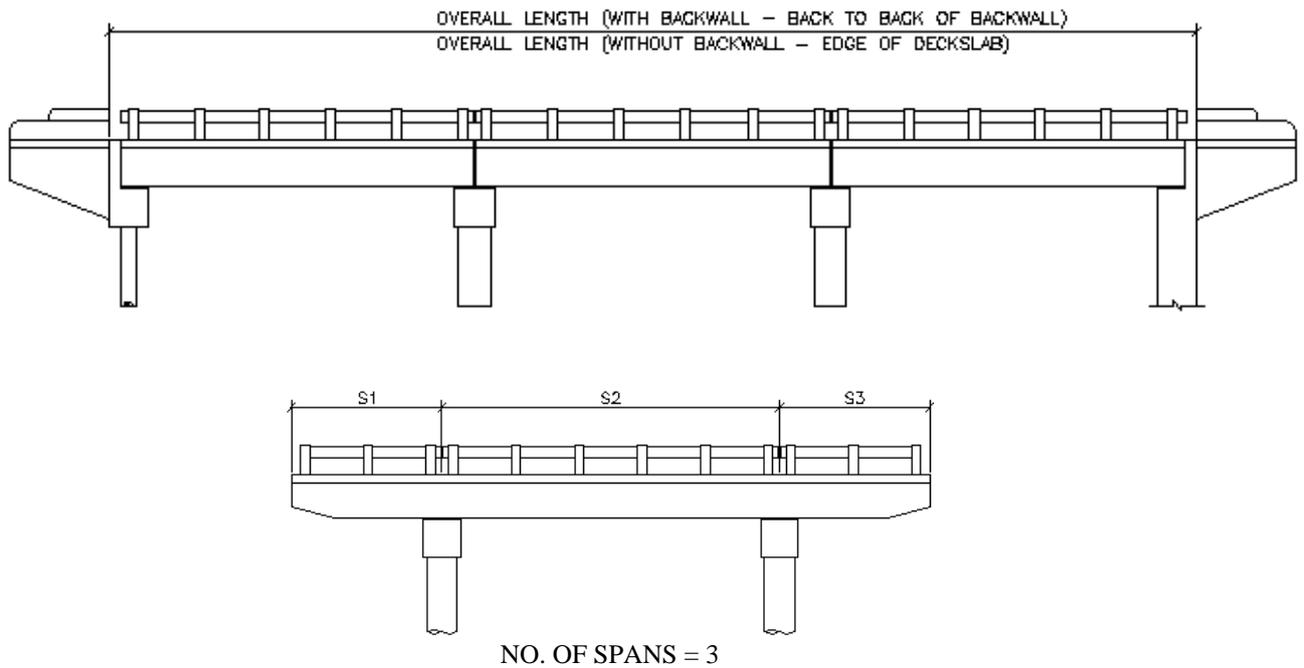


Figure 7-6
Bridge Skew Definition

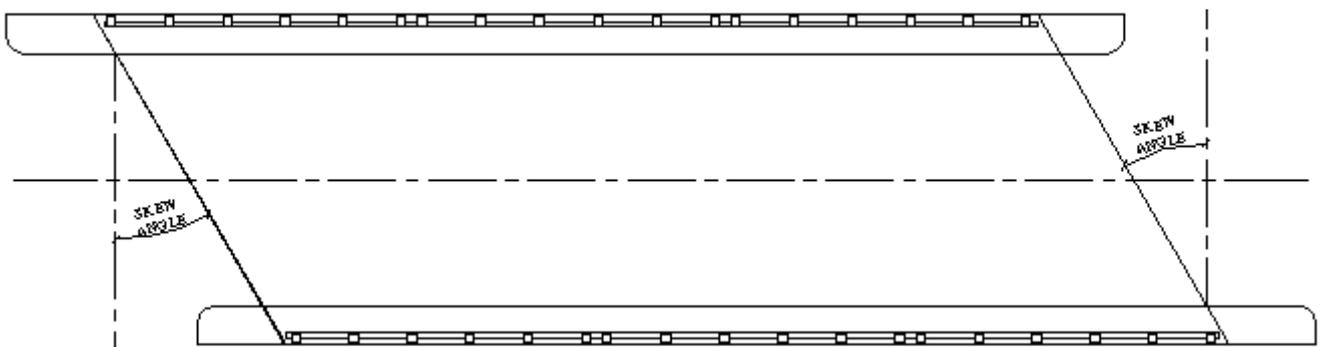
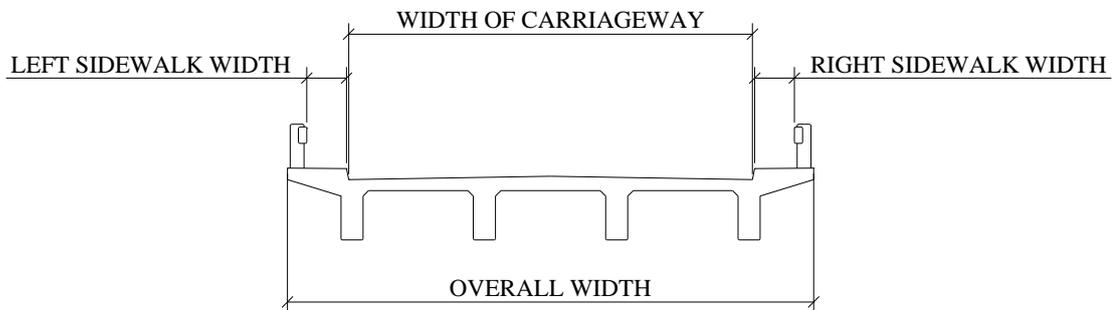


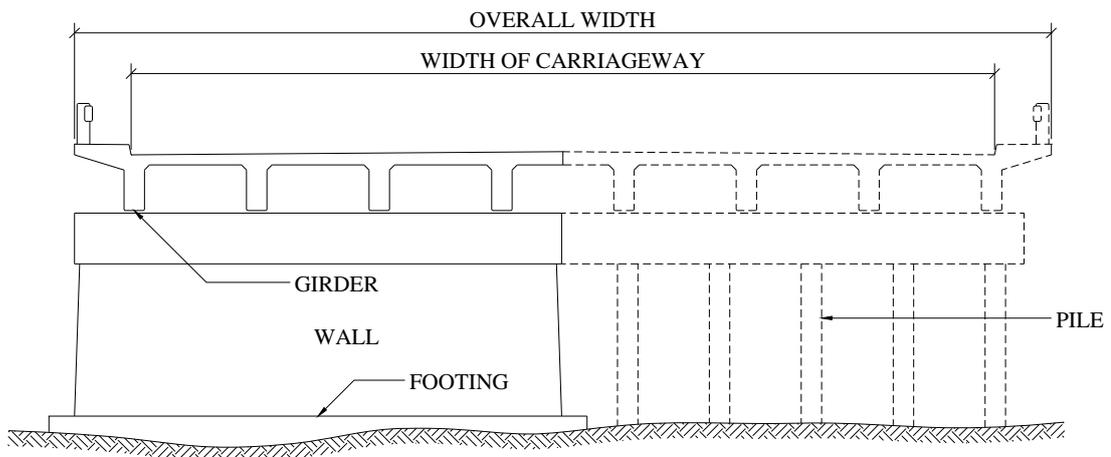


Figure 7-7
Overall Width, Width of Carriageway, Width of Sidewalk



NUMBER OF MAIN MEMBERS = 4

Figure 7-8
Section Definition – Modified Bridge

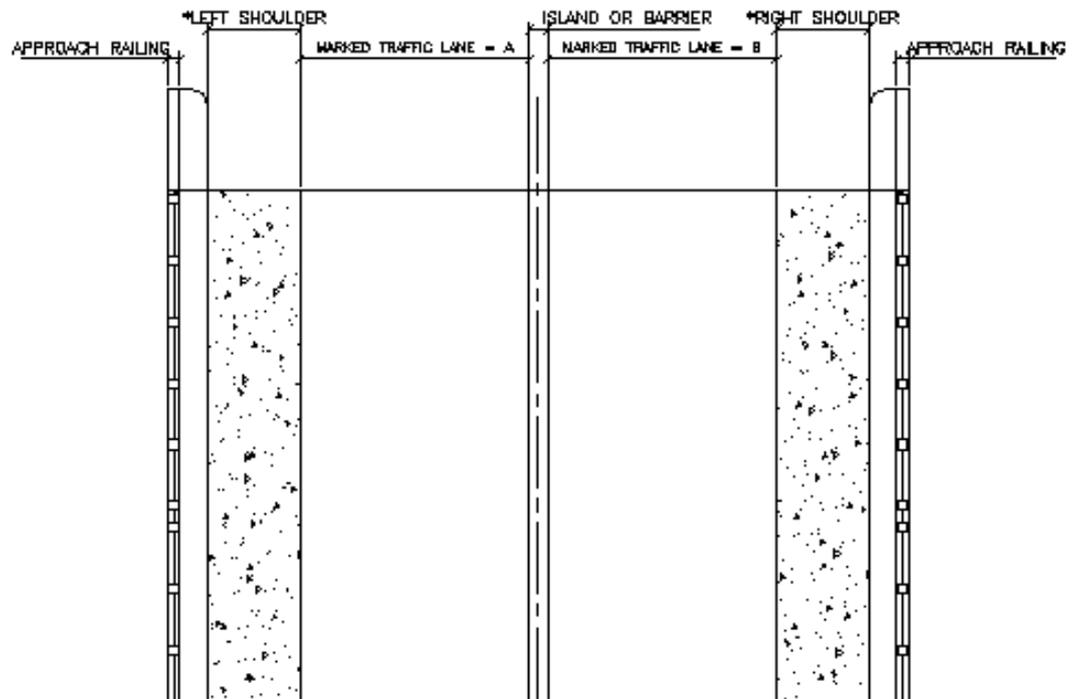


NUMBER OF MAIN MEMBERS = 8

The bridge inspectors shall complete the bridge modification section of the form if the bridge has been modified. Data needed for this section is summarized in Table 7-7.



Figure 7-9
Definition of Sidewalk, Shoulder, Carriageway and Island



$$\text{CARRIAGEWAY WIDTH} = A + B$$

* NOTE : APPLICABLE ONLY FOR BRIDGES WITH SHOULDERS



Table 7-7
Bridge Modification Inventory

Bridge Modification Item	Description
Type of modification	Refers to the modification done on the existing bridge - widening, lengthening, strengthening or seismic retrofitting. Note that for some bridges, two or all types of modification may have been undertaken.
Superstructure widening form	The location where widening of the superstructure has been done
Superstructure widening detail	Checks if the material and details of the superstructure widening are of the same detail as that of the existing bridge
Superstructure widening type	Refers to the type of superstructure used for widening
Superstructure widening material	Refers to the material used for widening of the superstructure
Type of pier widening	Refers to the type of substructure used for widening
Type of abutment widening	Refers to the type of abutment used for widening
Pier / abutment widening material	Refers to the material used for widening of the piers and abutments
Type of strengthening	Refers to the strengthening of the elements of the existing bridge.
Type of seismic retrofitting	Refers to the measure/s done on the existing bridge to increase earthquake resistance.
Type of lengthening	Refers to the location of the additional span/s. The bridge inspectors shall indicate the number of span added at the low and high chainage. The total number of additional spans shall also be indicated on the form.
Modifications comments	Any different modification features of the bridge would be discussed in this section.



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DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS

The General Span Information describes each span of the bridge. A separate sheet is required for each span of the bridge. Data for this Section are summarized in Table 7-8.

Table 7-8
Bridge Span Inventory

Span Item	Description
Span number	The span being inspected.
Length of the span	For single span bridges : distance from edge to edge of deck slab. For multi-span bridges (with expansion joint at pier/s) : a) Distance from edge of deck slab at the abutment to edge of deck slab at pier. b) Distance from edge of deck slabs at piers For multi-span bridges (without expansion joint at pier/s) : a) Distance from edge of deck slab at the abutment to center of support at pier. b) Distance from center to center of supports at piers
Skew angle	The acute angle the bridge makes with respect to the transverse line measured in degrees. Refer Figure 7-6.
Number of main members	For girders, the number of main members would normally be the number of girders. For voided slabs, the number of main members would normally be one. For a truss bridge, the number of main members would normally be two. For a Bailey type bridge, the number of main members would be the number of panel trusses, for double construction, the number would be four. For a cable supported bridge, the number of main members would be the number of layers of supporting cables.



Table 7-8
Bridge Span Inventory (Continued)

Span Item	Description
Main member type	The primary support system for the span to transfer the bridge loads longitudinally to the supports. Refer to Figure 7-10
Girder form	The type of girder for girder type bridges.
Main member material	Material of the span primary support system.
Main members prestressed?	If the main member material is concrete, indicate if the <i>main members are prestressed</i> or not.
Continuity	The condition of the main members at the start and end of spans whether continuous or simply supported. Refer to Figure 7-13.
Secondary member type	Secondary Members refer to the part of the bridge, which support the deck slab and are supported by the main members. Examples are the transverse beams and stringer for a steel truss bridge and transoms for Bailey bridge. Secondary members transfer the loads between the bridge deck and the main members. Some bridges (e.g. girder bridges) do not have secondary members. Diaphragms are not secondary members as they are not required to transfer loads. Refer to Figure 7-11.
Secondary member material	Material of span secondary support system.
Secondary members prestressed?	If the main member material is concrete, indicate if the <i>main members are prestressed</i> or not.
Other member type	This classification includes others bridge members that are not in the load bearing paths but are still essential to the safety of the bridge. This includes members such as diaphragms, bracings and other supporting members. Refer to Figure 7-12.
Deck material	Material of deck construction.
Railing type	Refers to deck railings.

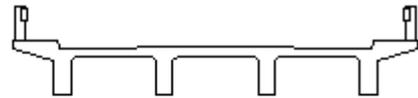
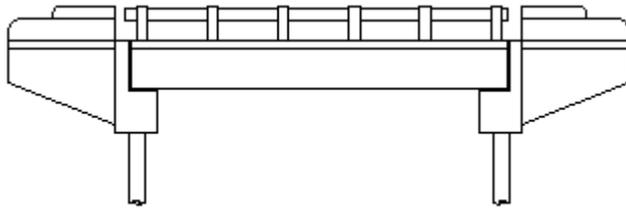


Table 7-8
Bridge Span Inventory (Continued)

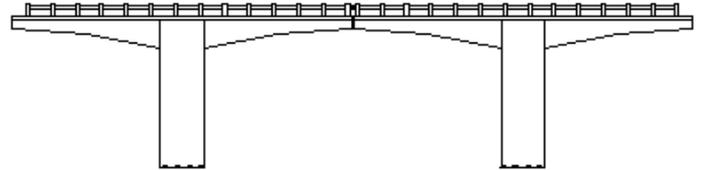
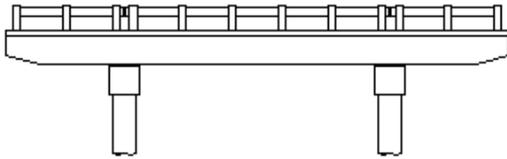
Span Item	Description
Main members prestressed?	If the main member material is concrete, indicate if the <i>main members are prestressed</i> or not.
Continuity	The condition of the main members at the start and end of spans whether continuous or simply supported. Refer to Figure 7-13.
Secondary member type	Secondary Members refer to the part of the bridge, which support the deck slab and are supported by the main members. Examples are the transverse beams and stringer for a steel truss bridge and transoms for Bailey bridge. Secondary members transfer the loads between the bridge deck and the main members. Some bridges (e.g. girder bridges) do not have secondary members. Diaphragms are not secondary members as they are not required to transfer loads. Refer to Figure 7-1.



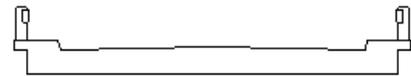
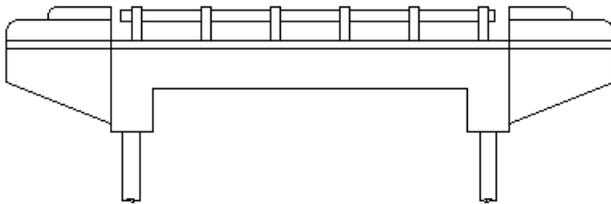
Figure 7-10
Main Member Types



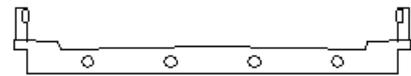
GIRDER



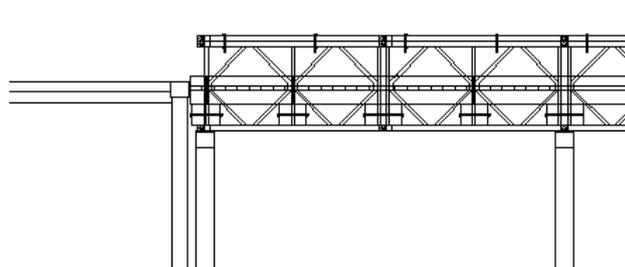
CANTILEVER GIRDER



SLAB



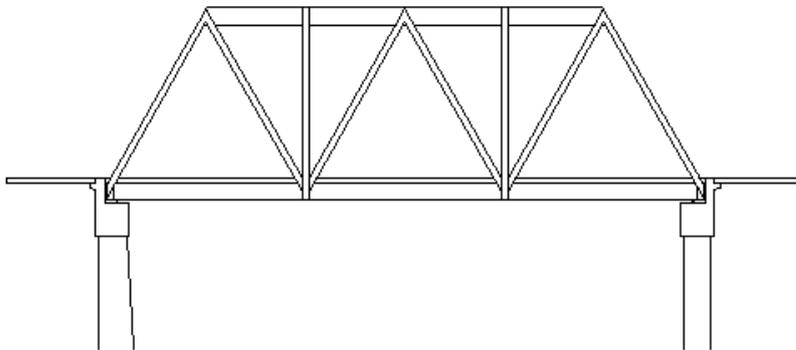
VOIDED SLAB



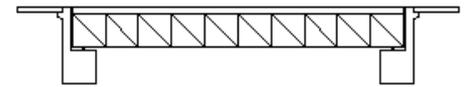
DEMOUNTABLE BAILEY TYPE



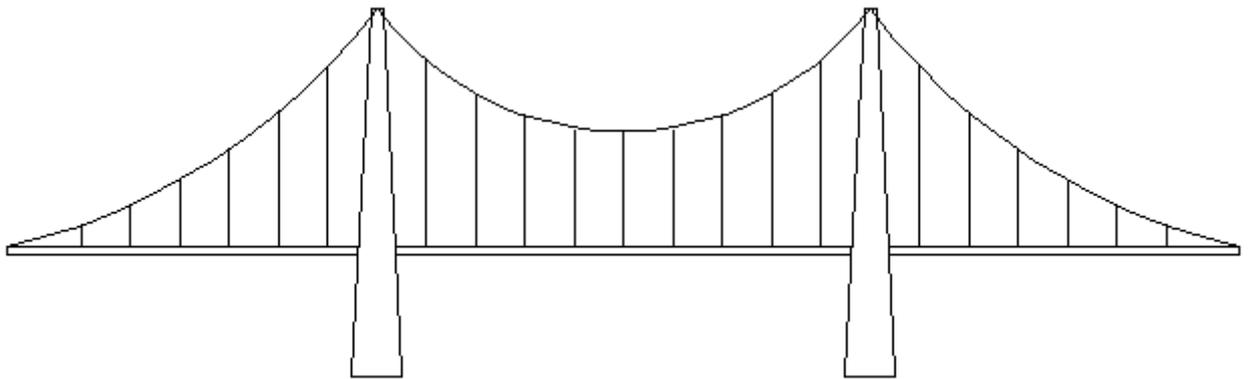
Figure 7-10(Continued)
Main Member Types



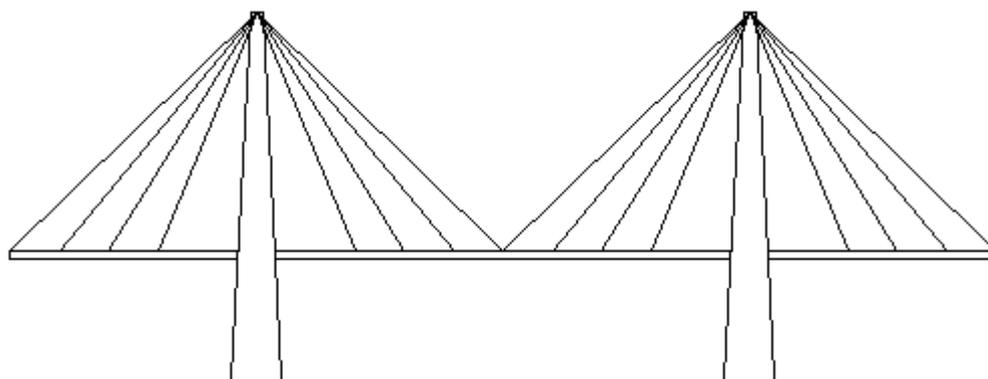
THROUGH TRUSS



DECK TRUSS



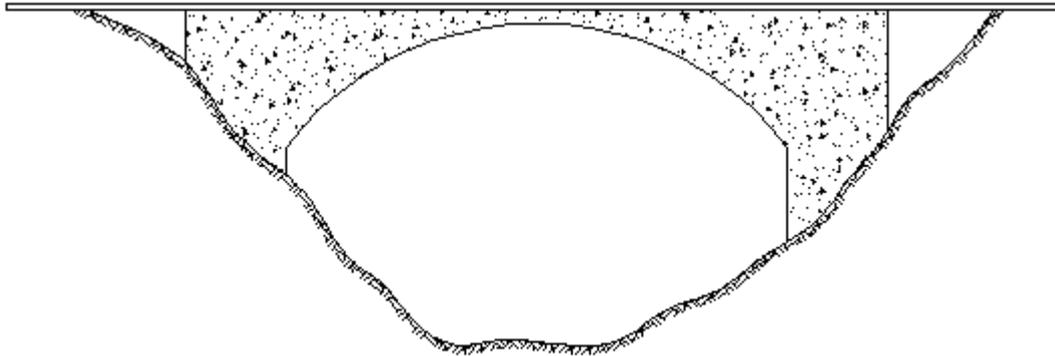
SUSPENSION



CABLE STAYED

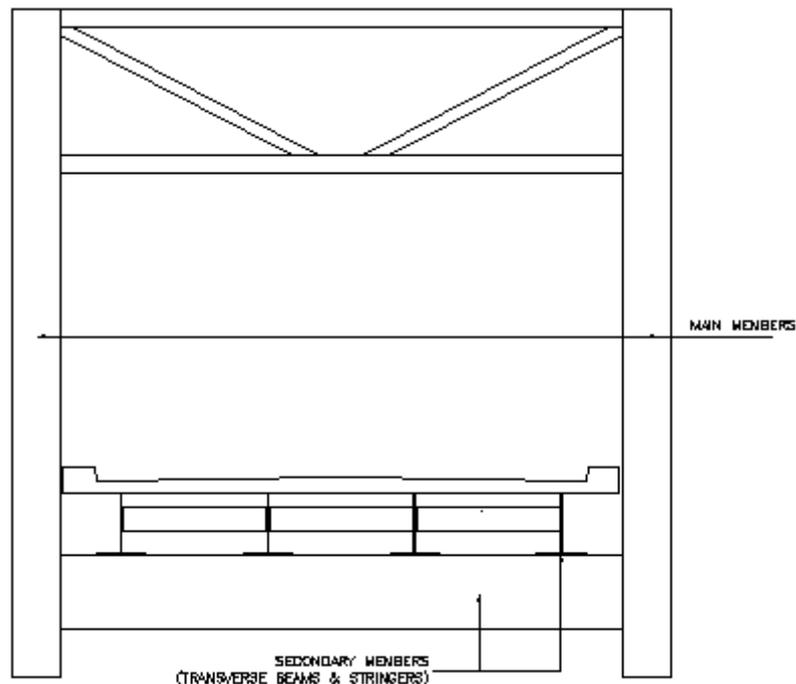


Figure 7-10 (Continued)
Main Member Types



ARCH

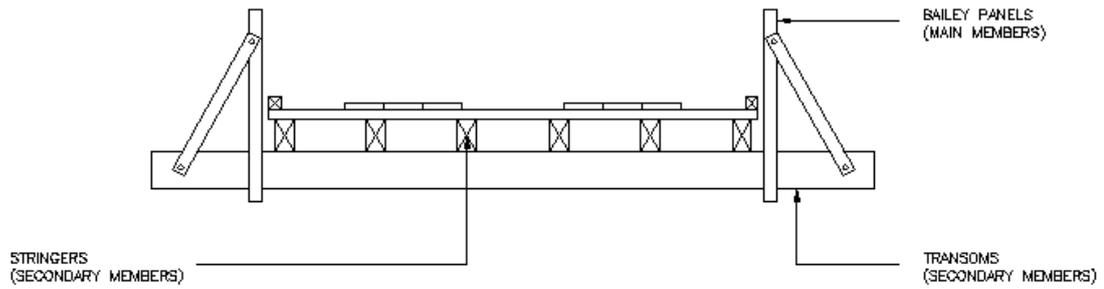
Figure 7-11
Secondary Member Types



THROUGH TRUSS



Figure 7-11 (Continued)
Secondary Member Types



BAILEY BRIDGE



Figure 7-12
Other Members

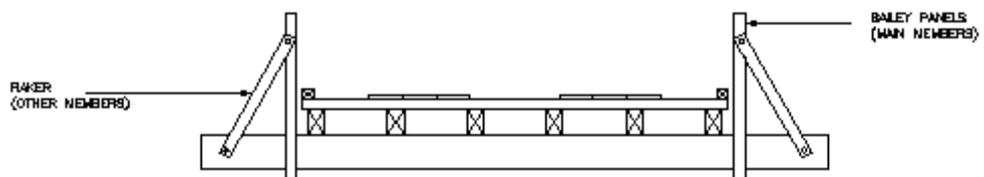
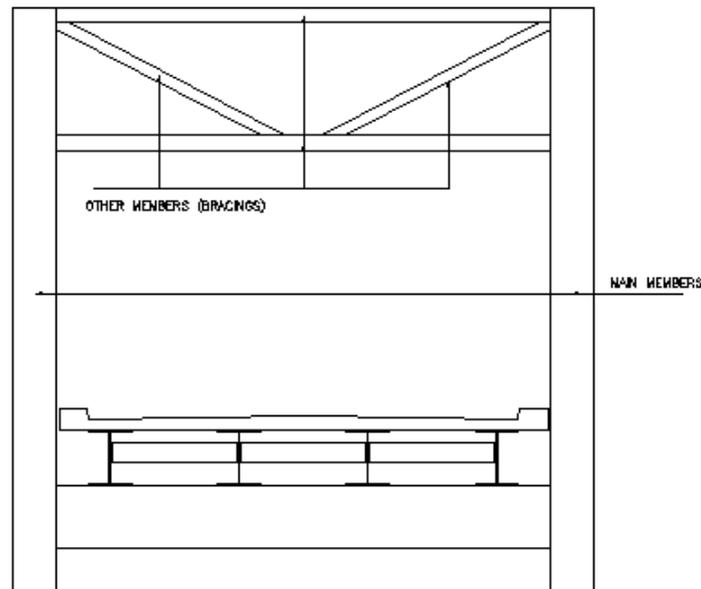
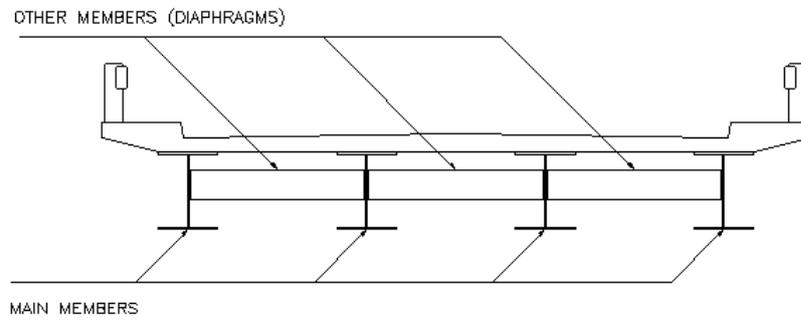
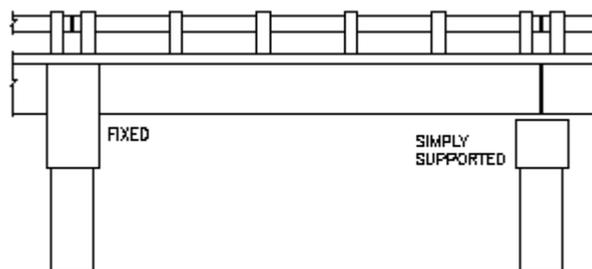
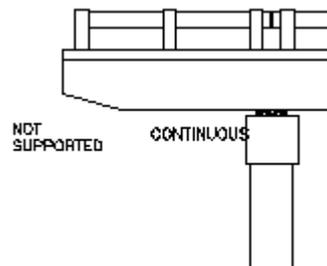
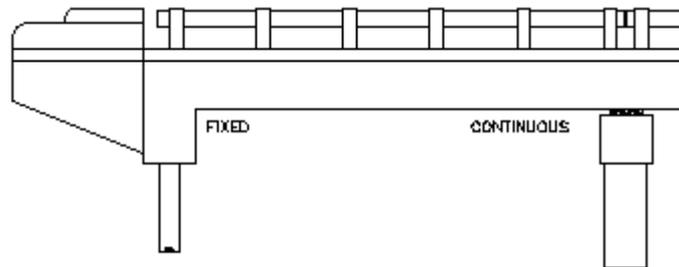




Figure 7-13
Span Continuity





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DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS

The General Pier Information describes the piers for a multi-span bridge. For a single-span bridge, this section is omitted. For a cantilever type of bridge, the cantilever portion is considered a span and therefore the support before the cantilever is considered to be a pier.

A separate sheet is required for each pier of the bridge.

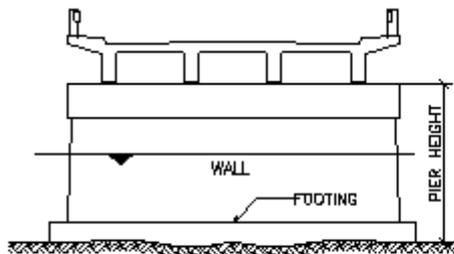
Data for this Section are summarized in Table 7-9.

Table 7-9
Bridge Pier Inventory

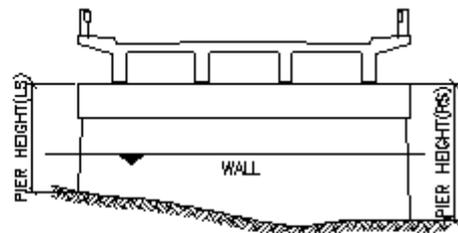
Pier Item	Description
Pier number	Refers to the pier being investigated.
Pier height	Refer Figure 7-14.
Pier height case	Indicates the method used to select and measure the pier height. Refer to Figure 7-14.
Pier type	The type of substructure - wall, columns, piles, etc. Refer to Figure 7-15.
Pier material	The material used for the construction of the pier
Pier foundation type	The type of foundation used for the existing bridge
Bearing type at low and high chainage	The type of bearing used to support the superstructure at the pier. Note that for a continuous superstructure, only the bearing type at low LRM will be checked. Refer to Figure 7-6.
Lateral restraint type	The system that restrains the superstructure against transverse movement. Refer to Figure 7-7.
Longitudinal restraint type	The system that restraint the superstructure against longitudinal movement. Refer to Figure 7-7.
Expansion joint type	The expansion joint details in the deck over the pier
Scour protection	The type of protection used to protect the pier against scour.
Pier Comments	The bridge inspector shall insert comments concerning any unusual features of the pier design, as appropriate.



Figure 7-14
Bridge Pier Height Definition

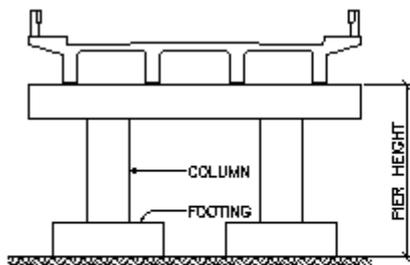


CASE 1

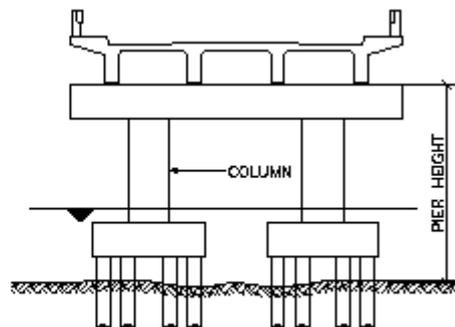


$$\text{HEIGHT} = \text{AVERAGE OF (HEIGHT(LS) + HEIGHT(RS))}$$

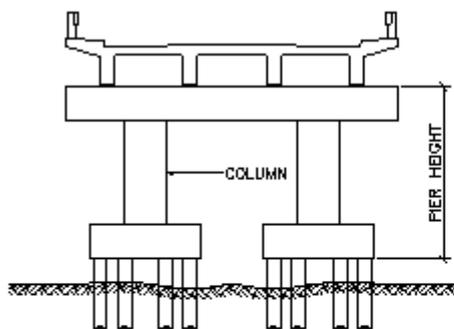
CASE 2



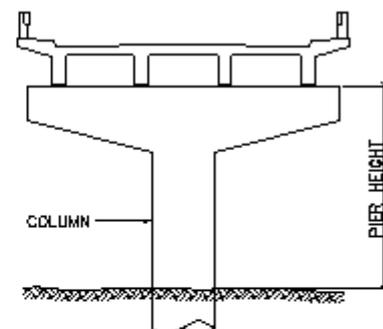
CASE 3



CASE 4



CASE 5

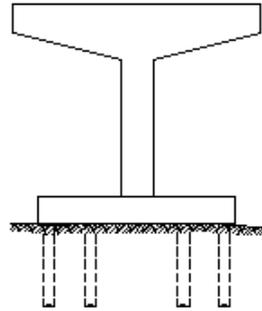


CASE 6

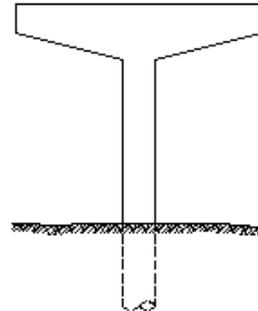
CASE 7 – AS-BUILT DRAWINGS



Figure 7-15
Pier Types

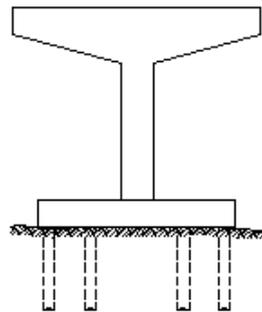


SINGLE COLUMN

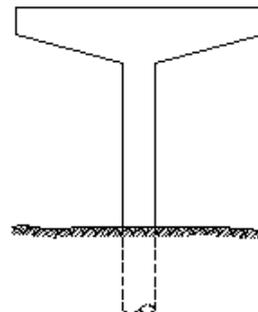


SINGLE PILE BENT

WITH AS-BUILT

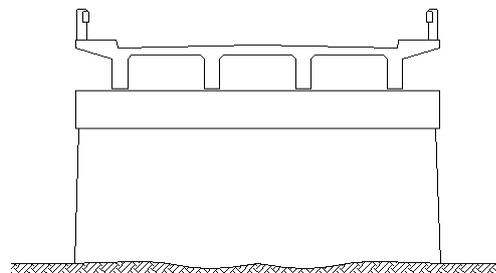


SINGLE COLUMN



SINGLE COLUMN

WITHOUT AS-BUILT



WALL



Figure 7-15 (Continued)
Pier Types

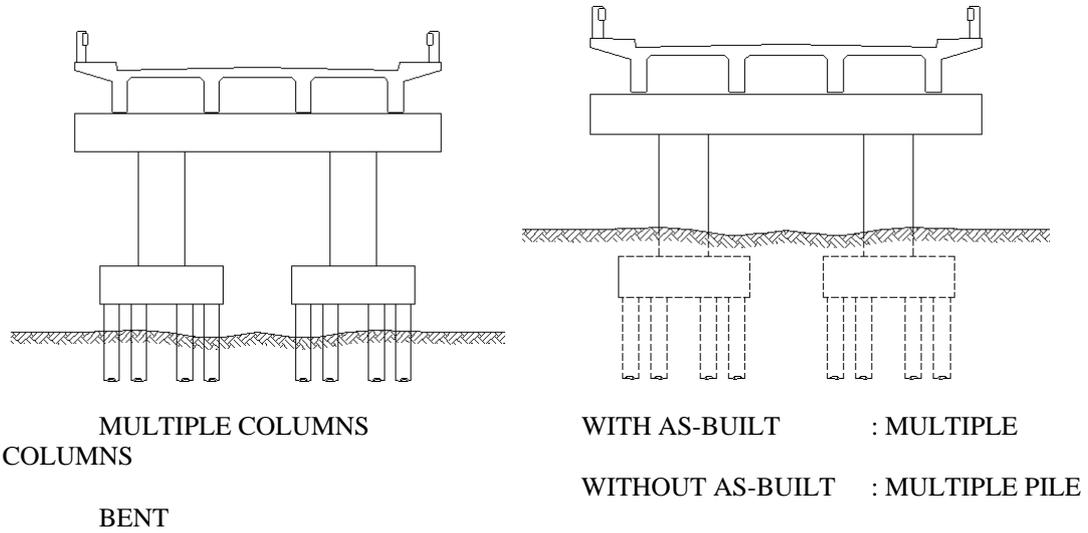
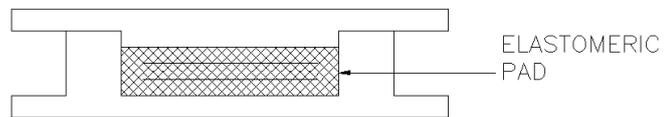




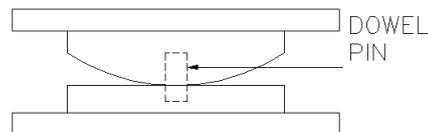
Figure 7-16
Bearing Types



ELASTOMERIC BEARING PAD



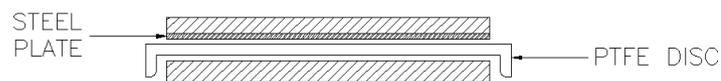
POT BEARING



ROCKER BEARING



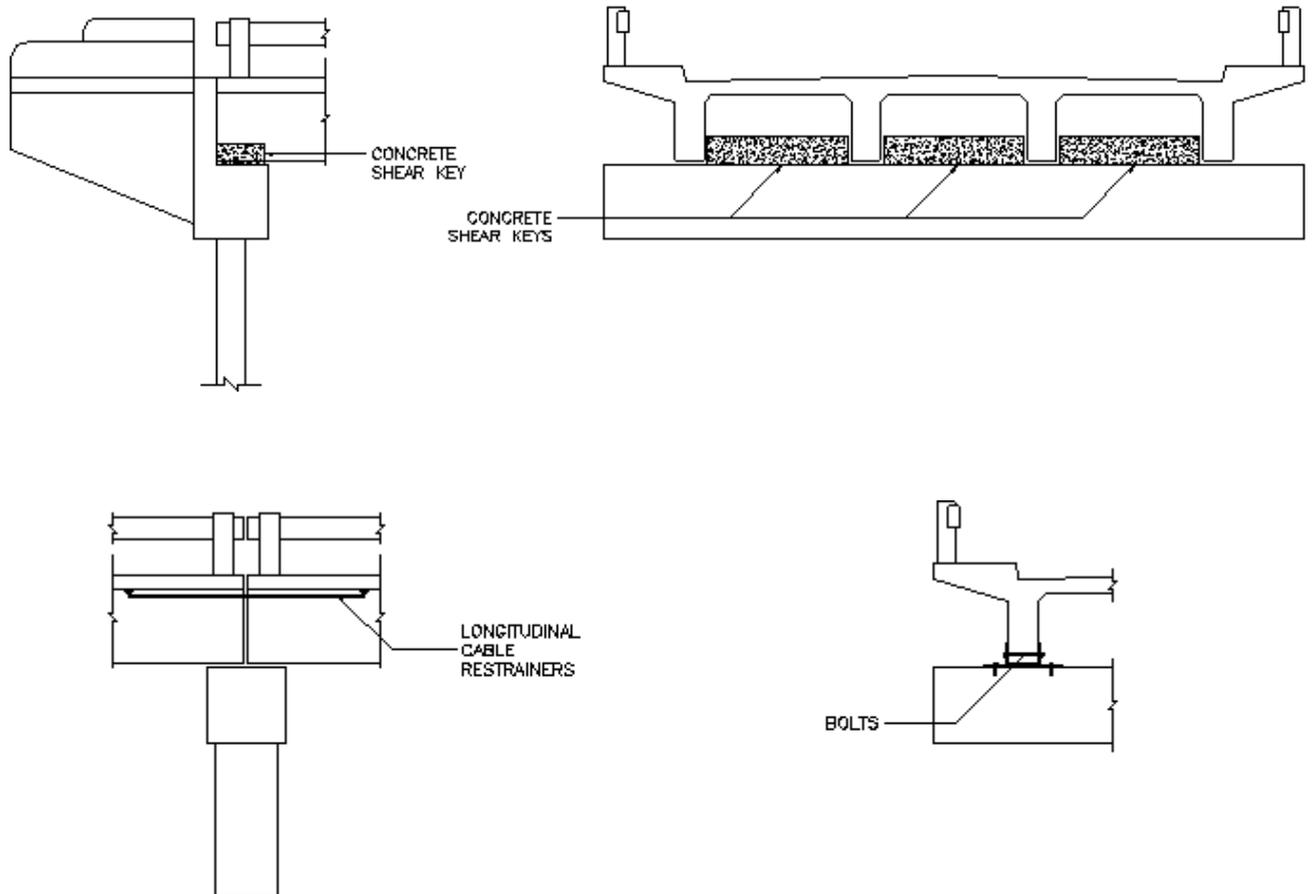
STEEL PLATE



PTFE COATED PLATE



Figure 7-17
Lateral and Longitudinal Restraints



A separate sheet is required for each abutment of the bridge. Each end of a bridge is defined as an abutment, though in cantilever superstructure bridges there may be no separate abutment structure and no abutment support.

Data for this Section are discussed in Table 7-10.



Table 7-10
Bridge Abutment Inventory

Abutment Item	Description
Abutment number	The designation for the abutments. Each bridge has two abutments, designated A1 and A2. Abutment number A1 is located at the low chainage end of the bridge. Abutment number A2 is located at the high chainage end of the bridge. All bridges have abutment though there may not be a separate abutment structure in all cases, for example the abutment of a bridge where the end span cantilevers behind the pier.
Abutment height	Measured from the top of the backwall or deck to the existing ground line. Value will be the average of height on both sides. Refer to Figure 7-18.
Abutment height case	Indicates the method used to select and measure the abutment height. Refer to Figure 7-18.
Abutment type	Refers to the type of abutment structure. Refer to Figure 7-19.
Abutment material	The material used in the abutment structure.
Abutment foundation	The type of foundation - spread footing, bored piles, driven piles, etc.
Bearing type	The bearings used to support the superstructure at the abutment. Refer to Figure 7-16.
Lateral restraint type	The system that restrains the superstructure against transverse movement. Refer to Figure 7-17.
Longitudinal restraint type	The system that restrains the superstructure against longitudinal movement. Refer to Figure 7-17.
Expansion joint type	The expansion detail in the deck at the abutment.
Scour protection	The type of works used to protect the abutment against scour.
Slope protection	Type of works used to protect the embankment at the abutment against erosion.
Abutment comments	The bridge inspector shall insert relevant comments on any unusual features of the abutment.
Wing wall type	The type of wingwall whether a solid wall, reinforced earth, protected slope, etc.
Wing wall material	The material used for the construction of the wingwall
Wing wall foundation type	The foundation used for the wingwall, - attached to the abutment backwall, spread footing, piles, etc.
Wing wall length	The distance from the end of the wingwall at the approach to the back of the abutment.



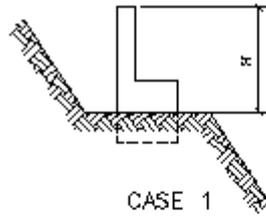
Table 7-11

Bridge Abutment Approach Data

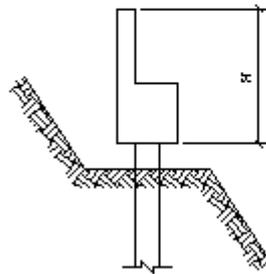
Bridge approach overall length	The overall length of the approach embankment to the bridge. This will normally be the length of the approach embankment though in many places this will be unclear. The accuracy of this measurement is low as it used mainly to show that a bridge has a short approach or a long approach. For example, for a bridge located on a flood plain, the length of approach may be 2.0 km.
Type of approach	Indicates the type of approach. This will generally be clear in rural areas but may be more difficult in urban areas where complex bridge abutment arrangements may be used.
Bridge approach comments	The bridge inspector shall insert appropriate comments describing any unusual features of the bridge approach.



Figure 7-18
Abutment Height



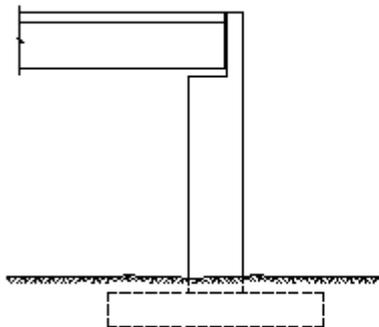
CASE 1



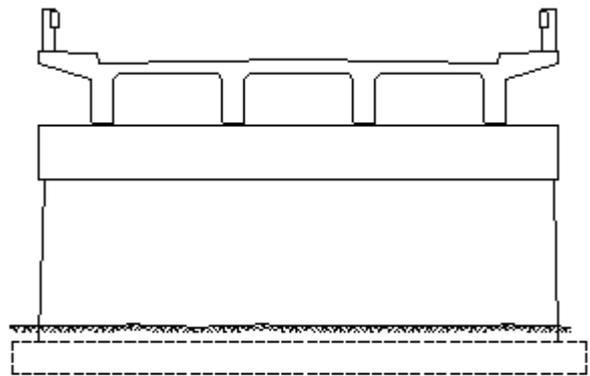
CASE 2

CASE 3 – AS-BUILT DRAWINGS

Figure 7-19
Abutment Types



ELEVATION



WALL

SECTION



Figure 7-19 (Continued)
Abutment Types

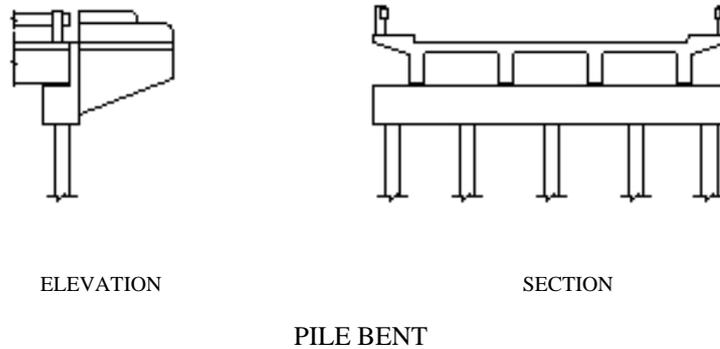
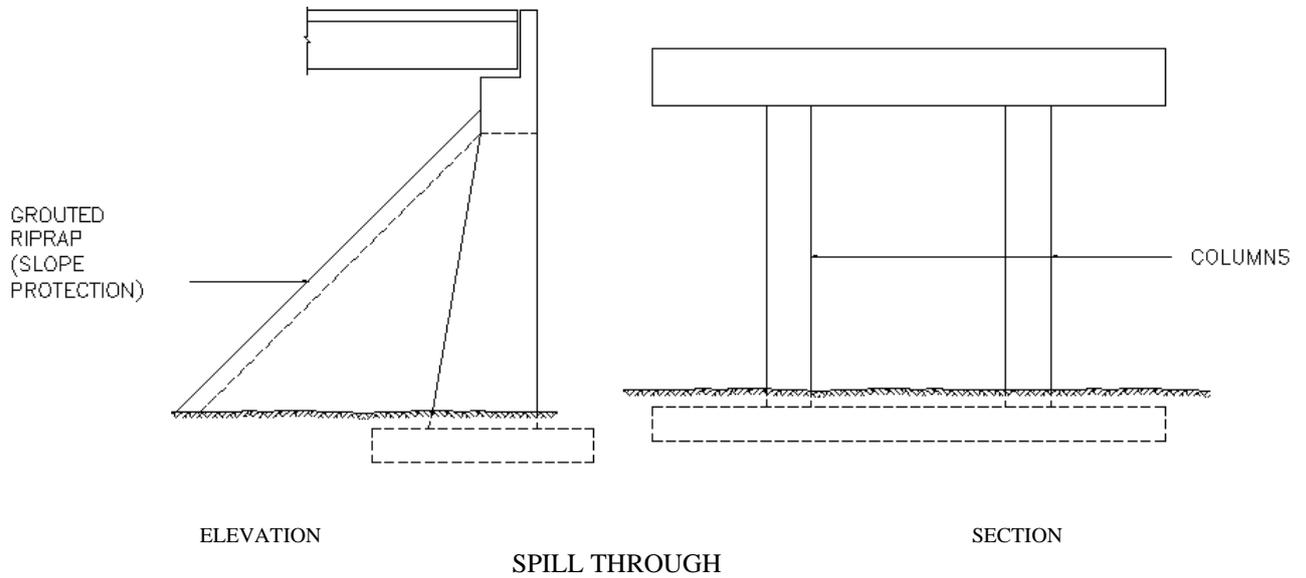
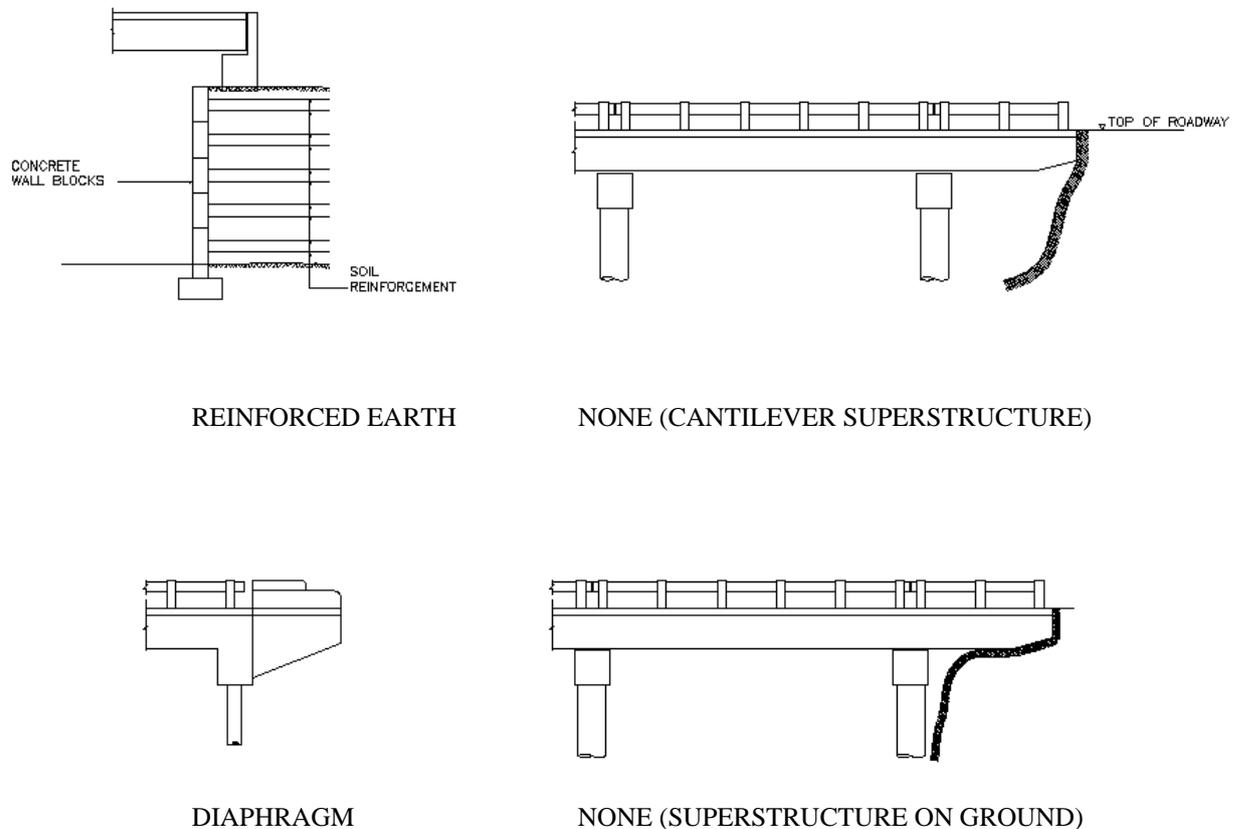




Figure 7-19 (Continued)
Abutment Types



7.4. Deliverables

A bridge inventory report is prepared following the inventory inspection.

The bridge inventory report shall include the following items:

- A fully completed bridge inventory inspection form (IIF).
- Inventory photographs

A sample completed bridge inventory inspection form (IIF) is included in Appendix F.

The bridge inventory shall be prepared in the offices in which the bridge inspectors are based for all bridges in each region. The reports shall be checked and reviewed in the Regional Office for completion and accuracy prior to finalization.

The data contained in the Bridge Inventory Reports shall be loaded into the RBIA in the Regional Offices when the reports have been accepted as accurate and complete. The photographs taken as part of the inventory inspection shall be loaded into the RBIA.

The Bridge Inventory Reports shall be retained in the Regional Offices for future reference.



APPENDIX A

MATERIAL DEFECTS



1. GENERAL

This appendix describes the defects that are normally found in concrete, steel and coatings. Each defect is briefly described and the causes producing it are identified.

2. CONCRETE

Concrete is used in structures as plain concrete, such as tremie and mass concrete; or it is combined with conventional steel reinforcement as reinforced concrete, or with prestressed steel reinforcement as prestressed concrete.

Defects in concrete can often be related to the lack of durability of the concrete, resulting from the composition of the concrete, poor placement practices, poor quality control or the aggressive environment in which it is placed.

The following defects commonly occurring in concrete are described:

Scaling	Spalling
Disintegration	Cracking
Water wash Alkali Aggregate	Reaction
Corrosion of reinforcement	Carbonation
Delamination	Surface Defects

2.1. Scaling

Scaling is the local flaking or loss of the surface portion of concrete or mortar. Scaling is common in non air-entrained concrete, but can also occur in air-entrained concrete in the fully saturated condition. Scaling is prone to occur in poorly finished or overworked concrete where too many fines and not enough entrained air is found near the surface.

2.2. Disintegration

Disintegration is the physical deterioration or breaking down of the concrete into small fragments or particles. The deterioration usually starts in the form of scaling and if allowed to progress beyond the level of very severe scaling is considered as disintegration.



2.3. Water Wash

Water wash is the deterioration of concrete brought about by water borne sand and gravel particles rubbing against concrete surfaces.

Water wash is generally an indication that the concrete is not durable enough for the environment in which it has been placed.

2.4. Corrosion of reinforcement

Corrosion is the deterioration of reinforcement by electrolysis. The alkali content in concrete protects the reinforcement from corrosion but when moisture, air and/or chloride ions above a certain concentration are dissolved in water and penetrate through the concrete to reinforcement this protection breaks down and corrosion starts. In the initial stages, corrosion may appear as rust stain on the concrete surface. In the advanced stages, the surface concrete above the reinforcement cracks, delaminates and spalls off exposing heavily rusted reinforcement.

2.5. Delamination

Delamination is defined as a discontinuity in the surface concrete which is substantially separated but not completely detached from concrete below or above it. Visibly, it may appear as a solid surface but can be identified as a hollow sound by tapping. Delamination begins with the corrosion of reinforcement and subsequent cracking of the concrete. However, in the case of closely spaced bars, the cracking extends in the plane of the reinforcement parallel to the exterior surface of the concrete.

2.6. Spalling

A spall is a fragment, which has been detached from a larger concrete mass. Spalling is a continuation of the corrosion process whereby the actions of external loads or pressure exerted by the corrosion of reinforcement results in the breaking off of the delaminated concrete. The spalled area left behind is characterized by sharp edges.

Vehicular or other impact forces on exposed concrete edges, deck joints or construction joints, may also result in the spalling or breaking off of pieces of concrete locally.

Spalling may also be caused by overloading of the concrete in compression. This results in the breaking off of the concrete cover to the depth of the outer layer of reinforcement. Spalling may also occur in areas of localized high compressive load concentrations, such as at structure supports, or at anchorage zones in prestressed concrete.



2.7. Cracking

A crack is a linear fracture in concrete that extends partly or completely through the member. Cracks in concrete occur as a result of tensile stresses introduced in the concrete.

Tensile stresses are initially carried by the concrete and reinforcement until the level of the tensile stresses exceeds the tensile capacity (modulus of rupture) of the concrete. After this point of concrete cracks and the tensile force is transferred completely to the steel reinforcement. The crack widths and distribution is controlled by the reinforcement in reinforced and prestressed concrete, whereas in plain concrete there is no such control.

The buildup of tensile stresses and, therefore, cracks in the concrete may be due to externally applied loads, external restraint forces, internal restraint forces, differential movement and settlements, or corrosion of the reinforcement. Externally applied loads generate a system of internal compressive and tensile stresses, in the members and components of the structure, as required to maintain static equilibrium. Cracks resulting from externally applied loads initially appear as hairline cracks and are harmless. However, as the reinforcement is further stressed the initial cracks open up and progressively spread into wider cracks.

External restraint forces are generated if the free movement of the concrete in response to the effects of temperature, creep and shrinkage is prevented from occurring due to restraint at the member supports. The restraint may consist of friction at the bearings, bonding to already hardened concrete, or by attachment to other components of the structure. Cracks resulting from the actions of external restraint forces develop in a similar manner as those due to externally applied loads.

Internal restraint forces are caused by the differential expansion or contraction of the exterior surface of concrete relative to the interior mass of the concrete, as in plastic shrinkage. The resulting surface cracks are normally shallow and appear as pattern cracks.

Differential movements or settlements result in the redistribution of external reactions and internal forces in the structure. This may in turn result in the introduction of additional tensile stresses and, therefore, cracking in the concrete components of the structure. Movement cracks may be of any orientation and width, ranging from fine cracks above the reinforcement due to formwork settlement, to wide cracks due to foundation or support settlement.

Typical cracking patterns observed in reinforced concrete structures and the typical cause of each type of cracking, is illustrated in Figure A1.

The severity of cracking is defined as follows:

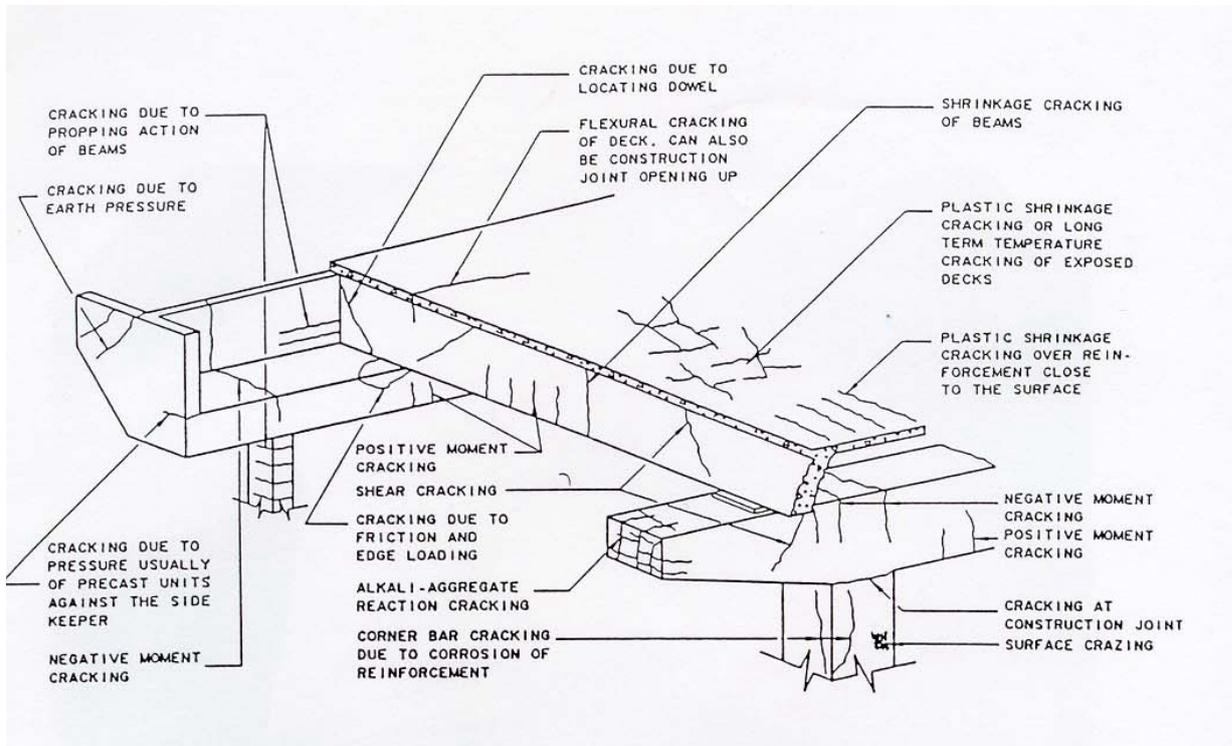
Hairline	up to 0.1 mm	Condition state 0
Fine	0.1 to 0.3 mm	Condition state 1
Medium	0.3 to 1.0 mm	Condition state 2
Heavy	Greater than 1.0 mm.	Condition state 3

Any engineering investigation arising from cracking of Condition state 2 or 3 would determine the cause of the cracking and would address these causes to prevent future cracking as well as



repairing the existing cracks.

Figure A1
Concrete Cracking



2.8. Alkali Aggregate Reaction

Some aggregates react adversely with the alkalis in cement to produce a highly expansive alkali-silica gel. The expansion of the gel and aggregates under most conditions lead to cracking and deterioration of the concrete.

The cracking occurs through the entire mass of the concrete. Alkali aggregate reactions are generally slow by nature, and the results may not be apparent for many years.

2.9. Surface defects

The following surface defects in concrete are described herein:

- Segregation
- Cold Joints
- Deposits – efflorescence, exudation, encrustation, stalactite
- Honeycombing:
- Abrasion and Wear
- Slippery Surface



Surface defects are not necessarily serious in themselves; however, they are indicative of a potential weakness in the concrete.

Segregation is the differential concentration of the components of mixed concrete resulting in non-uniform proportions in the mass. Segregation is caused by concrete falling from a height, with coarse aggregates settling to the bottom and the fines on top. Another form of segregation occurs where reinforcing bars prevent the uniform flow of concrete between them.

Cold Joints are produced if there is a delay between the placements of successive pours of concrete, and if an incomplete bond develops at the joint due to the partial setting of concrete in the first pour.

Deposits are often left behind where water percolates through the concrete and dissolves or leaches chemicals from it and deposits them on the surface.

Deposits may appear as the following:

- ◆ Efflorescence Deposits of salts, usually white and powdery.
- ◆ Exudation A liquid or gel-like discharge through pores or cracks in the surface.
- ◆ Encrustation A hard crust or coating formed on the concrete surface.
- ◆ Stalactite A downward pointing formation hanging from the concrete surface, usually shaped like an icicle.

Honeycombing is produced due to the improper or incomplete vibration of the concrete that results in voids being left in the concrete where the mortar failed to completely fill the spaces between the coarse aggregate particles.

Abrasion is the deterioration of concrete brought about by vehicles scraping against concrete surfaces, such as decks, curbs, barrier walls or piers.

Wear is usually the result of dynamic and /or frictional forces generated by vehicular traffic, coupled with abrasive influx of sand and debris. It can also result from friction of water-borne particles against partly or completely submerged members. The surface of the concrete appears polished.

Slippery Surface may result from the polishing of the concrete deck surface by the action of repetitive vehicular traffic.

2.10. Carbonation

Carbon dioxide in the atmosphere can dissolve in moisture within the concrete pores and react with calcium hydroxide in the cement paste to form a neutral calcium carbonate. Over a long period of time this gradually lowers the alkalinity of the concrete cover to the steel reinforcement, thus reducing the passive oxide layer around the steel and placing it in an environment whereby it is susceptible to corrosion.



3. STEEL

The use of steel has progressed from cast iron, wrought iron, rivet steel and plain carbon steel to notch tough low temperature steel.

The following defects commonly occurring in steel are described:

- Corrosion
- Permanent Deformations
- Cracking
- Loose connections

3.1. Corrosion

Corrosion is the deterioration of steel by chemical or electro-chemical reaction resulting from exposure to air, moisture, industrial fumes and other chemicals and contaminants in the environment in which it is placed. The terms rust and corrosion are used inter-changeably in this sense. Corrosion, or rusting, will only occur if the steel is not protected or if the protective coating wears or breaks off.

Rust on carbon steel is initially fine grained, but as rusting progresses it becomes flaky and delaminates exposing a pitted surface. The process thus continues with progressive loss of section.

3.2. Permanent deformations

Permanent deformation of steel members can take the form of bending, buckling, twisting or elongation, or any combination of these. Permanent deformations may be caused by overloading, vehicular impact or damaged intermediate lateral supports or bracing.

Permanent bending deformation may occur in the direction of the applied loads and are usually associated with flexural members; however, vehicular impact may produce permanent deformations in bending in any other member.

Permanent buckling deformations normally occur in a direction perpendicular to the applied load and are usually associated with compression members. Buckling may also produce local permanent deformations of webs and flanges of beams, plate girder and box girders.

Permanent twisting deformations appear as a rotation of the member about its longitudinal axis and are usually the result of eccentric transverse loads on the member.

Permanent axial deformations occur along the length of the member and are normally associated with applied tension loads.



3.3. Cracking

Crack is a linear fracture in the steel. Cracks are mainly produced due to fatigue and can, under certain conditions, lead to brittle fracture.

Brittle fracture is a crack completely through the component that usually occurs without prior warning or plastic deformation. Brittle fracture may result at fatigue prone details after initial fatigue cracking.

The primary factors leading to fatigue cracking are: the number of applied stress cycles, which is a function of the volume of traffic; the magnitude of the stress range, which depends on the applied live load; and the fatigue strength in the connection detail. Cracks caused by fatigue usually occur at points of tensile stress concentrations, at welded attachments or at termination points of welds. Cracks may also be caused or aggravated by overloading, vehicular collision or loss of section resistance due to corrosion. In addition, stress concentrations due to the poor quality of the fabricated details and the fracture toughness of materials used are contributing factors. Material fracture toughness will determine the size of the crack that can be tolerated before fracture occurs.

Welded details are more prone to cracking than bolted or riveted details. Grinding off the weld reinforcement to be smooth or flush with the joined metal surfaces improves fatigue resistance. Once cracking occurs in a welded connection, it can extend into other components due to a continuous path provided at the welded connection, and possibly lead to a brittle fracture.

Bolted or riveted connections may also develop fatigue cracking, but a crack in one component will generally not pass through into the others. Bolted and riveted connections are also susceptible to cracking or tearing resulting from prying action, and by a build-up of corrosion forces between parts of the connection.

As cracks may be concealed by rust, dirt or debris, the suspect surfaces should be cleaned prior to inspection.

Cracks that are perpendicular to the direction of stress are very serious, with those parallel to the direction of stress less so. In either case, cracks in steel should generally be considered serious, as parallel crack may for a number of reasons turn into a perpendicular crack.

Any crack should be carefully noted and recorded, as to its specific location in the member, and member in the structure. The length, width (if possible) and direction of crack should also be recorded.

3.4. Loose connections

Loose connections can occur in bolted or riveted connections; and, may be caused by corrosion of the connector plates or fasteners, excessive vibration, overstressing, cracking, or the failure of individual fasteners.



Loose connections may sometimes not be detectable by visual inspection. Cracking or excessive corrosion of the connector plates or fasteners, or permanent deformation of the connection or members framing into it, may be indications of a loose connection. Tapping the connection with a hammer is one method of determining if the connection is loose.

4. TIMBER

There are two types of defects found in timber structures.

- Biological
- Non-biological

4.1. Biological Defects

The main forms of biological defects are caused by fungi, termites and marine organisms. These defects are indicated by decay and deterioration thus, reduces the structural strength of timber structures.

Fungal attack is characterized by discoloration or staining when mild but becoming soft and spongy when decay is more advanced. Decay can be found at locations where water could possibly penetrate the members or where high moisture levels are encountered.

Termites usually degrade timber much more quickly than fungi by eating the inside portion of the timber. Termite attacks occur with some pre-existing fungal decay. This decay accelerates as termites increase in number inside the timber structure, moving fungal spores and moisture about with their bodies.

Marine organisms attack the portions of the timber structure in contact with seawater. A serious feature of their attack is that only small holes may be visible on the surface of a timber pile while the interior may be eaten away.

4.2. Non-biological Defects

Non-biological defects are caused by the following:

- Defective Joints

Loose or damaged joints can seriously affect the strength of the timber bridge. Corrosion reduces the size and weakens the steel fasteners as well as the strength of the surrounding wood due to some chemical reaction. Shrinkage in timber and vibration from traffic can work loose bolted joints.

- Shrinkage and Splitting

Shrinkage happens when the timber dries up below its fiber saturation point. Maximum shrinkage occurs parallel to the annular rings, about half as much occurs perpendicular



to the annular rings and a small amount along the grain.

- Splitting happens when the interior member remains above the fiber saturation point while the outer layers shrink. Splitting also happens when the timber is restrained by fasteners while in the process of shrinking.

Overstressing of the timber component may cause splintering, cracking or even shattering of the timber, often associated with sagging, buckling or other deformity.

- Fire

Timber structures burn when subjected to high temperatures as in the case of fire thus, greatly reduces the structural strength.

5. MASONRY

The defects found in masonry structures are:

- Fretting of blocks and/or mortar jointing
- Cracking
- Abrasion of blocks and/or mortar jointing
- Biological attack from plants or marine organisms

5.1. Fretting of Blocks and Mortar Joints

This defect is caused by the loss of cementing or binding agents by leaching due to the percolation of water through the structures.

5.2. Cracking

This defect is caused by the factors affecting the stability of a masonry structure which include:

- differential settlement across an abutment or pier, which may cause longitudinal cracks along the masonry.
- movement or settlement of the foundations of an abutment or pier, which may cause transverse cracks across the masonry structure, and settlement in the roadway.
- outward movement of the spandrel walls due to lateral pressure, which may cause longitudinal cracking near the edge of the arch.
- settlement at the sides of an abutment or pier, which may cause diagonal cracks from the side and extending to the center at the crown.
- movement of the wing walls, which may cause cracking and loss of the road surface.

5.3. Abrasion

This defect is caused by water borne abrasive particles as water run along the faces of piers and abutments. This may cause loss of surface texture and color changes, may cause erosion and may even reduce the bond between mortar and stones.



5.4. Biological Attack

This defect happens when plants attached themselves to the masonry or, when roots and stems grew in joints or crevices. Once established, they can cause rapid deterioration of the masonry structure by exerting a wedging force dislodging the blocks. The invasion of plant roots and stems into mortar beds is one of the most common sources of failure of joints.

Department of Public Works and Highways
BRIDGE MANAGEMENT SYSTEM
BRIDGE CONDITION RATING CRITERIA

BRIDGE ELEMENT		SPAN	BRIDGE ATTRIBUTE	DECK (1/2)
MATERIAL TYPE	CONDITION STATE	SEVERITY OF DEFECT		
		TYPE OF DAMAGE	CONDITION	
CONCRETE Deck Slab	0 - Good	1 Cracking	Hairline crack or no crack	
		2 Spalling Scaling Disintegration	Affected area is \leq 150mm wide in any direction, or depth is less than 25mm	
		3 Delamination	Delaminated area measuring \leq 150mm in any direction	
		4 Rebar exposure/corrosion	No damage	
		5 Honeycomb	Affected area is \leq 150mm wide in any direction	
		6 Water leakage	Not visible	
	1 - Fair	1 Cracking	\leq 0.3mm, 1 direction, spacing $>$ 500mm	
		2 Spalling Scaling Disintegration	Affected area is $>$ 150mm to \leq 300mm wide in any direction. or depth is 25mm to 50mm	
		3 Delamination	Delaminated area measuring \geq 150mm to \leq 300mm wide in any direction	
		4 Rebar exposure/corrosion	Main rebar exposed is \leq 500mm wide, corroded or flaking only	
		5 Honeycomb	Affected area is $>$ 150mm to \leq 300mm wide in any direction	
		6 Water leakage	Water leak in 1 spot has an area of \leq 200mm wide	
	2 - Poor	1 Cracking	$>$ 0.3mm to \leq 1.0mm, 2 directions, spacing is $<$ 500mm to \geq 200mm	
		2 Spalling Scaling Disintegration	Affected area is $>$ 300mm to \leq 600mm wide in any direction, or depth is 50mm to 100mm	
		3 Delamination	Delaminated area measuring $>$ 300mm to \leq 600mm in any direction	
		4 Rebar exposure/corrosion	Main rebar exposed is $>$ 1500mm to \leq 1000mm wide, corroded	
		5 Honeycomb	Affected area is $>$ 300mm to \leq 600mm wide in any direction	
		6 Water leakage	Water leak in 1 spot has an area of $>$ 200mm to \leq 500mm wide	
	3 - Bad	1 Cracking	$>$ 1.0mm, 2 directions, spacing is $<$ 200mm	
		2 Spalling Scaling Disintegration	Affected area is $>$ 600mm wide in any direction, or depth is more than 100mm	
		3 Delamination	Delaminated area measuring $>$ 600mm in any direction	
		4 Rebar exposure/corrosion	Main rebar exposed is $>$ 1000mm wide and corroded	
		5 Honeycomb	Affected area is $>$ 600mm wide in any direction	
		6 Water leakage	Water leak in 1 spot has an area of $>$ 500mm wide	

Department of Public Works and Highways
BRIDGE MANAGEMENT SYSTEM
BRIDGE CONDITION RATING CRITERIA

BRIDGE ELEMENT		SPAN	BRIDGE ATTRIBUTE	DECK (2/2)
MATERIAL TYPE	CONDITION STATE	SEVERITY OF DEFECT		
		TYPE OF DAMAGE	CONDITION	
STEEL Deck Slab	0 - Good	1 Corrosion	Loose rust formation and pitting in the paint surface, no section loss	
		2 Cracking	No cracks	
		3 Deformation/Buckling	No deformation on bridge components	
		4 Loose connection	No bolts missing, <= 10% of fasteners loose	
	1 - Fair	1 Corrosion	Loose rust formation with scales/flakes, <= 10% section loss	
		2 Cracking	Spot cracking on secondary members only	
		3 Deformation/Buckling	Partial deformation on secondary members only	
		4 Loose connection	Loose fasteners is > 10% to <= 20%, falling out of bolts in > 1 pc on joints	
	2 - Poor	1 Corrosion	Stratified rust with pitting of metal surface, >10% to <=20% section loss	
		2 Cracking	Spot cracking on primary bridge components	
		3 Deformation/Buckling	Partial deformation on primary members	
		4 Loose connection	Loose fasteners >20% <=30%, bolts fall out in > 3pc on sec. mem. joints	
	3 - Bad	1 Corrosion	Extensive rusting w/ local perforation/rusting through > 20% section loss	
		2 Cracking	Cracking on primary members, especially in welded parts	
		3 Deformation/Buckling	Outstanding deformation due to buckling or partial yielding	
		4 Loose connection	> 30% fasteners loose, bolts fall out in > 3pc on primary member joints	
TIMBER Deck Slab	0 - Good	1 Decay/Splitting/Cracking	Not visible	
		2 Disconnection	Timber deck/running board intact, connectors in good condition	
	1 - Fair	1 Decay/Splitting/Cracking	Fungi attack is visible, minor cracking/splitting	
		2 Disconnection	Connectors are damaged but timber deck/running board still intact	
	2 - Poor	1 Decay/Splitting/Cracking	Major splitting and cracking	
		2 Disconnection	Timber deck/running board connectors are severely damaged	
	3 - Bad	1 Decay/Splitting/Cracking	Severe splitting and cracking	
		2 Disconnection	Timber deck/running board totally disconnected or missing	

BRIDGE ELEMENT	SPAN	BRIDGE ATTRIBUTE	MAIN/SECONDARY MEMBER(1/3)
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BRIDGE MANAGEMENT SYSTEM
BRIDGE CONDITION RATING CRITERIA

MATERIAL TYPE	CONDITION STATE	SEVERITY OF DEFECT	
		TYPE OF DAMAGE	CONDITION
CONCRETE Girder	0 - Good	1 Cracking	Hairline crack or no crack
		2 Spalling Scaling Disintegration	Affected area is \leq 150mm wide in any direction, or depth is less than 25mm
		3 Delamination	Delaminated area measuring \leq 150mm in any direction
		4 Rebar exposure/corrosion	No damage
		5 Honeycomb	Affected area is \leq 150mm wide in any direction
		6 Water Leakage	Not visible
	1 - Fair	1 Cracking	\leq 0.3mm, 1 direction, spacing $>$ 500mm
		2 Spalling Scaling Disintegration	Affected area is $>$ 150mm to \leq 300mm wide in any direction. or depth is 25mm to 50mm
		3 Delamination	Delaminated area measuring $>$ 150mm to \leq 300mm wide in any direction
		4 Rebar exposure/corrosion	Main rebar exposed is \leq 50 mm wide, corroded or flaking only
		5 Honeycomb	Affected area is $>$ 150mm to \leq 300mm wide in any direction
		6 Water Leakage	Water leak in 1 spot has an area of \leq 200mm wide
	2 - Poor	1 Cracking	$>$ 0.3mm to \leq 1.0mm, spacing is $<$ 500mm to \geq 200mm
		2 Spalling Scaling Disintegration	Affected area is $>$ 300mm to \leq 600mm wide in any direction, or depth is 50mm to 100mm
		3 Delamination	Delaminated area measuring $>$ 300mm to \leq 600mm in any direction
		4 Rebar exposure/corrosion	Main rebar exposed is $>$ 500mm to \leq 1000mm wide, corroded
		5 Honeycomb	Affected area is $>$ 300mm to \leq 600mm wide in any direction
		6 Water Leakage	Water leak in 1 spot has an area of $>$ 200mm to \leq 500mm wide
	3 - Bad	1 Cracking	$>$ 1.0mm, 2 directions, spacing is $<$ 200mm
		2 Spalling Scaling Disintegration	Affected area is $>$ 600mm wide in any direction, or depth is more than 100mm
		3 Delamination	Delaminated area measuring $>$ 600mm in any direction
		4 Rebar exposure/corrosion	Main rebar exposed is $>$ 1000mm wide and corroded
		5 Honeycomb	Affected area is $>$ 600mm wide in any direction
		6 Water Leakage	Water leak in 1 spot has an area of $>$ 500mm wide

BRIDGE ELEMENT		SPAN	BRIDGE ATTRIBUTE	MAIN/SECONDARY MEMBER(2/3)
MATERIAL	CONDITION		SEVERITY OF DEFECT	Effective August 22, 2007

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BRIDGE MANAGEMENT SYSTEM
BRIDGE CONDITION RATING CRITERIA

TYPE	STATE	TYPE OF DAMAGE	CONDITION
STEEL Girder/Truss	0 - Good	1 Corrosion	Loose rust formation and pitting in the paint surface, no section loss
		2 Cracking	No cracks
		3 Deformation/Buckling	No deformation on bridge components
		4 Abnormal vibration	Not detected
		5 Loose connection	No bolts missing, <= 10% of fasteners loose
		6 Paint peel off	Surface area affected is <= 10% in a member
	1 - Fair	1 Corrosion	Loose rust formation with scales/flakes, <= 10% section loss
		2 Cracking	Spot cracking on secondary members only
		3 Deformation/Buckling	Partial deformation on secondary members only
		4 Abnormal vibration	Not detected
		5 Loose connection	Loose fasteners is > 10% to <= 20%, falling out of bolts in > 1 pc. on joints
		6 Paint peel off	Surface area affected is >10% to <= 20% in a member
	2 - Poor	1 Corrosion	Stratified rust with pitting of metal surface, >10% to <=20% section loss
		2 Cracking	Cracking on secondary members of bridges is severe
		3 Deformation/Buckling	Partial deformation on primary members
		4 Abnormal vibration	Not detected
		5 Loose connection	Loose fasteners >20% <=30%, bolts fall out in > 3pc on sec. mem. joints
		6 Paint peel off	Surface area affected is > 20% to <= 30% in a member
	3 - Bad	1 Corrosion	Extensive rusting w/ local perforation/rusting through > 20% section loss
		2 Cracking	Cracking on primary members, especially in welded parts
		3 Deformation/Buckling	Outstanding deformation due to buckling or partial yielding
		4 Abnormal vibration	Detected
		5 Loose connection	> 30% fasteners loose, bolts fall out in > 3pcs. on primary member joints
		6 Paint peel off	Surface area affected is > 30% in a member
Bailey Demount-able	0 - Good	1 Corrosion	Loose rust formation and pitting in the paint surface, no section loss
		2 Loose connection	No bolts missing, <= 10% of fasteners loose
		3 Deformation/Buckling	No deformation on bridge components
	1 - Fair	1 Corrosion	Loose rust formation with scales/flakes, <= 10% section loss
		2 Loose connection	Loose fasteners is > 10% to <= 20%, falling out of bolts in > 1 pc. on joints
		3 Deformation/Buckling	Partial deformation on secondary members only
	2 - Poor	1 Corrosion	Stratified rust with pitting of metal surface, >10% to <=20% section loss
		2 Loose connection	Loose fasteners >20% <=30%, bolts fall out in > 3pc on sec. mem. joints
		3 Deformation/Buckling	Partial deformation on primary members
	3 - Bad	1 Corrosion	Extensive rusting w/ local perforation/rusting through > 20% section loss
		2 Loose connection	> 30% fasteners loose, bolts fall out in > 3pc on primary member joints
		3 Deformation/Buckling	Outstanding deformation due to buckling or partial yielding

BRIDGE ELEMENT		SPAN	BRIDGE ATTRIBUTE	MAIN/SECONDARY MEMBER(3/3)
MATERIAL TYPE	CONDITION STATE	SEVERITY OF DEFECT		
		TYPE OF DAMAGE	CONDITION	

		1 Fretting	Page 4 of 5 from the joints in few places to a depth of 20mm	
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Department of Public Works and Highways
BRIDGE MANAGEMENT SYSTEM
BRIDGE CONDITION RATING CRITERIA

MASONRY Arch	0 - Good	Abrasion	
		2 Cracking	No damage
		3 Material displacement/loss	Stones or bricks intact in good condition
		4 Bulging	No damage
	1 - Fair	1 Fretting Abrasion	Mortar loss from joints over an extended area, depth is >20mm <=50mm
		2 Cracking	<= 3mm wide with no water leakage
		3 Material displacement/loss	Stones or bricks starting to be displaced
		4 Bulging	Slight bulging
	2 - Poor	1 Fretting Abrasion	Extensive loss of mortar resulting in the loss of few stones
		2 Cracking	> 3mm to <= 5mm wide with slight water leakage
		3 Material displacement/loss	Loss of some stones or bricks
		4 Bulging	Small range of bulging
	3 - Bad	1 Fretting Abrasion	Mortar becomes ineffective
		2 Cracking	> 5mm wide around the bearing or step in the face of masonry
		3 Material displacement/loss	Extensive loss of stones endangering the stability of structure
		4 Bulging	Serious bulging near cracks
TIMBER Beam	0 - Good	1 Decay/Splitting/Cracking	Not visible
		2 Disconnection	No disconnection
	1 - Fair	1 Decay/Splitting/Cracking	Decay starting to form, minor cracking and splitting is visible
		2 Disconnection	Connectors are slightly damage but still intact
	2 - Poor	1 Decay/Splitting/Cracking	Decay is very visible, presence of major cracks and splitting
		2 Disconnection	Connectors are damaged and members are disintegrating
	3 - Bad	1 Decay/Splitting/Cracking	Decay in advance stage, severe cracking and splitting
		2 Disconnection	Members are totally disconnected or missing

BRIDGE ELEMENT		SPAN/ABUTMENT	BRIDGE ATTRIBUTE	RAILING/WINGWALL
MATERIAL TYPE	CONDITION STATE	SEVERITY OF DEFECT		
		TYPE OF DAMAGE	CONDITION	
	0 - Good	1 Cracking	Hairline or no crack	
		2 Delamination/Disintegration	Delaminated area measuring <= 150mm in any direction	
		3 Impact/Accident Damage	None visible	

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BRIDGE MANAGEMENT SYSTEM
BRIDGE CONDITION RATING CRITERIA

CONCRETE	1 - Fair	4 Rebar exposure/corrosion	No damage
		5 Water leakage	Not visible
		1 Cracking	Cracks are ≤ 0.3 mm wide in more than 500mm intervals
		2 Delamination/Disintegration	Delaminated area measuring > 150 mm to ≤ 300 mm in any direction
		3 Impact/Accident Damage	Minor damage on component with no impact
	2 - Poor	4 Rebar exposure/corrosion	Rebars partially exposed, ≤ 500 mm width
		5 Water leakage	Water leak in 1 spot has an area of ≤ 20 mm wide
		1 Cracking	Cracks are > 0.3 mm to ≤ 0.5 mm wide in less than 500mm interval
		2 Delamination/Disintegration	Delaminated area measuring > 300 mm to ≤ 600 mm in any direction
		3 Impact/Accident Damage	Accident damage has minor impact
	3 - Bad	4 Rebar exposure/corrosion	Main rebars exposed between > 500 mm to ≤ 1000 mm
		5 Water leakage	Water leak is visible in > 2 to 5 locations
		1 Cracking	Cracks are more than 0.5mm wide
		2 Delamination/Disintegration	Delaminated area measuring > 600 mm in any direction
		3 Impact/Accident Damage	Post or rails totally shifted out of position or missing.
STEEL	0 - Good	4 Rebar exposure/corrosion	Main rebars exposed in > 1000 mm width, and corroded
		5 Water leakage	Water leak is visible in > 5 locations
		1 Corrosion	Loose rust formation and pitting in the paint surface. No noticeable section loss
		2 Loose connection	No bolts missing, $\leq 10\%$ of fasteners loose
	1 - Fair	3 Impact/Accident Damage	Not visible
		4 Paint peel off	Surface area affected is $\leq 10\%$
		1 Corrosion	Loose rust formation with scales/flakes, $\leq 10\%$ section loss
		2 Loose connection	Loose fasteners is $> 10\%$ to $\leq 20\%$, falling out of bolts in > 1 pc on joints
	2 - Poor	3 Impact/Accident Damage	Minor damage on component with no impact
		4 Paint peel off	Surface area affected is $> 10\%$ to $\leq 20\%$
		1 Corrosion	Stratified rust with pitting of metal surface, $> 10\%$ to $\leq 20\%$ section loss
		2 Loose connection	Loose fasteners $> 20\%$ $\leq 30\%$, bolts fall out in > 3 pc on sec. mem. joints
	3 - Bad	3 Impact/Accident Damage	Accident damage has minor impact
		4 Paint peel off	Surface area affected is $> 20\%$ to $\leq 30\%$
		1 Corrosion	Extensive rusting w/ local perforation/rusting through $> 20\%$ section loss
		2 Loose connection	$> 30\%$ fasteners loose, bolts fall out in > 3 pc on primary member joints
		3 Impact/Accident Damage	Post or rails totally shifted out of position or missing.
		4 Paint peel off	Surface area affected is $> 30\%$

BRIDGE ELEMENT		PIER/ABUTMENT	BRIDGE ATTRIBUTE	MAIN STRUCTURE (1/2)
MATERIAL TYPE	CONDITION STATE	SEVERITY OF DEFECT		
		TYPE OF DAMAGE	CONDITION	
	0 - Good	1 Cracking	Hairline crack or no crack	
		2 Spalling Scaling Disintegration	Affected area is ≤ 150 mm wide in any direction, or depth is less than 25mm	

Department of Public Works and Highways
BRIDGE MANAGEMENT SYSTEM

BRIDGE CONDITION RATING CRITERIA

CONCRETE	3 - Good	3 Delamination	Delaminated area measuring \leq 150mm in any direction	
		4 Rebar exposure/corrosion	No damage	
		5 Honeycomb	Affected area is $<$ 150mm wide in any direction	
		6 Tilt/Settlement	Not visible	
		1 - Fair	1 Cracking	\leq 0.3mm, 1 direction, spacing $>$ 500mm
			2 Spalling Scaling Disintegration	Affected area is $>$ 150mm to \leq 300mm wide in any direction. or depth is 25mm to 50mm
	3 Delamination		Delaminated area measuring $>$ 150mm to \leq 300mm in any direction	
	4 Rebar exposure/corrosion		Main rebar exposed is \leq 50 mm wide, corroded or flaking only	
	5 Honeycomb		Affected area is $>$ 150mm to $<$ 300mm wide in any direction	
	6 Tilt/Settlement		Not visible	
	2 - Poor	1 Cracking	$>$ 0.3mm to \leq 1.0mm, 2 directions, spacing is $<$ 500mm to \geq 200mm	
		2 Spalling Scaling Disintegration	Affected area is $>$ 300mm to \leq 600mm wide in any direction, or depth is 50mm to 100mm	
		3 Delamination	Delaminated area measuring $>$ 300mm to \leq 600mm wide in any direction	
		4 Rebar exposure/corrosion	Main rebar exposed is $>$ 500mm to \leq 1000mm wide, corroded	
		5 Honeycomb	Affected area is $>$ 300mm to $<$ 600mm wide in any direction	
		6 Tilt/Settlement	Not visible	
	3 - Bad	1 Cracking	$>$ 1.0mm, 2 directions, spacing is $<$ 200mm	
		2 Spalling Scaling Disintegration	Affected area is $>$ 600mm wide in any direction, or depth is more than 100mm	
		3 Delamination	Delaminated area measuring $>$ 600mm in any direction	
		4 Rebar exposure/corrosion	Main rebar exposed is $>$ 1000cm wide and corroded	
		5 Honeycomb	Affected area is $>$ 600mm wide in any direction	
		6 Tilt/Settlement	Detected	

BRIDGE ELEMENT		PIER/ABUTMENT	BRIDGE ATTRIBUTE	MAIN STRUCTURE (2/2)
MATERIAL TYPE	CONDITION STATE	SEVERITY OF DEFECT		
		TYPE OF DAMAGE	CONDITION	
	0 - Good	1 Fretting Abrasion	Mortar loss from the joints in few places to a depth of 20mm	
		2 Cracking	No damage	
		3 Material displacement/loss	Stones or bricks intact and in good condition	
		4 Bulging	No damage	

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BRIDGE CONDITION RATING CRITERIA

MASONRY Wall	1 - Fair	1 Fretting Abrasion	Mortar loss from joints over an extended area, depth is >20mm <=50mm
		2 Cracking	<= 3mm wide with no water leakage
		3 Material displacement/loss	Stones or bricks starting to be displaced
		4 Bulging	Slight bulging
	2 - Poor	1 Fretting Abrasion	Extensive loss of mortar resulting in the loss of few stones
		2 Cracking	> 3mm to <= 5mm wide with slight water leakage
		3 Material displacement/loss	Loss of some stones or bricks
		4 Bulging	Small range of bulging
	3 - Bad	1 Fretting Abrasion	Mortar becomes ineffective
		2 Cracking	> 5mm wide around the bearing or step in the face of masonry
		3 Material displacement/loss	Extensive loss of stones endangering the stability of structure
		4 Bulging	Serious bulging near cracks
TIMBER Pile	0 - Good	1 Decay/Splitting/Cracking	Not visible
		2 Disconnection	No disconnection
	1 - Fair	1 Decay/Splitting/Cracking	Decay starting to form, minor cracking and splitting is visible
		2 Disconnection	Connectors are slightly damage but still intact
	2 - Poor	1 Decay/Splitting/Cracking	Decay is very visible, presence of major cracks and splitting
		2 Disconnection	Connectors are damaged and members are disintegrating
	3 - Bad	1 Decay/Splitting/Cracking	Decay in advance stage, severe cracking and splitting
		2 Disconnection	Members are totally disconnected or missing

BRIDGE ELEMENT		PIER/ABUTMENT	BRIDGE ATTRIBUTE	FOUNDATION (1/2)
MATERIAL TYPE	CONDITION STATE	SEVERITY OF DEFECT		
		TYPE OF DAMAGE	CONDITION	
	0 - Good	1 Cracking	Hairline crack or no crack	
		2 Spalling Scaling Disintegration	Affected area is <= 150mm wide in any direction, or depth is less than 25mm	
		3 Delamination	Delaminated area measuring <= 150mm in any direction	
		4 Rebar exposure/corrosion	No damage	
		5 Tilt/Settlement	No visible	

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BRIDGE MANAGEMENT SYSTEM
BRIDGE CONDITION RATING CRITERIA

CONCRETE Pile	1 - Fair	6 Scouring	No scouring
		1 Cracking	<= 0.3mm, 1 direction, spacing > 500mm
		2 Spalling Scaling Disintegration	Affected area is > 150mm to <= 300mm wide in any direction. or depth is 25mm to 50mm
		3 Delamination	Delaminated area measuring > 150mm to <= 300mm in any direction
		4 Rebar exposure/corrosion	Main rebar exposed is <= 500mm wide, corroded or flaking only
		5 Tilt/Settlement	Not visible
	2 - Poor	6 Scouring	Minor scouring
		1 Cracking	> 0.3mm to <= 1.0mm, 2 directions, spacing is <500mm to >= 200mm
		2 Spalling Scaling Disintegration	Affected area is > 300mm to <= 600mm wide in any direction, or depth is 50mm to 100mm
		3 Delamination	Delaminated area measuring > 300mm to <= 600mm in any direction
		4 Rebar exposure/corrosion	Main rebar exposed is >500mm to <=1000mm wide, corroded
		5 Tilt/Settlement	Visible
	3 - Bad	6 Scouring	Foundation is exposed up to the bottom of footing or cassion
		1 Cracking	> 1.0mm, 2 directions, spacing is < 200mm
		2 Spalling Scaling Disintegration	Affected area is > 600mm wide in any direction, or depth is more than 100mm
		3 Delamination	Delaminated area measuring > 600mm in any direction
		4 Rebar exposure/corrosion	Main rebar exposed is > 1000mm wide and corroded
		5 Tilt/Settlement	Very visible
6 Scouring	Foundation is exposed bellow the footing/cassion		

BRIDGE ELEMENT		PIER/ABUTMENT	BRIDGE ATTRIBUTE	FOUNDATION (2/2)
MATERIAL TYPE	CONDITION STATE	SEVERITY OF DEFECT		
		TYPE OF DAMAGE	CONDITION	
	0 - Good	1 Corrosion	Loose rust formation and pitting in the paint surface, no section loss	
		2 Cracking	No cracks	
		3 Deformation/Buckling	No deformation on bridge components	
		4 Tilt/Settlement/Scouring	Not visible	
		5 Scouring	No scouring	
	1 - Fair	1 Corrosion	Loose rust formation with scales/flakes, <= 10% section loss	
		2 Cracking	Spot cracking on secondary members only	
		3 Deformation/Buckling	Partial deformation on secondary members only	
		4 Tilt/Settlement/Scouring	Not visible	
		5 Scouring	Not visible	

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BRIDGE CONDITION RATING CRITERIA

STEEL Caisson	2 - Poor	5 Scouring	Minor scouring
		1 Corrosion	Stratified rust with pitting of metal surface, >10% to <=20% section loss
		2 Cracking	Spot cracking on primary bridge components
		3 Deformation/Buckling	Partial deformation on primary members
		4 Tilt/Settlement/Scouring	Visible
	3 - Bad	5 Scouring	Foundation is exposed up to the bottom of footing or cassion
		1 Corrosion	Extensive rusting w/ local perforation/rusting through > 20% section loss
		2 Cracking	Cracking on primary members, especially in welded parts
		3 Deformation/Buckling	Outstanding deformation due to buckling or partial yielding
		4 Tilt/Settlement/Scouring	Very visible
5 Scouring	Foundation is exposed below the footing/cassion		

BRIDGE ELEMENT		PIER/ABUTMENT	BRIDGE ATTRIBUTE	EXPANSION JOINT (1/2)
MATERIAL TYPE	CONDITION STATE	SEVERITY OF DEFECT		
		TYPE OF DAMAGE	CONDITION	
POURABLE SEALS Sealant Asphalt	0 - Good	1 Water leakage	No leakage	
		2 Abnormal space/noise	Not detected	
		3 Difference in elevation	Difference in elevation is <= 10mm at expansion gap	
		4 Deteriorated Sealant	Not detected	
	1 - Fair	1 Water leakage	Detected area measures up to 25%, and 1m below the bearing shelf	
		2 Abnormal space/noise	Not detected	
		3 Difference in elevation	Difference in elevation is > 10mm to <= 20mm at expansion gap	
		4 Deteriorated Sealant	Sealer starting to flow out of the joint	
	2 - Poor	1 Water leakage	Detected area measure > 25% to <= 50%	
		2 Abnormal space/noise	Not detected	

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BRIDGE MANAGEMENT SYSTEM

BRIDGE CONDITION RATING CRITERIA

MATERIAL TYPE	CONDITION STATE	SEVERITY OF DEFECT	
		TYPE OF DAMAGE	CONDITION
STEEL	4 - Poor	3 Difference in elevation	Difference in elevation is > 20mm to <= 30mm at expansion gap
		4 Deteriorated Sealant	Overfilled sealer heavily impacted by traffic
	3 - Bad	1 Water leakage	Detected area > 50%
		2 Abnormal space/noise	Detected
		3 Difference in elevation	Difference in elevation is > 30mm at expansion gap
		4 Deteriorated Sealant	Pourable joint sealant maybe almost completely lost.
	0 - Good	1 Water leakage	No leakage
		2 Abnormal space/noise	Not detected
		3 Difference in elevation	Difference in elevation is <= 10mm at expansion gap
		4 Displacement	Bolts/anchorage/armoring firmly in place
		5 Cracking	No cracks
	1 - Fair	1 Water leakage	Detected area measures up to 25%, and 1m below the bearing shelf
		2 Abnormal space/noise	Not detected
		3 Difference in elevation	Difference in elevation is > 10mm to <= 20mm at expansion gap
		4 Displacement	Slight loosening of bolts/anchorage/armoring but still in place
		5 Cracking	Spot cracking on Secondary members only
	2 - Poor	1 Water leakage	Detected area measure > 25% to <= 50%
		2 Abnormal space/noise	Not detected
		3 Difference in elevation	Difference in elevation is > 20mm to <= 30mm at expansion gap
		4 Displacement	Bolts/anchorage/armoring may have failed
5 Cracking		Spot cracking on primary bridge components	
3 - Bad	1 Water leakage	Detected area > 50%	
	2 Abnormal space/noise	Detected	
	3 Difference in elevation	Difference in elevation is > 30mm at expansion gap	
	4 Displacement	Pourable joint sealant maybe almost completely lost.	
	5 Cracking	Cracking on primary members especially in welded parts	

BRIDGE ELEMENT		PIER/ABUTMENT	BRIDGE ATTRIBUTE	EXPANSION JOINT (2/2)
MATERIAL TYPE	CONDITION STATE	SEVERITY OF DEFECT		
		TYPE OF DAMAGE	CONDITION	
RUBBER	0 - Good	1 Water leakage	No leakage	
		2 Abnormal space/noise	Not detected	
		3 Difference in elevation	Difference in elevation is <= 10mm at expansion gap	
		4 Rupture	Fine or hairline crack detected on rubber seal	
	1 - Fair	1 Water leakage	Detected area measures up to 25%, and 1m below the bearing shelf	
		2 Abnormal space/noise	Not detected	
		3 Difference in elevation	Difference in elevation is > 10mm to <= 20mm at expansion gap	
		4 Rupture	Minor crack detected on rubber seal	
	2 - Poor	1 Water leakage	Detected area measure > 25% to <= 50%	
		2 Abnormal space/noise	Not detected	
		3 Difference in elevation	Difference in elevation is > 20mm to <= 30mm at expansion gap	

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BRIDGE MANAGEMENT SYSTEM
BRIDGE CONDITION RATING CRITERIA

3 - Bad	4 Rupture	Wide or large crack detected on rubber seal
	1 Water leakage	Detected area > 50%
	2 Abnormal space/noise	Detected
	3 Difference in elevation	Difference in elevation is > 30mm at expansion gap
	4 Rupture	Rubber seal dislodge or peel off from location

BRIDGE ELEMENT		PIER/ABUTMENT	BRIDGE ATTRIBUTE	BEARING/RESTRAINT
MATERIAL TYPE	CONDITION STATE	SEVERITY OF DEFECT		
		TYPE OF DAMAGE	CONDITION	
STEEL	0 - Good	1 Corrosion	Loose rust formation and pitting in the paint surface. No section loss	
		2 Loose connection	Up to 20% of fasteners loose or missing in one location	
		3 Abnormal Displacement	No abnormal displacement	
		4 Paint deterioration	No damage	
		5 Bed (support) damage	No damage	
	1 - Fair	1 Corrosion	Loose rust formation w/ scales/flakes define areas of rust <= 10% section loss	
		2 Loose connection	20% to 40% of fasteners loose or missing in one location	
		3 Abnormal Displacement	Bearing has been displace by <= 10%	
		4 Paint deterioration	Paint system starts to fail	
		5 Bed (support) damage	Partial (<= 50% of area at one location) cracking or spalling	
	2-Poor	1 Corrosion	Stratified rust with pitting of metal surface, > 10% to <= 20% section loss	
		2 Loose connection	> 40% to <= 60% of fasteners loose or missing in one location	
		3 Abnormal Displacement	Bearing has been displaced by > 10% to <= 20%	
		4 Rupture	Wide or large crack detected on rubber seal	
		5 Bed (support) damage	No damage	

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	3 - Bad	4 Paint deterioration	Paint system have failed and is not effective
		5 Bed (support) damage	Wide range (> 50% of area at one location) cracking/spalling
		1 Corrosion	Extensive rusting with local perforation, > 20% section loss
		2 Loose connection	> 60% of fasteners loose or missing in one location
		3 Abnormal Displacement	Bearing has been displaced by > 20%
		4 Paint deterioration	Paint system has completely failed
RUBBER	0 - Good	5 Bed (support) damage	Major splitting of bearing block, which loses bearing function
		1 Bulging	No bulging
		2 Abnormal displacement	No abnormal displacement
	1 - Fair	3 Bed (support) damage	No damage
		1 Bulging	Slight bulging is noticeable
		2 Abnormal displacement	Bearing has been displace by <= 10%
	2 - Poor	3 Bed (support) damage	Partial (<= 50% of area at one location) cracking or spalling
		1 Bulging	Minor bulging is noticeable
		2 Abnormal displacement	Bearing has been displaced by > 10% to <= 20%
	3 - Bad	3 Bed (support) damage	Wide range (> 50% of area at one location) cracking/spalling
		1 Bulging	Severe crack, abnormal bulge, worn out and aged
		2 Abnormal displacement	Bearing has been displaced by > 20%
		3 Bed (support) damage	Major splitting of bearing block which losses bearing function

BRIDGE ELEMENT		PIER	BRIDGE ATTRIBUTE	SCOUR PROTECTION
MATERIAL TYPE	CONDITION STATE	SEVERITY OF DEFECT		
		TYPE OF DAMAGE	CONDITION	
CONCRETE, MASONRY, GROUTED Rip Rap	0 - Good	1 Cracking	No cracking or hairline cracks only	
		2 Material loss/disintegration	Loss of stones at <= 50mm depth	
	1 - Fair	1 Cracking	Narrow cracks	
		2 Material loss/disintegration	Loss of stones between 50mm and 100mm depth	
	2-Poor	1 Cracking	With spalling	
		2 Material loss/disintegration	Section loss at > 100mm to <= 150mm depth	
	3 - Bad	1 Cracking	Severe cracks	
		2 Material loss/disintegration	Section loss is > 150mm depth	
GABION, MATTRESS	0-Good	1 Damage on containing wire	No damage	
		2 Material loss/disintegration	Loss of stones at <= 50mm depth	
	1 - Fair	1 Damage on containing wire	Protective paint is peeling off	
		2 Material loss/disintegration	Loss of stones between 50mm and 100mm depth	
	2-Poor	1 Damage on containing wire	Containing wires are heavily corroded with some broken portion	
		2 Material loss/disintegration	Section loss at > 100mm to <= 150mm depth	

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CONCRETE, MASONRY, GROUTED Rip Rap	3 - Bad	1 Damage on containing wire	Containing wires severely damaged and is no longer functioning
		2 Material loss/disintegration	Section loss is > 150mm depth
	0-Good	1 Cracking	No cracking or hairline cracks
		2 Bank erosion	<= 10% loss of embankment materials
		3 Slope erosion	<= 5% loss of embankment materials directly supporting foundation
		4 Material loss/disintegration	Loss of stones at <= 50mm depth
	1 - Fair	1 Cracking	Narrow cracks
		2 Bank erosion	> 10% to <= 30% loss of embankment materials
		3 Slope erosion	> 5% to <= 15% loss of embankment materials directly supporting foundation
		4 Material loss/disintegration	Loss of stones between 50mm and 100mm depth
	2-Poor	1 Cracking	With spalling
		2 Bank erosion	> 30% to <= 40% loss of embankment materials
		3 Slope erosion	> 15% to <= 20% loss of embankment materials directly supporting foundation
		4 Material loss/disintegration	Section loss at > 100mm to <= 150mm depth
	3 - Bad	1 Cracking	Severe cracks
		2 Bank erosion	> 40% loss of embankment materials
3 Slope erosion		> 20% loss of embankment materials directly supporting foundation	
4 Material loss/disintegration		Section loss is > 150mm depth	

BRIDGE ELEMENT		ABUTMENT	BRIDGE ATTRIBUTE	SLOPE/BANK PROTECTION
MATERIAL TYPE	CONDITION STATE	SEVERITY OF DEFECT		
		TYPE OF DAMAGE	CONDITION	
GABION MATTRESSES	0-Good	1 Damage on containing wire	No damage	
		2 Material loss/disintegration	Loss of stones at <= 50mm depth	
		3 Bank erosion	<= 10% loss of embankment materials	
		4 Slope erosion	<= 5% loss of embankment materials directly supporting foundation	
	1 - Fair	1 Damage on containing wire	Protective paint is peeling off	
		2 Material loss/disintegration	Loss of stones between 50mm and 100mm depth	
		3 Bank erosion	> 10% to <= 30% loss of embankment materials	
		4 Slope erosion	> 5% to <= 15% loss of embankment materials directly supporting foundation	
	2-Poor	1 Damage on containing wire	Containing wires are heavily corroded with some broken portion	
		2 Material loss/disintegration	Section loss at > 100mm to <= 150mm depth	
		3 Bank erosion	> 30% to <= 40% loss of embankment materials	
		4 Slope erosion	> 15% to <= 20% loss of embankment materials directly supporting foundation	
	3 - Bad	1 Damage on containing wire	Containing wires severely damaged and is no longer functioning	
		2 Material loss/disintegration	Section loss is > 150mm depth	
		3 Bank erosion	> 40% loss of embankment materials	

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BRIDGE MANAGEMENT SYSTEM
BRIDGE CONDITION RATING CRITERIA

STEEL Sheet Pile	0-Good	4 Slope erosion	> 20% loss of embankment materials directly supporting foundation
		1 Corrosion	Only loose rust formation can be observed, paint system still effective
		2 Displacement/deformation	Still firmly attached without any displacement/deformation
		3 Bank erosion	<= 20% loss of embankment materials
	1 - Fair	4 Slope erosion	<= 5% loss of embankment materials directly supporting foundation
		1 Corrosion	Protective paint system has failed, some section loss due to corrosion
		2 Material loss/disintegration	Attachment becoming loose with minor deformation/displacement
		3 Bank erosion	> 10% to <= 30% loss of embankment materials
	2-Poor	4 Slope erosion	> 5% to <= 15% loss of embankment materials directly supporting foundation
		1 Corrosion	Corrosion in advanced stage, large section loss
		2 Material loss/disintegration	Some unit starting to disintegrate, with major deformation/tilting
		3 Bank erosion	> 30% to <= 40% loss of embankment materials
	3 - Bad	4 Slope erosion	> 15% to <= 20% loss of embankment materials directly supporting foundation
		1 Corrosion	Severe corrosion and no longer effective
		2 Material loss/disintegration	Most of the units are displaced/deformed/tilted
		3 Bank erosion	> 40% loss of embankment materials
		4 Slope erosion	> 20% loss of embankment materials directly supporting foundation

BRIDGE ELEMENT		ABUTMENT	BRIDGE ATTRIBUTE	BRIDGE APPROACH
MATERIAL TYPE	CONDITION STATE	SEVERITY OF DEFECT		
		TYPE OF DAMAGE	CONDITION	
EMBANKMENT	0-Good	1 Depression	No Depression	
	1 - Fair	1 Depression	Slight depression: mean difference is <=25mm in elevation	
	2-Poor	1 Depression	Serious depression: mean difference is > 25mm to <= 50mm in elevation and 1.0m wide	
	3 - Bad	1 Depression	Outstanding depression: mean difference is > 50mm in elevation and 1.0m wide	



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APPENDIX B

BRIDGE CONDITION RATING CRITERIA



APPENDIX C

PHOTOGRAPHS OF CONDITION STATES



D.1 Equipment for Visual Inspection (Routine and Condition Inspection)

1. Safety Vest
2. Safety Shoes
3. Overalls
4. Flashlight
5. Hand Mirror for viewing behind bearings, etc.
6. Geologist's Hammer
7. 40-Meter Tape
8. 3-Meter Tape
9. Binoculars
10. Crayon for marking concrete or masonry
11. 35-70 MM (min.) Zoom Camera with date feature (preferably digital)
12. Inspection Forms
13. Writing/Sketching Paper
14. Copy of previous report
15. First-Aid Kit
16. Bridge Inspection vehicle or other inspection plant
17. Shovel and Broom
18. Extension Ladder (must be timber)
19. Boat or Barge
20. Crack Gauge
21. Wire Brush

D.2 Equipment for Engineering Inspection

1. Thickness gauge (for thickness of painting film)
2. Schmidt Rebound Hammer (for concrete compressive strength)
3. Phenolphthalein Solution (for concrete carbonation)
4. Ultrasonics (for detection of void and delamination of concrete, for detection of cracks and other anomalies in structural elements and joints for steel)
5. Spirit level with straight edge
6. Vernier Calipers
7. Cover meter (for determining concrete cover over reinforcing steel bars)



APPENDIX D

INSPECTION EQUIPMENT



BRIDGE CONDITION INSPECTION FORM (TYPE 2)



REPUBLIC OF THE PHILIPPINES
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Department of Public Works and Highways
BRIDGE MANAGEMENT SYSTEM

BRIDGE CONDITION INSPECTION FORM (TYPE 2)

LOCATION	
BRIDGE ID	
Bridge Name	
Road Name	
Road ID	
Section ID	
Location	
Region	
Province	
Congressional District	
Engineering District	
Municipality	
Barangay	
River Name	

BRIDGE DESCRIPTION	
Type of Bridge	
Superstructure	
Substructure	
Foundation	
Total Number of Span	
Total Number of Abutment	
Total Number of Pier	

Date of Field Inspection	
ACCOMPLISHED BY:	
SUBMITTED BY:	

Insert Name, Position, Signature and Date of Signing →
Initial all other pages



REPUBLIC OF THE PHILIPPINES
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SUMMARY

Bridge ID.

Bridge Name

BRIDGE CONDITION	
OVERALL CONDITION	
Good	<input type="checkbox"/>
Fair	<input type="checkbox"/>
Poor	<input type="checkbox"/>
Bad	<input type="checkbox"/>
RECOMMENDED ACTION	
Routine maintenance only	<input type="checkbox"/>
Major maintenance	<input type="checkbox"/>
Upgrading	<input type="checkbox"/>
Replacement	<input type="checkbox"/>
Bridge required	<input type="checkbox"/>
REASONS FOR RECOMMENDATION	
Bridge inadequate for traffic	<input type="checkbox"/>
Bridge alignment	<input type="checkbox"/>
Flooding	<input type="checkbox"/>
Safety	<input type="checkbox"/>
Bridge Deterioration	<input type="checkbox"/>
Scour and erosion	<input type="checkbox"/>
Excessive maintenance required	<input type="checkbox"/>
Inadequate load capacity	<input type="checkbox"/>
No bridge - bridge required	<input type="checkbox"/>
Other	<input type="checkbox"/>

Up to three (3) options may be selected.

BRIDGE INSPECTOR COMMENT

BRIDGE SURVEYED?	REASON FOR NO SURVEY
Yes <input type="checkbox"/>	Bridgeworks in progress <input type="checkbox"/>
No <input type="checkbox"/>	Access restricted <input type="checkbox"/>
LEVEL OF INSPECTION	
Full complete inspection <input type="checkbox"/>	Affected by natural disaster <input type="checkbox"/>
Partial inspection only:	
BIV not available <input type="checkbox"/>	No reason <input type="checkbox"/>
Other reason <input type="checkbox"/>	Other, insert reason <input type="text"/>

TYPE OF BRIDGE	ESTIMATED REMAINING BRIDGE LIFE
Standard Bridge <input type="checkbox"/>	Years <input style="width: 50px;" type="text"/>
Special Bridge <input type="checkbox"/>	

Special bridges are major complex bridges and require condition inspection in accordance with the bridge maintenance plan.

Remaining life of bridge shall be assessed in the range of 0-50 years

ROUTINE MAINTENANCE

This section requires the bridge inspector to provide cost estimates for the routine maintenance of the entire bridge for the following budget year.

Routine maintenance activity	P	Estimated Cost
Sweeping and cleaning of bridge deck	P	
Repairs to concrete bridge deck	P	
Repairs to concrete component	P	
Repairs to steel component	P	
Painting bridge components	P	
Repairs to Bailey bridges	P	
Repairs to timber components	P	
Cleaning bridge waterways	P	
Others (Specify)	P	
Total Estimated Cost	P	



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REPAIR RECORD

Bridge ID.

Bridge Name

MAJOR MAINTENANCE

DATE	MAJOR MAINTENANCE			IMPLEMENTATION				INSPECTOR COMMENTS
	TYPE	SCOPE	COST	START	COMPLETION	DURATION	STATUS	

ROUTINE MAINTENANCE

DATE	ROUTINE MAINTENANCE			IMPLEMENTATION				INSPECTOR COMMENTS
	TYPE	SCOPE	COST	START	COMPLETION	DURATION	STATUS	

LEGEND:	MAJOR MAINTENANCE TYPE A - Repair damage B - Protective measures C - Strengthen D - Replace E - None	ROUTINE MAINTENANCE ACTIVITY A - Sweeping and cleaning of bridge deck B - Repairs to concrete bridge deck C - Repairs to concrete component D - Repairs to steel component E - Painting bridge components	F - Repairs to Bailey bridges G - Repairs to timber components H - Cleaning bridge waterways I - Others (Specify)
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REPUBLIC OF THE PHILIPPINES
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SPAN ELEMENT - CONDITION

SPAN No. (one set of forms for each span) Bridge ID Bridge Name

ATTRIBUTE	ATTENTION REQUIRED	LEVEL OF INSPECTION	TYPE OF MAJOR MAINTENANCE	ESTIMATED COST (P)	REFERENCE	DESCRIBE DEFECTS AND RECOMMENDED WORKS
DECK	Immediate	3	Fully	Repair damage		
	Within 2 years	2	assessed	Protective measures		
	Within 10 years	1	Partially	Strengthen		
	None	0	assessed	Replace		
	Not Applicable		Not assessed	Other		
			Total Estimated Cost			
MAIN MEMBER	Immediate	3	Fully	Repair damage		
	Within 2 years	2	assessed	Protective measures		
	Within 10 years	1	Partially	Strengthen		
	None	0	assessed	Replace		
	Not Applicable		Not assessed	Other		
			Total Estimated Cost			
SECONDARY MEMBER	Immediate	3	Fully	Repair damage		
	Within 2 years	2	assessed	Protective measures		
	Within 10 years	1	Partially	Strengthen		
	None	0	assessed	Replace		
	Not Applicable		Not assessed	Other		
			Total Estimated Cost			
LEFT RAILING	Immediate	3	Fully	Repair damage		
	Within 2 years	2	assessed	Protective measures		
	Within 10 years	1	Partially	Strengthen		
	None	0	assessed	Replace		
	Not Applicable		Not assessed	Other		
			Total Estimated Cost			
RIGHT RAILING	Immediate	3	Fully	Repair damage		
	Within 2 years	2	assessed	Protective measures		
	Within 10 years	1	Partially	Strengthen		
	None	0	assessed	Replace		
	Not Applicable		Not assessed	Other		
			Total Estimated Cost			



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PIER ELEMENT - CONDITION

PIER No. (one set of forms for each pier) Bridge ID Bridge Name

Scour/Erosion Check, bridges across waterways only

Height, bridge deck to ground level, left, (m)	
Height, bridge deck to ground level, right, (m)	

ATTRIBUTE	ATTENTION REQUIRED	LEVEL OF INSPECTION	TYPE OF MAJOR MAINTENANCE	ESTIMATED COST (P)	REFERENCE	DESCRIBE DEFECTS AND RECOMMENDED WORKS
MAIN STRUCTURE	Immediate	3	Fully	Repair damage		
	Within 2 years	2	assessed	Protective measures		
	Within 10 years	1	Partially	Strengthen		
	None	0	assessed	Replace		
	Not Applicable		Not assessed	Other		
			Total Estimated Cost			
FOUNDATION	Immediate	3	Fully	Repair damage		
	Within 2 years	2	assessed	Protective measures		
	Within 10 years	1	Partially	Strengthen		
	None	0	assessed	Replace		
	Not Applicable		Not assessed	Other		
			Total Estimated Cost			
EXPANSION JOINT	Immediate	3	Fully	Repair damage		
	Within 2 years	2	assessed	Protective measures		
	Within 10 years	1	Partially	Strengthen		
	None	0	assessed	Replace		
	Not Applicable		Not assessed	Other		
			Total Estimated Cost			
BEARING/ RESTRAINT	Immediate	3	Fully	Repair damage		
	Within 2 years	2	assessed	Protective measures		
	Within 10 years	1	Partially	Strengthen		
	None	0	assessed	Replace		
	Not Applicable		Not assessed	Other		
			Total Estimated Cost			
SCOUR PROTECTION	Immediate	3	Fully	Repair damage		
	Within 2 years	2	assessed	Protective measures		
	Within 10 years	1	Partially	Strengthen		
	None	0	assessed	Replace		
	Not Applicable		Not assessed	Other		
			Total Estimated Cost			



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ABUTMENT ELEMENT - CONDITION (1/2)

ABUTMENT No. (one set of forms for each abutment) Bridge ID Bridge Name

Scour/Erosion Check, bridges across waterways only

Height, bridge deck to ground level, left, (m)	
Height, bridge deck to ground level, right, (m)	

ATTRIBUTE	ATTENTION REQUIRED	LEVEL OF INSPECTION	TYPE OF MAJOR MAINTENANCE	ESTIMATED COST (P)	REFERENCE	DESCRIBE DEFECTS AND RECOMMENDED WORKS
MAIN STRUCTURE	Immediate	3	Fully	Repair damage		
	Within 2 years	2	assessed	Protective measures		
	Within 10 years	1	Partially	Strengthen		
	None	0	assessed	Replace		
	Not Applicable		Not assessed	Other		
				Total Estimated Cost		
FOUNDATION	Immediate	3	Fully	Repair damage		
	Within 2 years	2	assessed	Protective measures		
	Within 10 years	1	Partially	Strengthen		
	None	0	assessed	Replace		
	Not Applicable		Not assessed	Other		
				Total Estimated Cost		
EXPANSION JOINT	Immediate	3	Fully	Repair damage		
	Within 2 years	2	assessed	Protective measures		
	Within 10 years	1	Partially	Strengthen		
	None	0	assessed	Replace		
	Not Applicable		Not assessed	Other		
				Total Estimated Cost		
BEARING/ RESTRAINT	Immediate	3	Fully	Repair damage		
	Within 2 years	2	assessed	Protective measures		
	Within 10 years	1	Partially	Strengthen		
	None	0	assessed	Replace		
	Not Applicable		Not assessed	Other		
				Total Estimated Cost		
LEFT WING WALL	Immediate	3	Fully	Repair damage		
	Within 2 years	2	assessed	Protective measures		
	Within 10 years	1	Partially	Strengthen		
	None	0	assessed	Replace		
	Not Applicable		Not assessed	Other		
				Total Estimated Cost		



REPUBLIC OF THE PHILIPPINES
DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS

ABUTMENT ELEMENT - CONDITION (2/2)

ABUTMENT No. (one set of forms for each abutment)

 Bridge ID

 Bridge Name

ATTRIBUTE	ATTENTION REQUIRED	LEVEL OF INSPECTION	TYPE OF MAJOR MAINTENANCE	ESTIMATED COST (P)	REFERENCE	DESCRIBE DEFECTS AND RECOMMENDED WORKS
RIGHT WING WAL	Immediate	3	Fully	Repair damage		
	Within 2 years	2	assessed	Protective measures		
	Within 10 years	1	Partially	Strengthen		
	None	0	assessed	Replace		
	Not Applicable		Not assessed	Other		
			Total Estimated Cost			
SCOUR/BANK PROTECTION	Immediate	3	Fully	Repair damage		
	Within 2 years	2	assessed	Protective measures		
	Within 10 years	1	Partially	Strengthen		
	None	0	assessed	Replace		
	Not Applicable		Not assessed	Other		
			Total Estimated Cost			
BRIDGE APPROACH	Immediate	3	Fully	Repair damage		
	Within 2 years	2	assessed	Protective measures		
	Within 10 years	1	Partially	Strengthen		
	None	0	assessed	Replace		
	Not Applicable		Not assessed	Other		
			Total Estimated Cost			



REPUBLIC OF THE PHILIPPINES
DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS

SPAN ELEMENT - DAMAGE RATING

SPAN No. (one set of forms for each span)

Bridge ID Bridge Name

Type of Material	Type of Damage	Severity of Defect	Affected		Damage Rating	Attrib. Cond. State
			Unit	%		
DECK						
<input type="checkbox"/> Timber	Decay/Splitting/Cracking					
	Disconnection/Displace.					
<input type="checkbox"/> Steel	Corrosion					
	Cracking					
	Deformation/Buckling					
	Loose connection					
<input type="checkbox"/> Concrete Slab	Cracking					
	Spalling/Scaling/Disinteg.					
	Delamination					
	Rebar exposure/corrosion					
	Honeycomb					
	Water leakage					
SECONDARY MEMBER (SM) / OTHER MEMBER (OM)						
<input type="checkbox"/> SM <input type="checkbox"/> OM						
<input type="checkbox"/> Concrete	Cracking					
	Spalling/Scaling/Disint.					
	Delamination					
	Rebar exposure/corrn.					
	Honeycomb					
	Water leakage					
<input type="checkbox"/> Steel	Corrosion					
	Cracking					
	Deformation/Buckling					
	Abnormal vibration					
	Loose connection					
	Paint peel off					
<input type="checkbox"/> Masonry	Fretting/Abrasion					
	Cracking					
	Material displace./loss					
	Bulging					
<input type="checkbox"/> Timber	Decay//Cracking					
	Disconnection/Displace.					

Type of Material	Type of Damage	Severity of Defect	Affected		Damage Rating	Attrib. Cond. State
			Unit	%		
MAIN MEMBER						
<input type="checkbox"/> Concrete	Cracking					
<input type="checkbox"/> RC	Spalling/Scaling/Disinteg.					
<input type="checkbox"/> Girder	Delamination					
<input type="checkbox"/> PC	Rebar exposure/corrosion					
<input type="checkbox"/> Girder	Honeycomb					
<input type="checkbox"/> Slab	Water leakage					
<input type="checkbox"/> Steel	Corrosion					
<input type="checkbox"/> Steel	Cracking					
<input type="checkbox"/> Girder	Deformation/Buckling					
<input type="checkbox"/> Steel	Abnormal vibration					
<input type="checkbox"/> Truss	Loose connection					
<input type="checkbox"/> Cable S.	Paint peel off					
<input type="checkbox"/>	Corrosion					
<input type="checkbox"/> Demount. (Bailey)	Loose connection					
	Deformation/Buckling					
<input type="checkbox"/> Masonry (Arch)	Fretting/Abrasion					
	Cracking					
	Material displacement/loss					
	Bulging					
<input type="checkbox"/> Timber	Decay/Splitting/Cracking					
	Disconnection/Displace.					
LEFT RAILING (LR) / RIGHT RAILING (RR)						
<input type="checkbox"/> LR <input type="checkbox"/> RR	<input type="checkbox"/> SM <input type="checkbox"/> OM					
<input type="checkbox"/> Concrete	Cracking					
	Delamination/Disinteg.					
	Impact/Accident damage					
	Rebar exposure/corrosion					
<input type="checkbox"/> Steel	Corrosion					
<input type="checkbox"/> Aluminum	Loose connection					
	Impact/Accident damage					
	Paint peel off					



REPUBLIC OF THE PHILIPPINES
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PIER ELEMENT - DAMAGE RATING

PIER No.	<input type="text"/>	(one set of forms for each pier)	Bridge ID	<input type="text"/>	Bridge Name	<input type="text"/>
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Type of Material	Type of Damage	Severity of Defect	Affected		Damage Rating	Attrib. Cond. State
			Unit	%		
MAIN STRUCTURE						
Concrete	Cracking					
	Spalling/Scaling/Disinteg.					
	Delamination					
	Rebar exposure/corrosion					
	Honeycomb					
	Tilt/Settlement					
Masonry	Fretting/Abrasion					
	Cracking					
	Material loss/displace.					
	Bulging					
	Tilt/Settlement					
Timber	Decay/Splitting/Cracking					
	Disconnection/Displace.					
	Tilt/Settlement					
BEARING/RESTRAINT						
Steel	Corrosion					
	Loose connection					
	Abnormal displacement					
	Paint deterioration					
	Bed (support) damage					
Rubber	Bulging					
	Abnormal displacement					
	Bed (support) damage					
SCOUR PROTECTION						
None						
Concret	Cracking					
Masonry	Material loss/disinteg.					
Riprap						
Gabion	Damage on containing wire					
Mattress	Material loss/disinteg.					
None						

Type of Material	Type of Damage	Severity of Defect	Affected		Damage Rating	Attrib. Cond. State
			Unit	%		
EXPANSION JOINT						
Seals	Water leakage					
	Abnormal space/noise					
	Difference in elevation					
	Displacement					
	Cracking					
Steel	Water leakage					
	Abnormal space/noise					
	Difference in elevation					
	Displacement					
	Cracking					
Rubber	Water leakage					
	Abnormal space/noise					
	Difference in elevation					
	Displacement					
	Rupture					
None						
FOUNDATION						
Concrete	Cracking					
	Spalling/Scaling/Disinteg.					
	Delamination					
	Rebar exposure/corrosion					
	Honeycomb					
	Tilt/Settlement					
Steel	Corrosion					
	Cracking					
	Deformation/Buckling					
	Tilt/Settlement					



REPUBLIC OF THE PHILIPPINES
DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS

ABUTMENT ELEMENT - DAMAGE RATING (1/2)

ABUTMENT No. (one set of forms for each abutment)

Bridge ID

Bridge Name

Type of Material	Type of Damage	Severity of Defect	Affected		Damage Rating	Attrib. Cond. State	Type of Material	Type of Damage	Severity of Defect	Affected		Damage Rating	Attrib. Cond. State
			Unit	%						Unit	%		
MAIN STRUCTURE							EXPANSION JOINT						
Concrete	Cracking						Seals	Water leakage					
	Spalling/Scaling/Disinteg.							Abnormal space/noise					
	Delamination							Difference in elevation					
	Rebar exposure/corrosion							Displacement					
	Honeycomb							Cracking					
Masonry	Tilt/Settlement						Steel	Water leakage					
	Fretting/Abrasion							Abnormal space/noise					
	Cracking							Difference in elevation					
	Deterioration							Displacement					
	Bulging							Cracking					
Timber	Tilt/Settlement						Rubber	Water leakage					
	Decay/Splitting/Cracking							Abnormal space/noise					
	Disconnection/Displace.							Difference in elevation					
	Tilt/Settlement						Displacement						
							Rupture						
SLOPE/BANK PROTECTION							FOUNDATION						
							None						
Concrete	Cracking						Concrete	Cracking					
Masonry	Bank erosion							Spalling/Scaling/Disinteg.					
Grouted	Slope erosion							Delamination					
Riprap	Material loss/disinteg.							Rebar exposure/corrosion					
Gabion	Damage on containing wire							Honeycomb					
Mattresses	Material loss/disinteg.						Tilt/Settlement						
	Bank erosion						Steel	Corrosion					
	Slope erosion							Cracking					
Steel	Corrosion					Deformation/Buckling							
Sheet Pile	Displacement/Deformation					Tilt/Settlement							
	Bank erosion												
	Slope erosion												
None													



REPUBLIC OF THE PHILIPPINES
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ABUTMENT ELEMENT - DAMAGE RATING (2/2)

ABUTMENT No. (one set of forms for each abutment)

Bridge ID Bridge Name

Type of Material	Type of Damage	Severity of Defect	Affected		Damage Rating	Attrib. Cond. State
			Unit	%		
BEARING/RESTRAINT						
Steel	Corrosion					
	Loose connection					
	Abnormal displacement					
	Paint deterioration					
	Bed (support) damage					
Rubber	Bulging					
	Abnormal displacement					
	Bed damage					
None						
LEFT WING WALL (LW) / RIGHT WING WALL (RW)						
			LW	RW		
Concrete	Cracking					
	Delamination/Disinteg.					
	Rebar exposure/corrosion					
Masonry	Corrosion					
	Loose connection					
	Deformation/Buckling					
	Paint peel off					
None						

Type of Material	Type of Damage	Severity of Defect	Affected		Damage Rating	Attrib. Cond. State
			Unit	%		
BRIDGE APPROACH						
Embankment	Material loss					
	Depression					
None						

Assessment of Bridge Approach will be limited to 6.0 meter length.



APPENDIX E

BRIDGE INSPECTION FORMS

Condition Inspection Form
Inventory Inspection Form



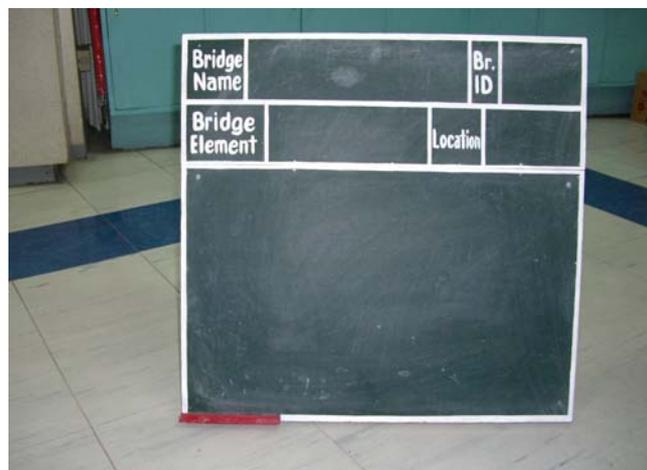
APPENDIX F

SAMPLE BRIDGE INSPECTION FORMS

Condition Inspection Form
Inventory Inspection Form



Blackboard (60 cm X 60 cm)





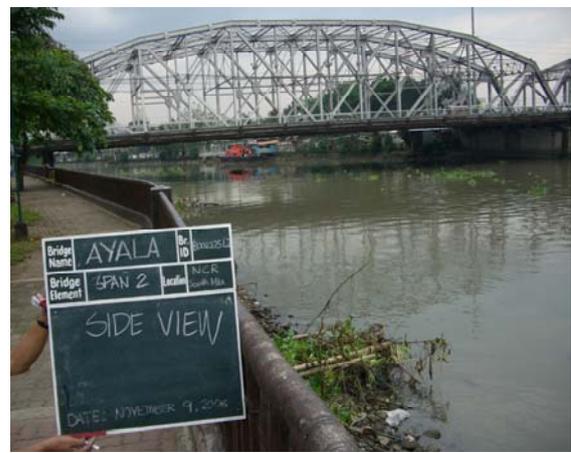
Entire View on Bridge



Front View



Side View



Side View



Damage Photo (Steel Bridge)

Gusset(Loose Connection)



Truss End Post (Corrosion)



Deck Slab(Rebar Exposure)



Deck Slab (Scaling)



Gusset (Corrosion)



Steel Expansion Joint (Abnormal Space)



Damage Photo (Steel Bridge)



Steel Bearing (Corrosion)



Steel Bearing (Painting Deterioration)



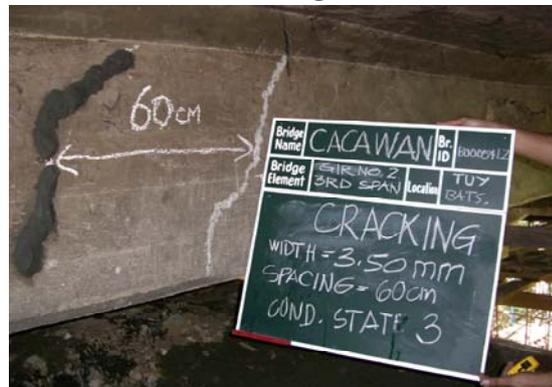


Damage Photo (Concrete Bridge)

Deck Slab (Cracking)



Girder (Cracking)



Concrete Slope protection (Cracking)



Expansion Joint Pourable Seals



Steel bearing (Bed Damage)



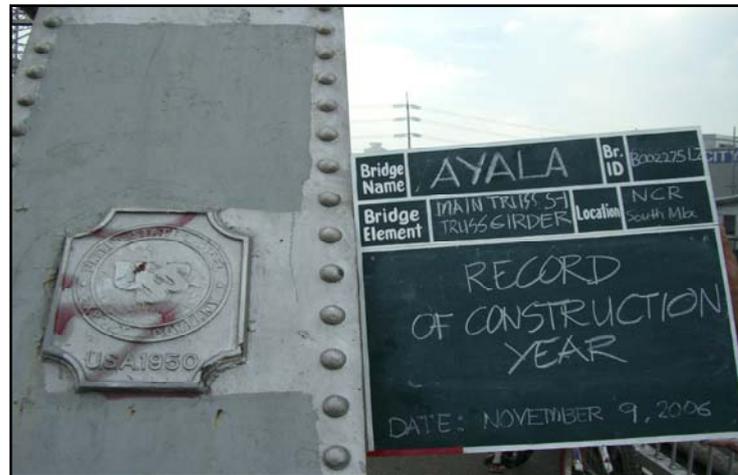
Foundation Concrete Pile (Scouring)





Other Information

Record Plate



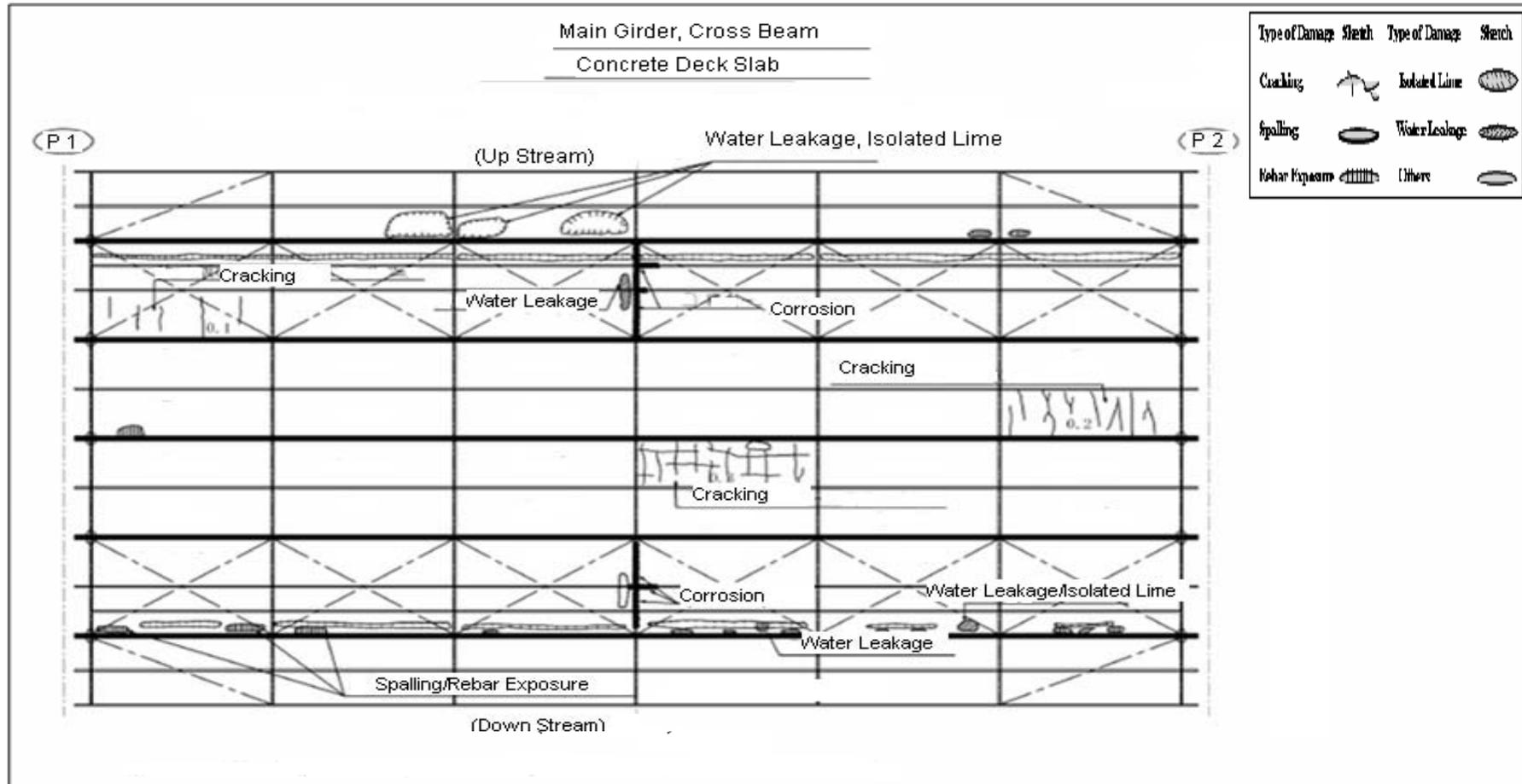


REPUBLIC OF THE PHILIPPINES
DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS

Bridge Name

Span No.

SKETCHES FOR DEFECTS



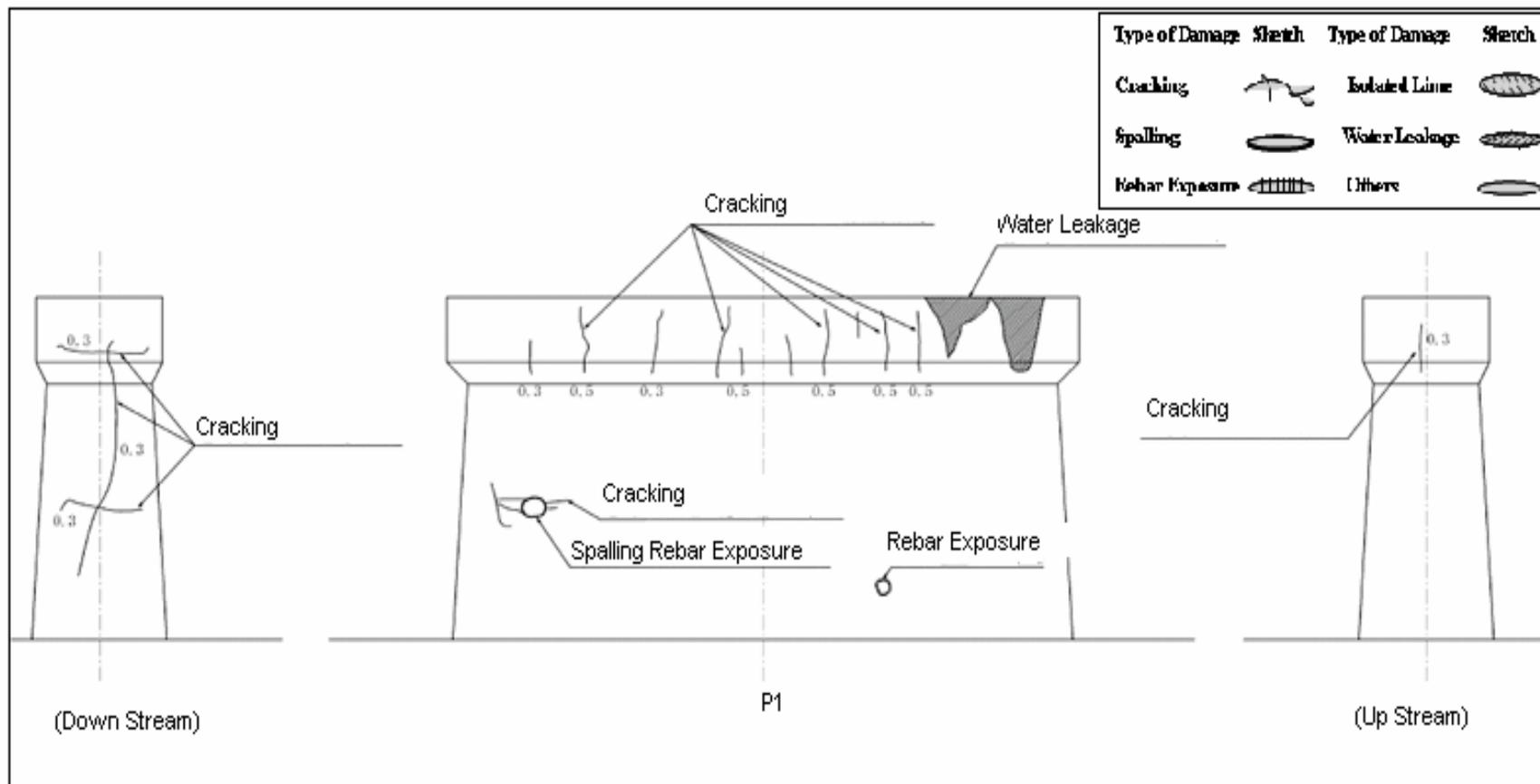


REPUBLIC OF THE PHILIPPINES
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Bridge Name

Pier No.

SKETCHES FOR DEFECTS





APPENDIX G

**SAMPLE INSPECTION PHOTOGRAPHS AND
SKETCHES**